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RADIO WORLD

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The First and Only National Radio Weekly

Eleventh Year—532d Issue

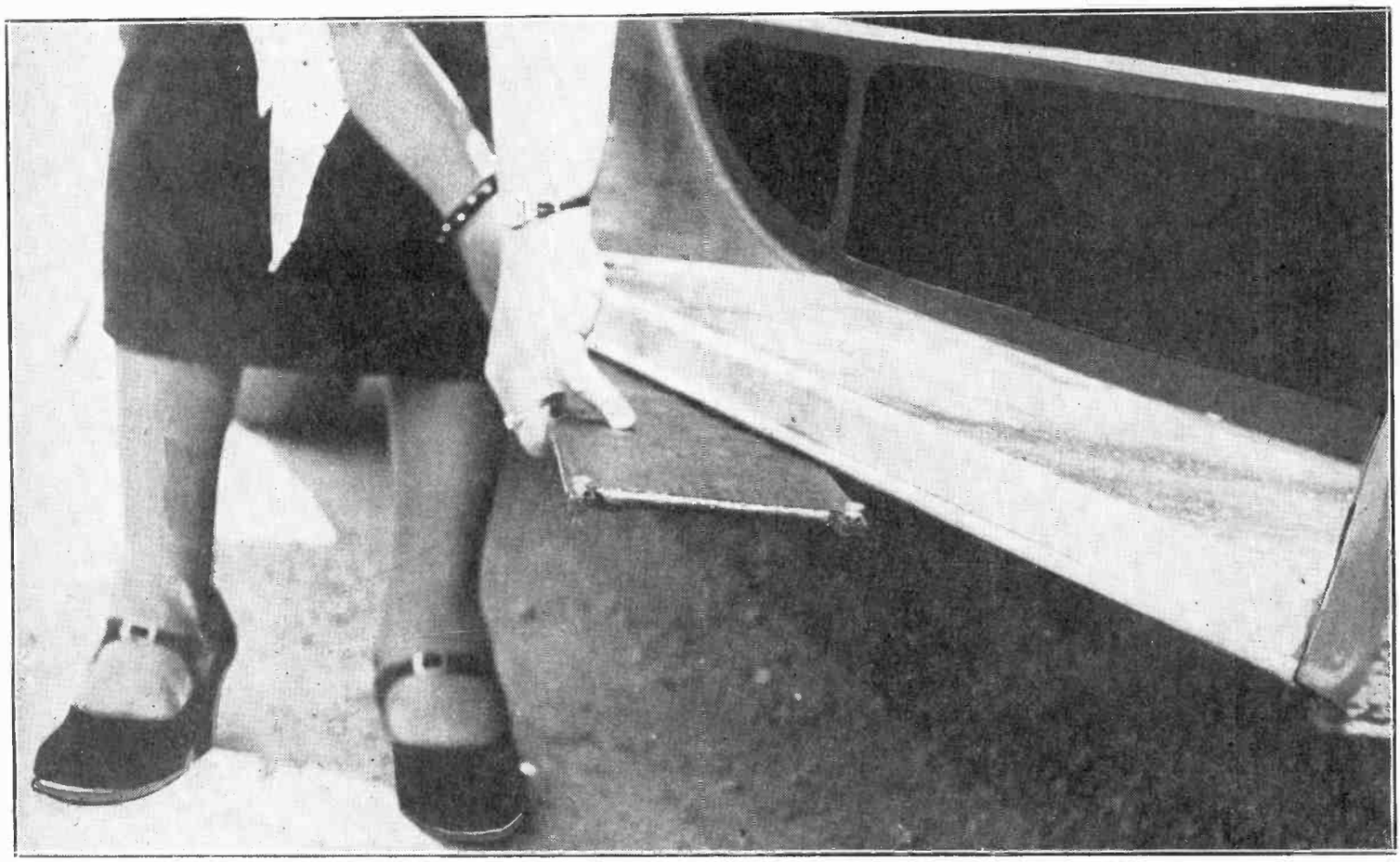
INTERFERENCE LOCATOR

ELECTRON-COUPLED CONVERTER

HOW TO WIND COILS

TRANSFORMER DESIGN FOR 46 TUBES

A RUNNING-BOARD AERIAL



A wound aerial proved effective for auto sets. It was placed under the running board. See page 9.

TELEVISION DEMONSTRATED TO SET LICENSEES

6-TUBE A-C SUPERHETERODYNE

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RADIO WORLD

The First and Only National Radio Weekly
ELEVENTH YEAR

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Oscillation Is Off Resonance

New Aspect Applied to Frequency Stability

By J. E. Anderson

THE investigation of frequency stability of oscillators ordinarily leads into complex mathematical formulas, especially when the oscillators are not simple. Invariably, however, the conclusion is reached that the plate resistance of the tube enters into the expression for frequency, and for that reason if there is any change in the plate resistance due to changes in plate, grid or filament voltages, the frequency of the circuit changes. When the grid resistance is not negligible, that is, when there is an appreciable grid current flowing, the grid resistance also enters into the expression for the frequency, and changes in frequency will result from changes in grid current.

The question of eliminating frequency changes with changes in the voltages on the elements resolves itself into making the frequency independent of the grid and plate resistances. As a rule, this can be done very easily at any one frequency, but for an oscillator that is to cover a large range of frequencies it is not so easy, for it would require a readjustment of many impedances every time the frequency is changed.

Stabilizing the Frequency

There are methods by which the change in frequency can be minimized at all frequencies by arranging the oscillator suitably. These we shall discuss.

Suppose we put a stopping condenser in the grid circuit of the oscillator and a grid leak from the grid to the cathode. The grid is operating at zero bias except for any drop there may be in the grid leak due to grid current. As the signal, which in this case is the free oscillation, goes positive the grid current increases and the drop in the leak increases. Thus there is a check on the amount of grid current. The grid resistance is therefore held more nearly constant than if the grid were free to swing to a high positive voltage. This, therefore, is one way of stabilizing the frequency.

Another way of stabilizing the frequency is to make the oscillating circuit just as highly resonant as possible, that is, to make its Q as high as possible. To explain how this works we shall discuss phase shift.

Phase Shift

In Fig. 1 is an oscillating circuit of some kind. The rectangle RLC represents the tuned circuit which is supposed to determine the frequency. The rectangle R1L1C1 represents all the rest of the circuit. The leads connecting the two are supposed to be of negligible length and impedance. Let us cut the leads in one place by an imaginary line. Above this line let us suppose that the voltage between the two conductors of the line is e. As we move toward rectangle RLC the voltage between the two lines changes in phase and magnitude. In the resonant circuit RLC there is a rapid change of both, the magnitude going up and the phase shifting either forward or backward, that is, the phase is either advanced or retarded.

As we move on the changes continue. In the tube, which is contained in R1L1C1, the magnitude goes up and the phase changes in one direction or the other. In this part of the circuit there must also be attenuation, the reason for which we shall come to presently. Finally we arrive at the imaginary line from below. The voltage across the line just below the line must be exactly the same as the voltage e with which we started, for the two are identical. Hence in going completely around the circuit there is no change whatsoever in either the magnitude or the phase. If there had been any change in the magnitude, the oscillation would either be decreasing or increasing. But we are considering the steady state.

A Tug-of-war

While we arrived at the conclusion that there is no net change of phase in the circuit we cannot make the same conclusion about any portion of it. There is a change of phase in the resonant circuit in one direction or the other, unless it should happen that the frequency of oscillation is exactly equal to the frequency of resonance. If we rule out this possibility, there is a change of phase. Therefore there must also be a change of phase in the rest of the circuit, and this change must be exactly equal in magnitude to the change in RLC, but it must be in the opposite direction. The only condition that there be no change of phase in RLC is that there be none in R1L1C1, that is, the "prime" part of the circuit must have the same frequency of resonance as the resonant circuit. That this condition be satisfied is not very likely unless the circuit has been so adjusted. In some frequency stabilizing schemes this is done for a particular frequency.

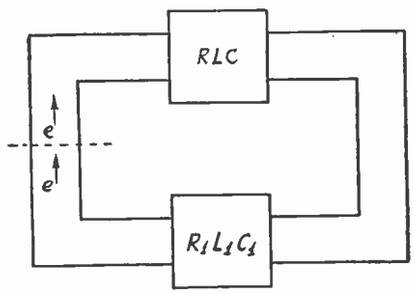

FIG. 1
Analogy of an oscillating circuit.

Both the circuits represented by the rectangles affect the frequency. One pulls the frequency in one direction and the other in the opposite. There is a tug-of-war between the two. Finally they compromise on some frequency where the net change of phase in the circuit is zero. Just how far this frequency will be off the resonant frequency of RLC depends on the relative selectivities of the two. Since RLC has been intentionally made a resonant circuit we may assume that the other part of the circuit is not able to pull the frequency off resonance very far. If R1L1C1 changes the phase very little, only a very little phase shift is necessary in RLC, and that means a very little change in the frequency.

Phase Shift Curves

In Fig. 2 are two phase shift curves of two circuits having selectivities of 100 and 500, the object of which is to show how rapidly the phase of a highly resonant circuit changes with frequency. The abscissas give per cent. off resonance and the ordinates the degrees of phase shift. The more resonant the circuit is the more rapid the shift, as can be seen by comparing the two curves. If the circuit were infinitely selective the phase shift curve would coincide with the axis of ordinates and there could be no frequency change due to phase shift in the circuit outside the resonant part. Possibly there could be no oscillation either, but that is open to question.

Let us assume that outside the resonant circuit there is an advance in phase of 10 degrees. Then there must be a retardation

(Continued on next page)

Stable Frequency Factors

Correct Phase or Steady Plate Resistance

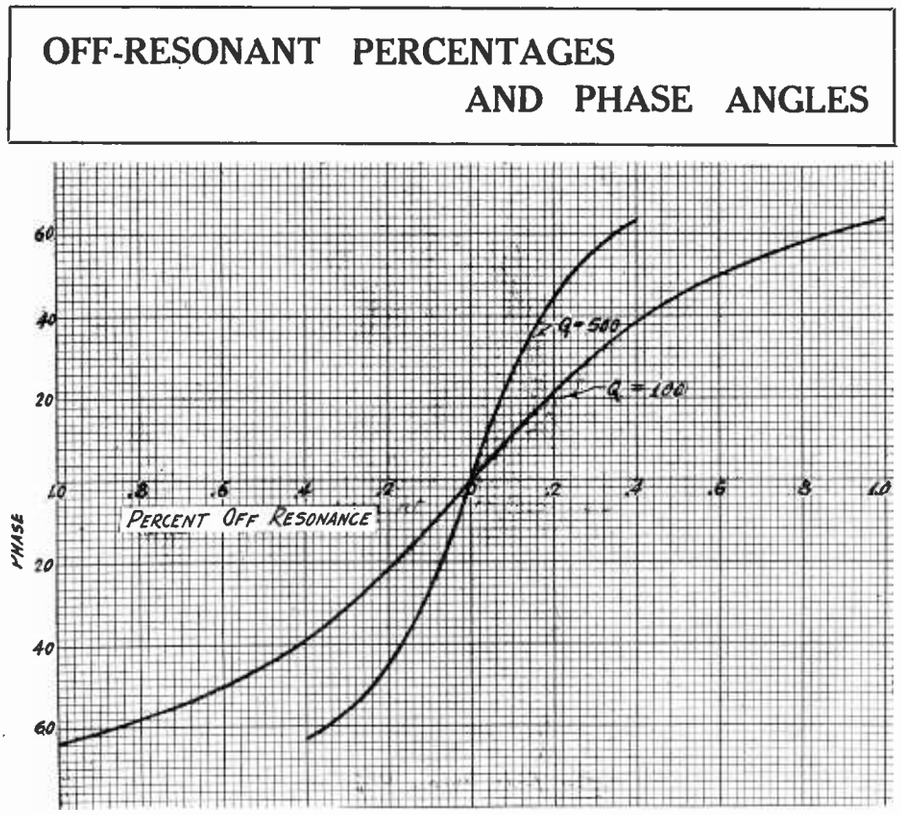

FIG. 2

These curves show the relation between the phase angle of a resonant circuit and the per cent frequency off resonance for two different values of selectivity. The steepness of either curve at any point is a measure of the frequency stability.

(*Continued from preceding page*)

of 10 degrees in the resonant circuit. What frequency shift is necessary to effect this for the two cases in Fig. 2? For the Q = 100 case the frequency change will be 0.0882 per cent and for the Q = 500 case only 0.01764 per cent. If the resonant frequency is 1,000 kc, the actual frequency shifts are only 882 cycles in the first case and 176.4 in the second case. Undoubtedly, the phase shift is much greater in some practical cases. Since a condenser advances the phase and a coil retards it, the resonant circuit must be operating on that side of resonance where the coil is more effective than the condenser and the frequency is higher than the resonant frequency.

Variation in Frequency

The fact that the generated frequency is slightly different from the natural frequency of the tuned circuit does not make the frequency unstable. As long as the phase shift does not change there is no change in the frequency. Then what would cause a change in the phase shift? Changes in the plate resistance of the tube for one thing, and this might change as a result of a change in the heater current, a change in the plate voltage, in the bias, or a change in the load on the tube. Particularly, it might change with modulation, which in effect is a change in the plate voltage. It might also change with a change in some inductance outside the resonant circuit, or with a change in a capacity.

Let us assume that the original phase shift is 10 degrees and that a change in the plate resistance causes a change of 10 per cent in the angle. What is the change in the frequency? Looking first on the Q = 100 curve at 10 degrees we find that the frequency is off 0.0882 per cent and at 9 degrees 0.007925 per cent. If the resonant frequency is 1,000 kc the two frequencies are 882 and 792.5 cycles per second. Hence the change in frequency due to a change in the phase shift of one degree in ten is 89.5 cycles per second. This represents a change of about 90 parts in one million, or 0.009 per cent. Looking on the Q = 500 curve we find frequency percentages of 0.01764 and 0.01585, which at 1,000 kc represent 176.4 and 158.5 cycles per second. The difference is 17.9 cycles per second. This is about 18 parts in a million, or 0.0018 per cent. It does not make much difference whether the phase shift is up or down, because the curves are very nearly straight at 10 degrees.

Resistance Change

We assumed that there was a change in the phase shift of 10 per cent at 10 degrees. Just how much resistance change does this represent in a simple circuit consisting of a resistance in series with a capacity, again assuming 1,000 kc? Suppose the resistance involved is 10,000 ohms and that it is the plate resistance of the tube. The effective capacity necessary to cause a phase shift of 10 degrees is 90.1 mmfd. Using this capacity we can find what change there must be in the resistance to make the phase shift 9 degrees. Computation shows that the resistance should be 11,120 ohms and therefore that the change in the resistance should be 1,120 ohms. This change could well be introduced by a change in the plate voltage and particularly by a change in the filament voltage.

It is important, however, that the total phase shift be as low as possible, because the rate of change of phase angle is greatest near the resonant frequency of the tuned circuit, so that for a given shift in phase the frequency shift would be least. This applies regardless of the value of the Q of the circuit. But the higher the selectivity the more rapid is the phase shift near resonance and for that reason the selectivity should be as high as possible.

The phase shift per cycle at the resonant frequency is proportional to L/R in which L is the inductance in the oscillating circuit and R the effective radio frequency resistance. It is this ratio that should be as high as possible, but it is equivalent to the Q of the circuit.

Suggested Stabilization

If the variable portion of the resistance in the feedback circuit can be made small in comparison with the total resistance, the frequency stability can be made much greater. Suppose, for example, we put in a 100,000 ohm invariable resistance in series with the plate resistance of 10,000 ohms. Then the circuit will operate much nearer the natural frequency because the total shift will be less and the slope of the phase shift curve at the operating point will be steeper. But this is not the most important function of the invariable resistance. Suppose the plate resistance of the tube changes by 10 per cent. Then the change in the total resistance will be only about 0.9 per cent and the frequency change will be only about 0.1 as great as if the fixed resistance were not used. We have to assume, of course, that with this high resistance in series the circuit will still maintain oscillation. It will if the back coupling is great enough and if the selectivity of the circuit is sufficiently high. The use of this high feedback resistance is one of the methods used for stabilizing frequency and also for obtaining a pure wave from the oscillator. The wave is pure because the amplitude of oscillation is small.

Zero Shift

If we are to work only at one frequency it is possible to arrange the circuit so that there is a zero shift in phase and so that the resonant circuit would oscillate at its natural frequency. This would make a very stable oscillator. To do this we would have to make use of both inductance and capacity, effectively in series with resistors, and to choose such values that as one part tended to advance the phase by a certain angle the other would retard it by the same amount. In effect we would have two tuned circuits normally adjusted to the same resonant frequency, but one having a high Q and the other a very low Q.

Lewis Winner Weds

LEWIS WINNER

Lewis Winner, publicity director of the Hammarlund Manufacturing Company, formerly technical editor of RADIO WORLD, and whose writings in several radio magazines are familiar to radio builders, recently forsook bachelor life. The bride was Miss Beatrice Kramer. The couple are living in the Bronx, New York City, and a very special radio installation was made by Mr. Winner, with speaker in the fireplace. However, the fireplace is mostly ornamental.

Amplified Oscillation

Its Use in Electron-Coupled Converter

By Capt. Peter V. O'Rourke

A STAGE of amplification of the oscillation voltage is included in the short-wave converter hookup, Fig. 1, so that a strong oscillation may be fed to the modulator, thus increasing the amplitude of the modulator output.

In short-wave converters almost every method of increasing the sensitivity has been used before, except this one.

The common recommendation is to use a very long aerial, with no series condenser in the antenna circuit, thus leading one to assume that something has to be done to improve sensitivity. The long aerial does it, in a way. Then the coupling between modulator and oscillator may be made tight, altogether too tight from the viewpoint of selectivity, yet this coupling improves the sensitivity. A built-in stage of intermediate frequency amplification might be included, and this could provide a gain of about 100, but the intermediate frequency then is forever fixed, and it may not be one to which your broadcast receiver is particularly sensitive.

Benefit Without Blight

One harmful effect of too tight coupling of modulator and oscillator is that the benefit of modulator tuning is almost lost. This affects selectivity. The two circuits tend to tune as one, and if the modulator is thus tuned to the oscillator frequency, at least it gives results better than if the modulator were untuned. However, the effect of tight coupling can prevail without the injuries if a stage of oscillation amplification is included.

Moreover, the coupling between oscillator and amplifier may be loose, and in that way the frequency stability of the oscillator is greatly improved. In test oscillators of precision manufacture the frequency stability must be very high, the goal sometimes being an error limitation to no more than 0.015 per cent., or 15 parts in 100,000. For a converter it is not imperative that the frequency stability be that high, but it is advisable not to ignore possibilities of stabilizing the frequency, especially for reception in the " daylight" frequencies, say, 10,000 kc up.

The idea of electron coupling between oscillator and amplifier is used. This was first proposed, in an entirely different type of oscillator circuit, by J. B. Dow, Bureau of Engineering, Navy Department, Washington, D. C., in a paper entitled "A Recent Development in Vacuum Tube Oscillator Circuits," published in the December, 1931, issue of "Proceedings" of the Institute of Radio Engineers.

Avoids Deleterious Coupling

He showed a favored circuit consisting of a screen grid tube as Colpitt oscillator, with an inductive load on the screen circuit and condenser feedback from the screen to the grid winding, while the plate load was inductive, an isolating condenser interposed between plate of oscillator and grid of amplifier tube, and a leak in the amplifier grid. Of this he said:

"Study of the circuit will indicate that oscillations generated by the frequency-determining portion of the circuit are not transmitted to the work circuit in the sense that alternating electromotive forces may be transmitted from one circuit to another by capacitive. inductive

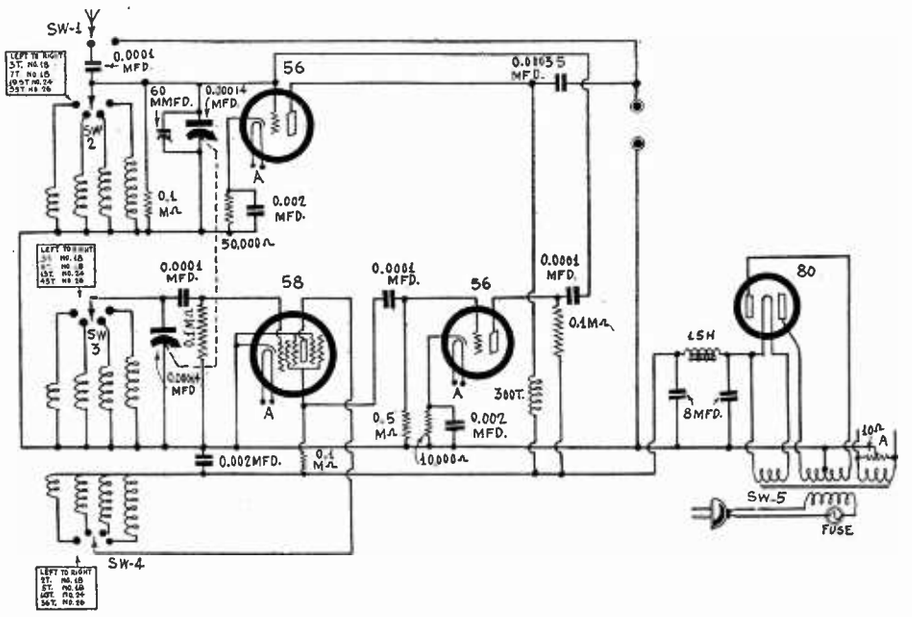

FIG. 1

Electron coupling between oscillator and modulator is used in this short-wave converter, and despite a strong oscillation voltage fed to the modulator, the two tuned circuits are independent.

or direct coupling. . . . Any coupling of this nature has a deleterious effect and is purposely avoided to prevent reaction of the work circuit upon the frequency-determining portion. The frequency-determining portion of the circuit serves merely to control electron flow to the separate anode associated with the work circuit, thereby causing a pulsating direct current to flow in the work circuit impedance where an alternating electromotive force may be reincarnated at a frequency determined by the pulses of the electrons which impinge upon that anode."

This form of coupling he named electron coupling.

The work circuit here may be regarded as the modulator.

The screen circuit may be used for feedback, as was done by Mr. Dow, but the number of turns on commercial coils is such as is determined by plate feedback considerations, so in Fig. 1 the plate circuit is fed back, while the electron flow between plate and screen couples the two loosely, and a load on the screen circuit, which may be a resistor, permits taking off the pulsating direct current. Fortunately, the screen is nearer the cathode in the '24 (or '24A, its quick-heater companion), so the screen is bound to attract electrons. Thus the oscillator may be a '24 or '24A, the modulator and amplifier '27's, and the rectifier an '80, or the new tubes may be tried, as shown, two 56's and one '58.

For greater precision the oscillator tube may be neutralized, a condenser of 20 mmfd. or so adjusted until no alternating current flows in the screen circuit of the oscillator. The condenser is connected from amplifier grid to oscillator grid and is adjusted when a small thermoammeter is in series with the screen circuit, to zero reading (plate circuit open). Thus the potential on the grid of the amplifier tube is made equal and opposite to that across the inter-electrode capacity of the oscillator.

Coil Switching

Now the output of the amplifier stage may be connected to the grid of the modulator for unity coupling. It should be observed that the modulator tuning is kept independent of the oscillator tuning, in that they do not unite, for the high resistance of the amplifier tube is between the two tuned circuits.

The result, therefore, is that an intense oscillation voltage may be safely delivered to the modulator tube, the only precaution necessary being that the negative bias on the modulator shall be high enough to support the largest value of input. Since the type of detector shown actually amplifies considerably, the amplitude may be taken as the product of the two voltages.

Virtually all converters have switching devices for band shifting, hence this practice is followed. There are eight tubings. On one there are two windings—(1) the grid winding of the oscillator, and (2) the plate winding of the oscillator. On the other is only the grid winding of the modulator.

Switch Type

The switch should be of the three-deck type, four positions on each deck, besides the three lugs for pointers, and the switch should be of the non-shorting type. The two windings for each band, oscillator coil, are on a single form, while the modulator's grid winding is on a separate form, and the companion forms may be in line, with a shield serving as anchorage for the horizontally-placed tubings. This shield separates oscillator from modulator coils, as there should be no coupling between them, and if the shield is grounded and used as a supporting bracket the original layout will be duplicated.

10-TUBE RECEIVER WITH CLA BEST SHORT-WAV

By Axel

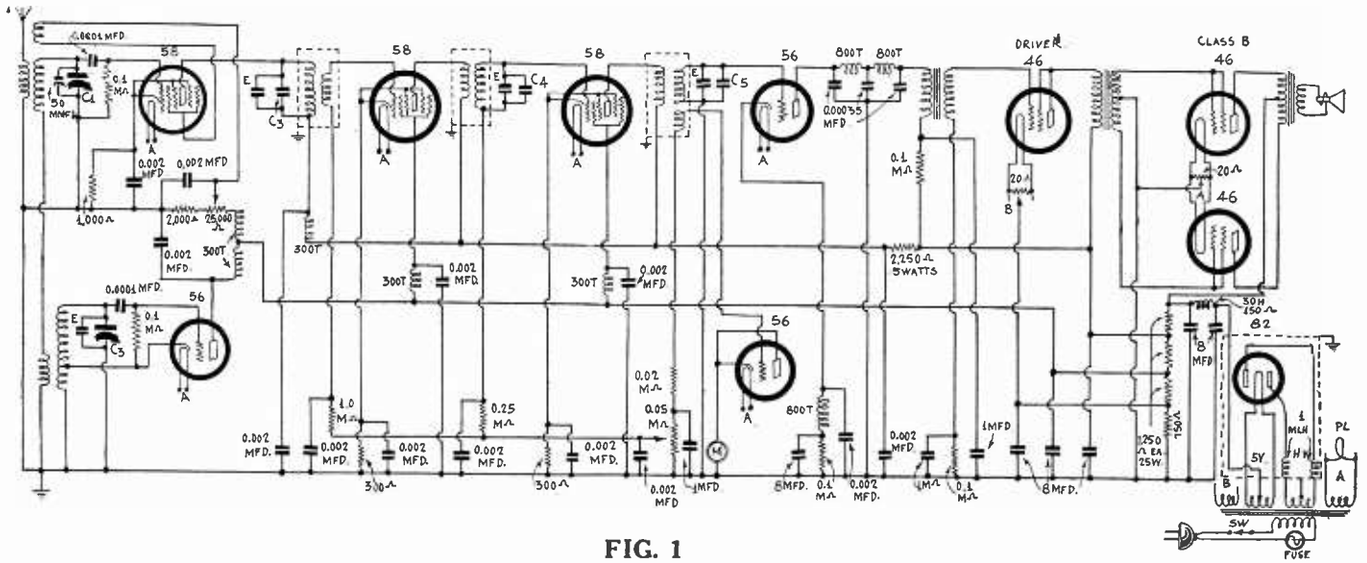

FIG. 1

WHEN you see a great deal of filtering in a diagram it should inform you at once that short waves are concerned. In general, the less filtering, the poorer the performance, or it would be happier to say the more filtering, the better the performance. Short-wave reception is not as bad as some folk say it is nor yet as good as some others with commercial motives would have you believe. There is a substantial in-between point, and if it were not substantial then short waves would not have achieved their present success.

The circuit shown, Fig. 1, is a ten-tube superheterodyne, primarily for short waves, and using plug-in coils. When it is a case of the best, and nothing but the best, plug-in coils must be the choice, although they should be good ones, meaning that the forms should be non-hygroscopic, metal-free and the wire should be large enough in diameter for the frequencies to be covered.

Screen Current Fed Back

The modulator is regenerative because sometimes improvement of selectivity is necessary for killing off adjacent-channel interference. Variation of the screen voltage governs regeneration. It will be noted that the screen current is fed back. A smoother control results if a limiting resistor is interposed between ground and the low voltage end of the potentiometer, so that the screen voltage never can be negative. The resistance and the 0.002 mfd. condenser serve as a filter circuit, and in addition a 300-turn honeycomb coil intercepts the circuit toward B plus.

The object of the filter combinations is to prevent the radio frequencies from going through the B supply, hence the chokes do this and are aided by condensers that send the radio frequencies to ground.

Frequency Stability

In the modulator circuit there are a leak and condenser for frequency stability. Since the circuit is regenerative it is advisable to include such a corrective. Of course in the oscillator the combination is present too, as here we desire the best possible frequency stability obtainable.

The two feedback circuits are different. One, in the modulator, is of the so-called tuned grid type, with inductive tickler carrying screen current, the other, in the oscillator, is of the modified Hartley type, with plate current in the lower leg of the grid winding, the tuning condenser across the total inductance, which consists of a tapped coil. Feedback is due to the mutual inductance and the automatically correct phase of the voltages. In the modulator the tickler connections would have to be reversed if regeneration failed.

Grid current may flow in either oscillator or modulator or both, but the high resistance grid circuit, due to the leak, tends to check this condition, because grid current will develop a voltage drop and cause a negative bias to be applied to the grid, and that in turn will reduce the grid current, so that constancy prevails.

Coil Bases

The plate circuit of the oscillator is non-reactive, considering the frequencies, and the plate could be returned directly to B plus, no load being present. However, to prevent the escape of oscillator current through other parts of the circuit, where not desired, additional precaution is taken in the form of a choke-condenser filter in the plate circuit.

The oscillator is coupled to the modulator by a winding inductively common to both. This requires a six pin coil base, and moreover a socket to match, but these sockets and coil forms now are obtainable. In the oscillator a UY base may be used.

Looking out of the modulator tube we find that the plate circuit is tuned to the intermediate frequency and that this circuit also is filtered with a condenser-choke combination. The tuning of the plate circuit is of course a filter, as the higher frequencies especially are bypassed, and these include the separate modulator and oscillator frequencies, each of which individually is higher than the intermediate frequency.

The grid circuit of the first intermediate tube should have a high impedance winding, which may be an r-f choke coil of the 200 or 300-turn type. Such transformers are commercially obtainable as antenna couplers intended for tuned radio frequency sets particularly. In fact, the intermediate transformers may be all of this type, and two condensers placed in parallel across the tuned winding, one a fixed condenser, (C3, C4, C5) of 0.00035 mfd. for coils intended for such capacity, or 0.0005 mfd. for coils intended for 0.0005 mfd. capacity. Then the additional and adjustable condensers, E, which are equalizers, say, 20-100 mmfd., will enable the selection of the intermediate frequency at 465 kc.

The Intermediate Frequency

A test oscillator should be used for determining this frequency, although in a pinch you can do it approximately by ear, that is, select some frequency near 465 kc. by turning the equalizers half way in when 0.00035 mfd. fixed condensers are across coils intended for such capacity. The line-up by ear is completed after the set is built, the test being for largest volume of sound.

The grids of the two intermediate frequency amplifier tubes are returned through resistor-capacity filtered circuits to the movable arm of a potentiometer in the automatic volume control circuit. The negative bias on the two intermediate tubes is increased as the signal level increases, and thus a relatively steady state of volume obtains, of a value determined by the setting of this front-panel actuated volume control. Thus the manual control is in the automatic volume control circuit, and two purposes are served at once.

Lest there be no bias, hence heavy plate current through these two tubes, when no signal is received, or at what should be silent points between stations, a fixed minimum bias is provided in the usual manner, by cathode-leg resistors, suitably bypassed.

Diode A-V-C Tube

And lest anything be overlooked, the screen circuits of the intermediate amplifiers are filtered by choke-condenser combinations that would resonate at a frequency vastly below that of the inter-

SS B OUTPUT
'E RESULTS WITH FILTRATION

Petersen

mediate amplifier, hence are substantially short circuits for the intermediate frequency.

The detector coil has a third winding which, if not present in coils, may be put on right over the secondary, consisting of 10 turns of any wire. This pickup winding feeds the diode detector used as automatic volume control. The diode results from connecting plate and cathode of a 56 tube (the new and glorified form of the '27), and using grid as the negative electrode, it being no longer a grid, of course, but one of the two affected plates.

If one side of the pickup coil were connected to the cathode-plate joint and the other directly to the 0.05 meg. (50,000-ohm) potentiometer, the low impedance input circuit to the a-v-c tube would put a severe drain on the detector input above, so a series resistor is included. 0.02 meg., to maintain an acceptable value of d-c resistance at the a-v-c input circuit. A 0-5 milliammeter is in the a-v-c circuit for use as a tuning meter.

The biasing resistor for the second detector is an 0.1 meg. across which is an 8 mfd. condenser, which may be an electrolytic with cap to cathode. Besides, as an extra precaution, a radio frequency choke with a condenser of 0.002 mfd. to ground, is in the cathode circuit, to insure adequate bypassing of radio frequencies, and in deference to the statement of some engineers that a paper or mica dielectic condenser should be used additionally, as electrolytics do not necessarily bypass radio frequencies completely.

Voltage Distribution

The volume is greater and tone better when a large condenser is across the detector biasing resistor, and 8 mfd. is specified as a minimum. More capacity may be added within the utmost practical limits. It so happens the voltage drop is small, and electrolytic condensers in containers ordinarily used for providing 8 mfd. at 500 volts are obtainable at around 30 or 40 mfd. at ratings beyond the 20 volts required.

In the detector plate circuit another filter presents itself, this one consisting of two 800-turn honeycomb coils, with condensers fixed of 0.00035 mfd. each from the three points to ground, or, if more convenient mechanically, to cathode.

The 275-volt tap of the voltage divider is used virtually directly for only the driver stage of the audio amplifier, for a resistor of 2,250 ohms is in series with the feed to the radio frequency and intermediate frequency tubes, this resistor resulting in the reduction to about 200 volts for the plates, but the second detector has a voltage-reducing resistor of 0.1 meg., with a capacity of 1 mfd., the filter thus constituted being very effective in hum riddance.

Separate Filament Winding

The driver stage (Class A) using a 46 with extra grid and plate interconnected, has a separate filament winding, because of the bias on this tube's grid. The bias should be 33 volts negative, hence the filament winding becomes positive by the same amount, realized by connecting filament center to the 750-ohm tap on the voltage divider. The output tubes, also 46 type, but with the two grids joined (Class B), do not require any negative bias, hence the filament is at ground potential.

The filament winding (A) for the power tubes is the same as that for all the other tubes except the driver. The reason for the separate windings is that if a biased tube in the audio channel was common the heaters would be positive in respect to the cathode. It is advisable with the new tubes to maintain the heater at a zero d-c potential in respect to cathode of heater type tubes, or, if there must be a difference, that the heater be negative in respect to the cathode. So we select the preferred method, zero difference.

The "push-pull" input transformer feeding out of the driver is of a special type now obtainable and soon to be generally available as standard for Class B amplifiers. The transformer has a step-down ratio. The single-sided transformer feeding out of the detector need not be special.

The output transformer most likely will be built into the speaker you use, otherwise it would be of the special type for these tubes, or the type for 245 tubes could be used, as the impedance requirements are not much different. One precaution, however, that should be taken is that the output transformer sometimes must carry very high alternating current.

The Class B amplifier, called push-pull, may not be such because the circuit never pulls but only pushes, and there is nothing to buck the distortion. Correct transformer design and other constants effectuate push-pull.

In this connection it is well to analyze the purpose of the Class B amplifier. Admittedly it is not a distortionless circuit. No one ever rates its maximum undistorted power output, for the rating would have to be zero. The continuous power output is given. It may be 20 watts. What is the advantage?

In speech and music there come passages that are tremendously louder than the average volume of sound of the program, and when these volume surges take place in a "distortionless" amplifier the output is far below the power handling capacity required, and distortion does take place. So the utput rating in undistorted power output is a low maximum value, and the average amount of distortion, all values of volume considered, is high. Therefore if a circuit is used that tolerates some distortion at the lower levels and does not exceed that amount at the highest levels, one has an amplifier that does not change its characteristic with volume but can take anything that you will give it. Hence the Class B amplifier, the new audio power amplifier with the almost unoverloadable characteristic.

The coils are wound on Hammarlund's Isolantite forms, which have a diameter of 1.5 inches, with handles that are screwed in. The forms have holes pierced to accommodate various winding lengths, as it would be impractical to drill Isolantite. For primaries the forms are grooved, width 3/16 inch, depth 1/64 inch. Primaries and secondaries are spaced 1/16 inch from each other.

The primaries are wound at bottom, in the slot, the secondaries adjoining. The grid connection for the secondary is made from the terminal of secondary nearer the primary. Thus for obtaining oscillation, winding in the same direction, the B plus connection for the tickler adjoins the ground end of secondary, 1/16 inch separation. The table cites tickler as primary.

The pickup coil is simply a continuation of the secondary, in the oscillator circuit, the number of turns being 1, 2, 3, 5 and 8. The actual test capacity was 0.000138 mfd. but condensers of the commercial rating of 0.00014 or 0.00015 mfd. may be used.

Plug-in Coil Winding Data

Diameter 1.5 Inch; Capacity 0.000138 mfd.

Modulator	*Oscillator*
14 TO 30 METERS	
Primary, 4 turns No. 30 dsc. **Secondary,** 7 turns No. 20 dsc. winding length, 1.167 inch; space wound 6 turns to inch.	**Primary,** 4 turns No. 30 dsc. **Secondary,** 6 turns No. 20 dsc; winding length, 1 inch; space wound 6 turns to inch.
28 TO 60 METERS	
Primary, 4 turns No. 30 dsc. **Secondary,** 14 turns No. 20 dsc; winding length 1.167 inch: space wound 12 turns to inch.	**Primary,** 4 turns No. 30 dsc. **Secondary,** 12 turns No. 20 dsc; winding length, 1 inch; space wound 12 turns to inch.
56 TO 125 METERS	
Primary, 5 turns No. 30 dsc. **Secondary,** 33 turns No. 20 dsc; winding length, 1.375 inch; space wound 24 turns to inch.	**Primary,** 5 turns No. 30 dsc. **Secondary,** 24 turns No. 20 dsc; winding length, 1 inch; space wound 24 turns to inch.
120 TO 300 METERS	
Primary, 5 turns No. 30 dsc. **Secondary,** 78 turns 10/41 Litz; winding length 1.393; space wound 56 turns to inch.	**Primary,** 10 turns No. 30 dsc. **Secondary,** 44 turns No. 28 ssc; winding length, 0.785 inch; space wound 56 turns to inch.
240 TO 550 METERS	
Primary, 8 turns No. 30 dsc. **Secondary,** 114 turns 10/41 Litz, two-bank winding; winding length, 1.062 inch; space wound 56 turns to inch.	**Primary,** 14 turns No. 30 dsc. **Secondary,** 70 turns No. 28 ssc; winding length, 1.25 inch; space wound 56 turns to inch.

A Seven-Tube Super

Standard Circuit Provides Excellent Results

By Alan Mannion

Thor Radio Co.

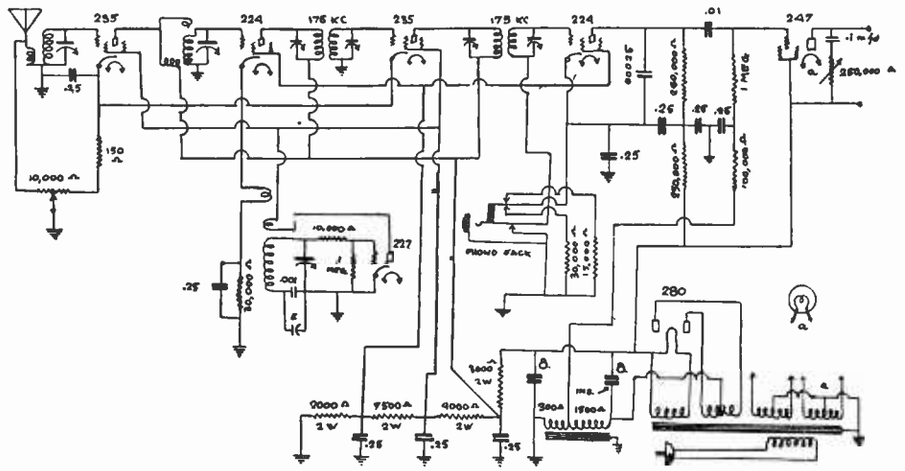

FIG. 1
A standard design for an 8-tube a-c super.

THE increasing demand for a-c operated superheterodyne receivers has brought about many circuit refinements and made necessary a wider general knowledge of the super's peculiarities and possibilities. This popularity is well deserved. Unlike the tuned radio frequency type of receiver, a high order of selectivity is obtainable without a sacrifice of sensitivity. Since the advent of the pentode power amplifier, the audio channel may be a single pentode, resistance coupled from the detector. This saving of space and reduction of the number of tubes needed is in line with the present-day-trend, that of "small set" construction.

The receiver here described was built on a chassis only 10 inch by 14 inch and was housed, including speaker, in a popular mantel-type Gothic cabinet. It consists of one r-f stage, separate oscillator, coupled to the first detector, followed by a stage of intermediate frequency amplification, second detector and pentode output. A 280 tube is used as rectifier.

The r-f stage ahead of the first detector is necessary if one desires separation of stations 10 kc apart all over the dial and avoidance of image interference. The gain in this stage is not so great as is possible if one were to use an additional i-f stage instead, but the increased selectivity and absence of repeat points makes some r-f ahead of the modulator advisable. The coupling to the modulator is through a high-gain r-f coil. This is a capacity-coupled type of coil, and has become almost standard practice for interstage r-f coupling. The r-f tube selected was a 235 super-control.

How Padded

The oscillator stage consists of a 227 tube and its associated coil. Since the intermediate frequency used was 175 kc, and the r-f coil's inductance was 245 microhenries, the oscillator coil inductance is 196.5 microhenries. These inductance values are those generally used, since most receivers use variable condensers of 0.00035 mfd., for tuning.

Care must be taken that the leads of the plate winding are correctly poled, otherwise the tube will not oscillate. Most of the oscillator coils on the market are correctly marked as to polarity, but in the case of some coil manufacturers the winding is done by machine, and the coil mounted on the same base used for the r-f coils. Since the stampings of these bases are alike, the plate winding terminals are incorrectly marked. In any case, provided that all other wiring is correct, oscillation failure may be overcome simply by reversing the plate and B plus leads.

The coupling to the modulator coil is effected by means of a third winding on the coil, which is wired in series with the modulator's cathode-to-ground connection. Four or five turns are sufficient for this winding, and no special polarity need be observed.

Padding is effected by means of a fixed 0.001 condenser shunted by a small equalizer condenser, adjustable by a screw. This parallel combination is placed in the grid-return of the oscillator's secondary winding. Since one side of the pad is at ground-potential, there is an agreeable absence of hand-capacity during the adjustment of the padding. This breaks the grid return to gound, however, and so a resistor of 100,000 ohms is connected between the grid and cathode of the 227 tube.

Precaution Against Loss

Since the 10,000 ohm suppressor connected to the grid is at hot r-f potential at both ends, it is suggested that this be mounted so that it is at least an inch away from the chassis, and kept well separated from all other leads. Failure to do this may result in loss of volume, and inability to make the oscillator "track," due to the extra capacity produced when this resistor is too close to the chassis.

The modulator is a 224 tube, biased as a detector. It is the purpose of this tube to mix, or beat-together, the incoming modulated r-f signal, with the signal generated by the local oscillator. This function produces the phenomenon of a resultant, or "beat frequency." In fact, there are several such mixture-frequencies present in this tube. In addition to the r-f and oscillator frequencies, there will be present frequencies which are the sum and difference of the first two. Thus if the r-f section is tuned to 660 kc, and the oscillator to 835 kc, there will be present in addition to these, frequencies of 1,495 kc and 175 kc. Since the last two are produced by combining the first two, they will be modulated with whatever audio frequency was present on the original r-f carrier-wave.

Looking out of the modulator, we find a stage of intermediate-frequency amplification. We have selected a frequency of 175 kc for our intermediate. Notice that around this tube are four tuned circuits, each resonant at the intermediate frequency. When properly "peaked" these i-f transformers will pass a band of frequencies only 10 kc wide at given input power, making possible the reception of stations on adjacent channels without interference. The peaking of these i-f transformers greatly increases the gain in this stage.

Good Audio Channel

And so we find a very narrow band of frequencies being fed into the second detector whose purpose it is to rectify the incoming wave, and pass on only the modulation, or audio tones impressed on the original carrier wave. Here, as in the case of the first detector, a 224 tube is used. Under the conditions of the circuit, this tube acts as a fine detector, and allows considerable gain. It is important that the screen voltage be low when a 224 is used as a detector with relatively low negative bias. In this case the screen voltage is around 20 volts. This ends the circuit of the "super" proper, since the audio end of the receiver may be changed if some other system is preferred, without interfering with the principle or operation of the tuner.

The volume level is controlled by the double-purpose potentiometer, which varies the bias on the r-f and intermediate tubes, and at the same time effects attenuation of the incoming signal. Though a higher value may be used, it is inadvisable to use less than 10,000 ohms here. The fixed resistance of 150 ohms is included to prevent these tubes from reaching a point of no-bias.

The audio channel and power supply are considered standard in most receivers employing pentode power amplifiers. Though many feared that the pentode would be ruinous to tone, due to the high percentage of third harmonic, experience has taught that it is possible to produce highly acceptable quality with the aid of this audio circuit. The resistance-coupled stage uses the hum-bucking arrangement familiar to readers and the biasing of the pentode by means of a grid return made to a tap on the field choke has proved effective. This is possible when the speaker field winding acts as a choke in the negative leg of the rectifier. An alternative method would be to take the bias through a resistor placed between the center-tap of the pentode filament winding, and ground. However, it was recently demonstrated that in order to attain the low level of wave-form distortion attained by the former method, it was necessary to use a 25 mfd. by-pass condenser across this resistor.

Phonograph Jack

This excellent audio channel may be used for the reproduction of phonograph records, and a jack is shown for this purpose. Since the second detector is a 224 tube, and we wish to take advantage of its high amplification, this jack is placed in the grid circuit of the tube. It is inadvisable to break the lead to the cap of the tube for this connection, so the grid-return is utilized. The

(*Continued on next page*)

Wound Aerial for Autos

Non-Directional, It Is Under Running Board

By Paul Erwin

WHAT kind of an aerial to use on an automobile and where to put the aerial are problems that arise. After having tried out various systems I finally selected one consisting of sixteen spaced turns of stranded aerial wire wound in a slot cut in a board 22.5 inches long and 6 inches wide. Both the beginning and the end of the winding were brought to binding posts at one extreme of the board, as shown in Fig. 1, for optional take-off and for optional grounding of the alternate terminal.

The device was small enough to fit under the running board. It was found entirely practical to space the board itself from the automobile's long step by bushings 1 inch or so high, through which screws were put. The object is to keep the aerial away from the metal finish at the running board edges.

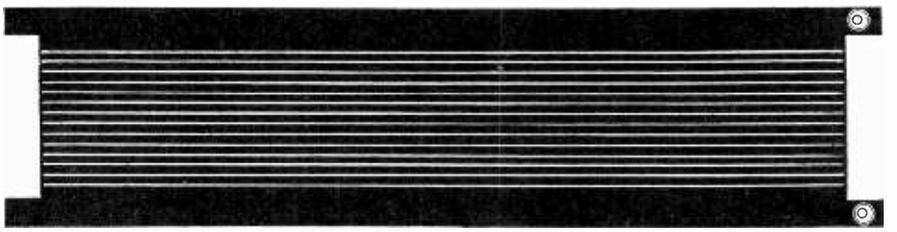

FIG. 1

How the author built a wound aerial for his automobile receiver. The aerial as thus constructed fits under the running board and preferably should stand off from it by 1 inch or more.

Completely Covered

No ground connection was used as part of the aerial itself, because the chassis of the automobile set is grounded, which serves radio frequency purposes, so far as stopping squealing that might otherwise result, or body capacity effects. However, if one terminal of the aerial is connected to the lead-in to the set, then the other may be grounded to the chassis, although little difference was noted when this was done. It seemed proof enough that the chassis itself does not afford a very effective ground, although undoubtedly helpful to the two ends previously stated.

Some protection should be afforded to this home-made auto aerial, and therefore I bought enough automobile top material for 25 cents to cover the board completely, cementing the ends together after providing for the outlead and locating the positions for the elevating bushings.

An aerial such as this is not particularly directional, in fact, is only trivially, and the loop effect is avoided. It is well known that if the wire were strung about in such fashion as to simulate the form and shape of a loop that the directional effect would prevail, for a loop's a loop the world over. Then when you are receiving a station with good volume while on the go, and you turn a corner, down goes the volume, or the station disappears completely, and one might assume it was another case of mysterious disappearance for the police to solve, except that when you turn another corner the station comes right back again.

Respect for Preference

That is complete confirmation of the loop effect, or directional receptivity, a nuisance indeed in automobile sets, as the only way you can continue to receive the station well is to go some place you don't want to go. It is assumed that the trip itself is more important, and an aerial should give a man the right to go where he pleases and still hear the station he most desires to hear.

The wound aerial is simple enough to make. The wood used was ordinary white pine. It is well to give this a coat of paint, and preferable to use insulating paint, new types of which have just come on the market. The insulation provided by one coat is enough to withstand several hundred volts d-c continuous application, but as only a few microvolts will be present at most, you get the benefit of better protection from moisture and more consistently good reception.

Inside Report

For the same reason of preventing losses the automobile top material is used as cover for the aerial. When the car runs along it picks up plenty of soot, grime, dust, earth and whatnot, as you know if you've ever run a rag under the running board, which I never did. But my wife tells me.

She is shown affixing the running board aerial in place (front cover), only so much of her, however, as is pertinent. If it is a job a woman can do thus readily it certainly can't be much work. As for myself, I am willing to bank on it that it's no job at all, from what my wife tells me. If a fellow has a wife who simply won't install a running board aerial for him when he is busy smoking his pipe and reading the snappy magazines, he should show more executive ability.

The reason for the feminine activity was not sheer laziness on the part of your correspondent, for there were additional factors. The main one was that the good woman was insistent on getting reception from an automobile set I had built, insistent to the point of being impertinent, and so I compromised with her. I would accept the consistently good reception as a family requisite and would build a running board aerial of unoriginal but serviceable design if she would install it.

Activity by Compulsion

And she took me up so fast I simply had to build the aerial, although I would have preferred to buy one, had I known of some good commercial product of the kind, in the interest of stimulating business, badly needed at this time as an economic something or other.

With the aerial properly installed—I assume it was done properly, for I was too busy cleaning my pipe to check up on the journeywoman's work—I consented to drive my wife to her cousin's house, three miles away, necessitating a circuitous course, as the whole trip is a detour from civilization. She suggested the destination, probably because of the kinks and queues in the road.

We made so many abrupt turns I thought the car was oscillating or shimmying. However, the auto set played right on, no matter in which direction we went, and my wife complimented herself on her fine work, never remembering that I was the one who had built the running board aerial.

So these words are written also in the faint hope that they will serve as a reminder to her of my excellent contribu- to the family welfare.

[Other Illustration on Front Cover]

"DOES SOMETHING," BOOSTS SALES

Alan Radio Corporation reports increased interest and sales in parts in its new store at 83 Cortlandt Street. Larger stock, greater variety of merchandise and special window displays of small and replacement parts are the reasons ascribed.

Tone Control in Power Tube Stage

(*Continued from preceding page*)

ground end of the second i-f transformer is connected to a normally closed jack. Inserting the plug for phone connection opens this circuit and puts the pick-up in series with the i-f secondary. This operation automatically throws the cathode lead from the normal bias resistor used during detection, to a lower value resistor suitable for high quality audio amplification. The excellent tonal response and really gratifying reproentirely hum-free, and when properly adduction of recorded music make this feature a desirable addition.

The tone control shown covers a wide range of frequencies, and it is recommended that it be included, though not strictly necessary. Considering that it is shunting the primary of the output transformer, it is in effect an "equalizer" at audio frequencies, and tends to flatten the transformer's impedance-frequency curve.

The receiver, called "The Pathfinder," is justed is capable of highly satisfactory performance. It is recommended that 0.25 mfd by-pass condensers be used throughout, as shown. While all leads should be as short as possible, this is especially necessary in grid and cathode circuits, if undesirable coupling between stages is to be avoided.

The procedure of superheterodyne circuit-adjustments is familiar to most readers, having been discussed in other articles.

An Interference Locater

A Sensitive, Loop-operated Portable Set

By Einar Andrews

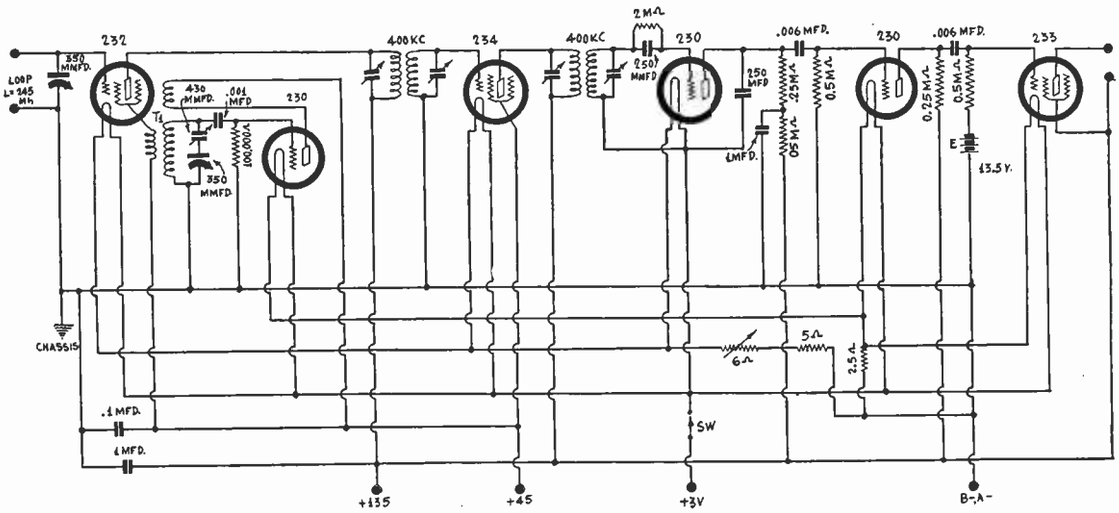

FIG. 1
A portable six-tube superheterodyne with loop pick-up, suitable either for entertainment or for tracking down interfering noises.

THERE is often demand for a receiver that can be used for tracing down the location of interfering noises. The requirements for such a receiver are (a) portability, (b) sensitivity, (c) directivity, and (d) economy of operation.

The first requirement is satisfied if we use resistance coupling to eliminate the weight of the audio transformers and the smallest available tubes to eliminate heavy batteries. Sensitivity is obtained by using a superheterodyne type circuit with at least 6 tubes of the proper type. Directivity is obtained by using a loop antenna, and in no other way. Economy of operation by using the smallest tubes and no more of them than absolutely necessary. We might add another requirement, that it should be especially sensitive on high audio frequencies as well as at high broadcast frequencies.

Conditions Easily Satisfied

The conditions imposed are rather easily satisfied for we do not have to make any provisions for the amplification of the very lowest audio notes. Neither is it necessary to take any steps to prevent them from coming through. With the set as shown in Fig. 1 there is good audio amplification at all notes to about 100 cycles per second, and a good deal below that, but down in the region where condensers of reasonable capacity are ineffective for by-passing there is little amplification. Hence there will be little chance for motorboating when the batteries get old. It should be pointed out that many broadcast receivers rated as of good quality do not have the level response characteristic that this has, and that the set may be used for entertainment as well as for chasing noise.

The Tuners

There are two separate tuned circuits in the receiver, the loop antenna tuned with the first 350 mmfd. condenser and the oscillator coil T1 tuned with the second. Independent tuning is used because it would be extremely difficult, if at all possible, to make the two dissimilar circuits track if the condensers were on one control. It is not absolutely necessary to pad the oscillator tuner when the two condensers are independent, but it is just as well to do so in order to make the two tuners read approximately the same.

The loop should be one wound for 350 mmfd. tuning. The best way to find the right number of turns for any given frame is to put on more than enough and adjust the turns until 550 kc comes in at 95 on the dial, assuming a 100 division dial. This may require not only changing the turns but also changing the spacing of the turns. On a frame 20 inches square with the turns spaced about one eighth of an inch with No. 20 wire about 15 turns should be needed.

For the loop the heaviest practical wire should be used. At least it should not be smaller than No. 20. The sensitivity of the receiver will in a large degree depend on the size of wire used in the loop, for the resonant voltage across the first tuning condenser, and hence the input voltage to the first tube, is inversely proportional to the resistance.

LIST OF PARTS

Coils

One loop as described.
T1—One oscillator coil as described.
Two 400 kc intermediate frequency transformers.

Condensers

Two 350 mmfd. tuning condensers.
One 350-450 mmfd. padding condenser.
One 0.001 mfd. fixed condenser.
Two 250 mmfd. fixed condensers.
Two 0.006 mfd. fixed condensers.
One 0.1 mfd. condenser.
Two 1 mfd. bypass condensers.

Resistors

One 100,000 ohm grid leak.
One 2 megohm grid leak.
Two 0.5 megohm grid leaks.
Two 0.25 megohm plate resistors.
One 50,000 ohm resistor.
One 2.5 ohm ballast resistor.
One 5 ohm ballast resistor.
One 6 ohm rheostat.

Other Requirements

Five UX sockets.
One UY socket.
One filament switch.
Two grid clips.
Two dials.
Eight binding posts.

The Oscillator Coil

The oscillator coil contains three windings. It may be one of the commercial oscillator coils wound for 350 mmfd. tuning condensers and a 400 kc intermediate frequency. Any one who prefers to wind his own can do so by putting on 85 turns of No. 32 enameled wire on a one inch form for the tuned winding. On the ground end of this winding put a layer of insulator, such as empire cloth, to a thickness of 1/16 inch. Then on top of this put on 50 turns of fine wire, say No. 36, for the tickler. Put some more insulator over this winding but only one layer. Then wind the pick-up winding. Since this winding is in the screen circuit of the first detector and also since the receiver is to be sensitive, it is best to use more pick-up turns than ordinarily. Fifteen or twenty can be used. Put both the tickler and the pick-up windings as near the ground end of the tuned winding as is practicable.

The Padding

The same series condenser is used in this oscillator as in one in which a gang condenser is used for tuning. This is only to make the dial readings on the two condensers nearly the same. The range of the condenser should be from 350 to 450 mmfd. if the intermediate frequency is 400 kc. The tracking can be made closer at the short wave end of the dial by adjusting the trimmers across the tuning condenser. If this is done and if the series condenser is adjusted by the method outlined in previous articles the tracking will be close.

In case it is desirable to use a two-gang condenser it can be done with careful adjustment of the inductance of the loop and of the trimmer and series condensers provided a tiny variable condenser is con-

(*Continued on next page*)

Winding Your Own Coils

Solutions for Mechanical Problems That Arise

By Sylvester Vardon

IN winding coils by hand it is difficult to apply and retain enough tension. Hence the wire is put on with various degrees of tightness. Particularly does this variety arise when the coil occupies a considerable percentage of the winding space of the form, for then the hand eventually has less gripping space. Reversing the end that is held reverses the direction of moving the hand, or if the shift is made to the other hand, makes you use your undextrous member.

It is clear that some form of machine winding is far preferable. The machine need not be automatic. A hand-drill often is pressed into service, by a special set-up, whereby the instrument support is obtained from a vise, and a thick dowel or spool is provided with a ¼-inch shaft for insertion in the chuck. Thus when the gear handle is turned the coil form receptacle is rotated.

With the right hand you may actuate the coil form and with the left hold the wire that is coming off a separate spool that also must be given support.

Get Some One's Help

It is of course handier to have someone slowly and steadily turn the drill, while you devote both hands to the winding, or your dextrous hand to guiding the wire. Unless you are ambidextrous you will be rather clumsy with one hand either at winding or guiding.

For broadcast use not a large percentage of coils is home-wound to-day, but with short waves the situation is quite the reverse. Therefore as coils of different numbers of turns will be wound, the question arises as to how and when to determine the length of the winding, for anchorage purposes.

The winding length may be taken from a table. If spacing is used, for simplicity one may space for the diameter of the wire and insulation used for actual winding, by putting on two turns from different spools, side by side, and removing the spacer winding after the other is complete.

The winding length, called the axial length of the coil, therefore should be determined. There may be a slight variation from the table, due to differences in actual thickness because of non-uniformity of the wire, temperature conditions and probably differences in applied tension, too little tension allowing possibility of a slight spreading, and also possibly due to the identity of pins for the connections.

The practice is generally followed of having one terminal of the winding end close to the pin to which the wire will be brought, but whatever other pin is used, it must be on a perpendicular plane circularly distant from the other by less than a circumference.

Where few turns of wire are to be put on the hole for the second terminal may be pierced exactly for the specified winding, the lead inside the form going to the inside of the pin for soldering, run at an angle. If the number of turns is rather substantial, say, a dozen or more, then the wire may be continued a bit beyond the prescribed number of turns, to be on a plane with the intended pin. Usually the number of turns specified is even, and the angular direction of leading the wire to the pin is intended. In this way there is virtually no increase in the inductance, whereas adding a fraction of a turn, the alternative method, of course does increase the inductance.

So decide which method you shall use, drill the holes for the terminal outlets, and get ready to wind the coil.

For plug-in coil winding it is well to scrape the insulation cleanly from the wire where the beginning of the winding is to be soldered to the pin of the form, and actually make this soldered connection. The problem is to have the insulation off not only just level with the end of the pin, but including some of the wire actually inside the pin, for solder may get in there and should be utilized for joining. If the wire is not soldered first to the pin access for scraping off insulation will be difficult unless excess has been left outside the pin, at bottom, for then the wire may be pushed up, inside the coil form, scraped and pulled back into position. At least 6 inches of excess is required, and 8 to 10 inches work more handily.

Mechanical Effect of Size Wire

With coils using small diameter wire, say, 24 or smaller, the flexibility makes the coil construction easier, but with larger wire, especially on small diameters now popular, the thickness and short space of turning combine to make the mechanical task rather awkward, and moreover with unwieldy wire there is always danger of accidentally scraping off insulation, particularly if it is enamel. Insulation thus removed does no harm if the winding is spaced, but if the coil is closely wound, lack of insulation may result in a short circuit. The leadout holes should be of ample diameter to permit working with the size wire intended, without danger of chafing the wire in threading or pulling.

When the end of the winding is reached the same problem arises as in the beginning, to anchor the terminal tightly in the pin and have no play in the wire between the inside terminal of the pin and the hole in the form for outlead. A practical method is to reach the end of the winding naturally, leave about 10 inches excess, put the entire excess through the pin, scrape off insulation from the wire where you can, up to the end of the pin, and push back enough of the excess through the inside of the form until the part of the wire on which you have been working is handy. Then continue scraping off insulation from the wire for one-quarter of an inch, in the direction of the winding. Now when the wire is pulled through the pin a taut line may be held, the soldering done, and the excess snipped off.

It is preferable to have the soldered connection made at the center of the pin's diameter, to avoid any possibility of the wire impeding the pin at the socket or of having to file or scrape at the soldered joint. By securing the form to a vise it is easy to pull on the wire, holding it at center, when the soldering is being done with the other hand. Also the wire at center tends to support the solder, for the wire will take solder more readily than nickel-plated portions of the pin. To get rid of any resistance to soldering due to plating, it is advisable before winding the coil to run a dull knife around the edge of the pin. Do not scrape below the edge on the outside, otherwise any excess solder may not run off.

Use of Binder

Only a little solder should be applied, as a large glob will result in the solder overspreading the diameter of the pin. What is desired is a resultant bead of hardened solder. This result in commercial practice is usually obtained by dipping, a process not so well suited to home activities.

Do not make the coil so carelessly that you have to push the wire back into the pin to reach a bared stretch for soldering.

That gives the coil too much opportunity to spread, and the inductance will change. With short-wave coils it is desirable to make them carefully and well, so that, so far as the coils can help, dial settings will be retained. Otherwise these settings will change, for the inductance will change.

Even the tightest possible winding, whether close-winding or space-winding, will not result in exactly the same axial length each time, and coils with the same number of turns will have slightly different inductance. The reason is that, especially for coils of short axial length, the inductance depends very considerably on this length, as well as on the number of turns.

If the outlet holes are predetermined, then the coil will have the same winding length, because all windings terminate at the same distance from the beginning, but every effort should be made to get the holes at the right distance so the number of turns can be just squeezed in. That applies particularly to close winding. Otherwise a close-wound coil will not stay close-wound at the ends, especially if subjected to much handling, and the wire will spread, and some turns even overlap others after a while. For this reason some form of binder is usually put at the last few turns, unless the form is highly frictional and will resist this tendency toward spreading. Some Isolantite coil forms have this purposely rough treatment, but usually bakelite and other phenolic compounds do not, and the binder may be used. Special binders are used by coil manufacturers. A substitute is collodion, obtainable at almost any drug store.

Receiver for Locating Interference

(*Continued from preceding page*)

nected across either the loop or the oscillator coil and this trimmer is put on the panel.

Grid leak and condenser method of detection is used in the second detector because of its sensitivity, but the tube used is a 230. However, a 232 may be put in if the builder desires it. The screen in that case should be connected to the same point as the screens of the other screen grid tubes in the circuit.

A 2 megohm leak and a 250 mmfd. stopping condenser are used for detection. A higher low frequency sensitivity could be obtained with a smaller condenser and a larger leak, but we must not forget that one object of the circuit is to bring out noise when there is noise present, and noise is carried by the higher frequencies. The by-pass condenser in the plate circuit of the tube is also one of 250 mmfd. A somewhat larger condenser would bring out the lower frequencies better but we want the high notes too.

The audio amplifier consists of two resistance coupled stages using one 230 general purpose tube and one 233 power tube. The stopping condensers in both stages are 0.006 mfd.

TRANSFORMER DESIGN FOR C
CORRECT CONST

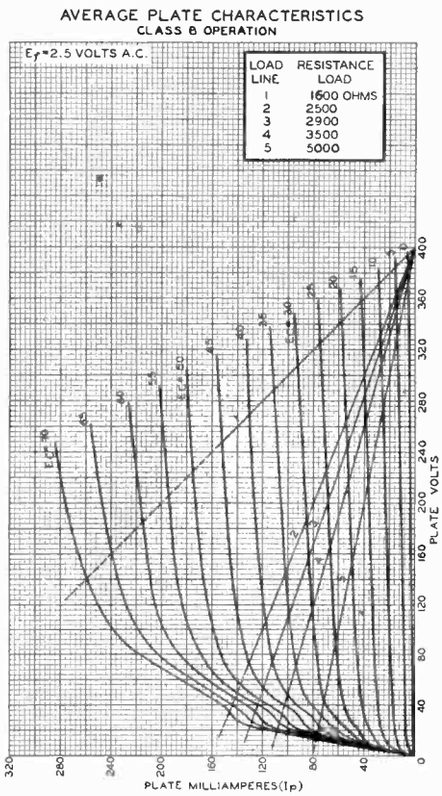

FIG. 1

Plate current plate voltage curve of the Class B 46, with load lines.

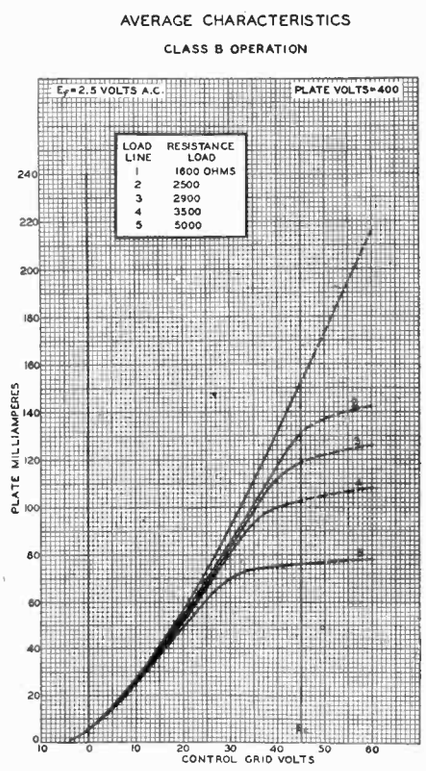

FIG. 2

These curves show the relationship between the control grid voltage and the plate current for five different loads on the 46 power tube with 400 volts in the plate circuit. The grid voltages are positive.

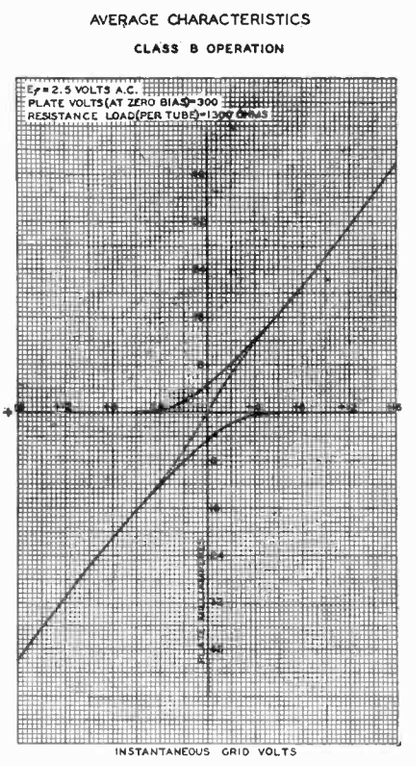

FIG. 3

The characteristics of a Class B amplifier with two 46 tubes with a load per tube of 1,200 ohms and a plate voltage of 300 volts at zero bias. Note that near the operating point the action is push-pull.

[In a pamphlet, "Technical Discussion on the application of the Type 46 Tube" (Laboratory Series, No. UL-1, Second Issue), RCA Radiotron, Inc., and E. T. Cunningham, Inc., give the transformer requirements for the Class B power stage, particularly for the special push-pull input transformer. The pamphlet is reprinted by us substantially complete as to text.—EDITOR.]

IN the application of the type 46 tube to a-c operated receivers there are certain points in the design of the circuits which require careful consideration. The characteristics of plate load, input transformer, and B supply are all interrelated. The particular values of certain constants in these circuits will depend upon the objects of the designer. The cost of parts permissible for a given design and the amount of output required will in general influence the choice of certain constants. These constants will in turn determine suitable values of the related constants.

An understanding of the circuit relations is important for the proper use of the tube. These relations can be most readily explained by considering the fundamental characteristics of the tube.

The general method of calculating circuit constants is first briefly outlined. Certain simplified curves and relations are then given. An example illustrates the use of these.

Amplifier Design

A simple method for designing the audio-frequency class B amplifier is to design the input transformer with sufficient step-down ratio to make the impedance of the source of driving power plus the transformer impedances appear as an impedance in the grid circuit which is negligible in comparison with the internal grid resistance (roughly 1,000 ohms) of the tube.

With this arrangement, and a source of driving power which is limited, the voltage on the grids of the class B tubes is limited. For a limited grid voltage on the class B tubes, the power output will be greatest for a plate load which causes the greatest value for the product of plate voltage and plate current swing.

Fig. 1 represents the I_p-E_p curves of the tube. A signal of amplitude E_c will swing the plate current from E_B to the E_c curve. Load line 1 represents a value of load resistance too low for maximum power output, since the plate voltage swing is too small. Load line 5 represents a value of load resistance too high for maximum power, since the plate current swing is reduced. Load line 4 represents the load resistance for which the product of plate current and plate voltage swing is a maximum and hence maximum power output. Load line 3 represents a load resistance less than load line 4.

The distortion with load line 3 occurs because the plate current for successive values of E_c does not increase in proportion to E_c. For signal amplitudes appreciably less than E_c load line 4 would be satisfactory. In fact at reduced signal levels the plate circuit distortion is less and the power output greater for load line 4 than for load line 3.

Good on Low Volume, Too

The difference is, however, not great, so that the load chosen for maximum power output, with say 5 per cent. overall distortion, will give equally good performance throughout the lower range of signal levels.

For the maximum signal voltage of amplitude E_c the load line 3 gives less distortion than any other load either higher or lower.

As a further illustration of the relation of the load resistance to the plate current characteristics of the tube, the plate currents corresponding to loads 1, 2, 3, 4 and 5 have been plotted against E_c in Fig. 2.

Since the tube is operated with zero bias voltage, the different positive values of grid voltage correspond to the signal voltage effective on the grid of one tube at various instants throughout the half cycle for which this grid is positive. The plate current cut-off occurs at a very

'LASS B USE; \NTS BRING TRUE PUSH-PULL

small value of negative voltage. The negative voltage variations on the grid of one tube are positive voltage variations on the grid of the companion tube.

A small region of overlapping of the characteristics of the two tubes permits the transfer of load from one tube to the other without appreciable distortion. Fig. 3 shows the resulting dynamic characteristic effective in the region of overlap. The slight deviation of the resultant characteristic from a straight line causes the distortion which occurs in this range of operation.

Relative Value of Load Resistance

Briefly stated, the lower the power of the driving source and the smaller the maximum signal voltage delivered to the grids of the class B tubes, the larger the value of load resistance required for maximum power output with minimum distortion, and vice-versa.

The discussion so far has been entirely regarding the plate circuit, when a certain maximum signal voltage can be delivered to the grids. It was assumed that the impedance in the grid circuit was so small that the voltage drop caused by the grid current flow through this impedance was negligible in comparison with the applied grid voltage. Practically with a limited source of driver power it is necessary to allow some impedance in the grid circuit.

There is, however, another factor which has an appreciable effect in determining the load which will produce greatest power output for a given amount of distortion. With a resistance in the grid circuit the third harmonic distortion due to the upward curvature of the grid current curve appears in the plate circuit in opposite phase to the distortion caused by the upward curvature of the plate current curve. An appreciable reduction in distortion results from resistance in the grid circuit. It should be noted that leakage reactance will shift the phase and prevent cancellation of the distortion voltage developed in it. Also the impedance of the leakage reactance is higher to higher frequencies. A low value of leakage reactance is required in the grid circuit to avoid excessive amplification of small amounts of higher frequency distortion components.

Transformer Effect on Grid Resistance

The use of an input transformer with less step-down ratio to the grids, and with close coupling between primary and secondary, will reflect the plate resistance of the driver as a greater resistance in the grid circuit. The resulting grid distortion will cancel part of the output plate distortion. For example, if the third harmonic in the grid circuit is 3.5 per cent, load 3 will give +3.5 per cent third harmonic in the output, while load 2 will give +1.2 per cent. A value of load near load 2 would then give greatest power output with minimum overall distortion. At the points of zero third harmonic there is a small percentage of fifth harmonic plus the driver tube second harmonic so that the total output harmonics is not zero. Less step-down ratio will also cause the grid resistance of the class B tubes to be reflected in the plate circuit of the driver tube as a lower load resistance. More power is obtained with a lower load resistance in the driver plate circuit but the second harmonic distortion from the driver is increased.

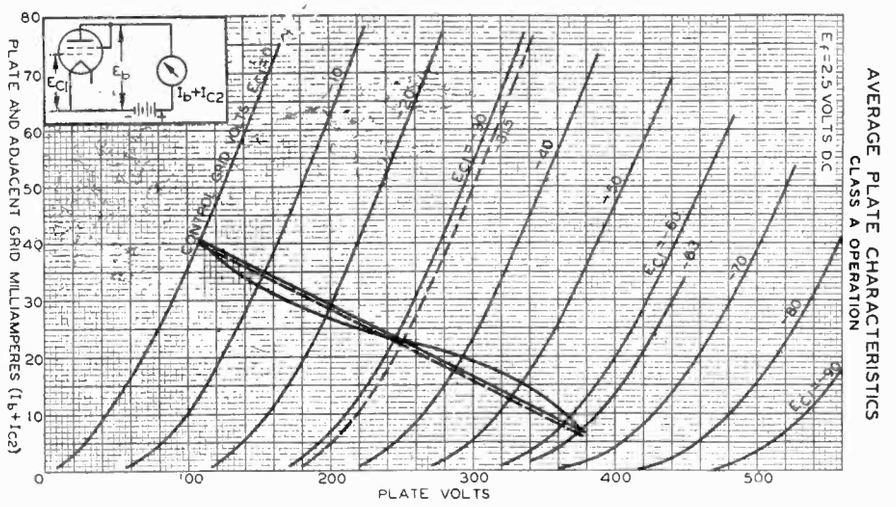

FIG. 4

A family of plate current plate voltage curves of the 46 tube used as a Class A amplifier. The operating bias is 31.5 volts negative and the plate current has been adjusted to 23 milliamperes. From the symmetry it is apparent that proper design and application result in substantially push-pull performance.

For an overall distortion of 5 per cent. total harmonics, usually not more than 2 per cent. of second harmonic can be tolerated from the driver tube. This usually requires a load resistance on a triode driver tube of three to four time the plate resistance of the tube. A load somewhat lower can be used with a push-pull driver.

Fig. 4 shows the load line for the grids of the type 46 class B tubes (and transformer losses) reflected on the plate characteristics of a type 46 tube operated class A as the driver tube. The load line is curved due to the curvature of the grid current characteristic.

Fig. 4 Analyzed

In this case the plate voltage on the class B tube was 300 volts and the output load resistance from plate to plate was 5,200 ohms. The input transformer ratio from primary to one-half the secondary was 2.44 to 1.0. The dotted line in Fig. 4 represents the load resistance determining the peak output power delivered to the primary of the transformer. In this case the dotted line represents a load of 7,250 ohms, or 3.0 times the plate resistance of the tube. The dotted line might have been assumed for the purpose of calculation. The peak power for the extremes of this line multiplied by the permissible peak power efficiency for the transformer gives the amount of the peak power available at the grids of the class B tubes.

From the amount of peak power and the I_{c}-E_{c} characteristics, in conjunction with the I_{p}-E_{c} or I_{p}-E_{p} characteristics, a suitable load resistance for the class B tubes can be chosen.

The choice of output load as outlined above is for maximum power output with a limited amount of distortion. It is conceivable that other factors might influence this choice, such as too much leakage reactance in the input transformer. This could, for example, be overcome by a higher step-down ratio if the driver tube could supply a sufficiently great voltage swing. The output load might then be chosen for the maximum power with a given amount of distortion, remembering that very little grid distortion would be produced with which to cancel plate distortion.

Peak Current

Another factor which might influence the choice of output load would be the amount of peak current which the B supply could deliver. High peak currents pulsating at an audio-frequency rate are required from the B supply. A specially designed B supply is necessary. The use of a higher output load resistance reduces the peak currents required from the B supply. With a poorly designed B supply the voltage fluctuations caused by high peak currents might be great enough to cause instability in other circuits of the receiver.

These are all problems which are of more or less importance depending upon the magnitude of these effects in the particular design.

In order to facilitate the choice of plate load which will give maximum power with approximately 5 per cent. total distortion, curves have been made showing the approximate value of the plate load, power output, and peak grid resistance versus peak grid power.

The peak grid power is equal to the product of maximum instantaneous grid

(*Continued on next page*)

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

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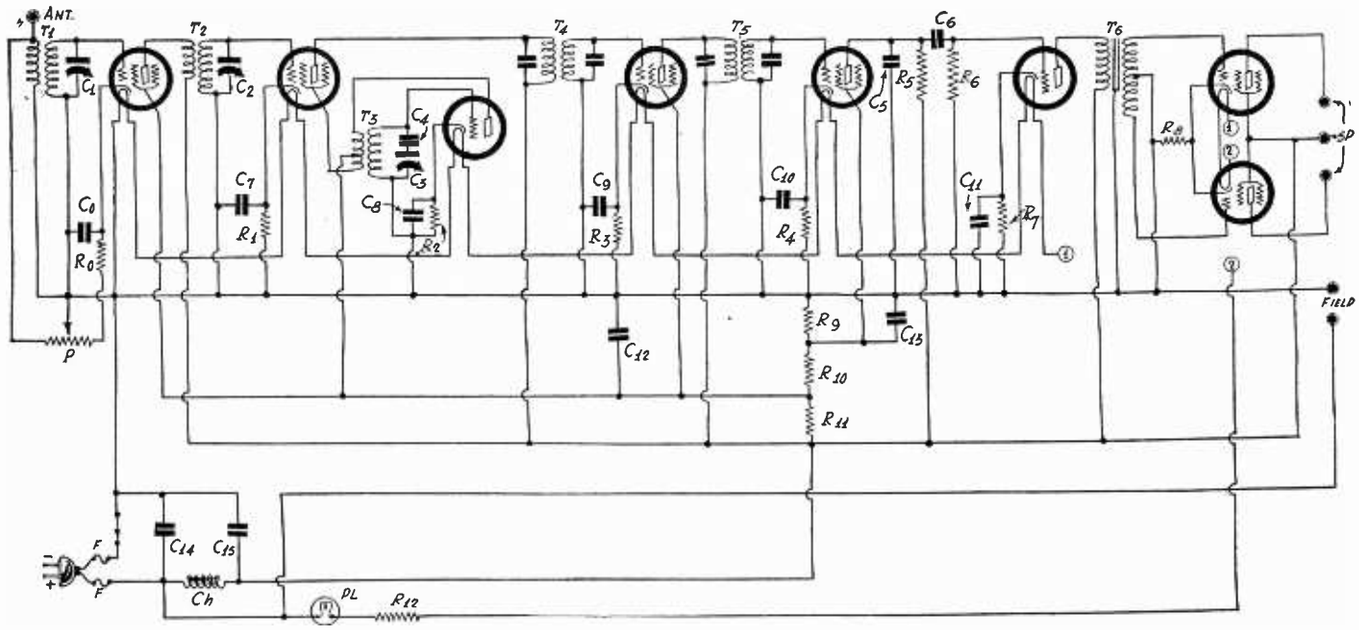


FIG. 1,013
An eight-tube superheterodyne designed for operation on a d-c line. All the filaments are connected in series. In the same series are also a pilot light and a limiting resistor.

D-C Superheterodyne

PLEASE publish a diagram of an eight-tube superheterodyne to be operated on a 110 volt d-c line. I prefer to use automobile type tubes, and the filaments should be connected in series.—W. W. F., Birmingham, Ala.

You will find the diagram in Fig. 1,013. We suggest that you change it so that the pick-up coil is in the cathode lead instead of the screen lead of the first detector tube. You might also improve the set by connecting a 4 mfd. condenser across the bias resistor for the two output tubes.

* * *

Sensitivity of an Auto Set

WHY IS my automobile receiver sensitive outside the car and not at all sensitive in the car? Outside it is all that I could desire but inside it is a dud.—B. W. C., Minneapolis, Minn.

The set is just as sensitive inside the car as outside, but in the car you don't give it a chance. You have neither ground nor antenna in the car, and every set requires both. You may call the car body a ground, but it is a very poor ground for it is well insulated from the earth by the rubber tires, and by the road itself in most places. You may call the device used for pick-up an antenna, but it is only a makeshift, and a very poor one, even though it may be the best possible under the circumstances. Only a very sensitive set can be used in a car with the expectation of getting much.

* * *

Police Radio Receiver

IN YOUR May 21st, 1932, issue you stated that police radio stations are transmitting on frequencies between 1,500 and 2,470 kc. Now I desire to build a very sensitive receiver with which to pick up the police signals but I want to make the tuner as simple as possible. Would you suggest the circuit to use and the tuning condensers?—C. L. Z., Detroit, Mich.

An automobile superheterodyne like our 631 should be all right provided that you change the tuning coils and the condensers. You need a capacity ratio of about 2.78, which can be obtained with a tuning condenser of about 125 mmfd. Of course, you can have a greater capacity ratio and thus cover a wider band of frequencies. The simplest way of adjusting the circuit is to remove turns from the coils until you get 2,500 kc on the tuner when the condenser is open. It is best to tune the oscillator independently of the r-f circuits.

* * *

Stability of Oscillators

WHAT are some of the conditions for frequency stability of r-f oscillators? Does the frequency of the ordinary laboratory oscillator vary enough to make any difference for routine laboratory work?—R. B., Greenwich, Conn.

The ordinary oscillator does not vary enough to worry about for work on receivers. For a high precision oscillator, one that can be depended on to do better than one part in one thousand, it is necessary to take precautions against frequency fluctuation. There are many factors affecting the frequency generated. Some are the temperature, the selectivity of the frequency-determining circuit, and the variation in plate and grid resistances. One of the most important conditions is that the

Determination of Peak Power Output

(*Continued from preceding page*)

voltage and maximum instantaneous grid current.

The plate load per tube is one-fourth of the load resistance effective from plate to plate of the output tubes.

The power output is the average watts output for the two tubes.

The peak a-c grid resistance is defined here as the ratio of the maximum instantaneous grid voltage to the maximum instantaneous grid current. This quantity is convenient for use in calculating the input transformer characteristics.

An example will illustrate the use of these curves. Consider one type 46 tube operated class A as the driver. The plate voltage is 250 volts, and bias —33 volts. The peak power output of the driver is found by drawing a load line through this point on the I_p-E_p characteristics of the tube. For a single triode the load line should represent a resistance of three to four times the plate resistance of the driver tube to assure sufficiently low distortion.

It is only necessary to divide the total plate voltage swing and the total plate current swing each by 2 then multiply these together and the product is the peak power output of the driver. For convenience a table of values of plate load and peak power output is shown below. The values shown are those found to give approximately optimum performance for the different types of tubes driving the type 46 tubes. From the table we find for one type 46 tube at 250 volts, the driver peak plate load is 8,000 ohms and the peak power output is 2.15 watts.

[*Some mathematics on the above will be published next week.*]

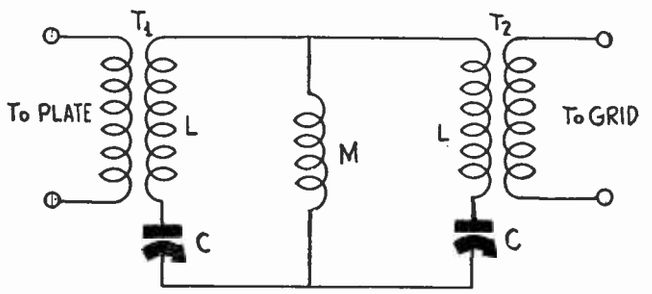


FIG. 1,014

A band pass filter in which the two resonant circuits are coupled with a capacity Cm. For a band width of 10 kc at 1,000 kc Cm should be 0.01 mfd.

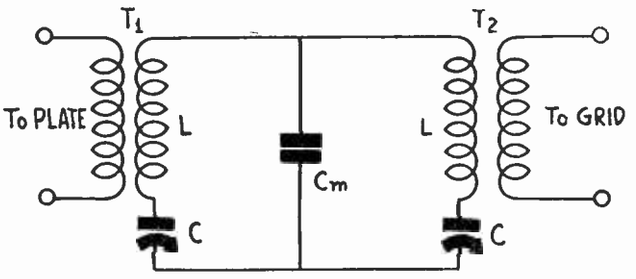


Fig. 1,015

A band pass filter in which the two resonant circuits are coupled with a small inductance coil M. For a band width of 10 kc at 1,000 kc M should have a value of 2.47 microhenries.

selectivity of the tuned circuit be as high as possible. Frequency variation is due to a change in phase of the energy fed back from the plate circuit. If the tuned circuit is highly resonant this change of phase is compensated for by a very small frequency change because of the rapidity with which the phase changes with frequency in such a circuit. It is also important to prevent grid current by using a high negative bias, or to prevent large changes in the grid current by using a stopping condenser and grid leak. Keeping the filament and plate voltages constant is essential because frequency variations are usually due to changes in the voltages, that is, changes not due to temperature variations. There is only one thing to do to keep the frequency from changing with temperature, and that is to keep the temperature from changing.

* * *

Receiving Continuous Wave Code

HOW IS it possible to receive continuous wave code signals on a short-wave receiver. My circuit is a super-heterodyne and it is very sensitive on voice and on television signals, but I don't get many code signals.—J. M. B., New York, N. Y.

All you need is an oscillator operating at the intermediate frequency. Couple this rather loosely to the second detector. Adjust its frequency to differ by about 500 cycles from the intermediate frequency. You will then be able to hear all the continuous wave signals that the set can pick up, and they will all be a 500 cycle whistle. A short-wave receiver with such an oscillator built in will be described shortly. This will show you how to wire the oscillator and how to couple it with the second detector. When receiving modulated signals the oscillator must be stopped for otherwise the heterodyne whistle will be heard continuously.

* * *

Noise in D-C Super

THERE IS a great deal of noise in a d-c 8-tube superheterodyne that I have built according to one of your diagrams. Nothing that I have tried has had the least effect on the racket. Apparently the noise comes from the d-c line. Please suggest a remedy.—R. B. H., Wilmington, Del.

If you had stated which diagram you followed in building the circuit we could have made specific suggestions. If you built a circuit with a push-pull output stage you should try a half megohm resistor across each half of the p-p input transformer. This is usually effective in removing high frequency noise picked up from the line. You should also check the circuit for defective contacts.

* * *

Screen Grid Audio Amplifier

WOULD YOU recommend the use of a 235 screen grid tube in a resistance coupled audio amplifier in order to get high gain? I am now using a 227 tube but the amplification is not quite as high as I should like it. What difficulties would likely result if I made the change?—F. W. R., Pueblo, Colo.

We do not recommend this tube in an audio amplifier because the circuit would undoubtedly become unstable. If you use separate B supplies for the tubes it would work all right but presumably you do not want to do this. It is difficult enough to make a resistance coupled amplifier stable with general purpose tubes.

* * *

Controlling Volume With Filament Current

HOW IS IT that the volume can be controlled by varying the filament current? Does not the mu of the tube depend on the geometry of the tube and does not the amplification depend on the mu of the tube? The geometry of the tube does not change with the temperature. Hence there should be no change in the amplification as the filament current is changed.—L. L., New York, N. Y.

If your reasoning were correct it would not be necessary to have any filament current at all, for the mu of the tube would be the same when the tube is cold. Undoubtedly it is, but there is more to amplification than the mu of a tube. There is also an internal resistance of the tube that must be taken into account. This increases as the filament current is reduced. A better measure of the amplification is the mutual conductance, and this varies rapidly with filament current.

* * *

Effectiveness of Loop

WHAT FACTORS in a loop determine its effectiveness as a pick-up for radio signals? Should the loop be square, longer than it is high, higher than it is long? Should it be wound in a spiral or should it be box like?—W. C. Y., New Bedford, Mass.

The effectiveness of a loop depends mainly on the area inclosed by one turn and on the number of turns. If the turns are not equal, then it depends on the average turns-area. According to this it does not matter much what the shape of the loop just so the product of the area and turns is large. One thing is of first importance, and that is the resistance of the loop. This should be as low as possible. A loop of very low resistance does not pick up any more voltage from the incoming wave than a loop of high resistance, but it does much more with the voltage picked up. If we have a loop with an inductance of 200 microhenries tuned with a capacity of 200 mfd. and this loop picks up a voltage E, then the voltage across the condenser will be 1,000 E/R, where R is the resistance in the loop. If we could reduce the r-f resistance to one ohm we would have a voltage across the condenser 1,000 times the voltage picked up. If we have a resistance of 5 ohm, the voltage across the condenser will be only 200 times the voltage picked up. A poor loop may have an r-f resistance of 50 ohms. In that case the resonant voltage across the condenser will be only 20 times the voltage picked up. By voltage picked up is meant the e.m.f. induced in the loop by the radio wave.

* * *

Modulation Capability

WHAT IS the meaning of modulation capability as applied to transmitters? Does it have any relation with percentage of modulation—C. H. R., Newark, N. J.

Modulation capability is the highest percentage modulation of which the transmitter is capable. During a program of any type the modulation must not exceed the modulation capability. If there are high sound peaks in the program, which would cause the modulation to exceed the maximum, it is necessary to tone down the entire program or only those sounds which might cause overmodulation. That is the function of the monitor at the transmitting studio.

* * *

Band Pass Filters

PLEASE show how to hook up pass band filters for broadcast tuning. I wish both capacity and inductance coupling types. I am planning to use tuning coils wound for 350 mmfd. condensers. What I wish to know in particular is the value of the coupling capacity and the coupling inductance for a 10 kc band width.—S. D. B., Fort Worth, Texas.

You will find the filter circuits in Figs. 1,014 and 1,015. If the tuning condensers are 350 mmfd. and the L windings match, then Cm, the coupling capacity, should be 0.01 mfd. and M, the mu coupling inductance, should be 2.47 microhenries.

SWISS RECEIVE BROADCASTS IN HOME BY WIRE

Washington.

Assistant Trade Commissioner Henry E. Stebbins reports to the Department of Commerce from Berne as follows:

A system whereby telephone subscribers can enjoy radio broadcasts without actually owning a radio set has been inaugurated recently in Switzerland. To date a total of approximately 2,000 installations have been put into effect in Basel, Berne, Geneva, Zurich, Chur, Lausanne, Lugano, Locarno, Bellinzona, and Montreux.

The advantages which the Swiss telegraph and telephone administration claim for the installation are (a) no antenna is necessary; (b) reception of the broadcasts from the two large broadcasting stations, which are served with special underground wires for broadcasting service, is absolutely clear; (c) there are no atmospheric disturbances; (d) there is no static caused by electric railroads or machines in the neighborhood; (e) no battery is needed; (f) there is a very simple receiving device; and (g) listening-in is very easy, for sound volume can be regulated.

Changes in Listing of Broadcast Stations

Changes in the list of broadcasting stations by frequencies, made since the publication of the list in the March 26th issue, follow:

630 kc, WOS, Jefferson City, Mo. Change owner to Missouri State Marketing Bureau.

860 kc, KMO, change frequency to 1330 kc, and power to 250 w.

1010 kc, KGGF, new location, Coffeyville, Kans. (Instead of South Coffeyville, Okla.)

1010 kc, WORK, York, Pa., York Broadcasting Co. 1KW. New Station.

1120 kc, KRKD, new location, Los Angeles, Calif. (Instead of Inglewood, Calif.)

1140 kc, WAPI. Change owner to WAPI Broadcast Co.

1200 kc, WABI. Change owner to Universalist Society of Bangor.

1200 kc. Insert KGVO, Missoula, Mont. Mosby's, Inc. 100 w. (See 1420 below.)

1130 kc, WJJD. Change owner to WJJD, Inc.

1230 kc, KFQD. Change power to 250 w.

1310 kc. Delete WFDV. See 1500 kc below.

1310 kc, KRMD. Shreveport, La. Change owner to Radio Station KRMD, Inc.

1310 kc, WEBR, Buffalo, N. Y. Change power to 250 w. (*) Max. day power.

1330 kc. Insert KMO, Tacoma, Wash. KMO, Inc. 250 w.

1360 kc, WCSC, Charleston, S. C. Change ownership to South Carolina B'dc'g Co., Inc.

1420 kc, KGKX, Sandpoint, Idaho. Change owner to Sandpoint B'dc'g Co.

1420 kc, KFXY. Change location to Yuma, Ariz.

1420 kc. Delete KGVO, changed to 1200 kc. as noted above.

1420 kc, WPAD. Change owner to Paducah Broadcasting Co., Inc.

1500 kc, WFDV, Rome, Ga., Rome Broadcasting Corp., 100 w. Frequency changed from 1310 to 1500 kc.

1500 kc, WSYB. Change power to 250 w. (daytime).

MARQUETTE APPOINTS FRANK

David M. Kasson, formerly president of the Van Horne Tube Co., Franklin, Ohio, and now general manager of the Marquette Radio Co., New York, announces that Joseph Frank has the distributing right on merchandise manufactured by this company for New York, Pennsylvania and New Jersey.

His Bishop Sanctions Father Coughlin's Talks

Won't Interfere with Resumption of Broadcasts by Priest with 50,000,000 Audience—Cardinal O'Connell Opposed Speeches.

Detroit, Mich.

The Right Rev. Michael J. Gallagher, Bishop of Detroit, let it be known he will not interfere with the broadcasts of the Rev. Charles E. Coughlin, pastor of the Shrine of the Little Flower, Royal Oak, Mich., who has been making chain broadcasts for a few years, discussing political, social and economic problems, and who thus became to the American radio audience the most prominent ordained figure in the Roman Catholic Church.

It is estimated that Father Coughlin, whose series is to be continued in the Fall, has a Sunday audience of 50,000,000 listeners, and there was interest in what position the Bishop of Detroit would take about the resumption of broadcasts in view of criticism of Father Coughlin's speeches. This criticism came from communicants of his own faith as well, even from many who agreed principally with what he said, but doubted the propriety of a member of the priesthood saying it.

Cardinal O'Connell's View

Cardinal O'Connell, Archbishop of Boston, and dean of the Roman Catholic hierarchy in the United States, speaking at a communion breakfast in the Guild of St. Appollonia, in Boston, had criticized Father Coughlin's broadcasts unmistakably, although without mentioning Father Coughlin's name, and therefore interest centered on what position the Bishop of Detroit would take, although Father Coughlin was understood to have submitted to the Bishop every speech before it was broadcast. Cardinal O'Connell said:

"We do not like to hear hysterical addresses from ecclesiastics. They have a way of attracting attention they do not deserve. The Catholic Church is a tremendously serious organization. It deals in human souls. You can't begin speaking about the rich or making sensational accusations against banks and bankers or uttering demagogic stuff to the poor.

"You can't do it, for the Church is for all.

"When a parish priest tries to direct the affairs of a neighboring parish, he is very soon called to order by the Bishop.

Glad Talks Have Stopped

"But the radio is new and has brought new problems. Now individual priests try to speak to the whole world. That is all wrong. Let him speak to his own parish, his own people.

"The individual in Michigan takes it into his head to talk to the whole world. To whom is he responsible? Some people prefer to talk rhetoric instead of facts. But we of the Church are careful about that.

"This Sunday afternoon radio address has been stopped for the season. I am glad, for it was going a little too far. While we believe in free speech, you do not have to be told that the priest has his place, and he had better stay there. Better for him, and better for the world at large.

"I am saying this in perfect charity. Still, we vouch for only two programs, and no others. We are working for mankind and the Church, and we can not allow any one to help themselves at the expense of one or the other. This popularity is like the bouquet thrown to the opera singer—sometimes it hits her on the head. They cry hosannas today and crucify you tomorrow. The Church does not take sides, rich or poor, Republican or Democrat."

Father Coughlin's Views

Father Coughlin began his broadcasts in 1926 on a small scale then, in an effort to relieve a financial problem affecting his parish, which is in an automobile manufacturing district. Later he was heard over the Columbia Broadcasting System and during his chain talks he has attacked international banking, the Treaty of Versailles, "which," he says, "has done little more than perpetuate hostility"; the Hoover administration for aiding bankers and not the unemployed, the exploitation of the poor by the rich, the mania for mass production without regard for buying power, prohibition and birth control.

Coin Outlets Along Roads Suggested for A-C Plug-in

The press department of WOR, Newark, N. J., sent out the following:

One of the greatest handicaps ever imposed on portable radio receivers is the need for transporting one's own power sources, say WOR engineers in discussing the forthcoming season's probable developments along this line. This difficulty is further accentuated by the comparatively short life of dry batteries.

They recognize that almost all of the better type automobiles are not wired for radio but this does not do away with these same dry batteries for high voltage. Midgets, it is contended, would be ideal if a source of power was found for them.

So far as is known, none of the public utility corporations has taken cognizance of this potential source of revenue by putting outlets along highways—outlets that could be tapped by the insertion of a coin. Devices of this kind are already in use on self-refrigerating ice-boxes that are being cold on time payments. These require the insertion of a twenty-five-cent piece every twenty-four hours.

These outlets could be installed in camps, picnic grounds, on power line poles, where they could be used to furnish light for changing tires and making temporary repairs, and a host of other places.

It is pointed out that step-down transformers would be necessary to produce the required voltage, since most of the lines carry considerably higher power than is necessary. It is done for the home now and without difficulty.

Midget receivers are far more efficient than the portables. Although housed in a small cabinet easily transported, they usually contain superheterodynes capable of receiving over long distances and reproducing tone quality of a very acceptable degree of fidelity.

CANADIAN PLAN RELEASES FIVE WAVES TO U. S.

Washington.

Under the proposed Canadian plan for nationally-owned broadcasting Canada would release as well as have released to it some frequencies, the State Department announced. Canada would get three new channels, one of them exclusive, and five shared channels would be released exclusively to the United States. The State Department has approved the plan. So has the Federal Radio Commission.

Frequencies Listed

The United States has agreed to Canada having exclusively the 540-kilocycle frequency, and to share with the Dominion the 1,050 and 1,100 kilocycle channels. Frequencies of 580, 890, 1,010, 1,200 and 1,210 kilocycles, now shared by the two countries, would be released for the exclusive use of the United States.

The 540-kilocycle channel is outside the United States broadcast band, and is now used for Army and Navy aviation service. The United States would assign these services to another channel.

Stations Affected

The 1,050 and 1,100 kilocycle frequencies both are used as cleared channels by United States stations, the Commission explained, but it is expected stations using these channels will be able to operate as usual, says "The United States Daily," because Canada has agreed to place its stations on these frequencies as far as possible geographically from the United States stations.

Commission records show that the 1,050 kilocycle channel is now used by KFBI, Milford, Kans., and KNX, Hollywood, Calif., both with power of 5,000 watts. The 1,100 kilocycle channel is used by WPG, Atlantic City, N. J., and WLWL, New York City, both operating with 5,000 watts, and KGDM, Stockton, Calif., with power of 250 watts. None of these stations will be moved, and it is expected no interference will result from sharing the two channels with the Dominion.

Gain for United States

The 580, 890 and 1,010 kilocycle frequencies are regional Canadian shared channels, it was explained, and under the plan will be used exclusively by the United States, making room for more stations in this country or allowing for power increases for stations now using these channels. The 1,200 and 1,210 kilocycle channels are local Canadian shared frequencies, and would be effected just as would the three regional channels.

The committee reporting to the Canadian House of Commons recommended these locations and frequencies for main transmitters:

	Kilocycles
Prince Edward Island	630
New Brunswick	1,030
Nova Scotia	1,050
Quebec	903
Montreal area (1 kw.)	600
Montreal area (50 kw.)	730
Ottawa	880
Toronto area (500 w.)	1,120
Toronto area (50 kw.)	690
Western Ontario	840
Northern Ontario	960
Port Arthur-Fort William area	780
Manitoba	910
Saskatchewan	540
Alberta	1,030
British Columbia	1,100

Franklin Tribute On Air Friday

A history of electricity, from its original identification by Benjamin Franklin to the very latest development, will be presented over a National Broadcasting Company network on Friday, June 10th.

June 10th was the date on which Franklin, with his kite and key, brought down the lightning. At 7 p. m., EDST, therefore will be demonstrated in part over ments which his discovery has made possible.

Franklin did not originate the idea of electricity, but his kite demonstration was the first practical proof to catch popular attention. He also was the first to classify electricity as positive and negative.

The tribute to his memory and his genius will show, in brief form, the results which have come from his original success in capturing electrical power and putting it to work.

MAXIM BEGINS HIS 19th TERM

Hartford, Conn.

Re-elected as president of the American Radio Relay League for his nineteenth term, Hiram Percy Maxim, who has held that position since he founded the league in 1914, again presided over the annual meeting of the board of directors in this city. Charles H. Stewart, St. David's Pa., was also re-elected as vice-president.

A delegation was appointed to represent amateur radio at the International Radiotelegraph Conference to be held at Madrid this fall.

Appointees on the Madrid amateur delegation were Kenneth B. Warner, secretary of the league; Paul M. Segal, Washington, the league's general counsel, and, subject to his acceptance, Clair Foster, Carmel, Calif., Pacific division director of the league.

While at the Madrid conference, to be held beginning the 3rd of September, this delegation will safeguard the rights of amateurs all over the world as well as of the more than 25,000 stations in this country.

Ratification of the organization's stand against the inclusion of amateur stations in the proposed license fee amendment to a radio administrative bill now pending before Congress was voted unanimously, and favorable progress in this direction reported by headquarters officials.

Items of policy concerning the official relationship of amateurs with the Federal Radio Commission and licensing activities of the radio division of the Department of Commerce were given expression and a program for their prosecution outlined.

CARROLL PFLEEGOR'S CONTRIBUTION

In last week's issue, dated May 28th, was printed a stroboscope that, when used with a 60-cycle-operated light source, enabled reading of 33 1/3, 78, 900, 1200 and 1440 revolutions per minute. This stroboscope was drawn by Carroll Pfleegor, 596 East 164th Street, Bronx, New York City.

HINDENBURG'S ABUSE OF AIR CITED BY HARD

European government-controlled broadcasting exceeds American broadcasting in the potential cultivation of taste, but American broadcasting exceeds the European type by a vital margin in the potential cultivation of citizenship, William Hard, radio reporter of international politics, told the annual convention in Buffalo, N. Y., of the National Advisory Council on Radio in Education.

Hard recently returned from Geneva where he covered the Disarmament Conference for National Broadcasting Company listeners.

As an example of the way government control affects political broadcasting he referred to the recent German election campaign.

"There were four presidential candidates," he recalled, "Hindenburg, Duesterberg, Hitler and Thaelmann. Hindenburg already inhabited the presidential palace. He was thereupon the only presidential candidate admitted to the German air. A speech by him was broadcast on Wednesday afternoon. It was again broadcast, from a record, on Saturday evening. On Sunday the German radio listeners, thus educated in the speaking personalities of the presidential contestants for their suffrages, went to the polls.

Hitler Plea Refused

"They had heard, it is true, one other statesman besides Hindenburg. They had heard Bruening. A speech by him was broadcast on Friday evening. It was in support of Hindenburg. And that was the total of the German electioneering combat on the German air during the first round of the balloting this year.

"During the final round four weeks later Hitler, pointing out a clause in the German broadcasting charter enjoining political impartiality, demanded access to the German air. The authorities, after consulting the Minister of the Department of the Interior, informed Hitler that the Minister had now decreed that politics should be excluded from the German air.

"Nevertheless, on the Saturday evening before the final balloting, another speech was made by Bruening. He again supported Hindenburg. The Hitlerites rather naturally called the speech political. But government officials denied that the speech was political. They said it was governmental."

Sees American Superiority

During the Disarmament Conference, Hard said, the total number of broadcasts from Geneva to all European countries outside Switzerland was forty, while he alone, with his guest speakers, spoke to the United States forty-one times.

"When American radio meets European radio in the only field of direct comparison, the international field," said Hard, "it is not European radio, it is American radio, that proves its superior interest in non-commercial public affairs and instant world-wide political international education."

BLAN DISPLAYS A "MYSTERY"

Blan the Radio Man, 89 Cortlandt St., N. Y. City, once again has created a window attraction. This time he calls it "Almost Perpetual Motion." It is a balanced bar, with what resembles two small metal loops, and a special device attached. The whole unit is suspended from the ceiling of the window with wires and insulators. There is no belt, motor, secret wire or fan, yet the mysterious device keeps moving up and down. It hasn't anything to do with radio.

A THOUGHT FOR THE WEEK

SCENE: Office of a big national advertising agency. Phone rings. Radio contact man wanted on phone. "Oh, gosh! Oh, gee! (or words to that effect). It's Jones & Smith cancelling their order I got yesterday. Not in!" says the radio contact man. "No! I'll answer. Let's get the agony over. . . . Hello! Hello! . . . Yes, this is Muggins. . . . How are you, Mr. Jones? . . . Oh, you want to increase your broadcasting time from fifteen minutes to half an hour. . . . Oh, help! help! . . . I mean thank you, Mr. Smith, I'll be right over. . . . Boy, a glass of water. . . . I'm faint. . . . Hooray! Hooray! And to think I was almost out to him! . . . Oh, gee! Oh, gosh! . . . It's a great life!" etc., etc.

RADIO WORLD

The First and Only National Radio Weekly

Eleventh Year

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

Amateurs Plan Aid in Railroad Messages

Seattle, Wash.

Emergency communication along the Northern Pacific Railway in the future is to be handled by amateur radio, if a project now being worked out between the American Radio Relay League and E. E. Dildine, superintendent of Telegraphs of the railroad, reaches a successful conclusion.

Amateur stations all along the railroad's lines are being organized into a network sufficiently large and flexible to cope with any communications emergency that may arise, under the plan being carried out by the league, the national amateur organization. A league member, I. V. Iversen, of 6554 18th Ave., N.E., Seattle, operator of station W7AW, is representing the league in organizing the network.

All superintendents of the railroad have been notified that in case of wire failure their emergency dispatches will be handled over amateur radio lines. So that the system may be kept active when not functioning in regular emergency work, test messages will be sent from various places along the line at irregular intervals. Increased proficiency in amateur handling of the special traffic is expected to result from the tests, which will have particular interest for the amateurs participating.

Television Schedule of W2XBS Announced

W2XBS, National Broadcasting Company, Bound Brook, N. J., and New York City, licensed at 5,000 watts, frequency 2100-2200 kc., wavelength, 142.8 to 135.1 meters, is on the air with television from 2:00 to 5:00 p.m. and 7:00 to 10:00 p.m., EST daily, except Sundays and holidays, 60 lines, 20 frames per second. Regarding W2XF, same owner, ultra frequency band, no information is available.

W2XBT, licensed at 750 watts, same owner, sends facsimile, no television.

The W2XBS schedule should be added to the "Time Table of Television Transmitters" published last week, issue of May 28th.

IMPROVED TONE STRIKES SOME AS DISTORTION

The press department of WOR, Newark, N. J., studios at 1440 Broadway, N. Y. City, furnished the following information:

Radio engineers admit that the evolution of broadcasting has reached such a stage that the prospect of startling innovations is exceedingly remote. Nevertheless, they point out, scarcely a month goes by without seeing a development that makes for still further improvement.

Recently a radio critic tuned in a program from WOR and while he praised the work of the artists asserted that the quality of the signals failed to measure up to the station's usual standard. For once, J. R. Poppele, chief engineer of the station, smiled at adverse criticism, for behind that program was months of research and hard work.

Missed His Familiar Distortion

Poppele could afford to overlook the criticism. In fact he had expected it. Since the inception of radio broadcasting, listeners have been confined to an audible frequency range of from 30 to 5,000 cycles. Higher notes than 5,000 cycles were cut off by the absorption material used to deaden the walls and ceilings of the studios. With it went the sparkling brightness that characterized the program but found ill favor in the ears of the critic, for the broadcast had almost twice the naturalness of the other, the frequency range being increased to 9,000 cycles.

The critic did not know that he was listening to dynamic microphone pick-ups, which are just 300 times more sensitive than any previously developed. Neither did he know that he was being treated to a new type of studio, the first in the metropolitan area and the second in the entire world, developed after months of research by the engineers of the Electrical Research Laboratories.

Radio studios formerly deadened everything above 5,000 cycles. Amplifiers had a range up to 7,000 cycles but never had a chance to function. WOR's new studios, however, have such exceptional brilliance that amplifiers ranging up to 9,000 cycles had to be constructed to accommodate it.

Where Microphones Are Placed

Engineers have learned that half-deadened and half-alive studios are more nearly ideal, that is, that only half of the new studios are shielded with sound-absorbing material. Today the microphones are placed at the dead end so as to catch the sound waves after they are reflected from the brilliant ends. There they are picked up before the absorption material gets a chance to take the life out of them.

Both new studios are "floated" in rock wool, more than two and one-half tons of that isolation material having been used. In them one finds doors, weighing 200 pounds, anchored in felt and moving on ball-bearing hinges—doors that are built up of laminated wood, asbestos and absorption material, with jambs and sashes resting on light-density cork and with tiny, diamond-shaped glass panels to prevent reflection. There are windows with panes six inches apart and each resting in felt, the air space between them itself helping to make them sound-proof. Even the ventilation system is soundless, the work of Maxim, famous inventor of the gun silencer. On the floors a new material invented by a German chemist gives one who walks on it the impression of treading carpets of unusual thickness.

Circuit Breaker's Aid

Technicians find much to enjoy in the new studios. They see a system of indirect lighting which calls for four reflections from as many points to bring about equal diffusion in every spot. The motor room is completely shielded and remote from the broadcasting points. This same room houses another feat of modern science, where an alternating current power failure automatically starts a direct current generator within twenty seconds and without human touch.

Mr. Poppele, did everything with the exception of developing the half-dead, half-alive studio idea. Wallace D. Van Etten drew all the plans and supervised construction. Edward J. Content laid out the wire circuits and directed their installation, while Ray Lyon, head of development and research, built the special control cabinets.

Quick Service

By Kyle Lord

Use a skinny soldering iron for uniting heavy parts and the joint will stick like a Hollywood marriage.

* * *

Neutralizing screwdrivers fall out of your vest pocket with the best of regularity.

* * *

The answer to the complaint, "My set stopped playing" is a thousand hours of hard study. No one can know enough to make 'em all play.

* * *

A course in memory training: All the things you have to know to get maximum results from a short-wave converter.

* * *

Coils that won't cover the wave band make good spools for spare wire.

* * *

The real solution of the automobile antenna problem is to get a system of reception working that does not depend on anything but the motor.

* * *

There are few choices left in transmission. The broadcasting stations must stick to 50 cycles this or that side of the carrier, and the amateurs must monitor their receivers more closely than formerly. It was great when one could have his own way, and that way was whatever the accidents of time and place provided.

* * *

We're not so keen about efficiency when it interferes with our private doings. Like taxes, it seems to us something for the other fellow, rather than for ourselves.

* * *

Weightless batteries are needed before portables become true portables. What with the growth of white collar activities we become less and less equipped physically to tote 60 pounds.

* * *

It is a pleasure to sell a complete kit of tubes at list to a man who has burnt out one tube and has seven good ones.

* * *

What a compliment to the service man when a customer complains of fading and asks it be remedied. The greatest of scientists haven't made much headway, but while there is the service man there's hope.

STATION SPARKS

By Alice Remsen

The Voice of a Bird

FOR MABEL JACKSON

(WABC, Fridays 8:30 p. m.)

Deep in a forest the sound of a bird
Is heard.
Sweetly its voice is trilling and thrilling,
Laughter and love from its golden throat spilling,
Tall shadowed cloisters of leafy green filling
With the voice of a bird.

Slowly a ripple crosses the face of a silent pool;
Softly a breeze comes stealing along caressingly cool;
Gently a slender tree sways as the cadence swells;
Then from afar is heard the lingering sound of bells.

Still the bird sings and sings, and flings
Across the measured space of time,
A magic melody sublime,
Erasing mutterings of kings and things.

Deep in the forest the little folk stir and murmur
With delight.
A bee in flight becomes a proselyte,
And lights upon a budding blossom bright,
The flower a censor, bee an acolyte,
To the voice of a bird.

—A. R.

* * *

And the Golden Voice of Mabel Jackson will make all her listeners proselytes to its charm, when she sings such things as "The Italian Street Song" and "My Sunshine is You," on the Dupont program, "Today and Yesterday" over WABC. Listen; you'll like her.

* * *

News of the Studios

WABC

A new morning program worthy of a listen while you're eating breakfast is The Pebeco Playboys, heard each Tuesday and Thursday mornings at 8:45 a. m. They're clever boys, who play piano and sing together, and a young lady who chats charmingly with them. The commercial announcements are unobstrusive.

* * *

The Bourjois "Evening in Paris" program will go off the air for two weeks after June 13th, coming back for the summer with a fifteen-minute program, again featuring Alice Remsen as soloist, and a dance orchestra under the direction of Howard Lanin. 9:45 Monday evenings, Columbia network.

* * *

Jay C. Flippen, the flippant master of ceremonies, is now acting in that capacity for the Goodall program, with Phil Spitalny's orchestra of sixteen pieces and Helen Rowland for the vocal choruses. Flippen is well known to vaudeville audiences throughout the country. His humor and distinctive style of singing have also been a feature of several "Artists and Models" productions and Winter Garden revues. The series is sponsored by the Goodall Worsted Company, of Sanford, Maine, manufacturers of "Palm Beach" and "Nurotex" summer suitings.

* * *

WOR

With summer coming on, (this is not a song plug) Julian Woodworth, the dapper orchestra leader at the Governor Clinton Grill, is vexed by the problem of dressing up his musicians to match the freshly regilded Grill. It was white flannels with brown coats last summer; this year it looks as if grey flannels with blue coats will win; and as for more summer dance music—well—WOR will have plenty. Ernie Holst will broadcast from Post Lodge twice weekly, Neil Golden will be heard on Sundays, and Will Osborne daily from Playland.

Chandler Goldthwaite is one of the busiest as well as one of the highest paid organists in the profession, for, in addition to playing two commercials and two sustaining periods on WOR each week, he produces and plays a commercial program on one of the networks, writes arrangements for Stokowski's Philadelphia Symphony, and makes innumerable organ phonograph recordings.

His hobby is flying, perhaps a rather peculiar pastime for such a finely-developed, aesthetic nature. During the recent burning of the Cunard Line docks, he ordered his plane out in a hurry and spent two hours over the fire, diving through the smoke and zooming up over the spires of Manhattan. He came out of it with the inspiration for a smoky symphony, which you may expect to hear on the air very shortly.

* * *

NBC

Thursday and Saturday mornings Frank and Flo Cronin will have to rise early for they come on the air at 7:30 a. m. to entertain early risers with their songs and patter over WJZ. This won't feaze Frank and Flo, however, for they are old-time vaudeville artists, used to making trains at all hours. They are sponsored by McLaughlin, Gormley and King. Frank and Flo may also be heard on Tuesdays, Wednesdays, and Thursdays, at 9:30 p. m. over WOR, sponsored by Salada Tea.

* * *

Six New European attractions will be brought to the United States next season under the sponsorship of the NBC Artists Service. Emanuel Feuermann, considered one of the foremost cellists in Europe today; the famous Italian marionettes of the Teatro dei Piccoli, the Shan Kar Hindu dancers, the Vienna Choir Boys, Ignaz Friedman, Polish pianist, and Mary Wigman and her German dancing group will all make their American tours under NBC direction.

* * *

Edgar A. Guest, popular poet, has been on the air for several weeks presenting his poetic works in person during the Household program over an NBC network each Tuesday at 9:00 p. m. EDST. Mr. Guest shares honors on the program with Miss Alice Mock, soprano, formerly of the Chicago Civic Opera Company. A male trio and an orchestra supplement Miss Mock's singing during the musical portion of the broadcasts, which emanate from the Chicago studios. Guest began to work as an office boy for the Detroit "Free Press," became a reporter, exchange editor and finally a columnist; it was then he began to write his sympathetic poems, which have won such continent-wide favor.

* * *

Sidelights

BUDDY ROGERS made his first trip abroad as a deck-hand on a mule boat. . . . LOUIS SOBOL, like his famous predecessor, Walter Winchell, wears his hat while broadcasting—a newspaper habit, I guess. . . . WARD WILSON, erstwhile radio engineer, now NBC mimic, goes vaudeville for a while. . . . HOWARD CLANEY paints portraits of his fellow announcers for a hobby. . . . JOHN CHARLES THOMAS always winds up his broadcasts by saying "Good night, mother!" . . . JANE FROMAN, the Chicago blues singer, stammers when she speaks. . . . MABEL JACKSON was born in Dayton, Ohio. . . . ARTHUR ALLEN spends as much time gardening as he does rehearsing. . . . ANN LEAF wears three-inch heels but is still tiny. . . . LEONARD JOY has been married to the same wife for thirteen years and still buys her orchids; I'll say that Leonard is the ideal husband. . . .

* * *

BiographicalBrevities

ABOUT GRAHAM MCNAMEE

Many readers have expressed curiosity as to the personality and background of Graham McNamee. Well, in the first place he is an American, born in Washington, D. C. on July 10th, 1889. McNamee senior was legal advisor to a member of the president's cabinet—and a political change prevented Graham from spending his boyhood on the banks of the Potomac, and so he grew up in St. Paul. His father wanted him to study law—his mother chose music—and so at the age of six he was laboriously practising piano; but he liked to sing and so boyhood found him in a choir; his ambition was to be a concert artist, instead of which he obtained a job as a salesman for a wholesale meat company. After a year his employers decided that as a meat salesman he was a good concert artist. Then came New York and a successful appearance at Aeolian Hall, but not much money, so Graham took up jury service at three dollars a day—and that's where fate took a hand, for one day, during the court noon recess, he chanced to pass the old studios of WEAF at 195 Broadway. He saved his lunch money by looking over a broadcasting studio and started himself on a whirlwind radio career.

That was ten years ago. Since that time he has made a world-wide reputation for himself as an announcer—anything from sports to politics—not that there's much difference. He has shaken hands with the Prince of Wales and the Queen of Rumania and is now slinging puns with Ed Wynn. During his talks with Kings, Queens, cardinals, football captains, prize-fighters, and what-have-you, it is estimated that more persons have heard his voice than that of any other man alive. He is of medium height and weight, inclined to be sandy, with grayish-blue eyes, which hold a humorous twinkle; is a rather conservative dresser, likes the good things of this world without being a gourmand; is fond of music and high-brow literature, a good fellow when among friends—but very quiet among strangers. Can still sing well when he feels like it.

* * *

(If you care to know something of your favorite radio artist, drop a card to the conductor of this page. Address: ALICE REMSEN, care of Radio World, 145 W. 45th St., New York City.)

FASCINATION OF TELEVISION PUT AT 15 MINUTES

By HAROLD A. LAFOUNT
Federal Radio Commissioner

Ever since 1925 when C. Francis Jenkins gave his first public television demonstration consisting of flickering shadows of a little girl in silhouette bouncing a ball, the laboratories have become a magnet for the promoter who pictures to his prospective clients the untold wealth to be found in this new field, which in his opinion will far outstrip such prosaic industries as were created by the automobile and radio.

Ever since its creation, the Federal Radio Commission has been frequently petitioned to put television on a commercial basis, as if the Commission by the passing of rules and regulations could create for an industry a state of technical perfection which the best engineers of the country have not yet been able to achieve.

The position of the Commission is very clear and quite simple in this respect. As soon as the television art is perfected to the point where the average layman can expect a comparatively fair amount of entertainment from his television receiver, it seems reasonable to suppose that the Commission will not arbitrarily bar the way to economic progress in this field.

Not Yet Convinced

Nor has the Commission played the ostrich and stuck its head in the sand. The individual Commissioners and their engineers have traveled far and wide to see at first hand the latest developments of television in the laboratories. Frequent reports have been made to the Commission and such policies as have been adopted have in every instance been motivated by an acute perception of facts as they then existed. Very frankly, gentlemen, we are not yet convinced that television has emerged from the laboratory and is ready to matriculate into the more severe course of adult entertainment and education.

True, most of us have seen remarkable pictures in the laboratory—pictures whose depth and detail compare not unfavorably with the amateur motion picture projection. To the layman, however, there is always a missing element. While we may gaze in fascination for ten or fifteen minutes at a picture that has penetrated the mysterious ether through steel buildings and brick walls, to astonish the looker-in, yet after that much of such pleasing surprise, the mind becomes impatient and critical. The amount of action is strangely confined.

We not only have the three unities of Greek tragedy, time, place and action, but the actors themselves are limited to one, two or three persons at the most, whose visibility changes in inverse proportion to their number.

Outdoor Events Far Off

We have all dreamed of the day when the complete action and crowds of a bootball game could be seen in every home simultaneously with their occurrence, through simple television apparatus. But this dream is a long way from present actualities. The very best television picture of today can only show a comparatively small group of persons at any one time whose features are in any way recognizable.

These imperfections and limitations of present-day television result from the comparatively small number of what are known as television scanning lines. A number of years ago television was being developed on the basis of 48 scanning lines per picture, which means that whether the picture was an inch high or was projected to a large screen, the number of lines remained at only 48. From a projection standpoint it can be readily seen that if the ordinary motion picture screen is divided into 48 horizontal strips, the amount of resulting detail must necessarily be meager.

The number of lines has been gradually increased from 48 to 60, and we are now told that 120 lines are being used with the possibility of doubling this to 240 lines. Such an increase in line scanning will of course give a considerable increase in the detail of the picture transmitted, but the picture will still be far from approaching the quality of present-day motion pictures.

Rather complex engineering problems are involved in the development of the associated apparatus for both low and high frequency amplification which will permit full advantage to be taken of the increased detail accompanying the increase of the number of scanning lines.

Lower Frequencies Crowded

Just at this point is where some of the television problems of the Federal Radio Commission are encountered. The normal 60-line picture used by the majority of television experimenters today requires a single sideband modulation width of 43,200 cycles, or 86,400 cycles emission for double sideband transmission. If the number of lines is increased to 120, at 24 pictures per second, which is the standard talking picture speed, maintaining the five by six proportion of height to width, the number of cycles required per sideband increased to 207,360, or a total band width of 414,720 cycles required for double sideband transmission.

It can thus be seen that if 240 lines are used with the methods known today, a single sideband emission of 829,440 cycles would be required, or using double sideband transmission, a total band width of 1658.88 kc would be required for a single picture, which is almost twice the entire width of the whole present broadcasting band from 550 to 1,500 kc. As you know, the radio spectrum below 20,000 kc is now crowded, and does not contain space for such wide band emissions unless we abolish many other important services.

2,000 kc Width Suggested

For this reason it became evident that for pictures having any reasonable degree of detail it was necessary to find an entirely new part of the radio spectrum where comparatively wide frequency bands could be found for this new type of service, and consequently the so-called ultra-high frequency bands were selected. These bands run from 43,000 to 46,000 kc, from 48,500 to 50,300 kc, and from 60,000 to 80,000 kc. including a total frequency space of 24,800 kc. This appears to be a relatively large amount of space for such a new service, but we have already been informed by engineers of some of our leading companies that eventually for good service to the public, channels having widths of approximately 2,000 kc will be required, and on such a basis it can be seen that this apparently tremendous expanse boils down to only ten channels.

Perhaps this single reason more than any other justifies the policy of extreme caution which has been followed by the Federal Radio Commission in the approval of new television stations. If what has the essentials of a huge industry in the making must grow, live and prosper within perhaps only ten channels, only the most extreme caution in the original granting of television applications can prevent chaos.

The Federal Radio Commission in its determination of public interest, convenience and necessity must consider the use by any of its licensees of radio frequencies for purposes other than those intended in the license, such things as stock manipulations are not passed unnoticed. Our justification, however, for what appears to many to have been an unnecessarily severe control over television stations is not based upon the question of stock promotion at all, but on a protection of the industry itself. We wish to avoid the degeneration which occurred in broadcasting due to the breakdown of control, and to prevent such possibilities in television by subjecting all television applicants to the most rigid scrutiny before, rather than after the damage is done. I am very happy to say that fortunately we have received the hearty support of the industry.

[*From an address delivered before the eighth annual convention of Radio Manufacturers Association, Inc., at Chicago, during the Radio Trade Show.*]

NEW TONGUES BEING BUILT UP BY AMATEURS

Washington.

The following information was issued by the Department of Commerce, whose Radio Division has authority over amateurs:

A new language is springing up in the United States that is understood by no less than 26,000 persons, but is spoken by none—it is the language of the amateur radio operators and it is "talked" back and forth daily across thousands of miles of space by the use of dots, dashes and spaces.

L. C. Quaintance, of the Radio Division of the Commerce Department, recently picked up the following message transmitted in international Morse code:

"Tks om fr cl hrd u wkg wid sum vk ts am ur sigs vy gud wx tdy fb fr dx nil qrn qrm hr wl ob gess nm hr wl sa gm pse qsl ur crd gld 2 qso es hpe cu agn vy 73 es gl."

The Decodification

Translated for the layman it reads:

"Thanks, old man, for the call. I heard you communicating with some of the Australian amateurs this morning. Your signals are very good. Weather today is excellent for long distance communication, no static or interference here. Well, old boy, I guess there is nothing more here so I will say good morning. Please send me your card. I am glad to have communicated with you and I hope to do so again. Very best regards and good luck."

There is still another "language" used by the amateur operators. It is international in scope and can be understood fully as well by the Russian, Chinese. Spaniard, German or American. It is the "Q" system of communication.

Vocabulary Limited

The principal drawback to the "Q" language is the relatively limited vocabulary. It is intended specifically for the transmission of intelligence bearing directly upon radio communication, and not for the transmission of other messages.

This language is used by the approximate 50,000 amateur radio operators, half of whom are in the United States, as well as in the International Marine Service.

Besides the amateurs are developing technical vocabularies that are quite difficult, and represent months of study.

PUBLIC FOUND UNOPPOSED TO SPONSORSHIP

Frank A. Arnold, director of development, National Broadcasting Company, addressed the National Advisory Council on Radio in Education, at Buffalo, N. Y., stressing the importance and influence of radio and opposing government regulation of the problem of advertising on the air.

Mr. Arnold stressed the point that broadcasting was the only advertising medium of great nation coverage which essentially cooperated with other standard forms of advertising and was not directly in competition with them. Broadcast advertising, he continued, obtains its greatest acceptance when used in connection with a background of newspaper, magazine and outdoor advertising, using the radio in order to bring the combined message more directly into the home.

As a medium primarily of entertainment, education and religious inspiration, radio broadcasting has admitted advertising in much the same way as the daily newspaper or the national periodical admits advertising to its columns for the sake of revenue thus derived. Broadcasting is the only industry giving a multiple service that depends entirely on advertising revenues for its existence, he declared.

The British system was compared with the American system and attention called to the fact that Government ownership and control in this country would not only mean a heavy per capita tax levied on every owner of a receiving set, amounting to $6 to $10 per year, but also would probably stifle initiative and greatly interfere with the free development of programming.

60,000,000 Audience

Speaking of the radio audience, he called attention to the fact that recent figures show more than 16,000,000 radio receiving sets in the United States alone, which means a potential audience of 60,000,000 within the reach of a single radio broadcast. The cosmopolitan character of this audience, comprising all grades of literacy, as well as social and financial surroundings, was stressed as indicating the extreme difficulty in providing programs of universal acceptance. Variety and versatility were suggested as the best means of suiting the tastes of all.

The relation of the audience to the advertiser was outlined in detail with reference to the fact that recent investigations have shown the radio audience to be in favor of advertising or sponsored programs, objecting only when the advertiser oversteps the bounds of modernization in the use of his advertising copy.

Discussing at some length the medium and the audience, Mr. Arnold turned to the advertising message as being one of the greatest problems of the broadcasting station. Due to the fact that a new technique had to be devised in order to bring the radio message to the home in an acceptable form, there has been much experimenting by the advertiser in his endeavor to get his name and product before the listener in a way which shall be productive in point of sales.

Opposes Government Limitations

Mr. Arnold indicated that, in his judgment, the radio audience was the only source from which adequate remedy to advertising abuses could be obtained. In his opinion, Government regulation, such as that recently indicated in Canada, where the advertising message is restricted to 5 per cent of the program in which it appears, would not cure the evil—it would simply force the advertiser in preparing his advertising continuity to use bullets instead of bird-shot.

How He Says It Counts

It is not so much what the advertiser says as how he says it, and to limit him to a certain number of minutes without more definite restriction as to what he shall say might bring about a condition far worse than the original one, asserted Mr. Arnold.

Amateurs Revive Secret Society

Newark, N. J.

A revival of the secret fraternity of amateur radio, the Royal Order of the Wouff Hong, was one of the features of the annual Hudson Division Convention of the American Radio Relay League. Dormant now for several years, the Royal Order at one time included many of America's leading radio amateurs.

The convention, being held under the auspices of the northern New Jersey radio clubs, led by the Bloomfield Radio Club, was one of the largest events of its kind ever held in that division, which includes the metropolitan New York area.

Based on the traditional features of secret societies all over the world, but retaining an atmosphere distinctive of amateur radio, the Royal Order of the Wouff Hong was organized in 1922 for promoting brotherhood and good fellowship.

STIFFER RULING ON RECORDINGS

Washington.

Recently the Federal Radio Commission formulated and effected a new set of rules, and now comes the first revision, a return to approximately the former requirements about announcing recordings as such. This return makes the station more clearly identify the fact a recording is used and suggests the language. The full announcement follows:

IT IS ORDERED that Paragraph 176 of the Rules and Regulations of the Federal Radio Commission be, and the same is hereby, amended to read as follows:

A mechanical reproduction shall be announced as such except when its use is merely incidental, as for identification or background. The exact form of announcement is not prescribed but the language shall be clear and in terms commonly used and understood. The following are examples of statements sufficient for the purpose:

a. "This is a phonograph record."
b. "This is a player-piano record."

In all cases where electrical transcriptions made exclusively for broadcast purposes are so constructed as to record a single continuous program upon more than one mechanical reproduction, rather than a recordation of the entire program upon a single mechanical reproduction, the announcement required hereby shall be made at the commencement of each such program and in no event less than every fifteen minutes. All other announcements required hereby shall immediately precede the use of each separate mechanical reproduction.

AIR EDUCATORS IN QUANDARY ON COST DEFRAYAL

"Educators, to be successful broadcasters, must disregard many pedagogical practices which have been developed over many decades," Levering Tyson, director of the National Advisory Council on Radio in Education, told educators and broadcasters attending the second annual meeting of the Council in Buffalo, N. Y.

Must Hold Audience

"Transferring a leisurely classroom lecture to the air is the least effective and most unsatisfactory procedure in educational broadcasting." Mr. Tyson said. "The educational broadcaster must not only attract his audience to him, in the first place, but he must do what the commercial broadcaster has learned so clearly; he must hold his audience. He will find, however, that if he can get the American public, or even a section of it, to listen to him it will be worth the effort."

Public Responded Well

In reviewing the work of the year Mr. Tyson made special reference to the series of lectures prepared and broadcast under the auspices of the Council and presented with the cooperation of the Columbia Broadcasting System and the National Broadcasting Company. Five series of educational programs on the subjects of economics and psychology, vocational guidance, civics, and labor have been broadcast, and the public has responded to the extent of purchasing at cost nearly 250,000 copies of the printed material prepared to accompany these series. The Council believes that the value of an educational program lies chiefly in its stimulating qualities, and that it is advisable that printed listeners' handbooks and notebooks and reading guides, as well as the printed lectures, whenever feasible, should supplement an educatonal broadcast.

Still a Puzzle

In discussing the problem of how to support educational broadcasting in America, Mr. Tyson stated:

"The question of financial support for educational broadcasting is no nearer solution than it ever was. Costs are exceedingly heavy and stagger the uninitiated.

"How are these enormous costs to be met in America if educational broadcasting is to be developed and persist? It is hardly conceivable that private funds can be secured to develop a well-rounded program of educational broadcasting. It is not likely that a proposal that the industry should support educational broadcasting would receive much response. There is about as much likelihood that support should or could be secured from our Federal Government for this purpose. This question remains the most elusive and puzzling in educational broadcasting."

Noted Members

The National Advisory Council on Radio in Education was organized in 1930 to further the art of radio broadcasting in American education. Members include Robert A. Millikan, Michael I. Pupin, James E. Russell, F. P. Keppel, David Lawrence, Walter Lippmann, Dorothy Canfield Fisher and Raymond B. Fosdick.

RCA TELEVISION DEMONSTRATED TO LICENSEES

Due to the many inquiries received from its sets licensees as to the exact status of television, Radio Corporation of America decided it was better to demonstrate what has been accomplished, rather than merely describe it, so invited selected officials and engineers of the companies to the laboratory at 153 East Twenty-fourth Street, New York City. The demonstration was private, and such information as is published about it is due largely to discussions with some of those present. Other details have been known for some time, such as the use of the cathode ray tube and 120 lines for scanning, and transmission on ultra frequencies.

The pictures shown were said to be 4x5 inches and were of two types of subjects, one of the persons before the photo-electric cells at the transmitter, the other of the motion picture films. The results of actual persons being televised were said to have been inferior, but the transmission of film was described as good, with an unusual degree of clarity.

Not Keen to "Go To It"

It was not the intention to make those attending the demonstration enthusiastic over what they saw, nor yet to dampen their hopeful spirits, as they had an eager interest in television for commercial purposes. However, the general impression seemed to be that while considerable progress had been made, the results were not such as to warrant any television manufacturing undertakings by their companies, because of failure to provide a degree of detail and illumination such as would encourage laymen to buy a rather expensive installation.

In reality the licensees are guided in their television receiver activities by what RCA does, and none of the licensees is therefore expected to bring out a receiver before the licensing power does so.

As elaborate television equipment is being installed in Radio City, the Rockefeller Center now building in midtown New York City, RCA is expected to wait until it has occupancy there, about a year hence, before bringing out a set, as the problems are largely transmissional, and duplicating the expensive transmitting equipment is now deemed out of the question.

The results obtained in the film demonstration were regarded as marking the stage of television development up to the present, as no one at the demonstration could recall having seen superior results elsewhere, at that size. While it was recognized that a larger image would be preferable, the stumbling block is the cathode ray oscillograph tube, which can not well be made much larger without considerable increase in expense and introduction of much stiffer technical requirements.

Stopped, Looked But Did Not Listen

David Sarnoff, president of RCA, stood before the photo-electric cells at the transmitter, atop the Empire State Building, at Thirty-fourth Street and Fifth Avenue, about half a mile away from the reception point. At the receiving end were six ultra-short-wave receivers and some scanning systems. As he spoke his words were brought in on an independent receiver, "but it seemed almost every one present was looking, rather than listening," commented one spectator, "with all due respect to my friend Sarnoff."

James Wallington, announcer, introduced Jessica Dragonette, radio soprano, who sang a few pieces, but the engineers didn't seem to like the visible results of any of these.

Too Much Contrast

Uncanny contrasts were said to be present in the images, and what might pass for a beard and a moustache seemed momentarily to disfigure the originally attractive face of the soprano. Even Mr. Sarnoff looked at times in bad need of a shave, a condition in which none of his radio friends actually ever have seen him, for he is meticulous about his personal appearance.

The short film subjects proved attractive, and the engineers present, who had cast dubious glances to one another when RCA representatives were supposed not to be looking, discarded their furtive and silent criticism, and some actually cried "Good!" The money men in the crowd did not join in the exclamation.

Reflecting Mirrors Used

The films were generally admitted to have real entertainment value, not because of the subject-matter, but because of the way they came over.

The images were seen in reflecting mirrors, as the fluorescent screen was in a cathode ray tube only 8.5 inches long, and the consequently small screen had to be thrown up. The loss by mirror reflection is practically nothing. The magnification, however, reduced the illumination inversely as the square of the distance. The reason for not exhibiting much larger pictures was that the scant illumination originally present would be too greatly dissipated.

RCA maintains that television is still in the laboratory and should not be commercialized until it can render a service comparable in quality to present-day sound broadcasting. It is believed the television receiver, with extra receiver therein for sound, will be completely independent of broadcast receivers.

Tradiograms

By J. Murray Barron

H. Curtiss Abbott, vice-president of the Columbia Phonograph Company, foresees an expanding market for air cell receivers. Commenting on an exhibit, Mr. Abbott said: "Senator Arthur Capper, of Kansas, made the statement some days ago that the growing interest in politics over the country would provide a tremendous demand for more radios, especially in the rural sections. I believe that is true. This year, particularly, we have the Presidential campaign on, and radio will be used more even than in 1928."

* * *

Announcement was made by the Radio Corporation of America that a radio broadcast receiving set license has been issued to the International Radio Corporation, of Ann Arbor, Michigan.

* * *

T. F. Joyce is the new manager of advertising and sales promotion activities of RCA Radiotron Co., Inc., and E. T. Cunningham, Inc. Mr. Joyce succeeds J. W. McIver, become executive vice-president of the Forbes Lithograph Mfg. Company, Boston, Mass.

* * *

Announcement of price reductions on Eveready Layerbilt Batteries has been made by National Carbon Company, Inc. The Company announced at the same time the discontinuance of two types, Nos. 772 and 770. No. 485 lists at $1.95, No. 486 at $2.95 and No. 796 at $2.25.

* * *

The Outlet Radio Store has moved to 87 Cortlandt Street, N. Y. City. Here it will stock small and replacement parts, also various types of eliminators, speakers, a-c and d-c sets and trade-in sets.

TRADE RISKING $200,000,000, SAYS RMA HEAD

Chicago.

J. Clark Coit, president of Radio Manufacturers Association, Inc., at the opening of its eighth annual convention and trade show, said that the radio industry has confidence in the future, and is proving its confidence by investing $200,000,000 for new machinery, dies, tools, raw material, overhead and expenses for the coming season. He said:

"There are about 15,000,000 receiving sets in operation now. There should be a good volume of replacements. Besides there are 13,500,000 American homes still not radio-equipped. We believe that the record of last year, when 3,500,000 sets and 50,000,000 tubes were sold, will be bettered. Besides, prices are fairly well stabilized and even better stability is expected."

More than 100 manufacturers exhibited at the show, and about 15,000 persons attended. The show was closed to the public, since many of the models will not be released to the public for weeks or a few months to come.

New Incorporations

Feldstern's Radio & Television Co., Inc., Riverside, N. J.—Attys., Worth and Worth, Riverside, N. J.

Freshman Belmont Co., New York City, radio—Attys., Rasch and Gottlieb, Woolworth Bldg., New York, N. Y.

Franklin Electric Co., Philadelphia, Pa., electrical supplies—Attys., Corporation Guarantee and Trust Co., Philadelphia, Pa.

Corporate Changes

Western Electric Co., New York City, $180,000 to $142,500.

Names Changed

Newlands Radio Corp., New York City, to Bel Rad Products Co.

Corporation Reports

Crosley—A report of Crosley Radio for the March quarter shows net loss of $160,257, compared with net loss of $471,690 in the corresponding quarter last year. For the year ended March 31 the net loss was reported as $139,091, compared with net loss of $917,648 in the preceding year.

Electric Household Utilities Corporation and Subsidiaries—Year ended Dec. 31: Net loss after depreciation, adjustment of securities to market value and other charges, $424,990, against net profit of $1,234,191, or $3 a share on 411,418 shares, in previous year.

Receivers Appointed

The Irving Trust Co. was designated in the following case by Judge Goddard:

Apco Electric Corp., 1,164 Sixth Avenue, New York, N. Y.

Literature Wanted

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

Paul I. Jones, 648 S. Lucas St., Iowa City, Iowa.

Allan McCombs, 620 Race St., Statesville, N. C.

Jack Rosser, 717 Cabell Street, Lynchburg, Va.

Edward Anderson, 123 Hollister Ave., Ocean Park, Calif.

Roger M. Stern, 27 W. 85th St., New York, N. Y.

José Alvarez, 171 Hostos St., Mayagüez, P.R.

Rudolph Gowin, 3301 Cottage Grove, Chicago, Ill.

E. C. Thoma, 416 - 7th Ave., Pittsburgh, Penna.

Nickolas Sokoloski, 19131 Yonka St., Detroit, Mich.

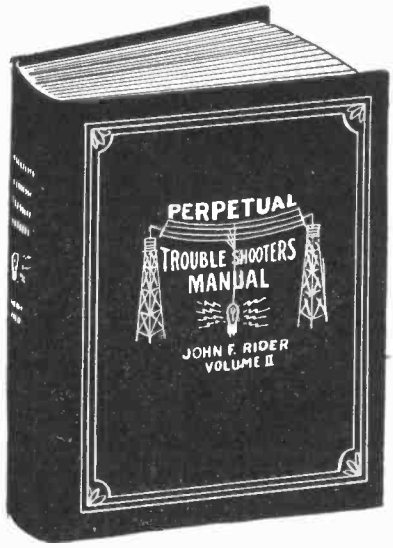
Henry J. Leinbach, 304 Juniper Street, Quakertown, Penna.

Rudy Kopernak, Bedford Radio and Supply Co., Bedford, Ind.

S. M. Lockwood, 4883 No. Paulina St., Chicago, Ill.

Volume No. 2 of Perpetual Trouble Shooter's Manual

Ready About June 6th



Having assembled 2,000 diagrams of commercial receivers, power amplifiers, converters, etc., in 1,200 pages of Volume No. 1 of his Perpetual Trouble Shooter's Manual, John F. Rider, noted radio engineer, has prepared Volume No. 2 on an even more detailed scale, covering all the latest receivers. Volume No. 2 does not duplicate diagrams in Volume No. 1 but contains only new, additional diagrams, and a new all-inclusive information on the circuits covered.

All Electrical Values Given for First Time

This new detailed, comprehensive information gives the resistance values from point to point in all circuits in Volume No. 2—such complete information as is unobtainable elsewhere. All condenser values are given. Chassis diagrams (pictorial), schematic diagrams and photographic views of receiver "insides" are included. Parts are identified on photographs. Intermediate frequencies are stated. Socket and tube identities are revealed, color codes given, continuities of sealed units disclosed. The information is painstakingly complete. Rider made personal trips virtually all over the country to obtain the information, and it's now yours.

Everyone who makes his living as a radio service man, salesman, laboratory man or in any other technical capacity, as well as all students and teachers of radio, should possess Volume No. 2.

Volume II and Volume I are loose-leaf editions of 8½ x 11" page size, flexible fabrikoid binding.

Volume No. 2—Perpetual Trouble Shooter's

EVEREADY-RAYTHEON FOUR-PILLAR TUBES

Type	List Price	Your Cost	Type	List Price	Your Cost
227	$1.00	$ .54	112A	$1.50	$ .81
224	1.60	.86	222	4.50	2.43
235	1.60	.86	230	1.60	.86
226	.80	.43	231	1.60	.86
171A	.90	.48	232	2.30	1.24
210	7.00	3.78	233	2.75	1.48
245	1.10	.59	234	2.30	1.40
247	1.55	.84	236	2.75	1.48
250	6.00	3.24	237	1.75	.94
v199	2.75	1.48	238	2.75	1.48
x199	2.50	1.35	239	2.75	1.48
120	3.00	1.62	280	1.00	.54
201A	.75	.40	281	5.00	2.70
200A	4.00	2.16	BH	4.50	2.43
240	3.00	1.62	Kino	7.50	4.05

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

SOLDERING IRON F R E E !

Works on 110-120 volts AC or DC, power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.

RADIO WORLD
145 West 45th St. N. Y. City

THIS ANSWERS YOUR TUBE QUESTIONS

A set of three issues of Radio World gives you a small but inclusive "tube library" and gives the answers to tube questions.

MAY 14th, 1932, ISSUE: Two full pages, listing all the receiving tubes (detectors, amplifiers, power tubes and rectifiers). Full characteristics given. List includes the eight new tubes: 234, 239, 841, 46, 56, 57, 58 and 82. Total, 42 tubes.

APRIL 30th AND MAY 7th, 1932, ISSUES: Analysis of five new tubes, 46, 56, 57, 58 and 82. Characteristics, curves, installation data, uses, fully described and illustrated in the April 30 issue (7 pages) and in the May 7th issue.

Send 45c for April 30th, May 7th and May 14th issues.

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

Quick-Action Classified Advertisements

7c a Word — $1.00 Minimum
Cash With Order

SERVICE MEN—EXPERIMENTERS: Build an A.C. tube voltmeter; no batteries; blueprint, $1.00. Burns, 1028 Forest Road, Schenectady, N. Y.

TELEVISION STATIONS—Complete list of operating television transmitters of the United States, with frequency, wavelength, power, owner, location, lines, frames, hours on the air and sound track schedules, in May 28th issue. Send 15c for a copy. Radio World, 145 West 45th Street, N. Y. City.

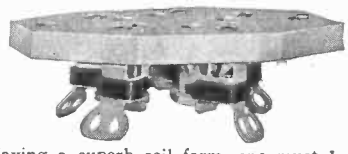
SUPERIORITY ON SHORT WAVES

ISOLANTITE COIL FORMS

The watchword of short waves is "Results." The best results are obtained with plug-in coils. The best plug-in coil results are obtained with non-hygroscopic, low-loss coil forms. Hammarlund's Isolantite coil forms, 1½" diameter, permit of an excellent "shape factor"—a better coil than with smaller diameters. These coil forms are obtainable with UX, UY or 6-pin bases. Removable knob included.

Cat. HCF-4—(UX, four-pin base). Net price.....59c
Cat. HCF-5—(UY, five-pin base). Net price.....59c
Cat. HCF-6—(six-pin base). Net price..59c

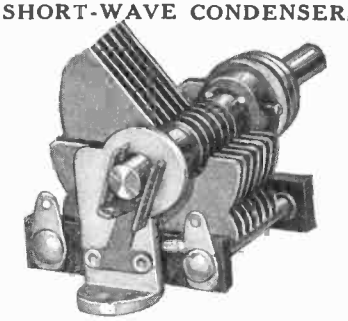
ISOLANTITE SOCKETS



Having a superb coil form, one must have an equally efficient socket for coil form receptacle to produce uniformly superior results. Hammarlund's Isolantite socket may be mounted below or above chassis. Elevating bushings are provided.

Cat. HS-4—(UX, four-prong socket. Net price.....44c
Cat. HS-5—(UY, five-prong socket). Net price.....44c
Cat. HS-6—(six-prong socket). Net price.44c

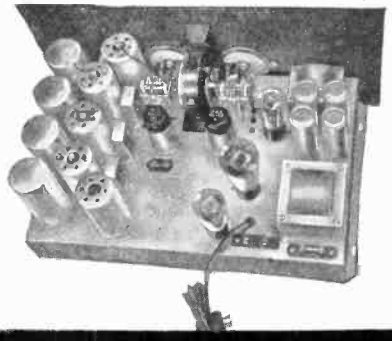
SHORT-WAVE CONDENSERS



Junior midline condensers, single panel hole mount, with Isolantite insulation. Entire condenser encompassed by 2-inch diameter. Front and rear brackets threaded for 6/32 machine screws for optional mounting to chassis. Shaft ¼ inch.

Cat. H-14, capacity 0.00014 mfd., single, net price $1.20
Cat. H-14, capacity 0.0002 mfd., single, net price $1.35
Cat. H-14D, two gang, 0.00014 mfd. each section $2.40

THE HAMMARLUND "PRO."



BUILD A SET FOR SHORT WAVES ON EARPHONES

(Battery Operated; two 230 tubes)

COILS

One set of plug-in coils, four pairs, total eight coils	$3.00
One 300-turn honeycomb coil	.30

CONDENSERS

Two 0.00014 mfd. junior midline tuning condensers (both)	2.40
One 0.0002 mfd. junior midline tuning condenser	1.35
Two 0.00035 mfd. fixed condensers (both)	.30
One shielded block containing three 0.1 mfd. condensers (black, common, to a minus; reds interchangeable)	.57

RESISTORS

One 0.05 meg. pigtail resistor (50,000 ohms)	.15
Two 4-ohm filament resistors in series, to constitute 8 ohms (both)	.20

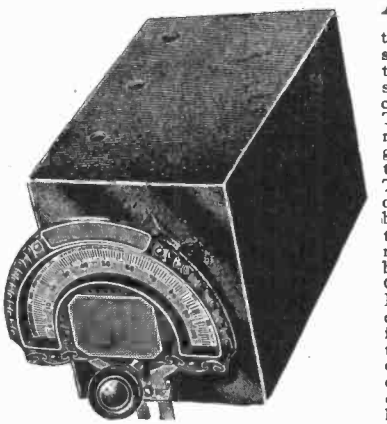
OTHER REQUIREMENTS

One 9 x 7½ inch wooden baseboard	.25
Four UX sockets (two for tubes, two for coil receptacles)	.40
One 7 x 10 inch bakelite drilled front panel	1.25
Two knobs, one for r-f condenser, other for feedback condenser (both)	.10
One vernier dial	.50
One push-pull A battery switch	.20
One binding post strip with eight posts on it	.25
One—34 tube and one—30 tube (both)	2.61
One pair of earphones	1.20

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

MATCHED TUNING UNITS

DIAL, SHIELDED CONDENSER, SHIELDED COILS



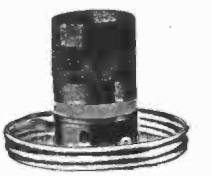
A 5-to-1 vernier dial (ghost type), with travelling light; a three-gang brass-plate shielded condenser, with trimmers built in; and a set of three shielded coils constitute the Matched Tuning Units for tuned radio frequency (two screen grid r-f and any type detector).

The coils are tapped once on each secondary, so that by switching it is possible to tune in from 80 to 200 meters, as well as the full broadcast band.

Order Cat. TU-RF @ $4.13

For double detection circuits two equal coils are furnished as above, while the third coil is for padding for broadcast band only. The padding condenser is supplied for 175 kc.

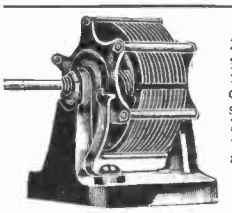
Order Cat. TU-O @..$4.83



Coils, 1" diam. tubing, 2" diam. shields. Four lugs at bottom, one at side. Code follows: P and B, primary; G and side lug, secondary. The tap for 80 meters, to which condenser stators may be switched, is the ground symbol lug at bottom. Markings stamped on shield base over which base the shield (not shown) fits tightly. For oscillation connect B to plate and P to B plus.

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

360-Degree Condenser



20 to 375 mmfd. capacity variation, effected over full 360 degrees, affords wide spreadout, better dial legibility. Great for test oscillators and all-wave tuning.

Price, $3.00 net.

DIRECT RADIO COMPANY
145 WEST 45TH STREET
NEW YORK, N. Y.

245

Tubes at 30¢ Each

Four for $1.00

Sold on basis of remittance with order. We will pay the postage.

RELIABLE RADIO CO.
143 West 45th Street New York, N. Y.

RADIO WORLD and "RADIO NEWS"

BOTH FOR ONE YEAR $7.00 Canadian and Foreign $8.50

You can obtain the two leading radio technical magazines that cater to experimenters, service men and students, the first and only national radio weekly and the leading monthly for one year each, at a saving of $1.50. The regular mail subscription rate for Radio World for one year, a new and fascinating copy each week for 52 weeks is $6.00. Send in $1.00 extra, get "Radio News" also for a year—a new issue each month for twelve months. Total, 64 issues for $7.00.

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

— — no greater magazine published on the development of INTERNATIONAL SHORT WAVE RADIO

INTERNATIONAL SHORT WAVE RADIO NEWS, edited by Clifford J. Daly in collaboration with Mander Barnett, Hollis S. Baird and Joseph L. McGrath needs no introduction to short-wave radio experimenters. From the very beginning it has led every publication in International Short Wave Radio. It gives you all the short-wave radio news—while it is news. Hot from the short-wave laboratories—just out of the short-wave experimental stations—all the latest happenings in short-wave radio—In South Africa, Arabia, Indo-China, Siam, Turkey, Dutch East Indies, Japan, Soviet Republics, Fiji, United States, Canada, Rhodesia, China, Algeria, Madagascar, Egypt, Morocco, Australia, New Zealand, Malaya, Belgian-Congo, British East Africa, the European, South and Central American countries—direct to you in International Short Wave Radio News.

Short Wave Radio today is the greatest growing, fastest moving industry in the whole world. Greater expansion is just around the corner. New developments are taking place throughout the world—you will want to know about them in detail. And you can—by reading International Short Wave Radio News.

International Short Wave Radio News is accepted by short-wave experimenters in eighty-five countries throughout the world as an indisputable authority in this particular sphere of radio. Every issue contains authoritative technical and general articles on the latest developments in short-wave radio on the five continents by such outstanding authorities as Dr. N. Koomans, Dr. Fritz Noack, J. Jonotskoff, Kurt Nentwig, Dr. Andre Szentirmay, R. Rapcke, H. Woltmann, Henri Chireix, Luang Jamni Kolakarn, Dr. A. Semm, Dr. Erwin Schliephake, Dr. Willis R. Whitney, Dr. E. Quack, Dr. E. Petrascu, Dr. Fritz Schroter, and scores of others of equal prominence in their native land. Think of what it will mean to you to have the results of the experiments and researches of these world renowned engineers brought to you through International Short Wave Radio News. You can use their researches—their results—to build your own future in Short Wave Radio.

In addition each issue contains over eight pages of accurate schedules and wave-lengths of the short-wave broadcasting stations throughout the world.

Send your subscription TODAY to the office nearest you

Special to Readers of Radio World

As a special gift we will send you absolutely free a copy of "The Romance of Shortwaves and Television"—a 132 page book describing in detail the fascinating subjects of Short Waves and Television with over 70 illustrations and complete instructions for the construction of Short Waves and Television Receivers. This offer, however, is void after June 15th in the United States.