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# SHORT-WAVE TIME TABLE

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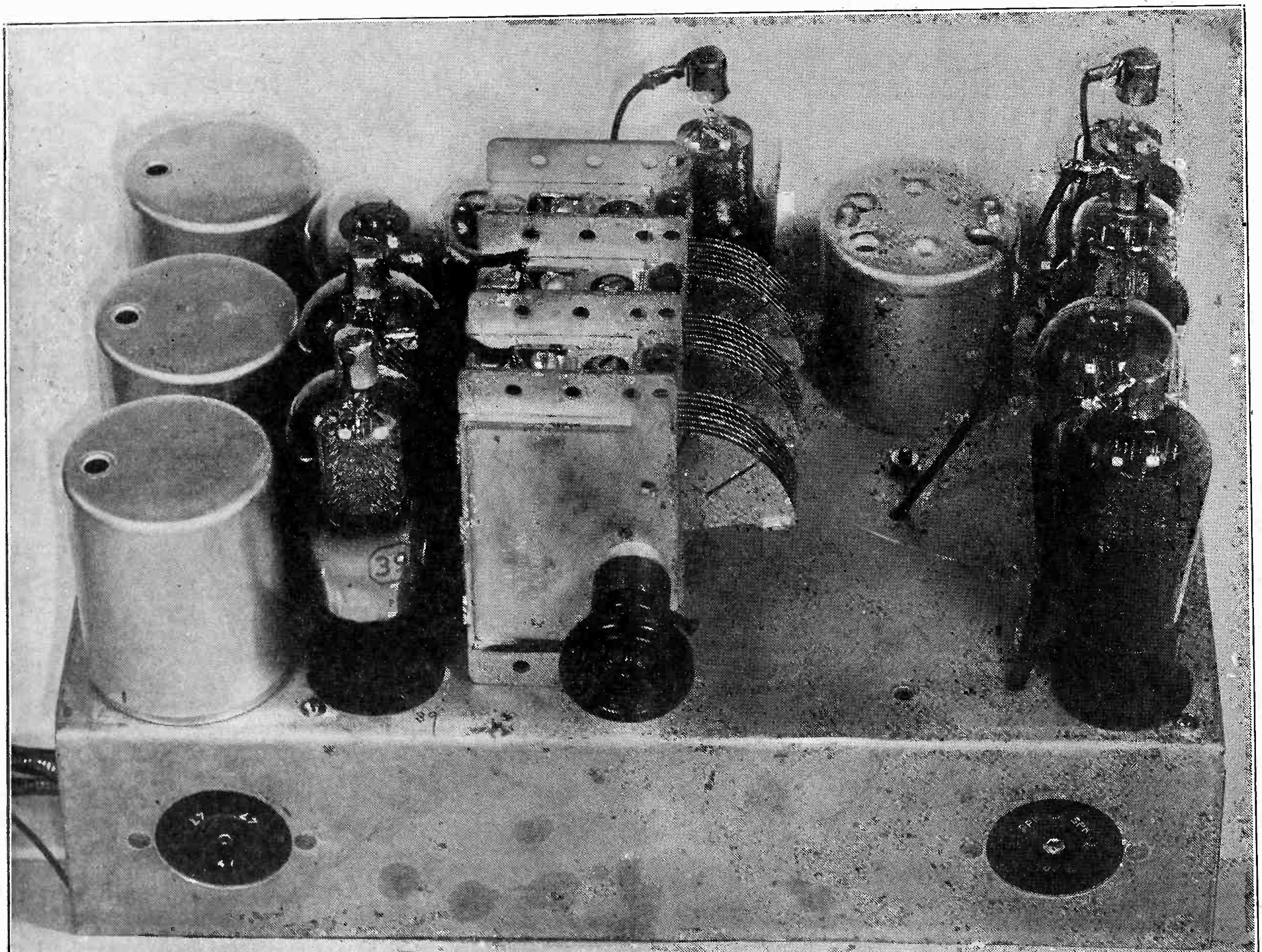
WORLD
The First and Only National Radio Weekly
*Eleventh Year* *558th Issue*

## New Use for Wave Trap to Eliminate Image Interference

## Radio Group Dissolved

## National Company's Short-Wave Circuits



J. E. Anderson's new auto super, with a-v-c. See page 10.

ROLAND BURKE HENNESSY
*Editor*

HERMAN BERNARD
*Managing Editor*

# RADIO WORLD

Reg. U. S. Pat. Off.

***The First and Only National Radio Weekly***
***ELEVENTH YEAR***

J. E. ANDERSON
*Technical Editor*

J. MURRAY BARRON
*Advertising Manager*

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# The National Co. Short-Wave Receivers

## *By James Millen, M. E.*

**General Manager, National Company**



INTERNATIONAL broadcasting has taken the short-wave receiver from the experimental laboratory and placed it in the parlor of the broadcast enthusiast. The repeated appearances of Ramsay Macdonald in England, Cosgrave in Ireland, Mussolini and the Pope in Rome before the international short-wave microphone, and the almost universal rebroadcast on long waves, have stimulated the interest of the average broadcast listener in the high frequency impulses that carry their voices across the oceans.

However, regardless of the possibilities of rebroadcast reception, there exists an admittedly greater fascination in receiving the voice of Senatore Marconi direct from HVJ, the Vatican City, Rome, Italy, than via the intermediary of a local station. And aside from the intriguing element of direct contact, it is occasionally possible to obtain better reception from a foreign short-wave station than from a semi-local rebroadcasting of the program. Also many interesting programs are being broadcast by domestic short-wave stations which may be received with consistent excellence, and the short-wave receiver thus contributes to the possible sources of radio entertainment. In rural communities, isolated from long-wave coverage, the short-wave receiver often provides the only reliable reception.

The short-wave receiver has definitely emerged from the laboratory. In simplicity, reliability, battery or light socket convenience, and appearance, it compares favorably with the conventional broadcast apparatus. It may take its place in the parlor with the long-wave receiver or in a "short-wave nook" where its offerings are reserved for the privileged ears of the real radio fans of the family.

### What Are Short Waves?

The expression "short-waves," offhand, is self-explanatory, but on further thought requires qualification. After all, the term is relative. Two hundred meters was a short wavelength ten years ago. Today one hundred meters is hardly among the conventional short-wave bands which, in general parlance, include the wavelengths between ten and sixty meters. The larger part of short-wave communication is carried on at present between fourteen and fifty-four meters, but successful experimental work has established two-way communication over short distances on wavelengths fifty centimeters long!

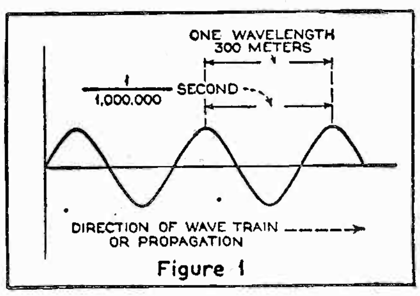



**FIG. 1**

**Graphical representation of wavelength and frequency. Wavelength is shown as distance in meters measured from crest to crest and equals velocity divided by frequency. So frequency equals wavelength divided by velocity.**

### Wavelength and Frequency

Wavelength is a physical conception by means of which we represent how a radio signal travels from the transmitting station to your receiver. A "wave form" is assumed, because a highly refined recording instrument placed anywhere within the influence of the signal would show a wavy line on the recording paper or tape. Such an instrument would show that the signal, starting at zero, would attain a certain maximum positive strength, then slowly decrease to zero again, to build up on the negative side to a similar maximum, again dropping to zero to recommence the "cycle." This cycle occupies a certain definite time, which can be measured directly and indirectly. Also, radio waves travel from the transmitting antenna to the receiving antenna with a speed that has been definitely established at about 300,000,000 meters a **second.**

Now if a railroad train, or any other object, travels at a known speed past a given point in a known time, the length of that object can be determined by multiplying the speed of the train (let us say) by the time interval. This relationship in reference to a wave "train," is shown in Fig. 1. The time element in this case happens to be one-millionth of a second, and the wavelength is therefore 300,000,000/1,000,000=300 meters. If the time consumed by one cycle is one millionth of a second the frequency with which that cycle will repeat itself is one million times in one second, and we can speak of the frequency of 300 meters as one million cycles.

The relationship is more simply expressed in the equations:

$$F = \frac{V}{\lambda} \text{ and } \lambda = \frac{V}{F}$$

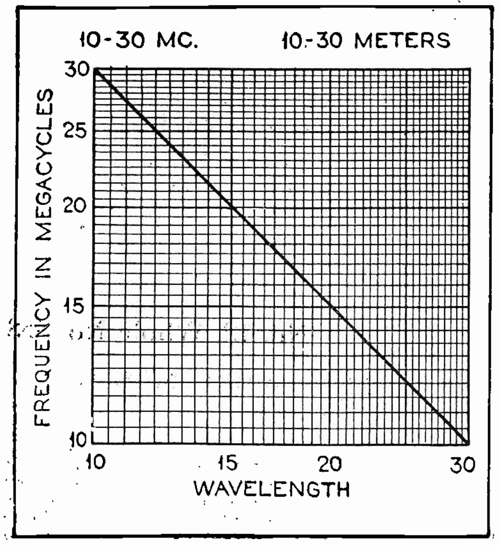
where F is the frequency in cycles per second, V the velocity of propagation or 300,000,000 meters per second and λ the wavelength in meters.

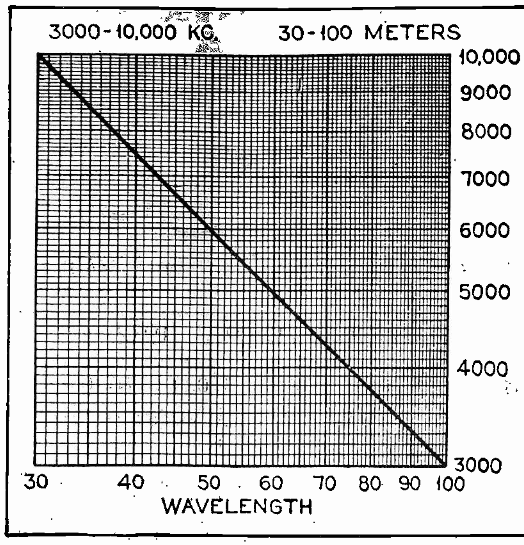
Thus, if we know either the wavelength or frequency we can always compute the other quantity by means of one of the two equations.

### Cycles, Kilocycles and Megacycles

For scientific purposes it is often more desirable to work with frequencies rather than with their corresponding wavelengths, principally because, regardless of wavelength, a certain definite frequency band is considered necessary for the transmission of radio telephone signals utilizing the systems employed today. This band is 10,000 cycles wide. That is, if a broadcasting station is transmitting on 300 meters, or one million cycles, it will occupy a band extending 5000 cycles on each side of the carrier frequency of one million cycles—i.e., between 995,000 and 1,-

*(Continued on next page)*




**Wavelength-frequency conversion graphs. These may be used for higher wavelengths (lower frequencies) by merely shifting the decimal point. Use of these graphs will yield approximate results, sufficiently accurate for frequency location in tuning. The numerical conversion table, frequency to wavelength or wavelength to frequency, is printed on page 20 in its most accurate form.**

(*Continued from preceding page*)
005,000 cycles. In order that no other station can overlap or interfere, the carrier of a second station must not be within 10,000 cycles of the carrier of the first station.

Due to the existence of this desirable frequency band, a broadcasting station operating on a fundamental of 300 meters will spread over a wave range of about three meters, and at 600 meters about twelve meters.

In other words, the amount of space required by a broadcasting station, in wavelength spread, varies with the wavelength, becoming greater as the wavelength increases. But the frequency band of ten thousand cycles remains constant. Hence, it is more convenient to compute many radio calculations in terms of frequency rather than those of wavelength.

Long wavelengths are low frequencies; short wavelengths are high frequencies. When frequencies become very high, it is less clumsy to group them into thousands of cycles—the kilocycles or kc.—and into millions of cycles—the megacycle or mc.

A wavelength of ten meters is equivalent to a frequency of 30,000,000 cycles, or 30,000 kilocycles or 30 megacycles.

Let us try to think in terms of frequency rather than wavelengths. If at first you are somewhat confused, you may readily translate frequency into wavelength by means of computation, or the conversion chart shown in Fig. 2.

## Characteristics of Short Waves

One of the principal advantages of short-wave communication lies in the multiplicity of available radio channels as contrasted to the congested conditions existing above 200 meters.

The frequency corresponding to ten meters is, as we have shown, 30,000 kc. Between this frequency and that of 1500 kc., corresponding to 200 meters, there exists a 28,500 kc. band of usable frequencies. Dividing this by 10 (10,000 cycles, the recommended band for a broadcasting station) we find that 2850 broadcasting stations, within interfering power-distances, could be accommodated without interfering with each other on a well-designed receiver. Between 200 meters and 600 meters, there is room for only 1000 similar stations.

High frequencies are characterized by an uncanny carrying power, low powers on low wavelengths transmitting over distances that could be spanned on long wavelenoths only by the expenditure of hundreds of times the same power.

Short-wave signals suffer from peculiar fading and absorption effects from which long-wave signals are relatively free. The most unusual of these is perhaps the so-called "skip-distance" effect. For instance, the direct wave from a fifty-watt transmitter operating on 7500 kc may be so attenuated at a receiving station five hundred miles away, by absorption or deflection due to terrestrial conditions, that the signal is entirely lost. However, another portion of the signal, traveling more directly upwards, collides with the somewhat problematical Kennelly-Heaviside layer—a stratum of ionized gases high above the earth's atmosphere—and is reflected to the earth thousands of miles away from the transmitter. Thus a receiver in Australia might hear a transmitter in New York City, the signal from which is inaudible in New Orlaens or Panama.

The tricks played by high frequencies vary with atmospheric conditions, the time of day and the frequency employed. But it is almost always possible, by making a shift in frequency, to pick out a short wavelength satisfactory for the communication desired. For instance, for consistent trans-oceanic telephone communication, three frequencies, approximating 20, 15 and 10 megacycles, are always available. During the day, the 20-megacycle frequency is generally used, propagation being shifted to 15 mc in the evening and to 10 at night.

The greatest distances will be received on the three principal bands in accordance with the table given below:

22 to 14 mc daytime.
14 to 10 mc morning and evening twilight.
10 to 2 mc night.

## Short-Wave Telephone Stations

Only a small percentage of the available short-wave frequencies is given over to telephone transmission, but the actual number of such stations in regular operation exceeds the number of broadcasting stations in the United States. The average short-wave receiver will pick up several times as many telephone stations as the average broadcast receiver.

Shortwave telephone services may be divided into six classes—broadcast, television sound accompaniment, amateur, trans-oceanic, commercial, police radio and airplane. The broadcast stations are generally given over to the simultaneous transmission of long-wave programs and are operated in conjunction with a long-wave station. For instance, W2XAD is a short-wave channel of WGY, Schenectady, N. Y., U. S. A. The following are the international frequency allocations for short-wave broadcasting:

| | |
|---|---|
| 6000-6150 kc. | (50-48.9 meters). |
| 9500-9600 kc. | (31.6-31.2 meters). |
| 11,700-11,900 kc. | (25.6-25.2 meters). |
| 15,100-15,350 kc. | (19.85-19.55 meters) |
| 17,750-17,800 kc. | (16.9-16.85 meters). |

Many of the amateur phone stations will be found on the 3,500-4,000 kc and 14,000-14,400 kc bands with the preponderance of traffic being handled on the 3,500-4,000 kc channel. While it would be stretching the point somewhat to say that amateur radio telephone conversations are entertaining, they are occasionally interesting.

Commercial transoceanic telephony is generally conducted on the three fixed service bands from 17,800-21,450 kc, 15,-350-16,400 kc and 9,600-11,000 kc. These conversations are generally "inverted"—that is, intentionally garbled so that they sound to the casual listener like Chinese. However, by beating the signal (permitting the receiver to squeal) at the correct frequency, it is sometimes possible to render inverted speech intelligible. The conversation between the technical operators is often carried on without garbling. On the occasions when commercial traffic is transmitted clearly, listening-in is quite as edifying as eavesdropping on a party wire.

## Airplane Traffic

Practically all airplane telephone traffic is handled on the 4,000-5,500 kc band, including point-to-point flying field and mobile services. This is often fascinating, always interesting, and some very reliable weather reports may be picked up from local airmail terminals. Police alarm stations, broadcasting to cruising squad cars, are shown in the call lists on page 19.

Four sets of coils are generally required to cover the short wave spectrum in which we are interested—22 to 13 mc, 14 to 7 mc, 8 to 4 mc, and 5 to 2 mc.

An easily acquired knack of tuning contributes an artistry to short-wave reception which is lacking on the broadcast band. The variation in technique may be attributed to the fact that the short-wave receiver is generally tuned with the circuit oscillating—i.e., with the regenerative control so adjusted that a whistle is heard each time a carrier frequency is crossed. (Most of these whistles will be broken up into the characteristic dots and dashes of the code transmitter.) The highest type of short-wave receiver has four controls—the main tuning control, the regeneration or oscillation control, a volume control, and the trimmer. These controls are much more closely interlocked than the comparable knobs on the broadcast receiver, and a variation of one of them may alter the wavelength to which the receiver is tuned.

In tuning, the regenerative control should be maintained just beyond the oscllation point. When the circuit is oscillating a distinct hiss is audible in the 'phones or speaker, the background noise is considerably intensified and a whistle will be heard whenever a carrier frequency is encountered. At the correct tuning point—with the circuit just oscillating—the background noise and signal response will be at a maximum. In other words the receiver is at its most sensitive adjustment. To maintain this condition while tuning, it will be usually necessary to vary the regeneration control for every ten degrees or so on the tuning dial. When a telephone carrier is crossed, readily identified by the steady whistle and generally modulated by voice or music, reduce the regeneration (retuning slightly with each variation in the regenerative control) until the circuit is no longer oscillating and the carrier is clear. A faint "swish" will now locate the carrier (if unmodulated) as the tuning dial receives its final adjustment.

## Zero Beat

In some instances of very weak signals, it is desirable to "zero beat" the carrier, rather than stop oscillations. As the carrier is approached with an oscillating receiver, the pitch of the whistle becomes lower, vanishing at zero beat—the exact resonance or tuning point—trailing off again into a squeal on the other side. Occasional stations are best received at zero beat with the circuit just oscillating. In achieving this adjustment a slight body capacity effect may make it necessary to tune slightly to one side of zero beat, the beat becoming zero when the hand is removed from the tuning control.

It will often be interesting to log the stations, and the author suggests ruling off a sheet of paper to accommodate the following observations:

Date, Time, Coil, Dial, Frequency, Call Letters, Language, Remarks.

The station may be logged in local time, but in corresponding with the station for verification of transmission, the hour should be given in G. M. T.—which is Eastern Standard Time plus five hours. Conversion can be readily made by means of the time chart on page 8.

Harmonics of long-wave broadcasting stations may fool you at first. However, such spurious short-wave signals can generally be identified by their position in reference to international allocations and the very mushy quality of speech. Local short-wave stations may be recognized without waiting for the quarter hourly signature by checking for simultaneous broadcasts on the long waves, though this is not altogether reliable in these days of chain broadcasts.

## Receiver Differences

A foreign language does not necessarily place a station beyond the confines of the U. S. A. The babel from W9XAA has been responsible for many fantastic tales of dx fish. But a station failing to sign at quarter hour periods may be tentatively logged as a foreigner.

The principal differences between the present receiver and its immediate predecessor, the SW-45, are best explained by reference to the wiring diagrams, Figs. 6 and 7, respectively the ACSW-58 and the DCSW-34. These are the substitution of the type 58 pentodes in the r-f and detector circuits ('34's in the d-c model), the provision for radio-frequency gain control and the radio-frequency filter in the plate circuit of the detector.

The new tubes, as intimated, have contributed in no small way to the high ef-

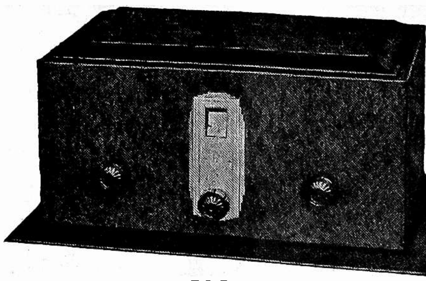


**FIG. 3**
**Front view of cabinet of the former model short-wave receivers for a-c or battery operation.**

ficiency of this circuit. The high amplification factor, transconductance and, above all, high plate impedance, enable the designer to achieve a degree of selectivity and sensitivity that have heretofore been little more than experimental ideals. The use of these tubes naturally necessitated the redesign of the plug-in radio-frequency inductors. The coils, T1 and T2, are wound on the low-loss R-39 material and are available in various sets, covering from 12 to 2000 meters, and band-spread coils can be obtained for special portions of the frequency spectrum.

## Control of Volume

It has heretofore been considered that the simple regeneration control in the detector circuit provided adequate overall volume control. Such an arrangement, however, results in several forms of distortion. The radio-frequency tube is necessarily operating at maximum amplification at all times, resulting in considerable overload of both that tube and the detector on strong signals. Backing up the regeneration control to reduce the signal strength results in additional distortion, due to the fact that the detector tube is then being operated with decreased plate or screen voltage. The obvious solution is to employ a second control operating at the input to the r.f. stage.

Under actual reception conditions, this additional control contributes several other advantages. The detector may always be operated on that portion of its characteristic at which best rectification is obtained, with a resulting improvement in tone quality and detecting efficiency. The receiver may also be operated in the condition of maximum selectivity by setting the regeneration control close to the point of oscillation and controlling volume altogether at the r.f. input. This latter feature is of particular utility in bringing in a foreign station having a frequency allocation close to that of a powerful local.

## Plate Circuit Filter

The radio-frequency filter in the detector plate circuit is the result of careful study of the problem. Few experimenters seem to realize the difficulties encountered when excessive r.f. is permitted to invade the audio-frequency circuits. The most noticeable characteristic of such a condition is the presence of hand-capacity effects on all parts of the a-f. system, including the headphones and loudspeaker leads as well as the metal cabinet. Another symptom is the exasperating fringe howl as the detector approaches oscillation. A sticky regeneration control—an apparently excessive amount of lost motion—is directly traceable in many cases to inadequate filtering in the detector output circuit.

The use of a detector tube having a high plate impedance precludes the employment of a fairly large by-pass condenser, which would necessarily attenuate the higher audio frequencies, resulting in muffled tone quality and even unintelligibility of speech. The matter resolves itself into the familiar high radio-frequency problem of an efficient r-f choke design. The inductance of the choke used is only 2½ millihenries, but what is more important, the distributed capacity has been reduced to 1 mmfd.

## Undesirable Coupling Eliminated

The remainder of the circuit is fairly conventional, and the important values are given in Figs. 6 and 7. Several electrical details, however, are worthy of special emphasis in reference to the general shielding and the design of the ganged tuning condensers.

It has been found that in the design of a single-control high-frequency receiver additional precautions must be taken to avoid coupling between the input and output circuits of the r-f. stage. Passing over the usual methods of circuit isolation, we come to a point which is often overlooked. This is the coupling through those portions of the tuned circuits which happen to be common in parts of the gang condenser frame. While the paths involved are very short, an inch or so represents an appreciable part of the total conductor length at frequencies above 15 megacycles, and is sufficient to cause instability and circuit interlocking.

To overcome this trouble, a special tuning condenser was developed, in which both rotors are entirely insulated from the condenser frame and from each other. This design makes it possible to isolate completely the input and output circuits of the radio-frequency stage, resulting in a perfectly stable system even at the highest frequencies to which the receiver will tune.

Plug-in coils are used in both the a-c and d-c models in preference to switching arrangements which necessarily introduce losses and concommitant complications inimicable to the highest efficiency in short-wave reception.

## Separate Power Pack Used

The direct current model differs from the ACSW-58 principally in the tubes em-

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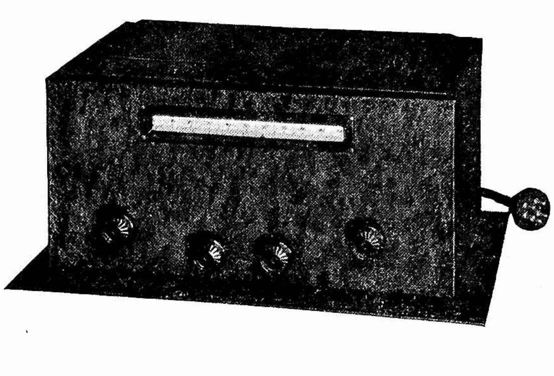
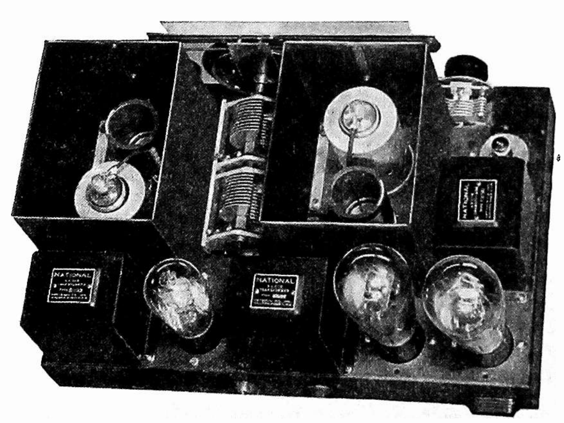


**FIG. 4**
**Front view of the Thrill Box in new form, using latest tubes and having full-vision dial.**
**FIG. 5**
**The top view of the a-c receiver. The push-pull 245's are at right.**



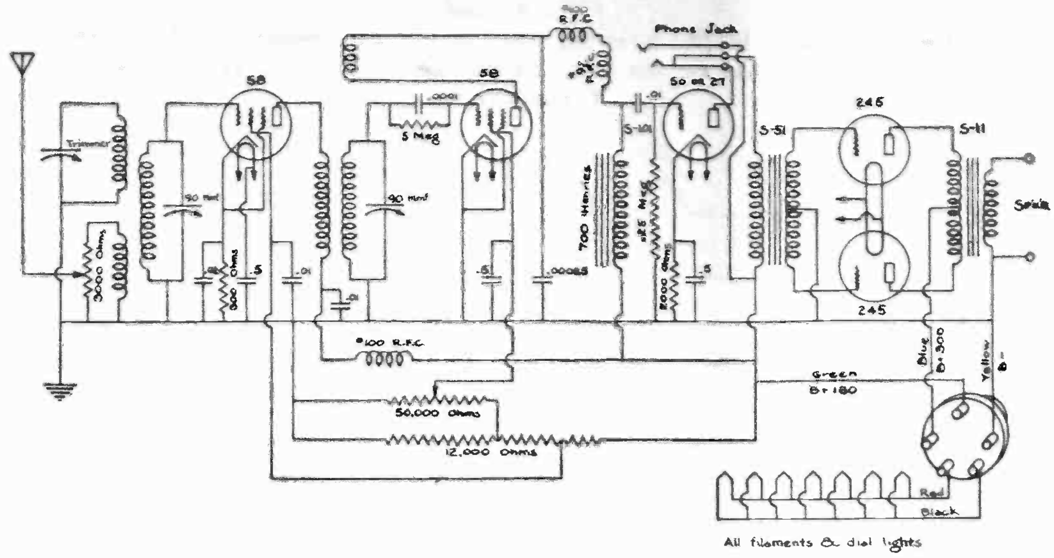



**FIG. 6**
**The circuit diagram of the new model a-c short-wave receiver, the ACSW-58, with connections to power supply. It is important that the voltages are correct (B + 300, B + 180). The 3000-ohm potentiometer is a selectivity and input control, while the trimmer is for close resonating, requiring resetting for each coil set only. The detector plate chokes have unusually low distributed capacity.**

*(Continued from preceding page)*
ployed. The general efficiency and operation are the same.

Despite the increasing tendency toward unitary design with built-in power supply, the receiver under consideration is constructed for use with a separate power pack. Single unit construction necessitates a large amount of shielding in the r-f and detector circuits for the elimination of hum, and this excessive shielding, in order to be effective, must be of a different nature than that which amply fulfills the r-f isolation requirements. Shielding, at best, is a costly nuisance which tends to offset the increased efficiency attained through the use of low-loss insulation and careful design. These considerations strongly recommend the use of the separate unit with a high-frequency receiver, limiting the shielding to radio-frequency fields.

The mechanical details of the receiver are fairly obvious from the accompanying photographs. Rigidity in the radio-frequency circuits is obtained through the judicious use of Isolantite and R-39 supports and mountings. In the design of the dial, consideration was given to the concensus of opinion among several hundred amateurs and experimenters who favored a full vision or open scale arrangement. The dial has a scale seven inches long, insuring accuracy in reading. The pointer moves horizontally across the entire length in a linear relationship to the tuning control.

# Installation and Operation

The importance of a good short-wave antenna cannot be overstated if the full possibilities of enjoyable reception are to be realized. Commercial companies have spent millions of dollars in the development of suitable short-wave aerial systems, while the average short-wave experimenter is content with a shoddy installation which experience has taught him works fairly well on his broadcast receiver.

Because an antenna is effective on the lower broadcast frequencies, it does not follow that it is a satisfactory short wave aerial. Induced currents, man-made static and leakage effects which would not be annoying on 300 meters, will seriously impair reception at 30 meters. The peculiar carrying power of the very high frequencies, which makes short-wave reception possible on almost any kind of an antenna is responsible for the slipshod aerial systems, which, in turn, are largely responsible for noisy reception and a retarded acceptance of short wave reception on the part of the average radio fan.

Wherever choice is possible the short-wave receiving station should be located away from power lines, electrically operated machinery of any kind and isolated, as far as practical, from roads carrying automobile traffic and monitored by traffic lights.

### Aerial Advice

While the antenna should be carefully installed, it need not be in any way elaborate. A single horizontal wire, T or L type, twenty-five to fifty feet in length will provide ample pick-up. If possible, the antenna should be erected in the open, and as high as practical. It should be well insulated, at each end, and of fairly heavy wire—say number 14, insulated or bare. It should be erected as far away as circumstances will permit from possible sources of noise interference, and should not parallel power lines. It should preferably run at right angles to the nearest road. It should be clear of tree branches in the strongest wind.

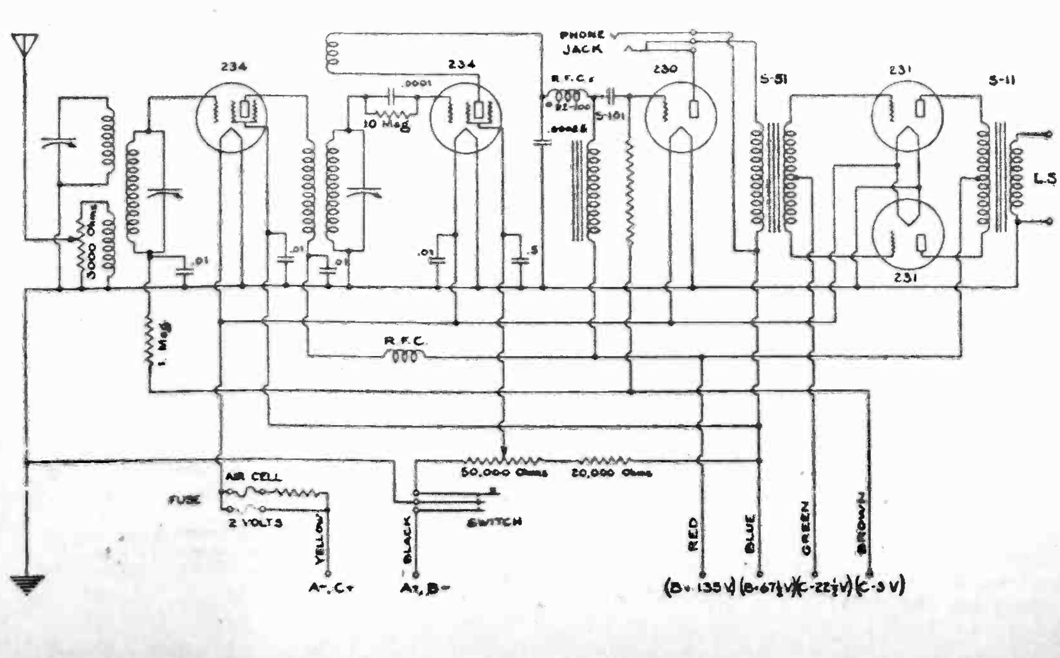
The leadin should be well supported, thoroughly insulated, and should be brought indoors through a leadin insulator not of the window strip variety. The lightning arrestor should be of the highest quality. Any joints in the antenna system—aerial, leadin and ground—should be soldered. It is particularly important that the leadin be kept as far away as possible from power lines, elevator shafts and electrical machines of all descriptions.

Equal care and attention should be directed to the ground connection. Where several possible grounds are available, they should be tried individually and in groups for the least noisy connection. The ground leads should be soldered to the clamps and the clamps themselves soldered to the pipes.

### Transposed Leadins

Indoor antennas are very effective, but obviously it is seldom possible to erect them as far away from interference inducing sources as an outdoor antenna. The indoor antenna is really nothing more than "leadin"—and it is appreciated that the ordinary leadin will pick-up noise. The main idea of the outdoor antenna is to obtain a noise free pick-up so that the signal to noise ratio will be improved. If an indoor antenna is erected, the same precautions as to rigidity, insulation and preferred location should be observed.

**FIG. 7**
**The d-c model, circuit of which is shown herewith, requires batteries for the filaments of the '34, '30 and '31 tubes, but the B voltage may be supplied either by batteries or by an a-c B supply. The same fundamental circuit is used as in the a-c model. The d-c model is the DCSW-34. Note the isolation of the r-f from the C biasing battery applied to the radio frequency stage. An Air-Cell A battery may be used (2 volts), with small limiting resistor (fuse at upper position) or a storage battery**



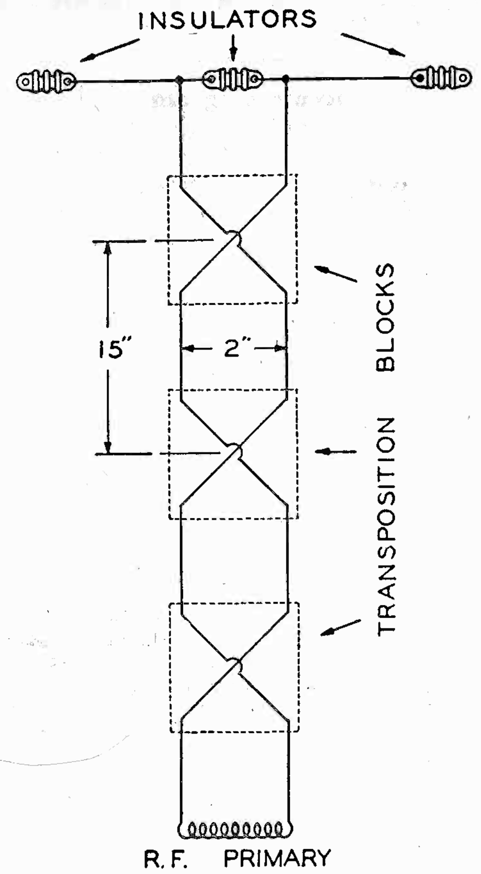
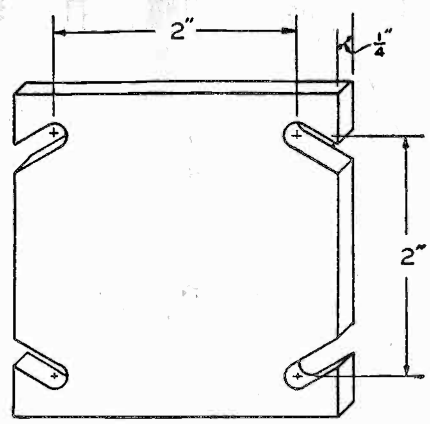



**FIG. 8 (Left)**
**The transposed leadin system, used for noise reduction. The aerial is separated at the center and the double leadin is brought down by transposition.**



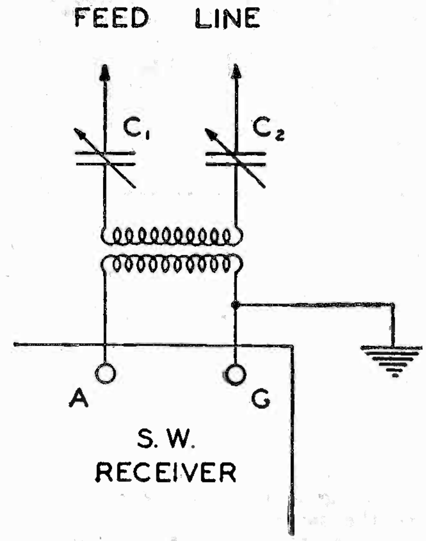




**FIG. 9 (Left)**
**A rubber or bakelite slab may be used for making a transposition block. For instance, in the Fig. 8 requirement three such blocks would be used.**

**FIG. 10 (Right)**
**If a ground is essential, transposed leadins may be used with this coupler system.**

Under no circumstances use any form of "patented" aerial tacked to the walls, under rugs, or socket type antennas and expect satisfactory short-wave results.

As mentioned above, with a properly located outdoor antenna, most of the noise is picked up by the leadin. With a special leadin, it is possible to reduce the noise pick-up considerably, thereby taking full advantage of the antenna pick-up. Such an arrangement is shown in Fig. 8. It will be observed that the aerial itself has been broken in the middle, and two leadins brought down, which are "transposed," or crossed, every fifteen inches by special blocks. These blocks which are from 2 to 2½ inches square, can be made from bakelite, by notching, as shown in Fig. 9.

The two leadins are connected to the antenna and ground posts of your receiver. No ground is used. If the receiver is unstable or hums without the ground, the ground may be connected providing the lead from the antenna primary, which connects to ground, is broken and connected directly to one of the leadins. An alternative circuit is shown in Fig. 7, whereby a special coupler is employed between the transposed leadins and the receiver. This coupler can be wound with ten turns of number 18 enameled wire on National R-39 standard coil forms. The two windings are close wound, and spaced ½ inch from each other. Condensers C1 and C2 are 30 to 60 mmf. midgets. Further details on transposed leadins can be obtained from the Lynch Manufacturing Company, 1775 Broadway, New York City, who are manufacturers of transposition blocks, antennae insulators and antenna couplers especially designed for short-wave reception.

## Installation

The receiver itself should be located as far as possible from any interference source such as elevators, electric fans, etc.

The ACSW-58 must be operated with a power supply furnishing the exact potentials shown in Fig. 6 under the indicated loads. This receiver is designed to operate in conjunction with the National 5880 ABS power unit, to which all connections are made by means of the single plug on the end of the receiver power cable. If an adequate power supply other than the National 5880 ABS is available, the plug should be removed from the cable, and the connections made in accordance with the following color code:

| *Wire Color* | *Connect to—* |
|---|---|
| Red or Black | 2½ volts A.C.* |
| Yellow | B— |
| Green | B+180 |
| Blue | B+300 |

It is strongly recommended that the National power unit be employed, due to ease of connection, reliability of operation and the elimination of any adjustment or experimentation.

## The D-C Model

The DCSW-34 should be connected to the various voltage sources indicated in the diagram, Fig. 7, and on the leads of the connection cable. The most convenient "A" battery is the Everready Air Cell, which will provide one year of average operation. If another source of filament potential is used, such as a storage battery or dry cells, a rheostat should be provided to maintain two volts at the set terminals.

The "C" potentials are preferably obtained from the usual batteries. Either "B" batteries or an eliminator may be employed as the high potential source. The National Velvet-B Type 3580 is recommended as a reliable and economical power unit for use in conjunction with the DCSW-34.

All connections should be thoroughly tightened. Pliers are preferable to fingers in making a permanent installation.

Antenna, ground and loudspeaker or output binding-posts are plainly marked. Telephone receivers are plugged into the jack, behind the set, by means of the conventional plug. When telephone receivers are used, the power amplifying stage and loudspeaker are automatically disconnected.

## Tubes

Satisfactory short-wave reception is impossible without perfect tubes. Tubes that will "play" on a broadcast receiver may be altogether unsatisfactory on the higher frequencies. Poor tubes may result in noisy reception, erratic volume and regeneration control, fringe howl and exceedingly bad microphonic conditions. By microphonics, we refer to the ringing sound occasioned by tapping the table or cabinet. A distant foot step may give rise to this trouble if other than perfect tubes are used.

Spare tubes—a duplicate of each tube in the receiver—should be maintained at hand. Do not experiment with "bootleg" tubes. Only the products of the most reputable manufacturers are recommended for use in all National "Thrill Boxes."

The a-c model, type ACSW-58, requires two type 58 variable mu pentodes in the radio frequency and detector stages, a type 56 or 27 in the first audio socket and two type '45 tubes in the push-pull power stage. The d-c model, DCSW-34, employs two type 34 variable mu screen grid tubes in the r-f and detector sockets, a type 30 first audio and two type 31 output tubes. The tubes required are plainly engraved on the sockets.

## Coils

Five sets of coils are furnished with each SW-58 and SW-34, two coils to a set, and covering wavelengths from 13.5 to 200 meters. One coil of each set is plugged into the r-f circuit (left-hand coil socket) and one coil into the detector coil socket. The two coils of each set are identical, and the wave bands they cover are indicated on the chart on the cover of the receiver. The coils for the a-c receiver are designed by numbers only, beginning with the number 60 and increasing with wavelength. The d-c coils may be identified by number—from 10 to 21 increasing with wavelength—and by the color strip molded into the top ring. The wavelength of the coils increases with the number of turns of wire.

Coils can be had extending the wavelengths of the receivers as high as 2000 meters and the coils forms are available for the home winding of special inductors.

Amateur bandspread coils may be ob-

(*Continued on next page*)

*The 2½-volt circuit center type must not be grounded directly, but is connected to B— (ground) through a 750-ohm, 10-watt resister, for biasing the 245 tubes.

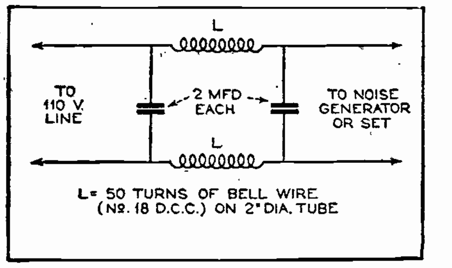



**FIG. 11**

**A filter for reducing noises picked up from the power lines (not needed when the official Power Unit is used).**

TIME AND DAY CONVERSION TABLE

| Longitude | | Place | | | | | | TODAY | | | | | | | | | | | | | TOMORROW | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EAST | 180 | Fiji Islands | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | 165 | New Zealand (*) | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | 150 | Australia, east | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 135 | Japan | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | 120 | China, Philippines | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | 105 | Indo China, Straits Settlements | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| | 90 | Calcutta (**) | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 |
| | 75 | | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 |
| | 60 | Mauritius, Seychelles | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 |
| | 45 | Aden, Somaliland, Madagascar | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 |
| | 30 | South Africa | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 |
| | 15 | Germany, Italy, Norway, Sweden | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 |
| | 0 | England, France, G.M.T. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| | 15 | | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | 30 | | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| | 45 | Brazil, east | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | 60 | Agentina, Porto Rico | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| | 75 | Washington, D. C., E.S.T. | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| | 90 | Chicago, C.S.T. | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | 105 | Denver, M.S.T. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| | 120 | San Francisco, P.S.T. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | 135 | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | 150 | Alaska | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | 165 | Samoa, Hawaii (***) | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| WEST | 180 | | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | | | | | | | YESTERDAY | | | | | | | | | | | | | TODAY | | | | | | |

NOTES:—(*) Add one-half hour for New Zealand Time.
(**) Calcutta local time Subtract one-half hour for India Standard Time.
(***) Subtract one-half hour for Hawaiian Standard Time.

NOTES:—0 is midnight, 1 is 1.00 A.M., etc. 12 is noon, 13 is 1.00 P.M., 15 is 3.00 P.M., etc.
Read the figure columns vertically, thus:—when it is 12, noon on Monday in New York E.S.T., it is 3.00 A.M. on Tuesday in Melbourne, Australia.
Or again; 11.00 P.M. on Sunday in San Francisco is 6.30 P.M. on Monday in New Zealand and 5.00 P.M. in Australia.
The hours of darkness—6 P.M. to 6 A.M. are shaded

**FIG. 12**

**Conversion table covering time and also the day in reference to the points of reception and transmission. The datum is EST time in New York, the converted time is Greenwich Meridian Time.**

(*Continued from preceding page*)

tained which spread the amateur bands over 50 dial divisions. No changes in the receiver are necessary, and these coils are recommended to the experimenter interested in amateur reception. The windings of the bandspread coils can, of course, be changed to provide similar spreading over any narrow portion of the short-wave spectrum.

### Choice of Correct Coils

Choose a set of coils covering the wavelength to which you wish to listen—making sure that the two coils used are from the same set. The process of choosing the correct coils for any station is very simple and becomes automatic after a few hours of experimental short-wave reception. First translate your local time into Eastern Standard Time, by means of the time chart, Fig. 12. Then refer to the call list on pages 18 and 19 and select a station broadcasting at that time.

For a start a station fairly close by is preferable. Note the wavelength and choose the coils covering that band as indicated on the same line with the station call letters. The correct coils are also indicated on the tuning curve on the inside cover of the receiver. Where due to overlapping, the wave desired can be tuned on two sets of coils, choose the higher wavelength coil.

If desired the 40 to 70 meter band coils may be chosen—No. 63 for the ACSW-58 and No. 13 (white band) for the DCSW-34—and the receiver tuned at random (but very carefully and slowly) with the certainty of running across several good stations.

### Tuning

The functions of the various controls have been indicated in the general discussion of the SW-58 and 34. From left to right they are the antenna trimmer, r-f volume control, tuning control and regeneration. The trimmer provides the most efficient lining-up between the antenna circuit and radio-frequency stage. It is not critical, requires little adjustment, and once set for the coils used, need be touched only for very weak stations. The r-f volume control increases clockwise and functions exactly as does the volume control on the conventional broadcast receiver. The tuning control is the familiar station selector. The regeneration control increases clockwise and also operates as a volume control, while performing additional function of throwing the circuit into oscillation which simplifies the location of stations and makes possible the reception of continuous wave code transmitters. (The circuit should go in and out of oscillation smoothly—without howling. If not, check as indicated under "Trouble Shooting.")

### Picking Out a Station

For a start, it will be best to turn the r-f volume control up full, and adjust the trimmer, by visual inspection, until the condenser is half in. Turn up the regeneration control until a distinct background hiss is heard. The set will now be oscillating. In this condition it is extremely sensitive, and as the dial is turned rapidly, a series of whistles and squeals should be heard as many stations, code, telephone television, etc., are passed. Adjust the trimmer for the loudest hiss.

By reference to the curve chart on the cover of the receiver, locate the approximate position on the dial where the station in which you are interested (unless tuning at random) is located. For instance, if you wish to listen to W8XK, Pittsburgh, Pa., U. S. A., which broadcasts on a wavelength of 48.86 meters, it will be found at about 60 on the dial with the 40 to 70 meter coils. You will also find listed on the log inside the receiver cover, 5 "spot" locations, giving the exact dial readings at which these stations will be received.

Turn the dial knob slowly until a continuous whistle is heard (interrupted whistle indicates a code station). This is probably the carrier of a short wave telephone station, and if modulated by speech or voice, these sounds will be heard above the squeal. Tune until the squeal is loudest.

The squeal can now be cleared up by backing down the regeneration control until the receiver stops oscillating. A slight readjustment of the tuning dial may be necessary as the regeneration control is moved. Adjust volume to suit, either by means of the r-f volume control or the regeneration control (below the point of oscillation). As a general rule it is desirable to operate with the regeneration control about ¼ turn below oscillation (after the station is located) and the r-f control set for the desired volume. (For extreme selectivity, the regeneration control should be set just below the oscillating point.)

The receiver is most sensitive in an oscillating state when the regeneration control is just above the oscillating point. When tuning with this adjustment, the circuit may stop oscillating, necessitating the turning up, slightly, of the regeneration control.

### Trimmer Adjustment

As already indicated, the trimmer adjustment need only be set for each set of coils, except for the reception of very weak stations, which may necessitate careful adjustment, all around, for best reception. On such stations, slight readjustment of the tuning dial may be necessary, following the movement of any of the other controls.

Code and television stations are good for practice tuning, and are located with the receiver oscillating as described. Code stations transmit either an irregular stream of dots and dashes, or a constant sequence of dots (for test purposes). Many code stations are modulated by a high pitched tone, and can be received when the regeneration control is turned below the oscillating point.

The carrier of a television station is constant, but is modulated by a variety of rising and falling tones. These tones alone are also received with the regeneration control turned down below the oscillation point. With the usual loudspeaker, the television signals are, of course, audible only. For picture reception, further amplification and a light reproducing system are required.

### Trouble Shooting

Carefully assembled and wired the ACSW-58 and the DCSW-34 should be as free from trouble as a reliable long wave broadcast receiver. However, it can happen in the best of families, and the major causes of faulty operation, with their symptoms, are described below. In general, the troubles will be the same as those which occasionally afflict the longer wave receivers, and their location follows the same procedure—voltage and continuity tests, etc.

No Signal: Burned out detector or a-f tubes, no plate or heater voltages. Same possibilities as exist on longer waves.

Weak Signal: Mixed coils. In this case the adjustment of the r-f volume control and trimmer will have practically no effect. If coils are matched properly, check for continuity in the windings. Open coupling condenser in the impedance coupled amplifier will cause weak signals, accompanied with pronounced loss of low frequencies in 'phone reception. Check antenna, grid cap connections, etc.

Faulty Regeneration: Sticky controls, howling, etc. May be caused by a poor detector tube, incorrect value of grid leak and short circuited radio frequency choke coil.

Poor Quality: Check on several stations before being satisfied that the trouble is in the set. Garbled or inverted speech is deliberate with most commercial point-to-point short wave stations. Also, poor reception conditions, accompanied with fading, is a frequent cause of poor quality on certain stations. Make the usual check on voltages and tubes. Muffled tone may be due to over regeneration, while scratchy, hashed speech on strong signals points the finger of suspicion to the grid leak in the impedance coupled amplifier.

Noise: Discrimination between receiver noise and pick-up noise is more important on short waves, and is effected by the usual tests. If noise is consistent, and checks show that the receiver is not at fault, a filter system in the line, such as shown in Fig. 11 should be employed, and, as a last resort, an anti noise antenna as already described on page 10. In the d-c model, the "B" batteries (when used instead of an eliminator) can be suspected if they have been in operation for several months. The usual sources of noise give rise to similar disturbances in short wave receivers with an amplified degree of annoyance.

(*Continued on next page*)

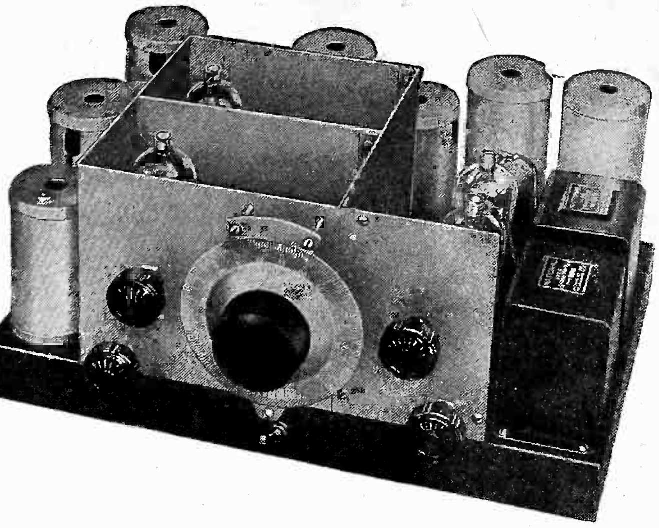


**FIG. 13**
**An ultra frequency receiver also among the National Company products. This is a superheterodyne, covering 40-75 mg. (about 4 to 7.5 meters) with four coils.**

**FIG. 14**
**The Model AGS communication receiver, 15,000 to 2,400 kc.**

# Radio Time the World Over

By the intelligent use of the foregoing time chart much futile listening on the short wavelengths can be avoided. In the revised call list shown on pages 18 and 19 transmission times are Eastern Standard. Eastern Standard Time (or any other time for that matter) can be translated into your local time by reference to the time chart, and stations listened to at the hours they are scheduled to be on the air.

Difference in time is a thing which is difficult for short-wave fans to understand. Listening to "Big Ben" strike midnight at 7:00 p. m. in New York should clarify the point, but still listeners who fail to hear European stations at 8:00 p. m. wonder why. Almost all stations broadcast at hours conforming with time in their part of the world. Europeans, with the exception of PCJ, who broadcasts special programs for American and Australian listeners, close down as early as 6:00 p. m. Eastern Standard Time. South Americans are heard from then on till midnight. Stations in Siam, Japan, and that part of the world, get busy while New Yorkers are thinking about breakfast. It is therefore quite natural that listeners should tune for European stations in the afternoons providing they live in the United States and tune for stations in the Antipodes, in the early mornings. Always keep a good station list on hand.

### Familiarity Breeds Results

As already explained, tuning a short-wave set is somewhat different from tuning a regular broadcast receiver. All in all, it is simply a matter of the operator learning how to tune his set. A good receiver does not solve the question of results on short waves, for the operator must become familiar with the short waves and their peculiarities. To bring about this familiarity is the purpose of this booklet. Once this is mastered, it is just as simple to get distant stations under ordinary circumstances as to get local stations.

The first thing a new listener should do is to log as many local stations as possible as already suggested. There is room for fourteen stations on the log provided on the inside cover of each SW-58-34. Since stations do not appear on every part of the dials, these stations, will act as guides to locating distant stations. The operator should also find just what each dial on his set does when tuned, and what effect they have on the stations once they are tuned in. Locating the spot where stations are heard the best is a good idea.

It is desirable to reiterate that the listener should time his reception, or tune on certain wavelengths at certain times of the day. From 14 to 20 meters all tuning should be done from daybreak till 3 p. m. local time. From 20 to 33 meters, stations to the east of the listener will be heard best from about 11 a. m. till 10 p. m. Stations to the west of the listener in this band should be heard best from midnight till about two hours after daybreak, when they will fade out. From 33 to 70 meters, distant stations can be heard only after darkness falls. Very little in the way of distance can be heard above 70 meters, although the ships, police, fire, coast guard and aircraft stations are all heard above that wavelength.

Short-wave stations have a habit of changing in volume from time to time, these changes being affected mostly by the amount of daylight between the stations and the listener. For example, European stations are always best for American listeners during the summer months. In reverse, South Americans are best during the winter months. Each year we hear from hundreds of listeners arguing that winter months are best for distant reception and others that summer is best. It depends mostly on the habits of the listener and his location. By habits we mean, the stations he generally tunes for. There is not the least doubt that European stations such as G5SW, 12RO, PCJ, Zeesen and OXY are best during the summer months.

### Pointers Listed

A few pointers for new listeners are:

Don't expect to find stations on all parts of the dials. Short wave stations are widely separated except in a very few places.

Don't expect stations to tune broadly. Most distant stations tune very sharply.

Don't expect to hear the world the first day you tune. It requires some knowledge of tuning to get excellent results.

Don't expect to hear a station simply because it is on the air. Many things govern short wave reception.

Don't get discouraged. If reception is poor one day, it may be fine the next.

Don't skim over the dials. Tune slowly.

Don't pass up any weak signals. Ofttimes a weak program can be brought out plainly by careful tuning.

Don't tune for stations when they are not on the air. Use the station list.

Don't get into the habit of tuning haphazardly. Learn where stations should be found on the dials of your particular receiver.

Don't tune above 33 meters for distant stations in daylight.

Don't tune below 25 meters for distant stations after dark.

[*The foregoing is one of a series of weekly articles on standard commercial receivers. Details are given in a single issue and with unparalleled completeness.*]

# DX Corner

There have been numerous requests for various features to appear in this column weekly. Naturally the object of this corner is to supply the information and subject-matter that the greatest number of fans request. In other words, this is to be a department for the DX-er, and of course, that can mean only one thing. There are definite subjects that interest a DX-er.

Just to present a DX special program for a week in advance, with the actual hours of broadcast, means considerable correspondence with dozens of broadcast stations. If the proposed broadcast program is to be of any value it must be accurate. With this thought in mind we shall soon have some very interesting things to look forward to.

In the meantime let me impress upon you that you personally are invited to send along any interesting material or thoughts or experiences or ideas that will fit into a DX-er's life. There has come into the experience of every radio fan some unique idea or wrinkle that has been of some advantage, so send yours along so that the other fellow may share it.

In my personal contact with many DX-ers I found that there was much information that in many cases would be of considerable general value. The DX-er is generous but it was simply because in many cases they were not in the habit of writing information or suggestions.

* * *

From Canada Phillip H. Robinson, Shelburne, writes that he believes the DX column improves Radio World fifty per cent. He pulls in KSL, Salt Lake City, and XER, Mexico City.

* * *

H. M. Yyall, 103 Main Street, Leominster, Mass., writes his general approval of the Radio World and thoroughly believes in the idea of a DX column. He would like it to be "sincere and honest" and to avoid "printing the names of fellows who just want to see their names in print." He also suggests printing a schedule of stations with their time on the air. As a further suggestion he takes up the idea of types of antenna and ground, also of radio receiver.

* * *

Myles Swartlex, 302 Chestnut Street, Philadelphia, Pa., writes his approval of this corner and lists among his good thrills one 25, three 50, twenty-nine 100 and two 250-watt stations. All this on a two-tube set, using one 224-A screen grid and one 227 tube. He also uses an indoor antenna, with radiator for ground.

* * *

M. Velazque, 375 Bradford Street, Brooklyn, N. Y., just read the notice regarding the DX column and is anxious to see the column get under way.

* * *

From New Haven, Conn., George H. Baldwin, Jr., of 3439 Yale Station, Yale University, writes of his great interest in DX, and also of his further interest in a battery set suitable for DX. He also sends in a very interesting record which we shall try to use in an early issue.

# Anderson's New Auto Set with 85 Tube and A. V. C.

## By J. E. Anderson

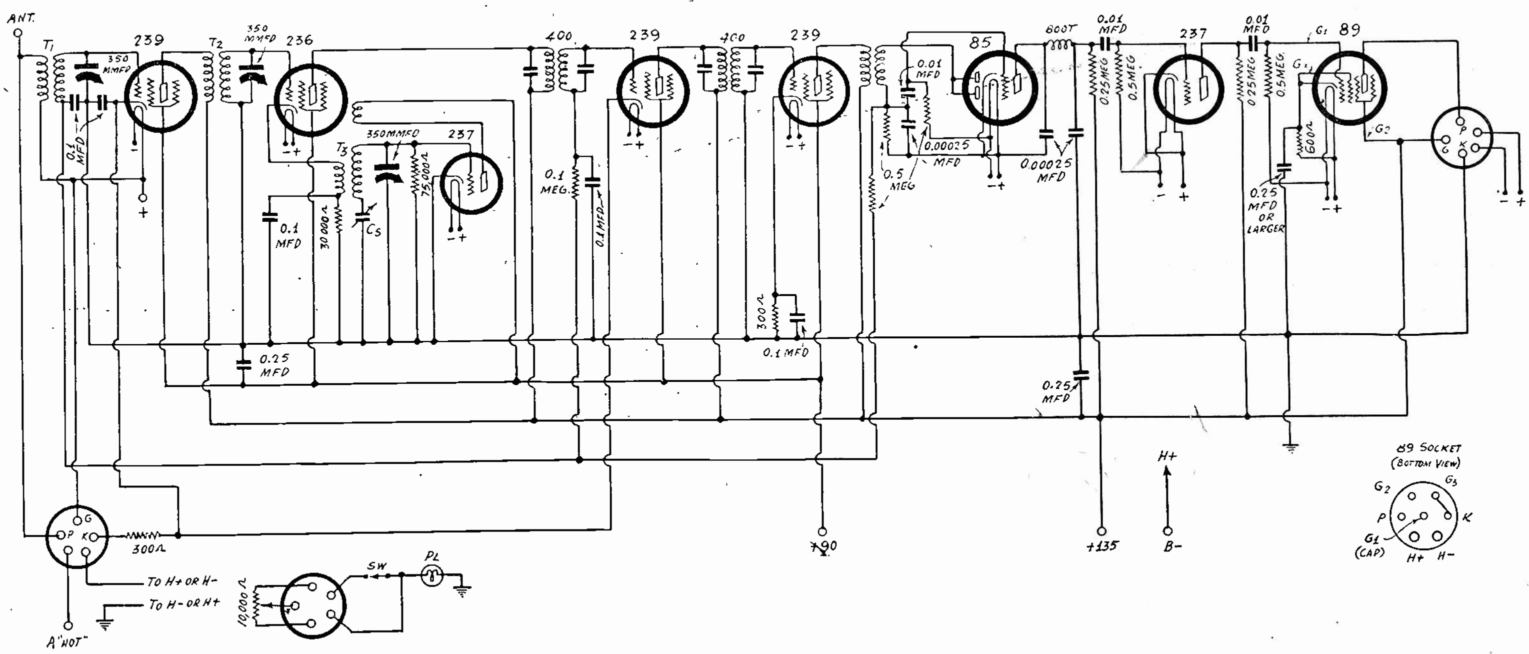



**FIG. 1**

**The circuit diagram of the 898 automobile superhetero dyne receiver. It employs diode detection, automatic volume control, and 89 output.**

TWO of the main requirements of an automobile receiver are automatic volume control and high sensitivity. Automatic volume control is required because the car is continually moving about through varying field strengths, and the signal must remain tolerably constant regardless of the pick-up. High sensitivity is required because the car may be at remote points from any broadcasting stations and it may also be in relatively dead spots. Moreover, the pick-up possible in a car is very poor and the set must be sensitive enough to overcome this disadvantage.

Herewith is the circuit of the 898, an eight-tube superheterodyne designed to meet the requirements of a car receiver.

First it contains a 239 tube as radio frequency amplifier, then a 236 as mixer, and then a 237 oscillator. In the intermediate amplifier are two 239 tubes. The i-f amplifier is followed by a half-wave diode detector-amplifier utilizing the 85 tube. The first audio amplifier, after the triode of the 85, is a 237 and after that an 89 power pentode.

### The Selector

In the radio frequency level there is the regular tuner comprising two radio tuners and the oscillator, the tuning being controlled by a three-gang condenser. In the intermediate frequency selector are first two doubly tuned transformers and then an untuned transformer, or one that is very broadly tuned. The coupling in the audio amplifier is by resistance-capacity throughout.

The first two radio frequency coils are ordinary shielded midget type transformers. The oscillator coil is also of the midget type and contains three windings. The resonant winding which determines the frequency has an inductance of 145 microhenries, which is the right value when the intermediate frequency is 400 kc, as it is in this receiver.

The untuned intermediate frequency amplifier was made up of two 800 turns duolateral coil. However, the full number of turns was not retained because it was found that the transformer had a natural frequency around 350 kc before the turns were changed. The two coils used were first mounted on wooden dowels. They were removed and about 50 turns taken off each one from the inside. They were then put on a single dowel, with a few paper washers between them but otherwise placed as close as possible. The paper washers used were originally parts of the two coils taken down. The two fibre end pieces of the original coils were also retained and used at the ends of the transformer for holding the coils together and to provide terminal lugs.

When this transformer of two 750-turn honeycomb coils was put in the circuit it was found that it had a very broad resonance characteristic with the peak close to the intermediate frequency used. However, the tuning curve was so broad that the untuned transformer added practically nothing to the selectivity of the set. No additional selectivity was needed because when the receiver was completed two strong stations working on adjacent channels could be separated without difficulty.

### Automatic Volume Control

The automatic volume control voltage is taken from the direct voltage component in the load resistance in the diode detector. This resistance has a value of 0.5 megohm. Another 0.5 megohm resistor is connected from the negative end of the load resistance to the grid returns of the controlled tubes. A 0.1 megohm by-pass condenser serves to filter the automatic bias voltage. This condenser is placed near the first resonant circuit and it also serves to complete that circuit. A 0.1 megohm resistor is placed in the grid return of the second controlled tube, which is the first i-f amplifier. The gain in the second i-f amplifier is not controlled, either by the manual control or the automatic. This tube is simply biased by a 300 ohm resistor in the cathode lead, and it is shunted by a 0.1 mfd. condenser.

It will be observed that the load resistance in the diode circuit is connected to the cathode of the tube and also to the positive side of the heater circuit. This connection is made so that the voltage of the storage battery may be used for bias on the triode part of the 85. This is achieved by returning the grid leak, which has a value of 0.5 megohms, to the negative side of the heater circuit. Thus the bias on the triode is about 6 volts.

Since the cathode, the 85 and the load resistance of the diode are connected to the positive heater circuit, the automatic voltage will be measured from the positive side of the heater circuit. It is desirable to arrange the circuit so that this is the case no matter which side of the heater circuit is connected to the chassis. This is accomplished by the simple expedient of connecting the slider of the manual volume control potentiometer to the positive side of the heater circuit. The two cathodes of the controlled tubes are joined together and then connected to a fixed bias resistor of 300 ohms, which appears at the right of the remote control socket. The 300 ohm resistor is connected to K of this socket, and this picks up one end of the potentiometer. The slider is connected to the G lug on the same socket. Therefore the two cathodes of controlled tubes are returned to the positive side of the heater circuit. Accordingly the voltage developed in the load resistance of the

## LIST OF PARTS

### *Coils*

Two midget shielded r-f transformers for 350 mmfd. condensers
One oscillator coil for 350 mmfd. condenser and 400 kc intermediate
Two doubly tuned and shielded i-f transformers, 400 kc
One untuned intermediate transformer as described (two 800 turn chokes)
One 10 m.h. r-f choke (800 turn duolateral coil)

### *Condensers*

One three-gang tuning condenser 350 mmfd. per section
One 350-450 mmfd. adjustable padding condenser
Four 0.1 mfd. by-pass condensers
Three 0.25 mfd. by-pass condensers
Three 0.01 mfd. condensers
Three 0.00025 mfd. condensers

### *Resistors*

One 600 ohm bias resistor
Two 300 ohm bias resistors
One 30,000 ohm resistor
One 75,000 ohm resistor
One 0.1 megohm resistor
Five 0.5 megohm resistors
Two 0.25 megohm resistors

### *Other Requirements*

Eight 5-contact sockets
Two 6-contact sockets
Six grid clips
One remote control unit comprising dial, 10,000 ohm potentiometer, cable, condenser pulley, and filament switch
One battery box
One chassis and chassis box
Two shielded battery cables, one three lead for B supply and one two lead for A.
One dynamic speaker with six volt field and 89 tube matching transformer
One 236 tube
Two 237 tubes
Three 239 tubes
One 85 tube
One 89 tube

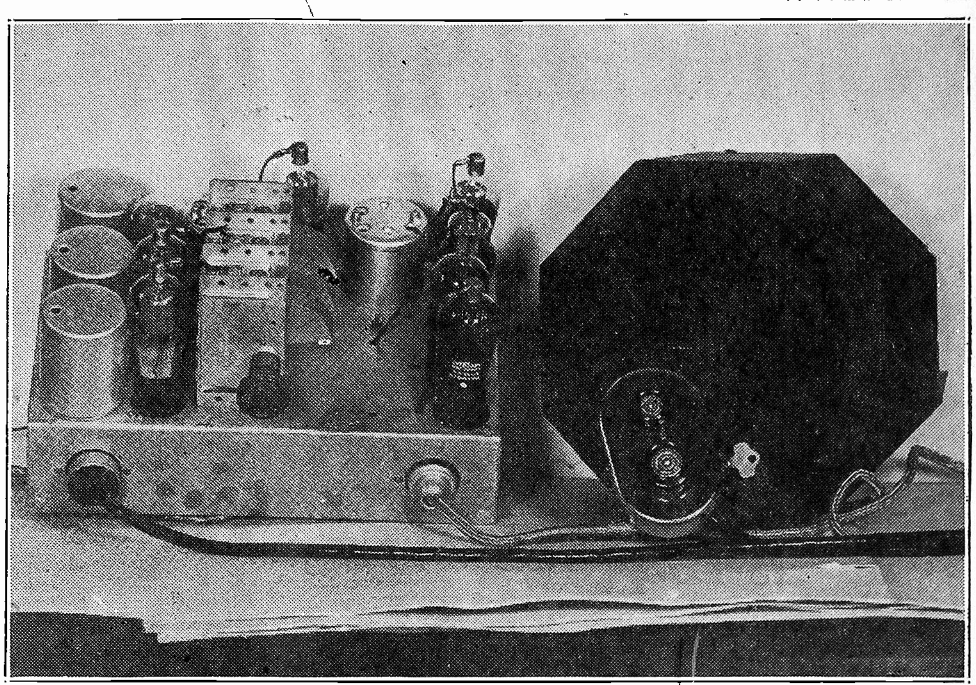


**FIG. 2**
**The arrangement of the parts on the 898 automobile receiver**

diode is always added to the fixed bias of the controlled tubes regardless of which side of the heater circuit is connected to the chassis.

## Another Precaution

One other precaution is necessary. The low potential end of the antenna coil must be connected to the negative side of the heater circuit, and therefore it must not be connected to the chassis. A dangerous short would result sometimes if the antenna coil were connected to the chassis and the slider of the potentiometer to the positive side of the heater circuit. To avoid this possibility the ground end of the antenna coil is also connected to the positive side of the heater circuit, or to the slider, which is the same thing. This connection could be made in the remote control but it is preferable to make it on the socket of the remote control on the chassis, or to the most convenient H plus point in the circuit.

The grid bias for the first audio amplifier is obtained in the same manner as that for the 85 triode. That is, the cathode is connected to the positive side of the heater circuit and the grid leak to the negative. Thus the bias on this tube is 6 volts. On the power pentode the same arrangement is used, as far as it is possible. This tube requires a higher bias than six volts and for that reason a 600-ohm bias resistance is connected between the cathode and the positive side of the heater circuit. This provides approximately the optimum bias for a plate voltage of 135 volts. The resistor is shunted by a 0.25 mfd. condenser to the chassis.

## Floating Heater Circuit

No part of the heater circuit has been connected to the chassis. Therefore either side may be connected to it, and it makes no difference to the various bias voltages which side is so connected, and in all but three tubes it makes no difference in the effective plate and screen voltages. In these three, the mixer, the oscillator, and the second i-f amplifier, there is a difference of six volts. They are lower when the positive side of the circuit is connected to the chassis. The difference is negligible. It is assumed that minus B is always connected to the positive side of the heater circuit, a connection that may be made on the car battery or in the receiver is desired.

The remote control is always wired in the same way. The resistance of the potentiometer is connected between the two leads terminating in the P and K prongs on the plug and the slider to the lead terminating in G prong. The lead terminating in the Hp prong is connected switch and to nothing else, and the lead terminating in the Hk prong is connected to opposite side of the switch and to the pilot light. One side of the pilot light is connected to the frame of the remote control.

The "hot" side of the car storage battery is connected to the Hp lug on the remote control socket in the set, and Hk on this socket is connected to that side of the heater circuit that has not been grounded. By ground is meant the chassis, both of the car and of the receiver.

Let us illustrate the connections to be made. Suppose the car is of the type that has the negative grounded. A plus is then "hot." When the receiver is mounted on the car the chassis becomes minus. In this case the negative side of the heater circuit is connected to the chassis and Hk on the remote control socket is connected to the positive side. Assuming that the remote control plug is in its socket, when the switch is closed the set goes on and so does the pilot light.

If the positive side of the car battery is grounded the negative side is "hot." In this case the positive side of the heater circuit is connected to the chassis and the negative side is connected to the Hk lug on the remote control socket. As before, the switch in the remote control device controls both the heater circuit and the pilot light.

## The Diode Circuit

The two diode plates are tied together then one side of the secondary of the untuned transformer connected to them. The other side of the secondary picks up two 0.5 megohm resistors, one 0.01 mfd. condenser, and one 0.00025 mfd. condenser. The connections of the other sides of the resistors and condensers have already been explained.

The question may arise as to why such a large filter condenser is connected across the load resistance, 250 mmfd. instead of the usual 100 mmfd. The reason is that when the smaller condenser is used the high audio notes are too prominent. The reason for their prominence is partly due to the use of an untuned transformer and partly to the use of a grid leak and an automatic volume control circuit. It will be noticed that the three 0.5 megohm resistors are virtually in parallel so that for high frequencies the load resistance is effective only one-third of its supposed value. Thus the time constant of the circuit for a given condenser is only one-third of what it would be if there were only one 0.5 megohm resistor. This means that the condenser across the load resistance may be larger for a given suppression of the high audio frequencies.

As a means of reducing the strength of the high audio notes still further a low-pass filter is put in the plate circuit of the 85 and this consists of two 250 mfd. condensers and a 10 millihenry choke. This coil is of the duolateral wound type and contains 800 turns. These devices for reducing the strength of the high notes help to remove hiss when the set is adjusted to high sensitivity, as well as 10 kc heterodynes between stations operating on adjacent channels. That is, they help to lower the noise level.

## Adjustment of Padding

When adjusting the tuning of the circuit first provide a modulated signal of 400 kc. Impress this signal on the grid of the 236 tube. Then tune each of the four i-f circuits for greatest response.

(*Continued next week*)

# Calibrating an Oscillator with Matched Reactances

## Curve Shown Will Closely Approximate Actual Results—How to Check Up for High Accuracy

### *By Herman Bernard*

KITS for modulated test oscillators are now obtainable, both for a-c and battery operation, and either with pre-calibrated scale, or with scale reading in one or the other customary numerical order, depending on whether condenser closes to the right or to the left. Since the inductance of the coils used is fixed and known, the process of calibration is greatly simplified. In fact, any one who carefully reads directions may calibrate his own oscillator, so long as the inductance is known and the condenser is of 0.00037 mfd. or higher capacity. It is assumed, however, that the tuning condenser used is one supplied with a kit, and thus matched with the coil, and on that basis the method of calibrating will be outlined.

The a-c oscillator circuit used is Shiepe's modification of the Hartley circuit. This type of oscillator is highly satisfactory, particularly as its stability is good and its oscillation is unfailing. The old saying is, if the oscillator won't oscillate, try a Hartley.

#### Oscillator Range

The circuits, both for a-c and battery operation, have been shown several times recently in RADIO WORLD. The Shiepe oscillator was described in the September 24th issue, while a painstakingly detailed account of the calibration of any low-frequency oscillator, using broadcasting stations as standards, was printed in the October 15th issue. The present article, however, as stated already, is based on the use of prescribed coils and prescribed condenser (0.00037 mfd. tuning condenser across 20 millihenries).

The oscillator is to have fundamental frequencies of from 53 to 155 kc, approximately. This range will obtain when the total inductance in the grid circuit is 20 millihenries, which is commercially attained by using two small 800-turn honeycomb coils connected in series aiding, when the tuning condenser has a capacity range of from 18 to 570 mmfd. There is a compensating condenser, a very little of the capacity of which may be used, and besides there is distributed capacity in the coils and capacity in the tube and wiring. These extra capacities will take care of themselves and are mentioned only as disclosing that the capacity actually in use is greater at all times than the capacity contributed by the tuning condenser alone.

It can be seen from the fundamental tuning range of 53 to 155 kc that the broadcast band is fully covered by the tenth harmonic. Thus the calibration, using broadcasting stations as standards, is simplified to the extent of making frequency identity easier.

The first requisite is that the oscillator be built, that the tube be inserted, and that the power be turned on. The second is that a broadcast receiver be in operation near the oscillator. No other coupling is necessary between receiver and oscillator than that which automatically takes place due to radiation.

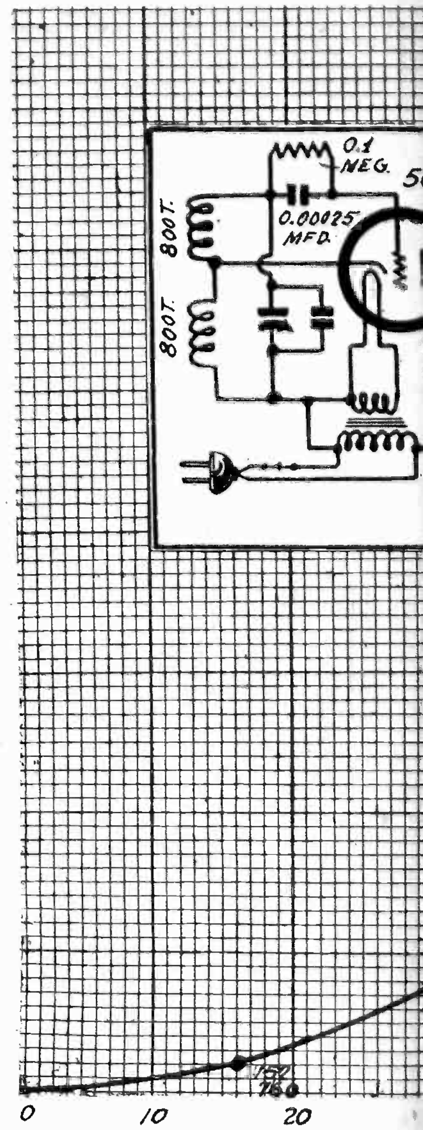
#### Output Post

The oscillator may be as far as 40 feet from the set, in the case of the a-c model, and still there is sufficient coupling, due no doubt in part to the a-c line carrying some of the oscillation output. Even if it doesn't there will be coupling, so an output post is not required, although one may be included as a courtesy to habit. The coupling between output post and oscillator need be only that arising from a few turns of wire under the bottom of the socket, conductively connected nowhere at that end, but insulated at that terminal to avoid trouble. After the turns are completed the other end is soldered to a lug at the output post. Instead of the under-socket method, the wire may be twisted a few times around the plate lead, and insulated at the bare end, other end soldered to binding post lug.

For purposes of calibration it is preferable to use low frequency broadcasting stations, otherwise entirely too many points are registered and it becomes confusing to identify them. In other words, the higher the frequency of the standard, the more harmonics of the test oscillator's fundamental will beat with the standard.

#### Start at Low End

Let us select first the lowest frequency that can be tuned in on the receiver with good strength. In the particular instance it was 570 kc, a wave shared in New York City by WMCA and WNYC. With the combination of inductance and capacity stated, 57 kc will be registered at about 98.5 on a numerical dial that has division numbers increasing with increase of condenser capacity. The receiver is carefully tuned to 570 kc and the oscillator dial is then slowly rotated to one side and the other of the point near 98.5 where the squeal with 570 kc is heard. The oscillator is so tuned that the modulation, consisting of the a-c line frequency, is loudest, and this should be in the center of the dial displacement represented by the complete tuning out of the frequency. The ideal condition exists when there is no difference in frequency between the tenth harmonic of the test oscillator and the fundamental of the station, when there is no squeal heard, but only the modulation hum. However, in practice the best that is generally attainable is a low growl, with hum additional, the lowest pitch representing th closest point to unity.




**Diagrams of a eralized tuning as standards a as well as w**

#### Calibration Begins

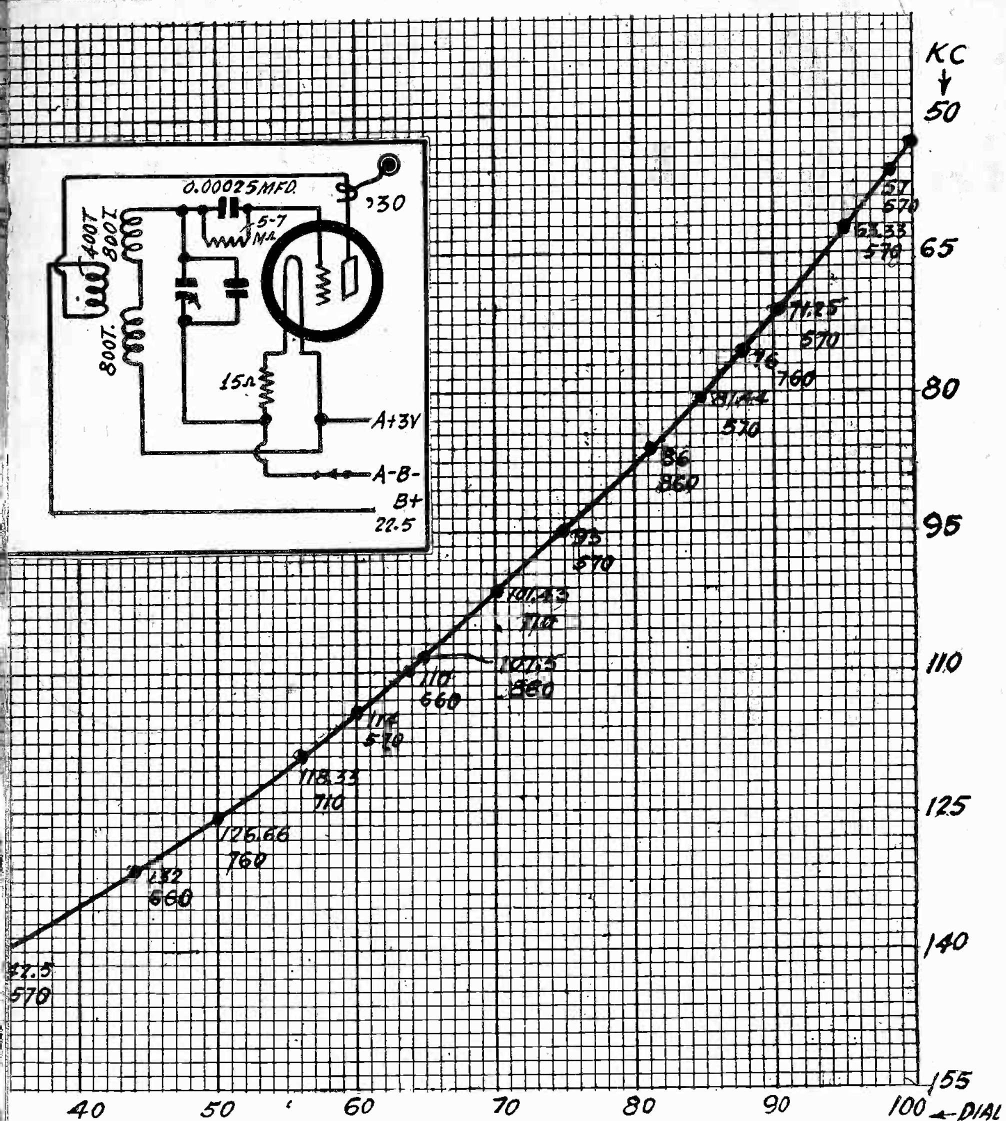
If we are using a numerical dial (0-1 or 100-0), then we may take the settin as we find it, ascribe to it 57 kc, and mak a notation to that effect on a piece paper. Be sure to write down both th dial setting and the frequency for eve useful frequency.

Now we have exhausted the use of tenth harmonic of the oscillator, but we leave the receiver tuned to 570 kc w may turn the oscillator to higher frequen cies and again pick up squeals and estab lish zero beats. These are due to oth harmonics of other test oscillator fr quencies beating with the same statio frequency.

Taking 570 kc, we find its fundament related to harmonics of the test oscill tor's fundamental as follows:

| (10) | (9) | (8) | (7) | (6) | (5) | (4 |
|---|---|---|---|---|---|---|
| **57** | **63.33** | **71.25** | **81.44** | **95** | **114** | **142.** |

Notice that only such values of fr quency as fall within the known frequenc range of the test oscillator (about 52 155 kc) are included. To express th numerical tabulation in words, when th test oscillator is at 57 kc there will be beat between its tenth harmonic and th 570 kc station's fundamental; when th test oscillator is at 63.33 kc there will b a beat between the ninth harmonic 63.33 and the station frequency; whe the test oscillator is at 71.25 kc ther will be a beat between the eighth ha




d battery-operated modulated test oscillators, with gen-
e based on matched reactances. Station frequencies used
e beaten with the tenth harmonics of the test oscillator,
her harmonics of other test oscillator fundamentals.

monic thereof and the station frequency, etc.

### Precautions

So as we turn the condenser and pick up additional squeals, and register zero beats, or lowest-pitched growls, we know what fundamental frequencies of the test oscillator are represented and also (although this does not concern us so much) the degree of harmonic of the test oscillator that is beaten with the station. The fundamental frequency has been given in the oscillator harmonic instances, which is why we are not concerned about the order of the harmonic. But if we are using some other station frequency for the low end we would have to figure out the frequency, by dividing the station frequency by 10, 9, 8, etc., knowing that the low frequency setting (57 kc) must come in near the highest capacity setting of the dial.

How near to the end depends, of course, on the station frequency selected. Moreover, care must be exercised in two directions: (1), because the next harmonic order is close by on the dial we must avoid being fooled; and (2), we must not be confused by some faint squeals that may be heard and which are due to two-thirds harmonics and other causes. A curve, giving approximate settings, is printed herewith, so we can't go far wrong, and as for being misled by minor squeals, this will not happen if we remember that about the same degree of intensity as prevails at the lowest test frequency of the oscillator will prevail throughout, using the same station as standard, or, if there is any change, the change will be toward greater amplitude. So weak squeals, particularly if unaccompanied by hum modulation, are to be ignored.

### Ten Settings So Far

It was stated that the settings are fairly close together at the low frequency end. Let us see how close. If 57 kc comes in at 98.5 on the dial, then the ninth harmonic of 63.33 will beat with 570 kc and come in at about 95 on the dial. The eighth harmonic of the test oscillator's 71.25 kc setting will beat with 570 kc, as will the seventh of 81.44, sixth of 95 kc, fifth of 114 kc and fourth of 142.5 kc. It is possible all sixth harmonics will be suppressed.

Already we have seven settings, a fair beginning, and using only one station. Let us turn to some other station, say, the next lowest in frequency, which in the New York area (for good signal intensity) is WEAF, 660 kc.

We find that the harmonics of the test oscillator (within the oscillator's frequency range) that will beat with 660 kc are:

| (10) | (9) | (8) | (7) | (6) | (5) |
|---|---|---|---|---|---|
| **66** | 73.33 | 82.5 | 94.44 | **110** | **132** |

The lowest frequency on the test oscillator that will register the beat is, of course, 66 kc, whose tenth harmonic is 660 kc, and will fall at about 94 on the dial. There is no need to use the next frequency, 73.33, as it is so close to one already registered (71.25 kc), nor is 82.5 kc of any advantage, as we have 81.44 registered already, nor 94.44, since we have 95 kc recorded, but 110 kc is of advantage, and this will fall at about 64 on the dial. So we register the first squeal, in the tuning directions from lowest to highest frequency, skip the second, third and fourth, register the fifth (110 kc) and also the sixth (132 kc). Thus we add three points, a total of ten so far.

### WOR and WJZ

Now we must use some other station. The next lowest broadcast frequency in the New York territory that provides good strength is 710 kc, assigned to WOR. We find the following test oscillator harmonics equalling the station's frequency:

| (10) | (9) | (8) | (7) | (6) | (5) |
|---|---|---|---|---|---|
| 71 | 78.88 | 88.75 | **101.43** | **118.33** | 142 |

We do not register 71, as we already have 71.25, but we may the use this new frequency simply as check-up, as about the same dial setting will prevail for the tenth harmonic of 71 kc as for the eighth harmonic of 71.25, found in WMCA's case. Nor do we need 78.88, for we have 81.44 recorded, but we do record 101.43, at about 70 on the dial, also 118.33, at about 56 on the dial, but not 142, as we have 142.5, but can use the new squeal for check-up. We have added two more points, total so far being 12.

Next take up WJZ, 760 kc. The harmonics of the test oscillator's fundamental that will beat with this station's frequency, in our range, are:

| (10) | (9) | (8) | (7) | (6) | (5) |
|---|---|---|---|---|---|
| **76** | 84.44 | 95 | **108.57** | **126.66** | **152** |

We register the fundamental, which will fall at about 88 on the dial, not the next one, 84.44 kc, because we have 81.44; 95, for reasons to be explained, although the frequency registration is repeated; 108.57 kc, at about 66 on dial, 126.66 at about 50 on dial, and 152 kc, at about 16 on dial.

Thus we have added three more points, total 15, not counting 95 kc as an extra point, since it is the same one as obtained previously.

By recognizing the fact that the eighth harmonic of 95 kc on the test oscillator coincides with the 760 kc station frequency, and that the sixth harmonic of 95 kc on the test oscillator coincides with the 570 kc station frequency, we have a ready means of establishing that our calibration is not off by an harmonic, or otherwise erroneous, for the same setting of the oscillator (normally at about 75 on the dial) will strike the beat with the two station frequencies. Therefore, to check up, when the oscillator is at 95 kc, get the beat with 660 kc, leave the oscillator set as it is, retune the broadcast receiver to WMCA, 570 kc, and pick up the squeal caused by the sixth harmonic of the test oscillator.

### Final Station

A final station, WABC, 860 kc, will beat with test oscillator frequencies' harmonics as ordered below:

| (10) | (9) | (8) | (7) | (6) |
|---|---|---|---|---|
| **86** | 95.55 | **107.5** | 122.85 | **143.33** |

We record 86 kc (dial 81), 107.5 kc (dial 66) and 143.33 (dial 30). The total registration is 18 points. Those registered are printed in bold-face type in the tabulations.

The curve shows the station fundamental under the fundamental of the oscillator tested by the vari-harmonic method.

So far we have taken up the case of a numerical dial, 0-100 or 100-0, and have obtained eighteen points to run a curve. Next we get some some plotting paper, preferably ten squares of tens, and record dial settings at the bottom, using division

*(Continued on next page)*

# A New Trap Suppressor of Image Interference

## By J. E. Anderson

EVERY superheterodyne may be divided into six different components, each having a separate function to perform. They are, the radio frequency tuner-amplifier, the oscillator, the mixer, the intermediate frequency selector-amplifier, the detector, and the audio frequency amplifier. While in some cases it may be difficult to make the physical division of the parts into these components, the various functions are always present. A functional diagram of a superheterodyne is shown in Fig. 1.

The function of the radio frequency tuner-amplifier is to select the signal desired from among all others present at the antenna and to amplify that signal to a suitable level.

The function of the oscillator is to generate an unmodulated oscillation of a frequency differing from the frequency of the desired signal by a fixed amount, the difference being equal to the intermediate frequency.

### Functions of Components

The function of the mixer is to combine the output of the radio frequency tuner-amplifier with the output of the oscillator to produce heterodynes between the oscillation and the various signals that arrive from the tuner-amplifier. The mixer is also called the modulator or the first detector.

The function of the intermediate frequency selector-amplifier is to select the heterodyne that contains the desired signal, exclude all others, and to amplify the desired heterodyne to the required level. The intermediate frequency selector-amplifier accepts and amplifies all heterodynes having the frequency to which the selector is tuned regardless of their source. There may be present in the output of the mixer heterodynes of the acceptable frequency that are not derived from the desired signal. These will cause interference.

The function of the detector is to demodulate the heterodyne containing the desired signal and to reproduce the original audio frequency signal.

The function of the audio amplifier is to amplify the demodulated signal to the required level.

### Omitting Components

In some circuits the tuner-amplifier is omitted, the first tube being the mixer. In others the tuner is omitted but the radio frequency amplifier is retained. In still others the amplifier is omitted but the tuner is retained. If it were not for image interference and harmonics it would be feasible to omit both the radio frequency tuner and the radio frequency amplifier, for then adequate gain and selectivity could be obtained in the intermediate frequency selector-amplifier. But the presence of images and harmonics makes a highly selective tuner-amplifier desirable.

The oscillator and the mixer cannot be omitted in any case for they are essential components in principle. However, the oscillator and the mixer can be combined in one tube, and this is done in a large number of commercial superheterodynes. A circuit in which the mixer and the oscillator are combined in one tube is called an autodyne oscillator.

In some simple superheterodynes the intermediate frequency amplifier is omitted, but the intermediate frequency selector can never be omitted for that is an essential part of the superheterodyne principle. In cases where the intermediate amplifier is omitted the necessary gain is obtained in the radio frequency amplifier or in the audio frequency amplifier. It is also obtained by using a highly sensitive mixer, usually of the autodyne type, and by regeneration.

In some receivers the audio amplifier is omitted or at least kept down to a single stage. When it is omitted the detector is made of the power type and the required gain is obtained in the radio frequency amplifier or in the intermediate frequency amplifier, or in both.

### Result of Tuner-Amplifier Omission

When the radio frequency tuner is omitted signals of all frequencies arrive at the mixer with the same relative strength they had at the antenna. Some undesired signals may be considerably stronger than the desired signal. The oscillation will mix with all of them and the mixer will turn out heterodynes the strengths of which are in proportion to the radio signals at the antenna. Only the intermediate frequency selector can differentiate between the desired and the undesired signals. If it should happen that two or more stations should produce heterodynes of the same frequency, there would not be any selection between them and the interference would be severe. In general there will be at least two stations which might be about equally strong, or it might be that some undesired station would be much stronger than the desired one.

Against this form of interference only the radio frequency tuner can discriminate and for that reason any superheterodyne that has no radio frequency selection is unsatisfactory. Indeed, in order to suppress image interference completely it is necessary that the radio frequency tuner be more selective than it would have to be in a tuned radio frequency receiver to discriminate adequately between the two interfering stations. Yet a superheterodyne without any radio fre-

# Calibration of a Test Oscillator

(*Continued from preceding page*)

one side of one little square for each dial division, and frequencies on the perpendicular 1.5 kc per side of small square, if the paper is not deep enough for 2 kc per side of small square. The illustration shows 1.5 kc per division.

Now we may keep the curve, using it any time we desire to know what the frequency is for any given dial setting. Or, we may mark the kc gradations in 10 kc steps, on the numerical dial, if there is room. Or, if we had a blank scale we could, by protraction, communicate the curve to the dial in terms of 10 kc separation.

The other alternative applies to the use of a pre-calibrated scale. In that instance the scale already is made as closely as practical, and the problem is to register coincidence at the two extremes, or near them.

We find we have missed out a little at the high frequency end of our scale, in that points are few there, and toward the very end there is none. If we can locate locals at 1500, 1400, 1300 kc, etc., we can register 150, 140, 130, etc., and get more definition at this end. But if we tied down the scale and the tuning at one end we still have to protect the other.

The capacity may be adjusted and that's what the compensating condenser is for. It is across the main tuning condenser, built in, and is to be left at its final adjustment.

First coincide the scale with the standard frequency (broadcasting station) by capacity adjustment. Then try the opposite end and see that if 1500 kc coinsides. It may not. If there is any difference it is very likely to be that the frequency reads too high; that is, the dial may read 150 when actually the frequency is 140 kc. The solution is to reduce the capacity of the compensator and move the two honeycomb coils closer together, even sawing off some of the coil dowel to permit tighter coupling. Adjust now for the high frequency end, using the compensator and the coincidence at the low frequency end will prove good.

The general accuracy obtained by the pre-calibrated scale method is better than 3 per cent., while at some settings, of course, the accuracy will be greater, often being 2 per cent., and occasionally 1 per cent. This is a steady disparity between scale and actual frequency, and does not refer to frequency changes in the oscillator itself, since the grid circuit is stabilized against frequency shifts due to the voltage differences arising from poor line regulation and unequal oscillation amplitudes. Now we have completed the work as relates to the broadcast band, for we use the tenth harmonic of the test oscillator's fundamentals, and we also find on inspection that some of the intermediate frequencies as used in commercial superheterodynes are included in the fundamental, e. g., 90 kc (dial 79); 115 kc (dial 59); 130 kc (dial 48.5). We desire also to be able to line up intermediate frequency channels of 172.5, 175, 177.5, 260, 400 and 450 kc. We use test oscillator harmonics for those purposes: second harmonic of 172.5, which is 86.25 kc (dial 81); second harmonic of 175 kc, which is 87.5 (dial 80.5); second harmonic of 177.5 kc, which is 88.75 (dial 80); second harmonic of 260, which is 130 (dial 48.5), same as for 130 originally; fourth harmonic of 400 kc, which is 100 kc (dial 67), and fourth harmonic of 450 kc, oscillator fundamental 112.5 (dial 63). These points are to be marked as to the actual intermediate frequencies desired to be calibrated, rather than in terms of oscillator fundamentals, where these fundamentals are raised to harmonics for intermediate line-up.

The calibration method thus outlined, while based on four particular standard frequencies, may be applied to other localities, as would be necessary, to other low broadcasting frequencies.

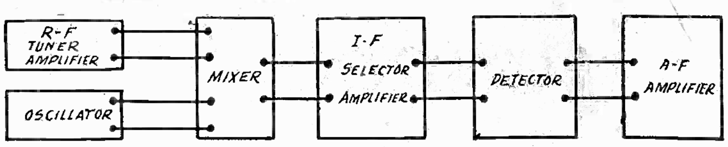



**FIG. 1**

**A functional diagram of a superheterodyne showing the various components. Of these the mixer, the oscillator, the intermediate frequency selector, and the detector are essential to the superheterodyne principle.**

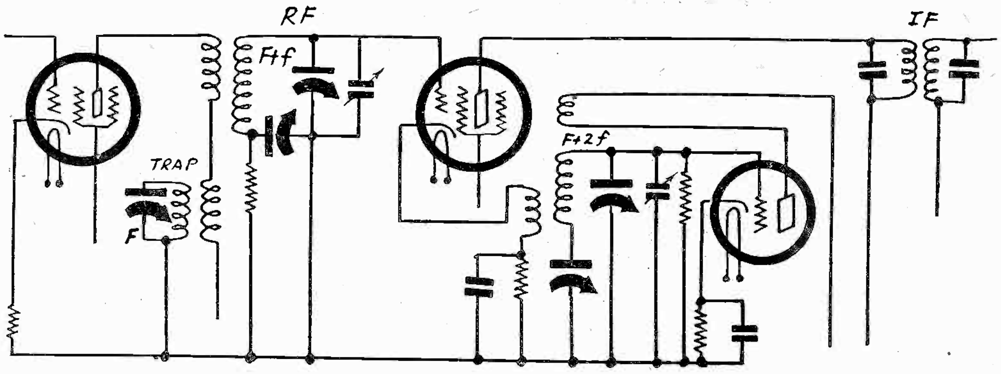



**FIG. 2**

**A section of a superheterodyne showing a way in which a trap circuit can be used for trapping out the image interference. The trap must track with the oscillator and if the r-f circuit is used that must track with both.**

quency tuning, but with a sharp intermediate frequency selector, may be too selective for good quality, for it might completely tune out a station only 10 kc off from the desired station and still be powerless to tune out a station twice the intermediate frequency removed from the desired station.

### Trapping Out Interference

The only object of having the radio frequency tuner is to suppress the frequency that might cause image interference. If the suppression could be accomplished by any other means the radio frequency tuner could be omitted. There are other methods possible. For example, in a superheterodyne in which the higher oscillator setting is used for bringing in the stations, a wave trap always tuned to the lower setting would suppress the frequency that would cause image interference, and no others. But if this trap is to function properly it would have to track just as well as the oscillator, and this could not be so easily accomplished because the trap would have to cover a very wide band, relatively. The necessary coverage could be narrowed considerably because if the trap is used the main reason for using a high intermediate frequency would be removed, and with a low intermediate frequency the necessary range of the trap would be narrowed to practical limits. No superheterodyne has yet been made on this principle.

Another idea that has been advanced is similar to this. It suggests coupling the grids of the radio frequency amplifiers and the mixer to the nodal points of the radio frequency coils, that is, nodal points for the frequency that would cause interference. If the nodal points can be made independent of frequency, or if a tracking arrangement whereby they would be made to assume the proper locations could be worked out, this would be a satisfactory solution.

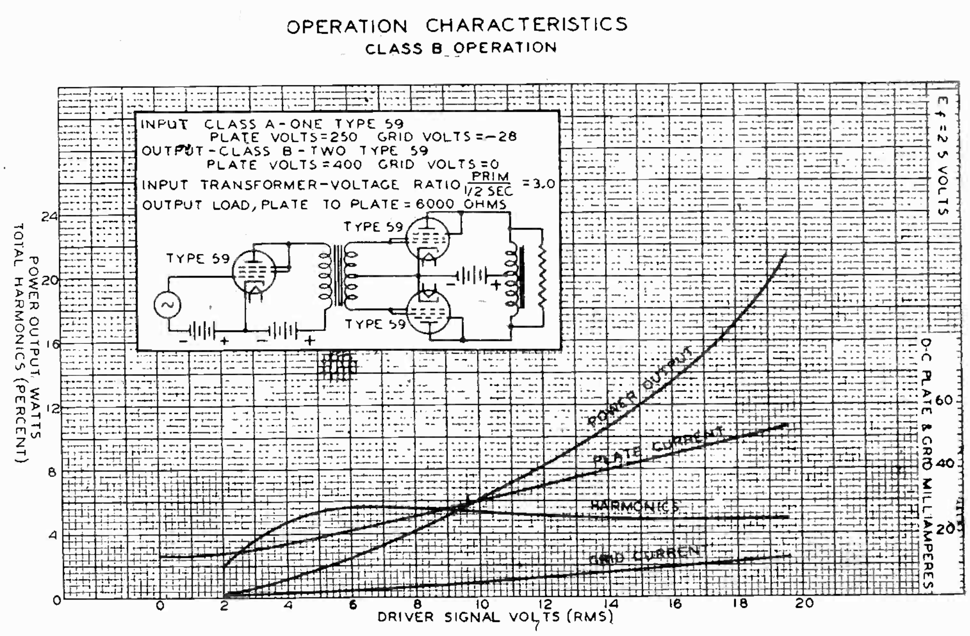
### Useful in Television

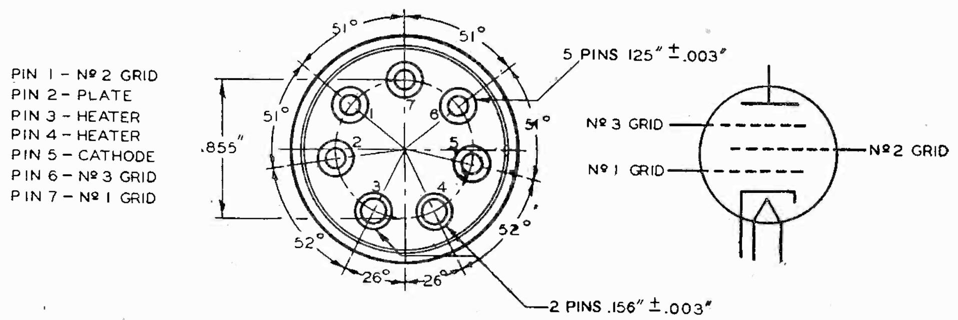
As long as high intermediate frequencies can be used there seems to be no real object of introducing complex arrangements for avoiding the image interference, at least not for broadcast reception, either on long or short waves. However, for television where a wide transmission band is required there would be a real advantage. Both the radio frequency and intermediate frequency tuners could be made relatively broad and if there were an image frequency that could be removed by the tracking trap. Such a receiver would not have to cover a wide range of frequencies and there would be little difficulty in making both the oscillator and the trap track.

If at the same time we had a straight that no essentially new problem arises in the padding theory. We may regard the trap as the radio frequency tuner and then pad the oscillator in the customary way. However, we would have to work on the basis of twice the intermediate frequency. That is, if the intermediate frequency is f, the padding would have to be arranged so that the oscillator always generated a frequency 2f higher than the natural frequency of the trap. If at the same time we ha da straight radio frequency circuit this would have to be padded on the basis of a frequency difference of only f.

In Fig. 2 is a portion of a possible receiver incorporating an image trap with natual frequency F, a radio frequency circuit with natural frequency F + f, and an oscillator with a natural frequency F + 2f. F + f would have to cover the broadcast range from 540 to 1,500 kc. Since f is fixed F would have to cover the range from 540 — f to 1,500 — f, and the oscillator would have to cover the range from 540 + f to 1,500 + f. The padding values in the two padded circuits would have to be based on F, but the tie-down frequencies would have to be based on those broadcast frequencies which give the best overall tracking. That is, $F_o$=600—f, $F_1$=1000—f, and $F_2$=1,450—f.

The theory of the trap is that at its natural frequency it introduces a very high impedance in the plate circuit of the first tube shown, so that at this frequency no current can flow in the primary of the radio frequency transformer and hence so that no voltage can be induced in that circuit. The effect of the trap at the desired signal frequency is negligible, provided that the trap circuit is reasonably selective.




BOTTOM VIEW OF BASE

**The 59 is the first seven-prong tube. In its characteristics it is similar to the 46 but is of the cathode type and it is this that accounts for the extra element in the prong. The relative positions of the various electrodes inside the tube are shown. There are three grids in all and to identify them they are numbered accordingly. For full details of connections see the tube chart in the Nov. 12th issue. A Class B curve is shown also.**

# Need of Wide Channels in Television Reception

## By Neal Fitzalan

THE frequency characteristics of television transmitters and receivers are receiving much consideration these days. Many words have been uttered and written regarding the necessity of a wide band if detail is to show in the reproduced picture. It seems that this has been somewhat exaggerated, at least in the upward direction. Of course, there is no doubt whatsoever that for perfect television the band of frequencies should be infinitely wide, but there is also no doubt that at present we are far from perfection. As the art stands today we can get along with a fairly narrow band of frequencies. Nothing is gained to speak of by increasing the width of the frequency band as long as the number of lines per frame and the width of the scanning line are so crude as at present. Moreover, even if a mechanism capable of much greater detail were used there is still reason why a very wide band is not necessary. A pleasing television picture does not consist of alternate black and white lines running vertically. Such a pattern would require a wide frequency band. In most pictures light and shade go from one to the other gradually, and the slow gradations remove the necessity of having a wide frequency band.

### Need of Lows

Very little emphasis has been given the need of reproducing the low frequencies, yet lows constitute a very large part of the picture. Let us see just how low the response should be in a typical case. Let the number of frames be 20 per second and the number of lines per frame be 60. The scanning proceeds in the direction of reading a printed page. There may be a gradual change in light and shade between the upper left corner and the lower right. The scanner jumps instantly from the lower right to the upper left and therefore there is a sudden change in the intensity. Thus for every frame there is a cycle. The electrical system must be responsive to this variation. That is, it must be responsive to a frequency of 20 cycles per second. Moreover, there will also be a strong component of half the frequency. Hence the system must be responsive to 10 cycles per second. That is necessary in order to get a correct broad outline of the picture.

There may also be a gradual change in light and shade from right to left. The scanning beam will change instantly from the end of a line at the right to the beginning of the next line at the left. The scanning of a line constitutes a cycle. In our supposed system there will be 20x60 of these cycles per second. Hence the system must be responsive to a frequency of 1,200 cycles per second. Incidentally, it is this frequency that characterizes television signals as they are heard on a loudspeaker.

In addition to being responsive to 20 and 1,200 cycles per second, the system must also be responsive to all the harmonics of these frequencies, at least up to the tenth. That puts us up to about 12,000 cycles per second.

### Picture Detail

There will also be variations of light and shade in each scanning line, for these variations constitute the detail of the picture. It is not possible to make any estimate of the frequencies involved in this detail for no two lines will be the same at any time nor will any one line be the same at two different times, unless it happens to be a still picture that is being transmitted. The conception of breaking up each line into as many elemental areas as there are lines per frame leads to a very wide frequency band, in most cases wider than is necessary and in some cases not wide enough. If we really were to send and receive a checker board pattern of 60x60 squares the frequency band obtained on that assumption would not be nearly wide enough. It would be necessary to multiply it by about 10 in order to get all the sharp edges. Fortunately, we will not be called on to view such checker boards. If sharp contrasts should occur in the picture it is a matter for the illuminating engineer at the television studio rather than for the radio engineer to solve.

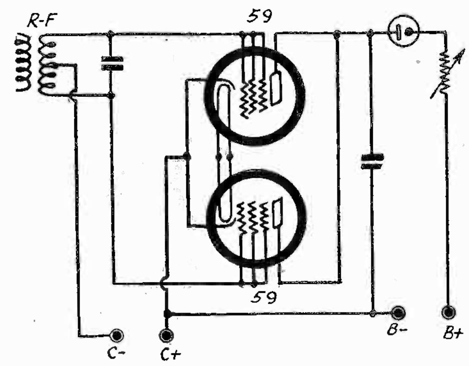



**FIG. 1**
**A suggested power detector for use in television. A high amplification at radio frequency is essential in order to drive this detector to its limit.**

Of course, there are normal cases where contrasts are unavoidable. The contrast between black hair or eyebrows and a white face, for example, or the contrast between a white collar and a black suit. In such cases a slight blurring at the edges would not be serious.

If we obtain the necessary frequency band on the checker-board theory we get 60x60x20, or 72,000 cycles per second for the case when we use 60 lines per frame and 20 frames per second. Each sideband should have this width. But that calls for a total band of 144,000 cycles. Only 100,000 cycles have been allowed by the Federal Radio Commission, and the practice is to allow only about 40,000 cycles per sideband. That is, allowed, not necessarily used either at the transmitter or at the receiver.

### Getting the Highs

The problem of getting the high frequencies, even when they are transmitted, is not an easy one, especially if the circuit is to be selective. Of course, if the circuit is to be used for television only it is not necessary to have a very great selectivity because the television stations are spaced 100,000 cycles apart.

Granting that the receiver has the necessary selectivity and no greater, we still have the problem of detection and audio amplification. A resistance coupled circuit is ordinarily recommended for audio frequency amplification. But it is difficult, if not impossible, to make an audio amplifier that will respond to a band of frequencies 40,000 cycles wide. Unavoidable shunt capacities will prevent gain on frequencies much above 10,000 cycles.

The problem of getting the high notes seems to be solved best by eliminating the audio amplifier entirely, that is, by stepping up the radio frequency signal until it is strong enough to load up a power detector and then put the television lamp in the plate circuit of that detector. The detector might well be of the full-wave type, that is, one that has the grids of two tubes in push-pull and the plates in parallel. Each tube should be worked near its cut-off point, that is, it should be operated as a plate bend detector. The signal voltage could be stepped up to such a value that the bias was just nullified once each cylce for each side of the circuit. That would result in a large plate current when a signal came through. But there would be practically no current without a signal.

How would this operate a neon tube? We would have to depend on the carrier to maintain a rather high average current through the neon tube and on the variation in this current for the variation in the light intensity.

### Getting the Lows

This arrangement would also solve the problem of getting the very low notes for they would be detected more thoroughly than any other. It would not be practical to use self bias on a detector of this type for there would be too much reverse feedback. It would not even be practical to obtain the bias from the B supply for there would be a considerable fluctuation in the voltage due to the great fluctuation in the current. A separate rectifier for the bias could be rigged up without any trouble. And if the power for this rectifier were taken from the a-c line the bias voltage would be constant.

In addition to providing an external bias for the power detector in order fully to get the low notes, it is also necessary to provide plenty of capacity in the B supply. It is also desirable to use a rectifier of the 83 type, or several of them if one cannot supply the current required. The point is that the regulation should be the best possible, for if it is not the voltage will drop on the peaks of the signal, especially on the low notes.

It will be useless, of course, to do anything to the receiver to bring out the low frequencies if they are not transmitted. But if the receiver is built right it will not become obsolete when transmitters have been perfected to the point where the low notes are impressed on the carrier.

### Increasing the Lines

When the number of lines is increased to 120 the necessary frequency range is doubled, yet the need for reproducing the low frequencies is not lessened, unless the number of frames is also increased. If the number of lines is 120 per frame and the number of frames 20 per second, the characteristic frequency of the signal will be 2,400 cycles instead of 1,200 cycles, and all harmonics, of course, will be doubled, except those due to the frame frequency.

Will the ultimate television receiver use some mechanical or optical scanning system or will it use some cathode ray scheme? At this time it is too early even to hazard a guess. Some prefer opticomechanical systems while others prefer cathode rays. Both methods have advantages and disadvantages, perhaps mostly disadvantages at this stage. But improvements are continually being made.

If the number of lines is to be much higher than 120 per frame it is probable that the cathode ray scanning method will come to the fore, because of the mechanical difficulty in making scanning discs and lenses for such scanners. It is quite likely that in the end, if we then have television at all, that the number of lines will not be much higher than 120 or 240. With 240 lines the frequency band required on the checker-board theory is 1,152,000 cycles, assuming 20 frames per second. This band is wider than the entire broadcast band, and it takes care of only one sideband. It is obvious that we cannot use this scheme on the low frequencies now assigned to television.

### Power Detector

It was suggested that a way of getting the highs and the lows was to omit the audio amplifier entirely and to use a power detector. One possible circuit is shown in Fig. 1. Two 59 tubes, used as triodes, are connected as a full-wave transrectifier. The grids are connected in push-pull with respect to the tuned input coil but the plates are connected in parallel. The grids are heavily biased so that when no signal is impressed neither tube draws any current. In other words, the bias is adjusted so that each tube is a plate bend detector.

Regardless of which tube is active the current flows through the neon tube and through the current-limiting rheostat. A rather small by-pass condenser is required from the plates to ground to take out some of the high frequency ripple in the rectified current. If the signal voltage is so high that the grids swing to zero bias the current pulses will be very strong and the mean value of the current, which would be registered on a milliammeter in series with the lamp, and which determines the mean brilliancy of the lamp, is also high.

For these particular tubes the required bias is of the order of 60 volts. Therefore the peak signal voltage across the entire tuned circuit ahead of the detector may be 120 volts. The insulation of the transformer should therefore be very good.

The fluctuation in the current through the neon tube that will cause changes in the illumination will be due to the modulation of the signal. That is, the mean current through the lamp will vary. If we have 100 per cent. modulation the carrier amplitude will vary between zero and twice the value of the unmodulated signal amplitude. It is the peak value for which the tubes must be biased. If we should let the unmodulated carrier peaks be equal to the bias there would be overloading on strong modulation.

# Radio University

*A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.*

**RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.**

IF a condenser and a high resistance are connected in series with each other and then in shunt with a tuned circuit is the damping on the tuned circuit materially increased?—P. C., Rye, New York.

It depends entirely on the relative values of the condenser and the resistance. If both the condenser capacity and the resistance are small the damping added to the circuit is small. If the capacity is large and the resistance small the damping is large. If both are large the damping depends mainly on the resistance, and is small if the resistance is large. If the capacity is small and the resistance large the damping will be small. A condenser alone shunted across a tuned circuit does not add to the damping but only changes the resonant frequency, assuming that a good condenser is added.

* * *

WHAT IS the principle of the radio transmission line? How is it that radio signals can be passed over lines of considerable length without any appreciable loss when an antenna near a wall or near trees will lose a great proportion of the signal?—W. G. B., Troy, New York.

One of the important features of the transmission line is that it is uniform. Another is that the impedance is low so that the signal is passed along with large current and low voltage. The line has a definite characteristic impedance. If a transformer is used at the input end to match the impedance of the signal source, the antenna for example, to the impedance of the line, and another transformer is used at the load end to match the impedance of the line to the impedance of the "sink," which may be a radio receiver, there is virtually no loss in the line. This can be proved mathematically and demonstrated experimentally.

* * *

WHEN I AM receiving distant stations with my superheterodyne I sometimes get steady pitch whistles of around 2,000 cycles. These appear to be heterodynes between stations yet I cannot see how they can be when the Federal Radio Commission will not permit a frequency deviation of more than 50 cycles per second. Can you explain the origin of these whistles? Quite often I also hear whistles which are so high that they are barely audible. I assume these to be the beats between two stations working on adjacent channels. Am I right?—C. W. J., Springfield, Ill.

The 2,000 cycle heterodynes you hear may be due to the beating of some Mexican station with an American station. To check on this point look up the Mexican stations and note with what American stations they should beat. Yes, you are right when you assume that the very high heterodynes are due to beating of two stations operating on adjacent channels. No doubt, you also hear fluttering on certain stations. This disturbance is due to two stations operating simultaneously on the same channel, but not quite synchronized. If you hear two signals on the same channel without any whistling or fluttering, you may be listening to two stations exactly synchronized, or you may have cross modulation.

* * *

IN A TEST OSCILLATOR that I built, using honeycomb coils, I find on putting a current meter in the cathode circuit that the plate current varies considerably, also erratically. That is, the erratic change is constant in relation to frequency, but the current change is a bumpy curve. I find that the current through the tube is steady from 100 on the dial (lowest frequency) to about 40 on the dial, when the current goes up rather abruptly, and then a point is reached, around 15, when it goes down to about the 100 dial setting value, and after that it goes up some more. So there you are and what do you make of it, or, rather, what shall I do about it?—O. W. A., Council Bluffs, Ia.

The change in current is due to the change in the intensity of the oscillation. If you have calibrated the oscillator yourself, on the basis of actually working it at virtually all the recorded frequencies, then the change, if any, introduced in the frequency by virtue of the current change is a part of the calibration, and nothing need be done about it. The frequency that is generated at any particular setting is the calibrated frequency, and that is what you want. If, however, you have done the calibration on the basis of a few points, and obtained the rest by interpolation or protraction, then you have no doubt introduced errors. For instance, a six-point curve would result in many errors of frequency at other than the six points. You will find that in nearly all oscillators the curve is not entirely smooth, but that a hump appears, somewhere at near the point you mention as being around 15 on the dial, although its location probably has something to do with the type and degree of coupling between plate and grid circuits. The current may be stabilized by using a high resistance load in the plate circuit, so that the tube's internal resistance is a rather small part of the total. However, then small current changes will produce large, effective voltage changes, hence you have the choice between current instability and voltage instability.

# Short-Wave Broadcast Stations

(We are indebted to the International Short-Wave Club, with headquarters at Klondyke, Ohio, U. S. A., for permission to publish this list, which includes stations authentically reported active.)

**All times are given in Eastern Standard Time, add five hours for G.M.T. Wavelength only is given. For frequency equivalent see conversion table on page 20.**

(Note—The following group of stations broadcasts musical programs. Commercial stations we listed separately.)

| *Wave Length Call* | *Location* |
|---|---|
| 14.47—LSY | Buenos Aires, Argentina. Near 4 P.M. Sundays. |
| 15.93—PLE | Bandoeng, Java. Tuesdays 8:40-10:40 A.M. |
| 16.87—W3XAL | Boundbrook, N. J. Week days. 7 A.M. to 3 P.M. |
| 19.57—W2XAD | Schenectady, N. Y. 3 to 6 P. M. daily. Sat. & Sun. 1 to 6 P.M. |
| 19.68— | Pontoise, France. 7 A.M. to 10 A.M. daily. |
| 19.73—DJB | Zeesen, Germany. 8 A.M. to 12 noon daily. |
| 19.84—HVJ | Vatican City. Broadcasts daily 5 A.M. to 5:15 A.M. |
| 19.90—T14-NRH | Heredia, Costa Rica. Saturday 11 A.M. to noon, 4-5 P.M. and 10-11 P.M. Sun. and Mon., 11 A.M. to noon and 4-5 P.M. |
| 20.60-HBJ | Geneva, Switzerland. Testing. |
| 20.95—G2NM | Sonning-on-Thames, England. Sundays. |
| 23.38— | Rabat, Morocco. Broadcasts Sunday, 7:30 to 9 A.M. |
| 25.20— | Pontoise, France. 10.30 A.M. to 1:30 P.M. daily. |
| 25.25—W8XK | Pittsburgh, Pa. 3 P.M. to 9 P.M. Daily. |
| 25.34—W9XAA | Chicago, Ill. Relays WCFL, irregularly. |
| 25.40—12RO | Rome, Italy. Broadcasts 11 A. M. to 12:30 and 3 to 5:30 P.M. |
| 25.42—W1XAL | Boston, Mass. testing, irregularly. |
| 25.53—G5SW | Chelmsford, England. Monday to Friday, 6:45 A.M. to 7:30 A.M. and 12:30 to 6:10 P.M. Sat. 7-8 A.M. and 12:30 to 6:10 P.M. |
| 25.60— | Pontoise, France. 3 P.M. till 6 P.M. Daily. |
| 25.60—VE9JR | Winnipeg, Canada. Daily exc. Sat. and Sun., 11:45 A.M. to 1:30 P.M. |
| 26.83—CT3AQ | Funchal, Madeira. Tues.-Thurs., 5 to 6:30 P.M.; Sun. 10:30 A.M. to noon. |
| 28.98—LSX | Buenos Aires, Argentina. Daily, 8 to 9 P.M. |
| 29.26—D1Q | Zeesen Germany. Used irregular. |
| 30-40—EAQ | Madrid, Spain. 6:30 to 8 P.M. daily. Sat. 1 to 3 P.M. |
| 31.00—T14NRH | Heredia, Costa Rica. Daily exc. Sunday 9 to 10 P.M. |
| 31.25—CT1AA | Lisbon, Portugal. Heard Tues., Thurs., Fri., 4 to 7 P.M. |
| 31.28—VK2ME | Sydney, Australia. Saturday midnight to Sunday 2 A.M., 4:30 to 8:30 A.M. and 1:30 to 3:30 P.M. |
| 31.30—HBL | Praquins, Switzerland. Testing near 4 P.M. |
| 31.36—W1XAZ | Springfield, Mass. 3:30 P.M. to 11:30 P.M. Daily. |
| 31.38—DJA | Zeesen, Germany. 2 P.M. to 6:30 P.M. daily. |
| 31.40—VK3ME | Melbourne, Australia. Wed. 5 till 6:30 A.M., Sat. 5-7 A.M. |
| 31.48—W2XAF | Schenectady, N. Y. Relays WGY daily 5 P.M. to 11 P.M. |
| 31.51—OXY | Skamleback, Denmark. Broadcasts 2 to 6:30 P.M. |
| 31.58—PRBA | Rio de Janeiro, Brazil. Heard between 6 P.M. and 8:30 P.M. |
| 32.26— | Rabat, Morocco, broadcasts, Sundays, 3 to 5 P.M. |
| 33.50—TGX | Guatemala City, Guatemala. Saturdays 10 P.M. till midnight. |
| 34.68—VE9BY | London, Canada. Mondays 3 to 4 P.M. and irregular times. |
| 38.60—HBP | Geneva, Switzerland. Testing. |
| 39.40—HJ3ABF | Bogota, Colombia. 7 P.M. to 11 P.M. |
| 40.50—HJ3ABD | Bogota, Columbia. Tues., Thur., Sat., 8 to 11 P.M. |
| 41.00—CM5RY | Matanzas, Cuba. Saturdays 10:45 to 11:30 P.M. |
| 41.60—EAR58 | Teneriffe, Sat. and Sun., 4:30 P.M. to 6:00 P.M. |
| 42.00—HJ4AAB | Manizales, Colombia. Thur. and Sat. 7-9 P.M. and 11-12 P.M. |
| 42.20—HKN | Medellin, Colombia. 8 P.M. till 10 P.M. 8:30-10:30 P.M. Earlier Sun. |
| 45.31—PRADO | Riobamba, Ecuador. Thursdays, 9 P.M. till 11 P.M. |
| 46.60—REN | Moscow, U. S. S. R. Relays Moscow, 1 P.M. to 6 P.M. |
| 46.67—VE9BY | London, Canada. Wednesday 8:30-9:30 P.M. Friday 7:00-7:55 A.M. and Saturdays 8-11 P.M. |
| 46.96—W3XL | Boundbrook, N. J. No regular schedule. |
| 47.00—HKS | Cali, Colombia. Irregular, near 10 P.M. |
| 47.00—HCIDR | Quito, Ecuador. 8 P.M. till 10 P.M. |
| 47.50—TITR | San Jose, Costa Rica. 10 to 12 A.M., 4 to 9:30 P.M. |
| 48.00—HKA | Barranquilla, Col. 8 P.M. to 10 P.M. Daily. |
| 48.85—VE9CL | Winnipeg, Canada. Daily except Sun., 6 P.M. till 8:30 P.M. |
| 48.86—W8XK | Pittsburgh, Pa. 4 P.M. to 11 P.M., daily. Late Saturdays. |
| 48.95—YV11BMO | Maracaibo, Venezuela. Broadcasts, 8 to 11 P.M. |
| 49.18—W9XF | Chicago, Ill. 3:30 P.M. to 1 A.M. daily. |
| 49.18—W3XAL | Boundbrook, N. J. Saturday 4 P.M. to midnight. |
| 49.20—JB | Johannesburg, South Africa. |
| 49.22—VE9GW | Bowmanville, Can. Week days, 3-9 P.M., Sun. 11 A.M.-7 P.M. |
| 49.29—VE9BJ | St. John, N. B. Near 5 P.M. and 11 P.M. |
| 49.34—W9XAA | Chicago, Ill. Relays WCFL, Sun. 11 A.M.-9 P.M.; Wed., Sat., 8:30 A.M. to 9 P.M.; Tues. and Thurs., 8:30 A.M. to 8 P.M. |
| 49.42—VE9CS | Vancouver, B. C. Sun. 3:30 P. M. to Midnight. Fri. at 0 to 1:30 A.M. |
| 49.50—W8XAL | Cincinnati, Ohio. 5 A.M.-9:30 A.M., 12:30-2:30 P.M. and 6 P.M. to 12:30 midnight. |
| 49.50—VQ7LO | Nairobi, Kenya, Africa. Daily 11 A.M.-3:30 P.M. Tues. 3 A.M.-4 A.M. Thursday 8 A.M. to 9 A.M. |
| 49.50—CMCI | Havana, Cuba. 9 P.M.-11 P.M. |
| 49.51—ZL2ZX | Wellington, N. Z. Mon., Wed., Thur., Sat., 2:15 to 6:15 A.M. |
| 49.59—VE9HX | Halifax, N. S. Mon., Tues., 6-10 P.M. Other days 6-7 P.M. |
| 49.96—VE9DR | Drummondville, Can. Relays CFCF, 7 P.M. to 12 Midnight. |
| 50.00—RW59 | Moscow, U.S.S.R. 9 A.M.-11 A.M., 2 P.M.-5 P.M. Daily. |
| 50.00—HKD | Barranquilla, Col. Daily 8-10 P.M. |
| 50.26—HVJ | Vatican City. Broadcasts daily, 2-2:15 P.M., Sun. 5-5:30 A.M. |
| 50.60—HKO | Medellin, Colombia. Mon., Wed., Fri. 8 to 10 P.M., Tues., Thurs., Sat. and Sun., 6 to 8 P.M. |
| 51.00—HKB | Tunja, Colombia. Irregular near 10 P.M. |
| 51.72—VK3LR | Victoria, Australia. Heard 2 A.M. to 6:30 A.M. |
| 52.70—FIUI | Tananarive, Madagascar. Sat., Sun. 1-3 P.M. Other days 9:15-11:15 A.M. |
| 58.00—PMY | Bandoeng, Java. 12:40 to 2:40 A.M. and 6:40 to 9:40 A.M. |
| 62.50—W2XV | Long Island City, N. Y. Wed. and Fri. 8 till 10 P.M. |
| 62.56—VE9BY | London, Canada. Saturday midnight on. |
| 70.1—RV15 | Khabarovsk, U.S.S.R., 3 A.M.-9 A.M. |
| 109.60—VE9CI | London, Ontario. Daily 9 to 11 P.M. Sun. 11 A.M.-7 P.M. |

# Short-Wave Commercial Stations

(Note—These stations are used for relaying telephone messages between countries, ships at sea and shore stations, and aircraft and airport stations. These stations oftimes may be on the air for hours without anything taking place on them, with the exception of the aircraft stations which come on the air and back off again in an instant, or as soon as a message is delivered. They are also sometimes rented to relay radio programs. Wavelength only is given. For frequency equivalent see conversion table on page 20.)

| *Wave Length Call* | *Location* |
|---|---|
| 14.01—WKK | Lawrenceville, N. J. Phones 8 A.M. till 4 P.M. LSN. |
| 14.19—LSM | Buenos Aires, Arg. Phones Europe, mornings. |
| 14.24—WKA | Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M. |
| 14.27—LSN | Buenos Aires, Arg. Phones WLO, 8 A.M.-4 P.M. |
| 14.47—LSY | Buenos Aires, Arg. Phones 10 A.M. to 2 P.M., irregular. |
| 14.55—PMB | Bandoeng, Java. 3:10 A.M.-4:40 A.M. and 8-9:20 A.M., PCK. |
| 14.70—GBA | Rugby, England. Phones to ships and LSN, irregular. |
| 14.97—DHO | Nauen, Germany. Phone to LSG., 7 A.M.-11 A.M., Irreg. |
| 14.97—OPL | Leopoldsville, Belgian Congo. Phones ORG mornings. |
| 15.07—LSG | Buenos Aires, Arg., phone to FTM 10:30 A.M.-3:30 P.M. |
| 15.13—WKN | Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M. |
| 15.23—EAQ | Madrid, Spain. Phones to LSY 7-11 A.M., Irreg. |
| 15.24—CEC | Santiago, Chile. Phones LSR HJY near 11 A.M. and 4 P.M. |
| 15.50—FTM | St. Assise, France, 10 A.M.-2 P.M. LSG. |
| 15.57—PPU | Rio de Janeiro, Brazil. Phone to FTM, 10:30 A.M.-3 P.M. |
| 15.58—DFA | Nauen, Germany. Phone to XDA, Irreg., 10 A.M.-2 P.M. |
| 15.61—WKF | Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M. |
| 15.62—ORG | Brussels, Belgium. Testing phone, 11 A.M.-11:30 A.M. |
| 15.77—WKW W2XBJ | Rocky Point, N. Y. Testing, mornings. |
| 15.82—LSR | Buenos Aires, Arg. Phones HJY, CEC, 11 A.M. and 4 P.M. |
| 15.90—ZSB | Cape Town, South Africa, 3 A.M. to 8 A.M. GAA. |
| 15.93—PLE | Bandoeng, Java. Tues., Fri., 5:40-10:40 A.M. PCK. |
| 16.06—OCI | Lima, Peru. Testing with HJY near 2 P.M. |
| 16.11—GBU | Rugby, England. 6 A.M.-2 P.M. WMI. |
| 16.25—HJY | Bogota, Col. Phones CEC, LSR, 11 A.M. and 4 P.M. |
| 16.35—WLA | Lawrenceville, N. J. Phones England 8 A.M. till 4 P.M. |
| 16.35—ZLW | Wellington, New Zealand. Phones VK2ME irregularly. |
| 16.38—GBS | Rugby, England, 6 A.M.-2 P.M. WND. |
| 16.39—YVQ | Maracay, Venezuela. Testing, near 10 A.M., irregular. |
| 16.44—FTE | St. Assise, France. Phones to FZR, 5 to 9 A.M. |
| 16.50—PMC | Bandoeng, Java. Phones PCV, 3:10-9:20 A.M. |
| 16.54—GBW | Rugby, England, 6 A.M.-2 P.M. WNC. |
| 16.57—GBK | Bodmin, England, 6 A.M.-2 P.M. CGA. |
| 16.67—KQJ | Bolinas, California. Testing. |
| 16.82—PCV | Kootwijk, Holland, 6 A.M.-9 A.M. Java. |
| 17.05—Ships | Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ). |
| 17.52—WOO | Ocean Gate, N. J. Phones ships, irregularly. |
| 18.06—DAN | Norden, Germany. Testing with ships, 9 A.M.-12 noon. |
| 18.44—WLK | Lawrenceville, N. J. Phones England. |
| 18.56—GBX | Rugby, England, 4 P.M.-11 P.M. VK2ME. |
| 18.71—KKP | Kaunuku, Hawaii. Phones KWO, 2 P.M.-7 P.M. |
| 18.90—FTK | St. Assise, France. Phones to FZS, 9 to 10 A.M. |
| 19.03—J1AA | Kemikawa-Cho, Japan. Experimental. Heard early morn'gs. |
| 19.46—KWO | Dixon, California. Phones Hawaii 2:00 till 7:00 P.M. |
| 19.54—KWU | Dixon, California. Phones Hawaii 2:00 till 7:00 P.M. |
| 20.27—WKU W2XBJ | Rocky Point, N. Y. Testing in daytime. |
| 20.42—PSS | Rio de Janeiro, Brazil. Testing with LSN, near 6 P.M. |
| 20.56—WMN | Lawrenceville, N. J. Phones England, daylight. |
| 20.70—LSN | Buenos Aires, Argentina. Phone WLO, afternoons. |
| 20.73—WMF | Lawrenceville, N. J. Phones England, daylight. |
| 20.75—GBW | Rugby, England. Phones WNC 6 A.M.-6 P.M. |
| 20.97-21.26— | Amateur phones heard in daylight. |
| 21.63—WIY W2XBJ | Rocky Point, N. Y. Testing irregular. |
| 21.70—SUZ | Cairo, Egypt. Phones GAA 7 A.M. to 3:30 P.M. |
| 21.77—KKW | Bolinas, Calif. Used for experimenting. |
| 21.90—KKZ | Bolinas, Cal., testing irregularly. |
| 22.06—GBB-GBC | Rugby, England. Phones CGA and ships, afternoons. |
| 22.26—WAJ | Rocky Point, N. Y. R. C. A. test station. |
| | Lawrenceville, N. J. Phones England, daylight. |
| 22.40—WMA | Drummondville, Canada. Phones |
| 22.55—CGA | GBC 8 A.M. to 2 P.M. |
| 22.68—Ships | Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ). |

| Wave Length Call | Location |
|---|---|
| 22.93—J1AA | Kemikawa-Cho, Japan. Experimental tests, irregularly. |
| 23.00—German ships | 11:15 A.M. and 1:30 P.M. |
| 23.36—WOO | Ocean Gate, N. J. Phones ships, irregularly. |
| 23.38—CNR | Rabat, Morocco. Phones St. Assise, 5 A.M., 8 A.M. |
| 23.45—IAC | Coltana, Italy. Tests irregularly. |
| 24.00—DAN | Norden, Germany. Phones ships, noon to 3 P.M. |
| 24.40—PLM | Bandoeng, Java. Phones VK2ME near 6:30 A.M. |
| 24.40—ZLW | Wellington, New Zealand. Phone VK2ME, 3 to 8 A.M. |
| 24.41—GBU | Rugby, England, 2 P.M.-7 P.M. WMI. |
| 24.46—FTN | St. Assise, France. Testing with USA, daytime, irregularly. |
| 24.60—GBX | Rugby, England, 4 A.M.-9 A.M. VK2ME-VLK. |
| 24.6—GBS | Rugby, England, 2 P.M.-7 P.M. WND. |
| 25.05—KKQ | Bolinas, California. Testing irregularly. |
| 25.50—XDA | Mexico City. Testing with XAM near 1 and 6 P.M. |
| 25.65—KIO | Kauhuku, Hawaii. Phones to KES, 2 to 8 P.M. Irregular. |
| 25.67—YVQ | Maracay, Venezuela. Testing with Germany, 5-7 P.M. |
| 25.75—PPQ | Rio de Janeiro, Brazil. Testing near 6 P.M. irregularly. |
| 26.80—XAM | Merida, Yucatan, test with XDA, near noon and 6 P.M. |
| 27.35—OCI | Lima, Peru. Phone HJY evenings. |
| 27.68—KWV | Dixon, California. Phones Hawaii, irregularly. |
| 27.80—GBP | Rugby, England. Phones VLK and J1AA, 9 P.M. and 6 A.M. |
| 28.09—WNB | Lawrenceville, N. J. Phones Bermuda, daytime. |
| 28.09—GBP | Rugby, England. Testing with JIAA and others. |
| 28.12—CEC | Santiago, Chile. Testing with HJY, evenings, irreg. |
| 28.44—WOK | Lawrenceville, N. J. Phones LSN, evenings. |
| 28.5—VK2ME | Sydney, Australia, 1 A.M.-7 A.M. GBX. |
| 28.80—KEZ | Bolinas, California. Testing. |
| 28.80—PKP | Medan, Sumatra. Phones Java and VLK, 3 A.M. to 8 A.M. |
| 29.04—ORK | Brussels, Belgium. Phones OPM 2-4, 9-11 A.M. and 3-6 P.M. |
| 29.35—PSH | Rio de Janeiro, Brazil. Testing with W2XBJ, evenings. |
| 29.58—OPM | Leopoldville, Belgian Congo. Phones ORK 9-11 A.M., 3-6 P.M. |
| 29.80—VRT ZFB | Hamilton, Bermuda. Phones WNB in daytime. |
| 29.83—SUV | Cairo, Egypt. Phones GAA after 3:30 P.M. |
| 30.10—LSL | Buenos Aires, Arg. Works irreguarly. |
| 30.15—GBU | Rugby, England, 5 P.M.- 11 P.M. WMI. |
| 30.20—HJY | Bogota, Colombia. Phones OCI irreguarly, evenings. |
| 30.3—LSN | Buenos Aires, Argentina, 6 P.M.-6 A.M. WLO. |
| 30.40—WON | Lawrenceville, N. J. Phones England, evenings. |
| 30.60—GCW | Rugby, England. Phones America, evenings. |
| 30.75—VK2ME VLK | Sydney, Australia. Phones Java, 4 A.M.-8 A.M. |
| 30.77—WOF | Lawrenceville, N. J. Phones England, evenings. |
| 31.60—WEF W2BJ | Rocky Point, N. Y. Testing irregularly, evenings. |
| 31.63—PLW | Bandoeng, Java. Phones Australia, 3 A.M.-8 A.M., irregular. |
| 31.74—WES W2XBJ | Rocky Point, N. Y. Testing irregularly, evenings. |
| 31.86—PLV | Bandoeng, Java. Phones Australia and Sumatra, 4 A.M.-8 A.M. |
| 32.1—CGA | Drummondville, Can., 6 P.M.-6 A.M. GBK. |
| 32.21—GBC | Rugby, England. Phones to ships, irregularly. |
| 32.4—GBK | Bodmin, England, 6 P.M.-6 A.M. CGA. |
| 32.72—WNA | Lawrenceville, N. J. Phones England, evenings. |
| 33.25—GBS | Rugby, England, 6 P.M.-6 A.M. WND. |
| 33.27—KEJ | Bolinas, California. Testing irregularly. |
| 33.52—WEL W2XBJ | Rocky Point, N. Y. Testing irregularly, evenings. |
| 33.70—ZLT | Wellington, New Zealand. Phones VLK 1 A.M.-9 A.M. |
| 33.95—Ships | Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ). |
| 3502—WOO | Ocean Gate, N. J. Phones ships, irregularly. |
| 36.00—DAN | Norden, Germany. Phones ships 2-4 A.M. and 3-9 A.M. |
| 36.00—German ships | 2:30 A.M., 4:45 P.M. and 9:30 P.M. |
| 36.65—PSK | Rio de Janeiro, Brazil Heard phoning WOK. |
| 37.76—VK2ME | Sydney, Australia, tests, 3:00-7:00 A.M. GBX. |
| 38.07—J1AA | Kemikawa-Cho, Japan testing with KEL irregularly. |
| 38.86—KEE | Bolinas, California. Testing, irregularly. |
| 39.42—KWX | Dixon, California. Phones Hawaii, nights. |
| 39.65—KWY | Dixon, California. Phones Hawaii nights. |
| 39.89—KDK KKH | Kauhuku, Hawaii. Phones KWO 9 P.M.-2 A.M. |
| 40.54—WEM W2XBJ | Rocky Point, N. Y. Testing irregularly, evenings. |
| 42.9—GBS | Rugby, England, 6 P.M.-6 A.M. WND. |
| 43.54—KEQ | Kauhuku, Hawaii, Phones California, nights. |
| 44.41—WOA | Lawrenceville, N. J. Phones VRT, nights. |
| 44.41—WOB | Lawrenceville, N. J. Phones England, nights. |
| 44.54—WEJ W2XBJ | Rocky Point, N. Y. Testing irregularly, evenings. |
| 44.91—DGK | Nauen, Germany. Heard testing with WEJ near 9 P.M. |
| 45.10—IAC | Coltano, Italy. Testing irregularly. |
| 51.00—XDA | Mexico City, Mexico. Testing with XAM, 10 A.M.-8 P.M., irr. |
| 51.09—WNB | Lawrenceville, N. J. Phones Bermuda nights. |
| 52.00—XAM | Merida, Yucatan. Testing with XDA, 10 A.M.-8 P.M., irreg. |
| 58.30—PMY | Bandoeng, Java. Phones Australia, near 11 A.M. |
| 59.42—VRT ZFA | Hamilton, Bermuda. Phones WNB and GMBJ, nights. |
| 60.26—GBC | Rugby, England. Phones to ships, irregularly. |
| 62.70—CGA | Drummondville, Canada. Phones ships irregularly. |
| 63.13—WOO | Ocean Gate, N. J. Phones ships, irregularly. |
| 71.82—Ships | Majestic (GFWV); Olympic (GLSQ); Belgenland (GMJQ); Homeric (GDLJ); Leviathan (WNBN); Monarch of Bermuda (GTSD); Minnetonka (GKFY); Empress of Britain (GMBJ). |
| 75—75.8—Amateurs | on voice. |
| 118.06—WOX | Bell Telephone test station. Irregularly. |

## Aircraft Stations

(Note—This group of stations is used to relay messages to and from airplanes, such as location of a plane, storms coming and other things. They come on the air suddenly, deliver a message and go right off again. Airplanes in flight may be found on the same wavelength. They will be found between 53.00 and 54.00).

## Police Stations

(Note—These stations are used by police departments to relay messages to police cars that patrol the cities. They come on the air, deliver their message and go right off again. When one is tuned in, just keep the dials at the same place and ofttimes many others may be heard. They will be found between 119.71 and 124.27 also between 175.23 and 192.55.)

## Identifying Stations

Here are a few tips on identifying stations that may be heard on a short wave receiver. The call letters of each station are given and then the identification signal.

PLE—Announces in English, Dutch, and French as "Bandoeng Radio."
Pontoise—Plays "Marseillaise" at start and close of program.
DJA and DJB—Announces all stations in chain broadcast like "Berlin, Dresden, Hamburg, Stuttgart."
HVJ—Announces "Hillo, Hillo, Radio Vaticano."
RABAT—Announces "Radio Rabat." Uses beat of Mentronome.
2RO—Lady announces "Radio Roma" or "Radio Roma Napoli."
G5SW—Announces "London Calling" or G5SW, Chelmsford."
EAQ—Announces "Hillo, Ay ah, coo., Transradio, Madrid."
T14-NRH—Bugle Call or Tic-Tac between selections.
VK2ME—Laughing notes of Kookaburra Bird open and close programs.
CT1AA—Six Cuckoo calls between selections.
VK3ME—Broadcasts 9:00 o'clock chimes at 6 A.M., E. S. T.
OXY—Broadcasts midnight chimes at 6 P.M., E. S. T.
TGX—Announces "Tay, hay, aykis, Guatemala."
HKF—Announces "Achay, kah, effay, Bogota."
PRADO—Announces "Estacion El Prado, Rio Bamba, Ecuador."
HSP2—Strikes six notes on piano between selections.
HKM—Announces "Achay, kah, emmie, Bogota, Colombia."
HKA—Announces "Achay, kah, ah, Barranquilla." Uses whistle.
F3ICD—Striking of gongs and symbols between selections.
CMCI—Announces in Spanish and English.
HCJB—Announces in Spanish and English.
HKD—Announces "Achay, kah, day, Barranquilla, Colombia."
HKO—Announces "Achay, kah, oh, Medellin, Colombia."
LSG—Calls "Allo, Allo, Paree, ici Burnos Aires."
FTM—Calls "Allo, Allo, Buenos Aires, ici Paree."
IAC—Calls "Pronto, Pronto, heir is Roma."
LSX—Announces "Ellie, essie aykiss, Transradio Buenos Aires."
YV11BMO—Announces "La Vox de Lago."
GENEVA—Announces in English and French.
PRBA—Announces "Radio Club de Brazil."
American Stations—Identified by the stations they relay.

Most telephone stations can be identified by the station or city they are heard calling and judging the wavelength it is heard on. For example, if you hear a station near 17 meters calling "Hillo Bandoeng" you are almost certain it is PCV, Kootwijk, Holland, who works with the Bandoeng telephone stations on 16.82 meters.

## Literature Wanted

E. Ricalde, 406 Central Park West, New York, N. Y.
"Serviceman" Fritz H. Anderson, 1025 S. 10th Ave., Maywood, Ill.
Ted Burbin, 240 Dundas St., W., Toronto, Ont., Canada.
Cleveland Comeaux, 2009 Barrancas Avenue, Pensacola, Fla.
Laskey Radio Parts & Service, 3310 West 118th St., Cleveland, Ohio.
Oakie Altoonian, 412 9th St., Augusta, Ga.
Jack McGinn, 316 Grove St., Petoskey, Mich.
John E. Shaw, Delhi St., Guelph, Ont., Canada.
B. B. Turner, 1526 Des Moines Ave., Portsmouth, Va.
Arthur Bouvier, 2537 N. Rampart St., New Orleans, La.
Raymond A. Cole, 35 Rustic Place, Great Kills, S. I., N. Y.
George Straub, Mauch Chunk, Penna.
E. A. Showalter, 512 E. 8th St., Little Rock, Ark.
James M. Covington, Corregidor, Cavite, Philippine Islands.

The conversion table printed herewith is highly accurate, because worked out by the factor 299,820. Most tables are based on the factor 300,000, which is erroneous to 6 parts in 100,000.

The table is entirely reversible, for instance, 10 meters equal 29,982 kc., or 29,982 meters equal 10 kc. Any quantities not included in the table may be read by shifting the decimal point. If moved to the right for frequency the point is moved to the left for wavelength, and vice versa. The shift is therefore in opposite directions.

The factor 299,820 is based on the velocity of a radio wave, which is equal to the velocity of light, or 299,820,000 meters per second. By dropping the three ciphers (dividing by 1,000), the factor 299,820 is used, and the answer reads in kilocycles.

Wavelength in meters is equal to velocity divided by frequency. Frequency in cycles is equal to the velocity divided by the wavelength.

*[Prepared by Bureau of Standards, Department of Commerce. Reprinted by permission of Government Printing Office.]*

| kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc | kc or m | m or kc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 29,982 | 1,010 | 296.9 | 2,010 | 149.2 | 3,010 | 99.61 | 4,010 | 74.77 | 5,010 | 59.84 | 6,010 | 49.89 | 7,010 | 42.77 | 8,010 | 37.43 | 9,010 | 33.28 |
| 20 | 14,991 | 1,020 | 293.9 | 2,020 | 148.4 | 3,020 | 99.28 | 4,020 | 74.58 | 5,020 | 59.73 | 6,020 | 49.80 | 7,020 | 42.71 | 8,020 | 37.38 | 9,020 | 33.24 |
| 30 | 9,994 | 1,030 | 291.1 | 2,030 | 147.7 | 3,030 | 98.95 | 4,030 | 74.40 | 5,030 | 59.61 | 6,030 | 49.72 | 7,030 | 42.65 | 8,030 | 37.34 | 9,030 | 33.20 |
| 40 | 7,496 | 1,040 | 288.3 | 2,040 | 147.0 | 3,040 | 98.62 | 4,040 | 74.21 | 5,040 | 59.49 | 6,040 | 49.64 | 7,040 | 42.59 | 8,040 | 37.29 | 9,040 | 33.17 |
| 50 | 5,996 | 1,050 | 285.5 | 2,050 | 146.3 | 3,050 | 98.30 | 4,050 | 74.03 | 5,050 | 59.37 | 6,050 | 49.56 | 7,050 | 42.53 | 8,050 | 37.24 | 9,050 | 33.13 |
| 60 | 4,997 | 1,060 | 282.8 | 2,060 | 145.5 | 3,060 | 97.98 | 4,060 | 73.85 | 5,060 | 59.25 | 6,060 | 49.48 | 7,060 | 42.47 | 8,060 | 37.20 | 9,060 | 33.09 |
| 70 | 4,283 | 1,070 | 280.2 | 2,070 | 144.8 | 3,070 | 97.66 | 4,070 | 73.67 | 5,070 | 59.13 | 6,070 | 49.39 | 7,070 | 42.41 | 8,070 | 37.15 | 9,070 | 33.06 |
| 80 | 3,748 | 1,080 | 277.6 | 2,080 | 144.1 | 3,080 | 97.34 | 4,080 | 73.49 | 5,080 | 59.02 | 6,080 | 49.31 | 7,080 | 42.35 | 8,080 | 37.11 | 9,080 | 33.02 |
| 90 | 3,331 | 1,090 | 275.1 | 2,090 | 143.5 | 3,090 | 97.03 | 4,090 | 73.31 | 5,090 | 58.90 | 6,090 | 49.23 | 7,090 | 42.29 | 8,090 | 37.06 | 9,090 | 32.98 |
| 100 | 2,998 | 1,100 | 272.6 | 2,100 | 142.8 | 3,100 | 96.72 | 4,100 | 73.13 | 5,100 | 58.79 | 6,100 | 49.15 | 7,100 | 42.23 | 8,100 | 37.01 | 9,100 | 32.95 |
| 110 | 2,726 | 1,110 | 270.1 | 2,110 | 142.1 | 3,110 | 96.41 | 4,110 | 72.95 | 5,110 | 58.67 | 6,110 | 49.07 | 7,110 | 42.17 | 8,110 | 36.97 | 9,110 | 32.91 |
| 120 | 2,499 | 1,120 | 267.7 | 2,120 | 141.4 | 3,120 | 96.10 | 4,120 | 72.77 | 5,120 | 58.56 | 6,120 | 48.99 | 7,120 | 42.11 | 8,120 | 36.92 | 9,120 | 32.88 |
| 130 | 2,306 | 1,130 | 265.3 | 2,130 | 140.8 | 3,130 | 95.79 | 4,130 | 72.60 | 5,130 | 58.44 | 6,130 | 48.91 | 7,130 | 42.05 | 8,130 | 36.88 | 9,130 | 32.84 |
| 140 | 2,142 | 1,140 | 263.0 | 2,140 | 140.1 | 3,140 | 95.48 | 4,140 | 72.42 | 5,140 | 58.33 | 6,140 | 48.83 | 7,140 | 41.99 | 8,140 | 36.83 | 9,140 | 32.80 |
| 150 | 1,999 | 1,150 | 260.7 | 2,150 | 139.5 | 3,150 | 95.18 | 4,150 | 72.25 | 5,150 | 58.22 | 6,150 | 48.75 | 7,150 | 41.93 | 8,150 | 36.79 | 9,150 | 32.77 |
| 160 | 1,874 | 1,160 | 258.5 | 2,160 | 138.8 | 3,160 | 94.88 | 4,160 | 72.07 | 5,160 | 58.10 | 6,160 | 48.67 | 7,160 | 41.87 | 8,160 | 36.74 | 9,160 | 32.73 |
| 170 | 1,764 | 1,170 | 256.3 | 2,170 | 138.1 | 3,170 | 94.58 | 4,170 | 71.90 | 5,170 | 57.99 | 6,170 | 48.59 | 7,170 | 41.82 | 8,170 | 36.70 | 9,170 | 32.70 |
| 180 | 1,666 | 1,180 | 254.1 | 2,180 | 137.5 | 3,180 | 94.28 | 4,180 | 71.73 | 5,180 | 57.88 | 6,180 | 48.51 | 7,180 | 41.76 | 8,180 | 36.65 | 9,180 | 32.66 |
| 190 | 1,578 | 1,190 | 252.0 | 2,190 | 136.9 | 3,190 | 93.99 | 4,190 | 71.56 | 5,190 | 57.77 | 6,190 | 48.44 | 7,190 | 41.70 | 8,190 | 36.61 | 9,190 | 32.62 |
| 200 | 1,499 | 1,200 | 249.9 | 2,200 | 136.3 | 3,200 | 93.69 | 4,200 | 71.39 | 5,200 | 57.66 | 6,200 | 48.36 | 7,200 | 41.64 | 8,200 | 36.56 | 9,200 | 32.59 |
| 210 | 1,428 | 1,210 | 247.8 | 2,210 | 135.7 | 3,210 | 93.40 | 4,210 | 71.22 | 5,210 | 57.55 | 6,210 | 48.28 | 7,210 | 41.58 | 8,210 | 36.52 | 9,210 | 32.55 |
| 220 | 1,363 | 1,220 | 245.8 | 2,220 | 135.1 | 3,220 | 93.11 | 4,220 | 71.05 | 5,220 | 57.44 | 6,220 | 48.20 | 7,220 | 41.53 | 8,220 | 36.47 | 9,220 | 32.52 |
| 230 | 1,304 | 1,230 | 243.8 | 2,230 | 134.4 | 3,230 | 92.82 | 4,230 | 70.88 | 5,230 | 57.33 | 6,230 | 48.13 | 7,230 | 41.47 | 8,230 | 36.43 | 9,230 | 32.48 |
| 240 | 1,249 | 1,240 | 241.8 | 2,240 | 133.8 | 3,240 | 92.54 | 4,240 | 70.71 | 5,240 | 57.22 | 6,240 | 48.05 | 7,240 | 41.41 | 8,240 | 36.39 | 9,240 | 32.45 |
| 250 | 1,199 | 1,250 | 239.9 | 2,250 | 133.3 | 3,250 | 92.25 | 4,250 | 70.55 | 5,250 | 57.11 | 6,250 | 47.97 | 7,250 | 41.35 | 8,250 | 36.34 | 9,250 | 32.41 |
| 260 | 1,153 | 1,260 | 238.0 | 2,260 | 132.7 | 3,260 | 91.97 | 4,260 | 70.38 | 5,260 | 57.00 | 6,260 | 47.89 | 7,260 | 41.30 | 8,260 | 36.30 | 9,260 | 32.38 |
| 270 | 1,110 | 1,270 | 236.1 | 2,270 | 132.1 | 3,270 | 91.69 | 4,270 | 70.22 | 5,270 | 56.89 | 6,270 | 47.82 | 7,270 | 41.24 | 8,270 | 36.25 | 9,270 | 32.34 |
| 280 | 1,071 | 1,280 | 234.2 | 2,280 | 131.5 | 3,280 | 91.41 | 4,280 | 70.05 | 5,280 | 56.78 | 6,280 | 47.74 | 7,280 | 41.18 | 8,280 | 36.21 | 9,280 | 32.31 |
| 290 | 1,034 | 1,290 | 232.4 | 2,290 | 130.9 | 3,290 | 91.13 | 4,290 | 69.89 | 5,290 | 56.68 | 6,290 | 47.67 | 7,290 | 41.13 | 8,290 | 36.17 | 9,290 | 32.27 |
| 300 | 999.4 | 1,300 | 230.6 | 2,300 | 130.4 | 3,300 | 90.86 | 4,300 | 69.73 | 5,300 | 56.57 | 6,300 | 47.59 | 7,300 | 41.07 | 8,300 | 36.12 | 9,300 | 32.24 |
| 310 | 967.2 | 1,310 | 228.9 | 2,310 | 129.8 | 3,310 | 90.58 | 4,310 | 69.56 | 5,310 | 56.46 | 6,310 | 47.52 | 7,310 | 41.02 | 8,310 | 36.08 | 9,310 | 32.20 |
| 320 | 936.9 | 1,320 | 227.1 | 2,320 | 129.2 | 3,320 | 90.31 | 4,320 | 69.40 | 5,320 | 56.36 | 6,320 | 47.44 | 7,320 | 40.96 | 8,320 | 36.04 | 9,320 | 32.17 |
| 330 | 908.6 | 1,330 | 225.4 | 2,330 | 128.7 | 3,330 | 90.04 | 4,330 | 69.24 | 5,330 | 56.25 | 6,330 | 47.36 | 7,330 | 40.90 | 8,330 | 35.99 | 9,330 | 32.14 |
| 340 | 881.8 | 1,340 | 223.7 | 2,340 | 128.1 | 3,340 | 89.77 | 4,340 | 69.08 | 5,340 | 56.15 | 6,340 | 47.29 | 7,340 | 40.85 | 8,340 | 35.95 | 9,340 | 32.10 |
| 350 | 856.6 | 1,350 | 222.1 | 2,350 | 127.6 | 3,350 | 89.50 | 4,350 | 68.92 | 5,350 | 56.04 | 6,350 | 47.22 | 7,350 | 40.79 | 8,350 | 35.91 | 9,350 | 32.07 |
| 360 | 832.8 | 1,360 | 220.4 | 2,360 | 127.0 | 3,360 | 89.23 | 4,360 | 68.77 | 5,360 | 55.94 | 6,360 | 47.14 | 7,360 | 40.74 | 8,360 | 35.86 | 9,360 | 32.03 |
| 370 | 810.3 | 1,370 | 218.8 | 2,370 | 126.5 | 3,370 | 88.97 | 4,370 | 68.61 | 5,370 | 55.83 | 6,370 | 47.07 | 7,370 | 40.68 | 8,370 | 35.82 | 9,370 | 32.00 |
| 380 | 789.0 | 1,380 | 217.3 | 2,380 | 126.0 | 3,380 | 88.70 | 4,380 | 68.45 | 5,380 | 55.73 | 6,380 | 46.99 | 7,380 | 40.63 | 8,380 | 35.78 | 9,380 | 31.96 |
| 390 | 768.8 | 1,390 | 215.7 | 2,390 | 125.4 | 3,390 | 88.44 | 4,390 | 68.30 | 5,390 | 55.63 | 6,390 | 46.92 | 7,390 | 40.57 | 8,390 | 35.74 | 9,390 | 31.93 |
| 400 | 749.6 | 1,400 | 214.2 | 2,400 | 124.9 | 3,400 | 88.18 | 4,400 | 68.14 | 5,400 | 55.52 | 6,400 | 46.85 | 7,400 | 40.52 | 8,400 | 35.69 | 9,400 | 31.90 |
| 410 | 731.3 | 1,410 | 212.6 | 2,410 | 124.4 | 3,410 | 87.92 | 4,410 | 67.99 | 5,410 | 55.42 | 6,410 | 46.77 | 7,410 | 40.46 | 8,410 | 35.65 | 9,410 | 31.86 |
| 420 | 713.9 | 1,420 | 211.1 | 2,420 | 123.9 | 3,420 | 87.67 | 4,420 | 67.83 | 5,420 | 55.32 | 6,420 | 46.70 | 7,420 | 40.41 | 8,420 | 35.61 | 9,420 | 31.83 |
| 430 | 697.3 | 1,430 | 209.7 | 2,430 | 123.4 | 3,430 | 87.41 | 4,430 | 67.68 | 5,430 | 55.22 | 6,430 | 46.63 | 7,430 | 40.35 | 8,430 | 35.57 | 9,430 | 31.79 |
| 440 | 681.4 | 1,440 | 208.2 | 2,440 | 122.9 | 3,440 | 87.16 | 4,440 | 67.53 | 5,440 | 55.11 | 6,440 | 46.56 | 7,440 | 40.30 | 8,440 | 35.52 | 9,440 | 31.76 |
| 450 | 666.3 | 1,450 | 206.8 | 2,450 | 122.4 | 3,450 | 86.90 | 4,450 | 67.38 | 5,450 | 55.01 | 6,450 | 46.48 | 7,450 | 40.24 | 8,450 | 35.48 | 9,450 | 31.73 |
| 460 | 651.8 | 1,460 | 205.4 | 2,460 | 121.9 | 3,460 | 86.65 | 4,460 | 67.22 | 5,460 | 54.91 | 6,460 | 46.41 | 7,460 | 40.19 | 8,460 | 35.44 | 9,460 | 31.69 |
| 470 | 637.9 | 1,470 | 204.0 | 2,470 | 121.4 | 3,470 | 86.40 | 4,470 | 67.07 | 5,470 | 54.81 | 6,470 | 46.34 | 7,470 | 40.14 | 8,470 | 35.40 | 9,470 | 31.66 |
| 480 | 624.6 | 1,480 | 202.6 | 2,480 | 120.9 | 3,480 | 86.16 | 4,480 | 66.92 | 5,480 | 54.71 | 6,480 | 46.27 | 7,480 | 40.08 | 8,480 | 35.36 | 9,480 | 31.63 |
| 490 | 611.9 | 1,490 | 201.2 | 2,490 | 120.4 | 3,490 | 85.91 | 4,490 | 66.78 | 5,490 | 54.61 | 6,490 | 46.20 | 7,490 | 40.03 | 8,490 | 35.31 | 9,490 | 31.59 |
| 500 | 599.6 | 1,500 | 199.9 | 2,500 | 119.9 | 3,500 | 85.66 | 4,500 | 66.63 | 5,500 | 54.51 | 6,500 | 46.13 | 7,500 | 39.98 | 8,500 | 35.27 | 9,500 | 31.56 |
| 510 | 587.9 | 1,510 | 198.6 | 2,510 | 119.5 | 3,510 | 85.42 | 4,510 | 66.48 | 5,510 | 54.41 | 6,510 | 46.06 | 7,510 | 39.92 | 8,510 | 35.23 | 9,510 | 31.53 |
| 520 | 576.6 | 1,520 | 197.2 | 2,520 | 119.0 | 3,520 | 85.18 | 4,520 | 66.33 | 5,520 | 54.32 | 6,520 | 45.98 | 7,520 | 39.87 | 8,520 | 35.19 | 9,520 | 31.49 |
| 530 | 565.7 | 1,530 | 196.0 | 2,530 | 118.5 | 3,530 | 84.94 | 4,530 | 66.19 | 5,530 | 54.22 | 6,530 | 45.91 | 7,530 | 39.82 | 8,530 | 35.15 | 9,530 | 31.46 |
| 540 | 555.2 | 1,540 | 194.7 | 2,540 | 118.0 | 3,540 | 84.70 | 4,540 | 66.04 | 5,540 | 54.12 | 6,540 | 45.84 | 7,540 | 39.76 | 8,540 | 35.11 | 9,540 | 31.43 |
| 550 | 545.1 | 1,550 | 193.4 | 2,550 | 117.6 | 3,550 | 84.46 | 4,550 | 65.89 | 5,550 | 54.02 | 6,550 | 45.77 | 7,550 | 39.71 | 8,550 | 35.07 | 9,550 | 31.39 |
| 560 | 535.4 | 1,560 | 192.2 | 2,560 | 117.1 | 3,560 | 84.22 | 4,560 | 65.75 | 5,560 | 53.92 | 6,560 | 45.70 | 7,560 | 39.66 | 8,560 | 35.03 | 9,560 | 31.36 |
| 570 | 526.0 | 1,570 | 191.0 | 2,570 | 116.7 | 3,570 | 83.98 | 4,570 | 65.61 | 5,570 | 53.83 | 6,570 | 45.63 | 7,570 | 39.61 | 8,570 | 34.98 | 9,570 | 31.33 |
| 580 | 516.9 | 1,580 | 189.8 | 2,580 | 116.2 | 3,580 | 83.75 | 4,580 | 65.46 | 5,580 | 53.73 | 6,580 | 45.57 | 7,580 | 39.55 | 8,580 | 34.94 | 9,580 | 31.30 |
| 590 | 508.2 | 1,590 | 188.6 | 2,590 | 115.8 | 3,590 | 83.52 | 4,590 | 65.32 | 5,590 | 53.64 | 6,590 | 45.50 | 7,590 | 39.50 | 8,590 | 34.90 | 9,590 | 31.26 |
| 600 | 499.7 | 1,600 | 187.4 | 2,600 | 115.3 | 3,600 | 83.28 | 4,600 | 65.18 | 5,600 | 53.54 | 6,600 | 45.43 | 7,600 | 39.45 | 8,600 | 34.86 | 9,600 | 31.23 |
| 610 | 491.5 | 1,610 | 186.2 | 2,610 | 114.9 | 3,610 | 83.05 | 4,610 | 65.04 | 5,610 | 53.44 | 6,610 | 45.36 | 7,610 | 39.40 | 8,610 | 34.82 | 9,610 | 31.20 |
| 620 | 483.6 | 1,620 | 185.1 | 2,620 | 114.4 | 3,620 | 82.82 | 4,620 | 64.90 | 5,620 | 53.35 | 6,620 | 45.29 | 7,620 | 39.35 | 8,620 | 34.78 | 9,620 | 31.17 |
| 630 | 475.9 | 1,630 | 183.9 | 2,630 | 114.0 | 3,630 | 82.60 | 4,630 | 64.76 | 5,630 | 53.25 | 6,630 | 45.22 | 7,630 | 39.29 | 8,630 | 34.74 | 9,630 | 31.13 |
| 640 | 468.5 | 1,640 | 182.8 | 2,640 | 113.6 | 3,640 | 82.37 | 4,640 | 64.62 | 5,640 | 53.16 | 6,640 | 45.15 | 7,640 | 39.24 | 8,640 | 34.70 | 9,640 | 31.10 |
| 650 | 461.3 | 1,650 | 181.7 | 2,650 | 113.1 | 3,650 | 82.14 | 4,650 | 64.48 | 5,650 | 53.07 | 6,650 | 45.09 | 7,650 | 39.19 | 8,650 | 34.66 | 9,650 | 31.07 |
| 660 | 454.3 | 1,660 | 180.6 | 2,660 | 112.7 | 3,660 | 81.92 | 4,660 | 64.34 | 5,660 | 52.97 | 6,660 | 45.02 | 7,660 | 39.14 | 8,660 | 34.62 | 9,660 | 31.04 |
| 670 | 447.5 | 1,670 | 179.5 | 2,670 | 112.3 | 3,670 | 81.70 | 4,670 | 64.20 | 5,670 | 52.88 | 6,670 | 44.95 | 7,670 | 39.09 | 8,670 | 34.58 | 9,670 | 31.01 |
| 680 | 440.9 | 1,680 | 178.5 | 2,680 | 111.9 | 3,680 | 81.47 | 4,680 | 64.06 | 5,680 | 52.79 | 6,680 | 44.88 | 7,680 | 39.04 | 8,680 | 34.54 | 9,680 | 30.97 |
| 690 | 434.5 | 1,690 | 177.4 | 2,690 | 111.5 | 3,690 | 81.25 | 4,690 | 63.93 | 5,690 | 52.69 | 6,690 | 44.82 | 7,690 | 38.99 | 8,690 | 34.50 | 9,690 | 30.94 |
| 700 | 428.3 | 1,700 | 176.4 | 2,700 | 111.0 | 3,700 | 81.03 | 4,700 | 63.79 | 5,700 | 52.60 | 6,700 | 44.75 | 7,700 | 38.94 | 8,700 | 34.46 | 9,700 | 30.91 |
| 710 | 422.3 | 1,710 | 175.3 | 2,710 | 110.6 | 3,710 | 80.81 | 4,710 | 63.66 | 5,710 | 52.51 | 6,710 | 44.68 | 7,710 | 38.89 | 8,710 | 34.42 | 9,710 | 30.88 |
| 720 | 416.4 | 1,720 | 174.3 | 2,720 | 110.2 | 3,720 | 80.60 | 4,720 | 63.52 | 5,720 | 52.42 | 6,720 | 44.62 | 7,720 | 38.84 | 8,720 | 34.38 | 9,720 | 30.85 |
| 730 | 410.7 | 1,730 | 173.3 | 2,730 | 109.8 | 3,730 | 80.38 | 4,730 | 63.39 | 5,730 | 52.32 | 6,730 | 44.55 | 7,730 | 38.79 | 8,730 | 34.34 | 9,730 | 30.81 |
| 740 | 405.2 | 1,740 | 172.3 | 2,740 | 109.4 | 3,740 | 80.17 | 4,740 | 63.25 | 5,740 | 52.23 | 6,740 | 44.48 | 7,740 | 38.74 | 8,740 | 34.30 | 9,740 | 30.78 |
| 750 | 399.8 | 1,750 | 171.3 | 2,750 | 109.0 | 3,750 | 79.95 | 4,750 | 63.12 | 5,750 | 52.14 | 6,750 | 44.42 | 7,750 | 38.69 | 8,750 | 34.27 | 9,750 | 30.75 |
| 760 | 394.5 | 1,760 | 170.4 | 2,760 | 108.6 | 3,760 | 79.74 | 4,760 | 62.99 | 5,760 | 52.05 | 6,760 | 44.35 | 7,760 | 38.64 | 8,760 | 34.23 | 9,760 | 30.72 |
| 770 | 389.4 | 1,770 | 169.4 | 2,770 | 108.2 | 3,770 | 79.53 | 4,770 | 62.86 | 5,770 | 51.96 | 6,770 | 44.29 | 7,770 | 38.59 | 8,770 | 34.19 | 9,770 | 30.69 |
| 780 | 384.4 | 1,780 | 168.4 | 2,780 | 107.8 | 3,780 | 79.32 | 4,780 | 62.72 | 5,780 | 51.87 | 6,780 | 44.22 | 7,780 | 38.54 | 8,780 | 34.15 | 9,780 | 30.66 |
| 790 | 379.5 | 1,790 | 167.5 | 2,790 | 107.5 | 3,790 | 79.11 | 4,790 | 62.59 | 5,790 | 51.78 | 6,790 | 44.16 | 7,790 | 38.49 | 8,790 | 34.11 | 9,790 | 30.63 |
| 800 | 374.8 | 1,800 | 166.6 | 2,800 | 107.1 | 3,800 | 78.90 | 4,800 | 62.46 | 5,800 | 51.69 | 6,800 | 44.09 | 7,800 | 38.44 | 8,800 | 34.07 | 9,800 | 30.59 |
| 810 | 370.2 | 1,810 | 165.6 | 2,810 | 106.7 | 3,810 | 78.69 | 4,810 | 62.33 | 5,810 | 51.60 | 6,810 | 44.03 | 7,810 | 38.39 | 8,810 | 34.03 | 9,810 | 30.56 |
| 820 | 365.6 | 1,820 | 164.7 | 2,820 | 106.3 | 3,820 | 78.49 | 4,820 | 62.20 | 5,820 | 51.52 | 6,820 | 43.96 | 7,820 | 38.34 | 8,820 | 33.99 | 9,820 | 30.53 |
| 830 | 361.2 | 1,830 | 163.8 | 2,830 | 105.9 | 3,830 | 78.28 | 4,830 | 62.07 | 5,830 | 51.43 | 6,830 | 43.90 | 7,830 | 38.29 | 8,830 | 33.95 | 9,830 | 30.50 |
| 840 | 356.9 | 1,840 | 162.9 | 2,840 | 105.6 | 3,840 | 78.08 | 4,840 | 61.95 | 5,840 | 51.34 | 6,840 | 43.83 | 7,840 | 38.24 | 8,840 | 33.92 | 9,840 | 30.47 |
| 850 | 352.7 | 1,850 | 162.1 | 2,850 | 105.2 | 3,850 | 77.88 | 4,850 | 61.82 | 5,850 | 51.25 | 6,850 | 43.77 | 7,850 | 38.19 | 8,850 | 33.88 | 9,850 | 30.44 |
| 860 | 348.6 | 1,860 | 161.2 | 2,860 | 104.8 | 3,860 | 77.67 | 4,860 | 61.69 | 5,860 | 51.16 | 6,860 | 43.71 | 7,860 | 38.14 | 8,860 | 33.84 | 9,860 | 30.41 |
| 870 | 344.6 | 1,870 | 160.3 | 2,870 | 104.5 | 3,870 | 77.47 | 4,870 | 61.56 | 5,870 | 51.08 | 6,870 | 43.64 | 7,870 | 38.10 | 8,870 | 33.80 | 9,870 | 30.38 |
| 880 | 340.7 | 1,880 | 159.5 | 2,880 | 104.1 | 3,880 | 77.27 | 4,880 | 61.44 | 5,880 | 50.99 | 6,880 | 43.58 | 7,880 | 38.05 | 8,880 | 33.76 | 9,880 | 30.35 |
| 890 | 336.9 | 1,890 | 158.6 | 2,890 | 103.7 | 3,890 | 77.07 | 4,890 | 61.31 | 5,890 | 50.90 | 6,890 | 43.52 | 7,890 | 38.00 | 8,890 | 33.73 | 9,890 | 30.32 |
| 900 | 333.1 | 1,900 | 157.8 | 2,900 | 103.4 | 3,900 | 76.88 | 4,900 | 61.19 | 5,900 | 50.82 | 6,900 | 43.45 | 7,900 | 37.95 | 8,900 | 33.69 | 9,900 | 30.28 |
| 910 | 329.5 | 1,910 | 157.0 | 2,910 | 103.0 | 3,910 | 76.68 | 4,910 | 61.06 | 5,910 | 50.73 | 6,910 | 43.39 | 7,910 | 37.90 | 8,910 | 33.65 | 9,910 | 30.25 |
| 920 | 325.9 | 1,920 | 156.2 | 2,920 | 102.7 | 3,920 | 76.48 | 4,920 | 60.94 | 5,920 | 50.65 | 6,920 | 43.33 | 7,920 | 37.86 | 8,920 | 33.61 | 9,920 | 30.22 |
| 930 | 322.4 | 1,930 | 155.3 | 2,930 | 102.3 | 3,930 | 76.29 | 4,930 | 60.82 | 5,930 | 50.56 | 6,930 | 43.26 | 7,930 | 37.81 | 8,930 | 33.57 | 9,930 | 30.19 |
| 940 | 319.0 | 1,940 | 154.5 | 2,940 | 102.0 | 3,940 | 76.10 | 4,940 | 60.69 | 5,940 | 50.47 | 6,940 | 43.20 | 7,940 | 37.76 | 8,940 | 33.54 | 9,940 | 30.16 |
| 950 | 315.6 | 1,950 | 153.8 | 2,950 | 101.6 | 3,950 | 75.90 | 4,950 | 60.57 | 5,950 | 50.39 | 6,950 | 43.14 | 7,950 | 37.71 | 8,950 | 33.50 | 9,950 | 30.13 |
| 960 | 312.3 | 1,960 | 153.0 | 2,960 | 101.3 | 3,960 | 75.71 | 4,960 | 60.45 | 5,960 | 50.31 | 6,960 | 43.08 | 7,960 | 37.67 | 8,960 | 33.46 | 9,960 | 30.10 |
| 970 | 309.1 | 1,970 | 152.2 | 2,970 | 100.9 | 3,970 | 75.52 | 4,970 | 60.33 | 5,970 | 50.22 | 6,970 | 43.02 | 7,970 | 37.62 | 8,970 | 33.42 | 9,970 | 30.07 |
| 980 | 303.9 | 1,980 | 151.4 | 2,980 | 100.6 | 3,980 | 75.33 | 4,980 | 60.20 | 5,980 | 50.14 | 6,980 | 42.95 | 7,980 | 37.57 | 8,980 | 33.39 | 9,980 | 30.04 |
| 990 | 302.8 | 1,990 | 150.7 | 2,990 | 100.3 | 3,990 | 75.14 | 4,990 | 60.08 | 5,990 | 50.05 | 6,990 | 42.89 | 7,990 | 37.52 | 8,990 | 33.35 | 9,990 | 30.01 |
| 1,000 | 299.8 | 2,000 | 149.9 | 3,000 | 99.94 | 4,000 | 74.96 | 5,000 | 59.96 | 6,000 | 49.97 | 7,000 | 42.83 | 8,000 | 37.48 | 9,000 | 33.31 | 10,000 | 29.98 |

# STATION SPARKS
## By Alice Remsen

## The Dancer of Dreams
### FOR "TANGEE MUSICAL DREAMS"

**WLW to WJZ, 7:45 p. m., Tuesdays**

**Rustle of wind in the rushes,
Sweet rhythmic song of the thrushes;
Slim body poised for the dancing,
Over a white shoulder glancing,
Waiting for music entrancing;
Butterfly ready for flight—
Waving her wings in the light.**

**Pliant limbs gracefully dipping,
Thru the dance witchingly slipping;
Flame-colored chiffon and roses,
Fluttering down as she poses;
Girlish abandon discloses
Satiny skin of the maid—
Bloom of the peach is displayed.**

**Now on her toes she is dancing,
Water sprite slender advancing;
Beating a pulse to the singing
Music of violins, ringing;
Half-buried memories bringing.
Star in the midnight blue sky—
Borne on the breath of a sigh.**

**Wild throbbing heart 'neath her vesture,
Pale arms outflung in a gesture;
Fingertips languidly lifting,
Thru the air mystically drifting;
Petals the mirrowed lake rifting;
Powdered with silvery beams—
Such is the dancer of dreams.**

**—A. R.**

* * *

**And When You Listen to the Tangee Musical Dreams** you, too, will visualize just such a dancer—drifting through the golden haze of memory—bringing unforgettable visions of delightful charm. Listen in; you'll like this program!

* * *

## The Radio Rialto

Well, here I am in Cincinnati, Ohio; and I like it; left New York on Friday, November 11th, at 3:40 p. m., via the Pennsylvania, on the Spirit of St. Louis . . . a crack train, but to tell you the truth, I thought my spine would crack before I arrived at my destination . . . the roadbed was so curvy and Mr. Pennsylvania was too demonstrative in the matter of uncoupling cars and changing engines in the middle of the night; didn't sleep a wink; however, arrived safely and only forty minutes late . . . went to the Netherland Plaza Hotel, where Gus Arnheim and his orchestra hold forth. . . . This is really one of the finest hotels I ever encountered in my wanderings.

First thing I did was to hop a taxi . . . "15 and 5," the same as we in New York . . . and out to Station WLW . . . about fifteen miutes' ride from the center of the city, atop the Crosley radio plant . . . there I was greeted by Richard Nichols, the assistant manager, who took me around and introduced me to the folks —and that's just what they all are, real folks . . . and am I glad I'm here?—well rather! . . . there is Mrs. Grace Clauve Raine, the vocal director, a very charming lady; and Bill Stoess, head of the music department, who has been with the station for nine years, since WLW had only one studio, and Bill wrote continuity, directed programs, played fiddle and met himself coming and going; he's a great lad; John Clark, the station manager, I had already met, but was glad to see him again; he has one of the most fetching smiles I ever saw on a human being . . . an old friend of mine is here also, Jeff Sparks, who used to announce over NBC . . . Jeff looks well and sends love to all his friends in little old New York. . . . Met a few of the staff artists who are well known in New York: Thelma Kessler, dark-haired soprano, who is on the air four times weekly for the R. J. Dun Cigar Company; Joe Emerson, who also sings several times a week for a commercial sponsor; "Fats" Waller, the colored composer, and his company of entertainers; Vera Ross, clever comedienne, and Contrulli, who came here with an opera company and remained with WLW; all charming people.

So much for my first visit to the studios; I was so dog tired, Mr. Nichols said I should go home and sleep . . . and did I? . . . well—I woke up several hours later, hungry as a bear . . . went downstairs to the Restaurant Continentale, had an excellent dinner, and met the slick-haired Gus Arnheim. . . . He has a good band, very rhythmic. . . . Several entertainers, including Dorothy Thomas, Meri Bell and Bud Struck, vocalists, and the three Rhythm Rascals . . . By the way, I almost forgot to tell you that Paul Stewart, dramatic actor, came down on the same train with me, to join the happy WLW family. . . . Several people came to the station to wish Paul godspeed; these included his parents, and Kenneth Roberts, one of the ace announcers of WABC. Paul received several gifts, the most conspicuous of which were a nice large Mutt and Jeff book, a bag of marbles and a rag doll. I was quite jealous, as I had only flowers and chocolates. . . . On Sunday I had a treat; Eugene Perazzo, organist and pianist of WLW, called for me in his car and drove around the city. . . . Some very beautiful suburbs here—Clifton, Avondale, Hyde Park; there are numerous public parks scattered over the city, some fine old residences and plenty of up-to-date apartment houses, homes and office buildings. . . . After our tour of the city, went to the church of St. Francis De Sales, up to the dusty old organ loft, and sat through the service of the Rosary while Eugene played some gorgeous Bach music. . . . A very enjoyable interlude. . . . After the service, over to the Hotel Alms for dinner. . . . After dinner we visited Station KRC, the outlet for CBS programs here in Cincinnati; it is situated in the basement of the Hotel Alms. So much for my second day . . .

Make my debut on Tuesday, 9:30 p. m. . . . Also appear on Wednesday at the same time and Friday at 9:15 . . . WLW is a very powerful station, 50,000 watts, and is to be found right in the middle of the dial, or perhaps two degrees beyond; if any readers get my program, wish they would let me know; write to me direct to Station WLW, Cincinnati, Ohio, and I shall be very glad to hear from you. . . . Lou Handman, well-known song writer, opened on the station Monday at noon, with his wife, Florrie De Vere, and his sister, Edythe Handman; they are known as The Three Cheers, and may be heard each Monday, Tuesday, Wednesday and Thursday at noon; heard them today; very good. Voices blend well in excellent harmony. . . . Good routine, including piano and vocal solos. . . . Another fine program on this station is "Tales of Terror," each Monday at 10:30 p. m. Written by the clever youngster, Don Becker. . . . The Mooney brothers are another new act here, brought on from New York, under the caption of "The Sunshine Boys"; they may be heard each Monday, Tuesday and Wednesday at 11:00 a. m., Thursday at 7:45 p. m., and twice on Saturday, 12:15 and 7:45 p. m.

Billie Dauscha is due here some time this week. She will sing with a dance band those rhythmic songs she does so well, and I predict a big success for her, for she has a great personality. . . . The Tangee Musical Dreams offering emanates from Station WLW, with a New York outlet from WJZ. . . . The verses at the head of my department this week are dedicated to this excellent program, 7:45 p. m., Tuesday. . . . Of course, you've all heard Bill Stoess' program, "The Flying Dutchmen," which comes through WJZ and the Blue Network at midnight every Sunday. . . . Fine dance band. . . . Listen; you'll like 'em. . . . Charlie Dameron and Morrie Neuman are the featured vocalists.

As I write this, I pause every once in a while to gaze across the river at the blue hills of Kentucky. They don't look very blue at the present moment, but they make a body feel blue to look at them. . . . There's a grey mist hanging over them, and a little iron bridge, looking something like Hell Gate, is in the foreground. . . . Oh, gosh, if I look at that bridge much longer I'll get homesick for Broadway, Astoria and Octavia's good cooking. So, before I start to weep I'll say toodle-oo until next week.

* * *

## Biographical Brevities
### ABOUT THELMA KESSLER

**(WLW, Cincinnati)**

This lovely little lyric soprano was born in St. Joseph, Mo., although she calls Kansas City her home, and New York her abiding place; Cincinnati is her new love, and one that I'm sure she'll stick to for a long time, for they like her out here. . . . Miss Kessler won her first laurels in Kansas City, and incidentally a one hundred dollar cash prize, singing in an amateur contest when she was three years old; at eleven she sang in the first program to be broadcast over a radio station in that city. . . . After studying for a year at the Chicago Musical College, Miss Kessler so impressed Blanche Lederman and Cornelia Harzfeld, original sponsors of Marion Talley, that these lovers of fine music insisted upon sending her to New York for further study. . . . Four months after she arrived in New York Miss Kessler was awarded the Juilliard Fellowship and studied in that fine institution for three years.

Schooled for the opera stage, this young artist made her radio debut three years ago, over an NBC Coast-to-Coast network in the first Puccini opera series as Musette in "La Boheme," starring in a cast recruited from the ranks of the Metropolitan Opera Company. . . . As the result of her sensational performance during that broadcast, critics at the time were unanimous in predicting a brilliant career for this then almost unknown school girl from Kansas City. . . . Since that time she has more than lived up to the expectations of her admirers. She has been heard on scores of programs over the NBC and CBS networks, appearing in such beautiful productions as Swift's "Garden Hour," "Jack Frost Melody Moments," "Opera Miniatures," "Cathedral Hour," "American Radiator Hour" and many other popular broadcasts. . . . Her most recent network appearances were made during the Week End Hours series, sponsored by the Eastman Kodak Company over the Columbia chain. . . . Although primarily a lyric soprano, Miss Kessler possesses a rare versatility, enabling her to sing modern blues as well as the old masters.

# DECREE SIGNED FOR DISSOLVING OF RADIO GROUP

A consent decree was entered by Judge John P. Nields in the United States District Court, Wilmington, Del., whereby the Radio Corporation of America is to be freed of any ownership or control by Westinghouse Electric and Manufacturing Company and General Electric Company. In this way the trial of the case of the United States vs. RCA, Westinghouse, General Electric and others was avoided, and the conditions complained of by the Government remedied, either actually or by promised disposition within a specified time.

The heavy stock ownership of Westinghouse and General Electric in RCA is to be relinquished entirely, and it is expected that distribution of the RCA stock will be made to stockholders in the two companies. Besides, the exclusive cross-licensing agreements among the three companies are terminated with the signing of the decree. This effectuated step, with other remedies embodied in the decree, is intended to dissolve the interlocking ownership in RCA, abolish the so-called "radio group" and establish RCA on a basis with which the Government is satisfied.

The charges against the companies included violation of the United States anti-trust laws, and while the consent decree, signed by both sides, does not admit the violation of any law, but specifically reserves law-breaking admissions, the solution is on the basis of the correction of the evil complained of in the petition for dissolution.

The consent decree consists of a preamble and eight articles, of which the following is a digest:

### Preamble

Complaint dismissed as to General Motors Corporation, General Motors Radio Corporation, American Telephone & Telegraph Company and Western Electric Co., Inc. The remaining defendants are Radio Corporation of America, General Electric Company, International General Electric Company, Westinghouse Electric and Manufacturing Company, Westinghouse Electric International Company, National Broadcasting Company, Inc.; R. C. A. Communications, Inc.; R. C. A. Photophone, Inc.; R. C. A. Radiotron Company, Inc.

### I.

The court has jurisdiction and full authority and power to enter the decree.

### II.

General Electric and Westinghouse, and their subsidiaries, shall divest themselves of the holdings of stock in RCA a follows:

Within three months to dispose of one-half their shares to their common stockholders, the other half to be similarly disposed of within three years.

No restriction is put on the rights to make such terms of distribution to their stockholders as the companies see fit.

Not more than 150,000 shares of RCA stock are to be distributed to any one interest.

No voting rights are to be exercised by General Electric or Westinghouse in RCA stock meanwhile. Proxies may be given to members of the executive committee of the RCA board of directors.

The two companies are to report to the court at the expiration of the three-month and three-year periods as to compliance with the decree.

### III.

Resignation of official positions on RCA boards, etc., by officials of Westinghouse and General Electric to be made within ten days, except that for not more than five months Owen D. Young and Andrew W. Robertson may continue to serve as members of the boards and committees of RCA.

The advisory council of the National Broadcasting Company, so long as its functions continue to be merely advisory, is not deemed to be a board or committee within the meaning of Article III.

### IV.

An injunction is issued against the defendants either recognizing as exclusive or asserting to be exclusive the cross-licensing agreements. There are eight agreements and American Telephone & Telegraph Co. is a party to some of them, Westinghouse and General Electric to others, and RCA to all of them. Each patent holder is left free to exercise full patent rights as if the exclusive agreements had never been signed.

### V.

All agreements and contracts in violation of the anti-trust laws are enjoined specifically. No limitation shall prevail as to the field of operation under any of the patents, hence the patent rights where enjoyed, by original ownership or licensing, are not only non-exclusive but not restrictive as to fields. So where the patent owner may enter a field its patent licensee may enter the same field. No territorial restrictions may be enforced, either.

The exception to the article is that any agreement, if not made to restrict liberty of action as part of a general plan or purpose, may be executed in the same lawful manner as by any one else.

### VI.

Trial of the action may take place within two and a half years, regardless of the settlement terms. The defendants within one year must file a report with the Attorney General as to what has been done and what is being done toward compliance, and at the request of the Attorney General shall at any time give information requested. If prior to the two-and-a-half-year limit the defendants have complied with terms as covered by that period, then the complaint may be dismissed as to those matters concerning which there has been compliance in fact, otherwise after the two and a half years the case shall go to trial, unless good cause for delay in compliance is shown to the satisfaction of the court. Lack of diligence by the defendants in complying entitles the United States to move, prior to the two and a half years, for trial of the case.

### VII.

A subsidiary is defined as a corporation the majority of the voting stock of which is owned by any of the named defendants.

### VIII.

Jurisdiction is reserved by the court for the purpose of enforcing or modifying the decree, also jurisdiction to permit after three years any defendant to acquire stock in any other defendant or subsidiary, if it is proved to the court such acquisition will not tend to defeat the purpose of the decree.

### 4,000 Patents Concerned

The number of patents concerned is about 4,000. General Electric now owns 5,188,755 shares of RCA common and 27,080 shares of Class A preferred. Westinghouse owns 2,842,950 common and 50,000 shares of Class A preferred. The current indebtedness of RCA to General Electric and Westinghouse is $17,938,733. To offset this RCA will transfer to General Electric the RCA Building at Fifty-first Street and Lexington Avenue, N. Y. City, and issue $4,255,000 ten-year debentures to the two companies. The book value of the building is $4,745,000. The difference, $8,938,733, is discharged in consideration of the new agreements.

RCA will occupy quarters in the Rockefeller Center, where its wholly-owned subsidiary, the National Broadcasting Company, will have extensive sound and television studios. Lease commitments made to Rockefeller Center have been reduced by RCA through the issue of 100,000 shares of Class A preferred stock of RCA to Rockefeller Center, Inc.

### RCA's Enlarged Scope

Patent rights previously denied to RCA under exclusive cross-licensing contracts are now open to RCA, so that it may extend its sphere of activities to fields including commercial application of vacuum tube processes, including photo-electric cells, e. g., sorting and counting, operation of burglar alarms, garage doors and various other purposes served by photo-cell relays. RCA still remains the licensing factor of set manufacturing, power amplifier manufacturing and tube manufacturing under its own patents, and also under the patents of the other companies in which it holds sub-licenses itself, and retains the royalties derived from such licensing. But the basis is now non-exclusive.

RCA has been newly licensed by General Electric and Westinghouse to manufacture transmitters and transmitting tubes, and itself has licensed the two companies to make radio sets, starting after the two-and-a-half-year period.

In the communications and entertainment fields RCA will pay no license fees to the two companies, for its own enjoyment of the licenses is to be without compensation to the two companies, and it is to retain the license fees collected from its own licensees, amounting to 5 per cent. for domestic use and less for foreign fields.

# TRADIOGRAMS

***By J. Murray Barron***

Tobe Deutschmann Corp., Canton, Mass., announces a complete line of service and replacement condensers for use in repairing and constructing all types of radio apparatus. This new line is being introduced by a sales campaign under the direction of Raymond T. Perron.

* * *

Those seeking knowledge and information on tubes and their purposes find in Maxwell Pecker, of Thor Radio Co., 167 Greenwich Street, N. Y. City, a helpful authority on the subject.

* * *

If some folk think that kits are no longer in demand anywhere on earth they should have visited the radio show at Berlin, Germany. There were on display no less than 200 different electric set kits. The three-tube kits were the largest in number. On the other side the three-tube receiver is the most popular.

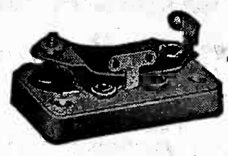
* * *

Bonafide manufacturers of radio receivers and other large users of cartridge, bypass and filter condensers may receive samples by addressing Cosmic Products Corp., 135-137 Liberty Street, N. Y. City. This line is meeting with much favor with the trade. The company is now in production.

* * *

Fleetwood Sales Co., 16 Hudson Street, N. Y. City, is now handling a complete line of radio parts for the serviceman, jobber and dealer and invites correspondence from interested users.

# PADDING CONDENSERS



700-1,000 mmfd. (Cat. PC-710) @ 50c net.
350-450 mmfd. (Cat. PC-3545) @ 50c net.

A HIGH-CLASS padding condenser is required, for a superheterodyne's oscillator, one that will hold its capacity setting and will not introduce losses in the circuit, for losses create frequency instability. The Hammarlund padding condensers are of single-condenser construction on Isolantite base, with set-screw easily accessible, and non-stripping thread. For 175 kc. intermediate frequency use the 700-1,000 mmfd. model.. For i.-f. from 460 to 365 kc., use the 350-450 mmfd. (General Motors models).

## 0.0005 HAMMARLUND S. F. L. at 98c.

A sturdy, precision straight frequency line condenser, with end stops. The removable shaft protrudes front and rear and permits ganging with coupling device, also use of clockwise or anti-clockwise dials, or two either side of drum dial. Front panel and chassis-top mounting facilities. True straight line. This rugged condenser has Hammarlund's high quality workmanship and is suitable for precision work. It is a most excellent condenser for calibrated radio frequency test oscillators, any frequency region, 100 to 60,000 kc., short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, rigidity; Hammarlund's perfection throughout.

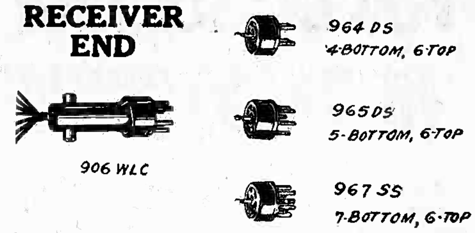
Order Cat. HO5 @........................................................98c net

**Guaranty Radio Goods Co., 143 West 45th Street, New York, N. Y.**

# ANALYZER

## Plugs and Adapters

### RECEIVER END




**906-WLC—Finest Analyzer Plug,** smaller diameter than that of smallest tube, so fits into tightest places in receivers. Seven-lead 5-ft. cable, six-pin base with stud socket at bottom center. Two grid caps interconnected (use handier one), and they also connect with stud socket, which is a latch lock, and with seventh cable lead, and with control grid of 7-pin tubes. Adapters (at right) all have six hole tops to receive Analyzer plug base, and have projecting stud that connects to Analyzer plug's stud socket. Latch in Analyzer Plug base grips adapter studs so adapter is always pulled out with Analyzer Plug (adapter can't stick in set socket). Pressing latch lever at bottom of Analyzer plug releases adapter.........................................$3.23

964 DS—Six-hole top with stud, four-pin bottom.. .73
965 DS—Six-hole top with stud, five-pin bottom.... .73
967 SS—Six-hole top with stud, seven-pin bottom.. .73

The four devices described above enable access to all UX, UY, six-pin and seven-pin tube sockets in receivers. Additional adapters for all unusual tubes are obtainable. Write your requirements.

### ANALYZER END

On the analyzer there must be socket accommodation for the tube removed from receiver. One universal socket and one adapter permit putting all UX, UY, six-pin and seven-pin tubes in Analyzer.

456 is a 9-hole "universal" socket into which will fit, with automatically errorless connection, any UX, UY or six-pin tube.........................................$ .62

976-SL. To enable putting 7-pin tubes into the universal socket, an adapter with seven-hole top and six-pin bottom is used. A 6-inch lead with phone tip is eyeleted to the side. A pin jack on Analyzer, connected to seventh lead of 906-WLC cable, picks up control grid of 7-pin tube through the eyeletted lead.........................$ .73

Additional adapters for all unusual tubes are obtainable. Write your requirements.

437-E. Those preferring two different sockets (universal and a separate 7-hole socket) rather than one socket and an adapter, may obtain a 7-hole socket to match the universal in size and mounting holes.................. $ .62

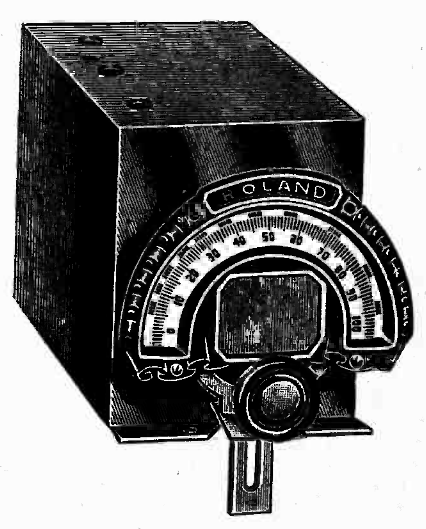
## MULTIPLE SWITCH

2NS9—K-P9. For switching to nine different positions, enabling current, voltage and other readings. Any one position opens a circuit and closes another. Thus the opener, by interruption, gives access to plate, cathode, etc., leads, for current readings, while the closer puts the current meter in the otherwise open circuit. Switch has detent for "snappy" action..........................$2.65

**JUNIOR OUTFIT**
**For Receiver End**

7-pin plain analyzer plug, 7-lead cable attached (977) ........................................$1.25
Three adapters for UX, UY and 6-pin sockets in receiver (976, 975, 974)...................... 2.19

**DIRECT RADIO CO.**
**145 West 45th Street, New York City**

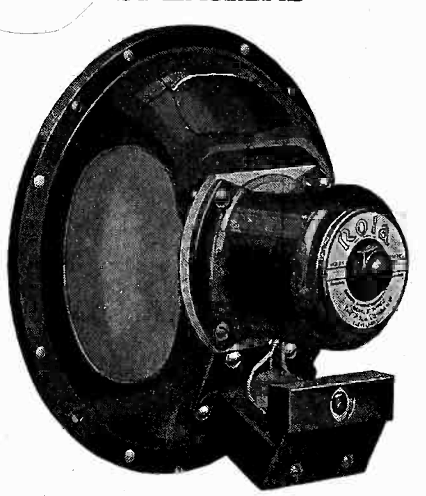



0.0005 mfd. Scovill tuning condenser, brass plates, shaft at both ends so condenser takes 0-100 or 100-0 dials and two can be used with drum dial; sectional shields built in, trimmers affixed; total enclosed in additional shield as illustrated. Access to trimmers with screwdriver. Side holes for bringing out leads to caps of screen grid tubes. Cat. SCSHC @....$1.95

Same as above, with ghost type dial (travelling light). Cat. SCSHC-DL @..........................$2.85

**DIRECT RADIO CO., 143 W. 45 St., New York City**

## Wide Choice of ROLA SPEAKERS




Series F represents 8-inch cone diameter, Series K-7 represents 10.5-inch and Series K-9 represents 12-inch, in the catalogue designations. The field coils of all speakers may be used across 110-volt d-c line, in d-c sets, where a separate B choke is used. The field is most often used as B choke and bias source in a-c receivers.

All speakers have field coil, tube-matched output transformer, plug and cable. Besides the speakers listed we can supply models for other purposes, of the same manufacture. Inquire for prices.

**8-INCH DIAMETER**

Cat. FP, for '47 or 89 single output; 1800 ohm field coil tapped at 300 ohms..........................$3.75
Cat. F-P-59, same as above, except for the new 59 tube ........................................ 3.85
Cat. F-P-2, for two '47 or 89 tubes in push-pull; 1800 ohm field coil tapped at 125 ohms...........3.80
Cat. F-P-2-59, same as above, except it is for new 59 tubes ........................................ 3.90
Cat. F-P-2 59-PAR, 1800 ohms tapped at 125 ohms, for two 59 tubes in parallel.................... 3.90
Cat. F-45, for single '45 output; 1800 ohm field coil tapped at 800 ohms.............................. 4.15
Cat. F-45-2, for two '45 tubes in push-pull; 1800 ohm field coil tapped at 500 ohms.................... 4.50

**10.5-INCH DIAMETER**

Cat. K-7-P, 1800 ohm field tapped at 300 ohms. For single '47 or 89...............................$4.20
Cat. K-7-59, same as above, except for new 59 tube ........................................ 4.30
Cat. K-7-45, 1800 ohm field, tapped at 800 ohms; for single '45 output............................ 4.20
Cat. K-7-P-2, 1800 ohm field, tapped at 125 ohms; for push-pull '47 or 89.......................... 4.80
Cat. K-7-2-59, same as above, except for new 59 tubes ........................................ 4.90
Cat. K-7-45-2, for push-pull '45's; 1800 ohm field, tapped at 500 ohms.............................. 5.10

**12-INCH DIAMETER CONE**

Cat. K-9-P, 1800 ohm field, tapped at 300 ohms; for single '47 or 89 output.........................$5.25
Cat. K-9-P-59, same as above, except for new 59 output ........................................ 5.35
Cat. K-9-45, for single '45 output; 1800 ohm field tapped at 800 ohms............................ 5.45
Cat. K-9-P-2, for two '47 or 89 tubes in push-pull; 1800 ohm field tapped at 125 ohms............. 5.75
Cat. K-9-P-2-59, same as above, except for new 59 tubes ........................................ 5.85
Cat. K-9-45-2, for two 45's in push-pull; 1800 ohm field tapped at 500 ohms...................... 5.95

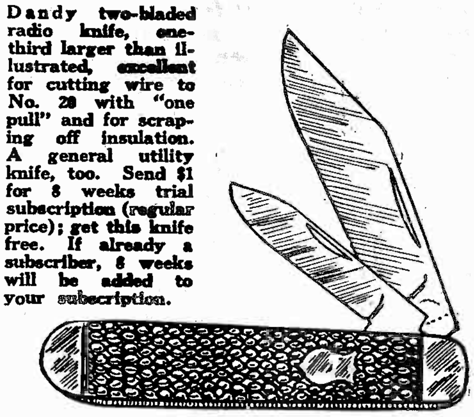
**MAGNAVOX AUTOMOBILE SPEAKER**

6 Inch cone, 6 volt field for connection to car's storage battery. Shielded cable supplied with each speaker. Cat. MAG-AU @ ..............................$4.50

**Guaranty Radio Goods Co.**
**143 West 45th Street, New York, N. Y.**

# RADIO KNIFE FREE

**Dandy two-bladed radio knife, one-third larger than illustrated, excellent for cutting wire to No. 28 with "one pull" and for scraping off insulation. A general utility knife, too. Send $1 for 8 weeks trial subscription (regular price); get this knife free. If already a subscriber, 8 weeks will be added to your subscription.**



**RADIO WORLD**
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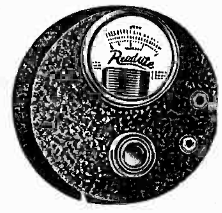
**THE FORD MODEL—"A" Car and Model "AA" Truck—Construction, Operation and Repair—Revised New Edition.** Ford Car authority, Victor W. Page. 703 pages, 318 illustrations. Price $2.50 Radio World, 145 W. 45th St., New York.

# THREE-IN-ONE TESTER *FREE!*

**EVERYBODY who does any radio work whatsoever, whether for fun or for pay or for both, needs a continuity tester, so he can discover opens or shorts when testing**

**A mere continuity tester is all right, but—**

**Often it is desired to determine the resistance value of a unit, to determine if it is correct, or to measure a low voltage, and then a continuity tester that is also a direct-reading ohmmeter and a DC voltmeter comes in triply handy.**




**So here is the combination of all three:**

**A 0-4½-volt DC voltmeter, a 0-10,000-ohm ohmmeter and a continuity tester. A rheostat is built in for correct zero resistance adjustment or maximum voltage adjustment. The unit contains a three-cell flashlight battery. Supplied with two 5-foot-long wire leads with tip plugs. Case is 4-inch diameter baked enamel. Weight, 1 lb. Sent you with an order for one year's subscription for RADIO WORLD (52 weeks) at the regular rate of $6. Order Cat. PR-500. Use Coupon below.**

**Radio World, 145 W. 45th Street, New York, N. Y.**
Enclosed please find $6 for one year's subscription for Radio World (one copy a week. 52 issues) Send Cat. PR-500 as premium.

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