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NEW RADIO QUESTIONS AND ANSWERS

ANSWERS TO QUESTIONS
MOST FREQUENTLY ASKED
BY BOTH NOVICES AND EXPERTS

BY ROBERT EICHBERG

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Contents

Introduction

Ever since the first radio enthusiast put the crystal detector in series with a pair of phones and listened to old KDKA sending out its test programs, questions have arisen relative to circuits, components and theories.

In eighteen years of radio experience the writer has answered many hundreds of thousands of questions from radio listeners. From these, those of most general interest have been selected, tabulated and classified under general headings for easy reference.

Radio developments bring such rapid changes that it is virtually impossible for anyone not actively engaged in the radio industry to keep abreast without reference to some work of this nature. Therefore, questions relating to automatic tuning, automatic volume control, phono-radio, auto-radio and various other phases of the art have been selected for inclusion in this volume.

Set Ailments and Their Symptoms

In order to save space, numerous questions as to "Can defective A.F. transformers be the cause of insufficient volume?" or "Do you think my loud speaker is going bad? My set sounds tinny," etc., the following table, adapted from material which has appeared in *Radio-Craft* and *Radio Today*. It lists the elements of the receiver, and the symptoms which defects in them may cause.

Alignment of Stages
- Lack of Sensitivity
- Spotty Sensitivity
- Poor Tone Quality
- Circuit Oscillation
- Code Interference
- Off-Calibration of Dial
- Poor Selectivity
- Spotty Selectivity

Antenna, Ground & Lightning Arrester
- No Short-Wave Reception
- Intermittent Reception
- Poor Reception
- Lack of Volume
- Excessive Noise
- Fading

A.F. Transformers
- Noisy Reception
- No Reception
- Reduced Volume
- Intermittent Reception
- Poor Tone Quality

Coils, R.F. and I.F.
- Intermittent Reception
- Off-Calibration of Dial
- Poor Selectivity
- Spotty Selectivity
- Lack of Sensitivity
- Spotty Sensitivity
- Poor Fidelity
- No Reception
- Fading
- Cross-Talk
- Circuit Oscillation

Condensers, Bypass
- Circuit Oscillation
- Poor Tone Quality
- Cross-Talk
- Intermittent Reception
- Poor A.V.C. Action
- Fading
- Loss of Volume
- Hum
- Excessive Hiss
- Noisy Reception
- Off-Calibration of Dial
- No Reception
- Short-Wave Dead Spot

Condensers, Filter
- Excessive Hum
- No Reception
- Low Volume
- Intermittent Reception
- Circuit Oscillation

Condensers, Tuning
- Noisy Reception
- Dead Spots
- Intermittent Reception
- Microphonic Howls
- Off-Calibration of Dial
- Fading

Interference, I.F. Wavetrap
- Code Interference
- Intermittent Reception

Interference, Atmospheric Conditions
- Fading
- Noisy Reception
- Distortion
- Lack of Short-Wave Reception
- Cross-Talk

Interference, House Wiring
- Intermittent Reception
- No Reception
- Noisy Reception

Interference, Local Machinery and Appliances
- Noisy Reception
- Clicks
- Sudden Change in Volume

Interference, Pipes in House
- Intermittent Reception
- Noisy Reception

Line Cord and Plug
- Intermittent Reception
- No Reception
- Noisy Reception

Oscillator Section
- Lack of Sensitivity
- Excessive Hiss
- Distortion
- Erratic Operation
- Dead Spots on Short Waves
- Frequency Instability
- Intermittent Operation
- Whistling

Power Transformer
- No Reception
- Intermittent Reception
- Excessive Noise
- Excessive Hum
- Short Tube Life

Radio Cabinet
- Resonance
- Tinny Sounds
- Rumbles

Reproducer
- Distortion
- Tinny Sounds
- Scratching and Grating
- Excessive Hum
- Intermittent Reception
- No Reception
- Low Volume

Resistors
- Intermittent Reception
- Distortion
- Poor A.V.C. Action
- Fading
- Circuit Oscillation
- No Reception
- Low Volume
- Short Tube Life

Shielding of Set and Components
- Circuit Oscillation
- Microphonics
- Noisy Reception
- Lack of Sensitivity
- Cross-Talk
- Fading
- Intermittent Reception

Tubes
- No Reception
- Distortion
- Hum
- Off-Calibration of Dial
- Lack of Sensitivity
- Loss of Selectivity
- Microphonics
- Intermittent Reception
- Fading
- Poor A.V.C. Action
- Noisy Reception
- Circuit Oscillation

Volume and Tone Controls
- Noisy Reception
- No Control of Volume
- Sudden Change in Volume
- No Control of Tone
- Sudden Change in Tone
- Intermittent Reception
- No Reception
- Loss of Sensitivity
- Circuit Oscillation

Wave-Change Switch
- Loss of Volume on Short Waves
- Intermittent Operation
- No Reception
- Noisy Reception
- Short-Wave Dead Spots
- Fading
- Loss of Volume
- A.V.C. Not Functioning

Wiring of Set
- Noisy Reception
- Excessive Hum
- Circuit Oscillation
- Lack of Short-Wave Reception
- No Reception
- Cross-Talk

NEW RADIO QUESTIONS AND ANSWERS

CHAPTER I

Definitions

A.C. AND D.C.

(Q) What is the difference between Alternating Current (A.C.) and Direct Current (D.C.)?

(A) Alternating current reverses its direction of flow at regularly recurring intervals. In standard house lighting current, the cycle is: Zero, maximum positive, Zero, maximum negative, Zero, and takes place completely 60 times per second. In brief, both terminals of the line go through this cycle, one being maximum positive when the other is maximum negative.

Direct current flows in one direction only, like the current from a battery.

A.C., for radio purposes, is more flexible; its voltage may be raised or lowered through the use of a transformer, and it is easily rectified (changed to direct current) when D.C. is needed. D.C.

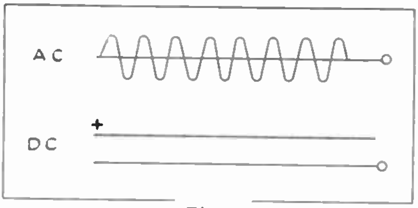


Fig. 1

may have its voltage reduced by being passed through a resistor; its voltage raised by changing it into a pulsating D.C. (which acts like A.C.) by mechanical means, such as a vibrator, or by certain tubes. It may then be handled like A.C., but must be rectified again to be used as D.C. at the new voltage.

AUDIO-FREQUENCY AMPLIFIER

(Q) What is an audio frequency amplifier?

(A) Frequency is the number of vibrations (or electrical impulses) per second. If the air is caused to vibrate at any frequency from about 30 to 14,000 times per second, the vibrations are audible—they can be heard by the human ear. An Audio-Frequency Amplifier is a device constructed to strengthen electrical impulses of the frequencies lying between these limits.

AUTODYNE CIRCUITS

(Q) I have been told that my set is an autodyne receiver, but I bought it for a superheterodyne. Was I misled?

(A) No. An autodyne is a superhet which uses the same tube as oscillator and first detector.

AUTOMATIC VOLUME CONTROL

(Q) What is an automatic volume control? Does it replace the usual manual volume control?

(A) The automatic volume control is a highly ingenious circuit which keeps the output of an intermediate frequency amplifier approximately constant, though the signal input to the amplifier may vary widely. It does not replace the manual volume control.

Quiet automatic volume control (Q.A.V.C.) is a means of reducing the set's sensitivity at will; so that background noise between stations will not be heard while the set is being tuned, though the signal input of a station's carrier wave will cause the set to function.

BAFFLES

(Q) What are baffles, and what are the "magic voice," the "labyrinth" and similar set features?

(A) When a loud speaker is reproducing the program of a station, its diaphragm vibrates, causing the air which rests against the back of the diaphragm to vibrate, as well as that which rests against the front of the diaphragm. There is some tendency of these vibrations to "cancel out," especially in the lower registers, but by placing the speaker in the center of a partition, the path which air vibrations must travel to get from the front of the speaker around to the back is greatly lengthened, and bass reproduction is improved. The longer the path, within certain limits, the better the reproduction, and the "labyrinth" forms a long, non-resonating path. The "magic voice" is another baffle system, tuned to resonate at frequencies which usually come through the amplifier weakly; thus it builds them up.

Of course, if the back of the loud speaker were sealed in, there would be no path from front to back, but this cannot be done. One reason is that the air cushion formed in the rear chamber would muffle the speaker tones.

BY-PASS CONDENSER

(Q) How can you tell a by-pass condenser from other condensers by looking at it?

(A) By-pass does not describe the condenser itself, but its use. It is simply a condenser used to provide a low impedance path for an alternating (or pulsating direct) current around some unit which has a higher A.C. impedance. For example, it is used to by-pass radio-frequency currents through a circuit, so that they will not have to travel through a power pack. You cannot tell by looking at a condenser; you can tell by analysing its purpose in a circuit.

CARRIER WAVE

(Q) What is the difference between a broadcasting station's wave and its carrier wave?

(A) In a broadcasting station, an alternating current is generated by oscillating vacuum tubes and fed into the antenna, after being amplified. The wave then radiated by the antenna is the station's carrier wave.

When sound is picked up by a microphone and amplified, then used to shape or "modulate" a carrier wave, the result is a modulated carrier, which is probably what you have in mind. But, to all practical intent, a station's wave and its carrier wave may be said to be identical.

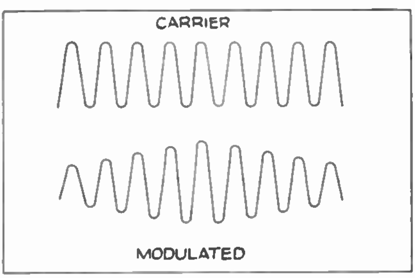


Fig. 2

BAND-PASS FILTER

(Q) My set is said to have a band-pass filter. What is that?

(A) A filter, electrically, is a circuit which prevents the passage of certain frequencies. A band-pass filter prevents the passage of all frequencies not in a certain continuous group, or "band."

CATHODE AND FILAMENT

(Q) Is the cathode of a tube the same as its filament?

(A) In some cases it is, in others it is not. The cathode of a tube is the element which emits electrons. In some models of tubes, particularly those designed for battery operation, the element which is heated by the passage of current (the filament) also emits electrons. In this case, the filament is also the cathode. In other tubes, designed for A.C. operation (especially in the earlier stages of the set), the alternations of the current would cause an irregular emission of electrons and hum in the set. For this reason, the filament (called a heater in this case) is kept separate from the cathode, which is made of a substance that heats and cools relatively slowly; so that the fluctuations of the heat in the filament have no effect on the electronic emission.

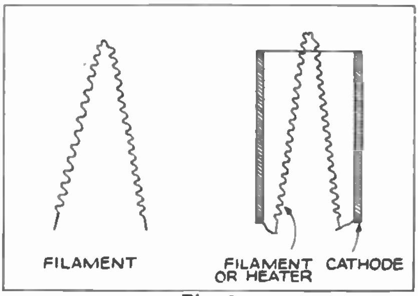


Fig. 3

AMPLIFIERS

(Q) I have heard of Class A, Class B, Class AB and Class C amplifiers. Please tell me what each of these is.

(A) The difference is in the degree of grid bias and its effect upon plate current. Class A: balance of grid bias with alternating grid voltage is such that the tube's plate current flows at all times. Class AB: balance is such that tube's plate current flows more than half, but less than all, of the electrical cycle. Class B: balance is such that plate current is Zero when no alternating grid voltage is applied; thus plate current flows for approximately half of each electrical cycle. Grid is biased to about cut-off point. Class C: balance is such that plate current is Zero when no alternating grid voltage is applied; since bias is greater than necessary for full cut-off, the plate current flows for measurably less than half of each electrical cycle.

LOUD SPEAKERS

(Q) A set I just bought is supposed to have a dynamic loud speaker, but I just got a manufacturer's diagram of it and see that there is no field winding. Does this make it a regular magnetic speaker?

(A) Not necessarily, for some dynamic speakers are now made with powerful permanent magnets to supply the field, instead of using electromagnets. The mark of the dynamic speaker is the voice coil, affixed to the diaphragm. A dynamic speaker is a "moving-coil" speaker. A magnetic speaker has fixed (i.e., stationary) coils which act upon an armature that transmits motion to the speaker diaphragm.

ELECTRONS

(Q) I hear of cathodes emitting electrons. What are electrons?

(A) They are generally considered the smallest possible particles of matter, and are sometimes defined as minute charges of negative electricity. This definition is supported by their tendency to be attracted by a positively charged electrode, such as the plate in a vacuum tube.

FIDELITY

(Q) Some radio sets are called "high fidelity" sets. What is high fidelity?

(A) In this application, fidelity means the degree to which a radio receiver accurately reproduces, at its loud speaker, the audio-frequency component of the wave which reaches its antenna. Some broadcasting stations radiate waves modulated by audible frequencies which range from 30 to 14,000 cycles, the average limits of human hearing. While almost any set will reproduce the frequencies from 100 to 4,000 cycles (and many up to 7,500) not all will take in the entire band. Those which do so, give more faithful reproduction—are, in short, high fidelity sets.

FILTERS

(Q) What are filters, as used in radio sets?

(A) Filters have several purposes in radio receivers. One type of filter, used in the power pack, permits the passage of direct current from the rectifier, but will not pass the fluctuations which result from rectification. Another common type is the band-pass filter, which permits the passage of certain frequencies, but cuts off, in whole or in part, frequencies lying above or below the desired band. Others include the "line noise filters" used to keep R.F. disturbances in the house current lines from getting into the set, while permitting the passage of the power; and 'needle scratch filters" used in phonograph installations, to cut off the high frequencies generated by the friction between the needle and the record's surface. Filters may consist of chokes or condensers, or combinations of the two; in a few applications, resistors may also be used.

FADING EFFECTS

(Q) Sometimes when I am listening to distant stations, the signals get weaker for a while and sometimes disappear, then come back again without my retuning the set. What is wrong with my radio? It does not happen on my friend's set.

(A) Probably nothing. Fading is an effect which often occurs when distant stations are received. It is due to atmospheric conditions between the transmitter and the receiver. There is nothing to be done about it. Your friend's set probably has an automatic volume control, which your set lacks. While AVC does not entirely overcome fading, it does tend to minimise the effects, by keeping volume relatively constant.

RECTIFIERS

(Q) What types of rectifiers are in general radio use, and what are their purposes?

(A) Vacuum tube and metallic. The former are used to change A.C. to D.C. in radio receivers; the latter, principally in midget form, to convert D.C. meters to A.C. use.

HETERODYNE RECEPTION

(Q) Please define heterodyne reception.

(A) The type of reception in which a locally-generated oscillation (usually of different frequency from the received wave) is combined with a received wave. This is also known as beat reception. A superheterodyne is so called because the combined wave is supersonic (above audible frequency).

INTERFERENCE

(Q) What are the causes of interference?

(A) Interference is of many types. Some of the causes are: (1) Atmospheric electricity—the true "static"; (2) Electric disturbances caused by motors, switches, arcing, etc.—called "man-made static"; (3) Signals of undesired stations; (4) Heterodyning between the waves of a received station and an undesired station; (5) Line noise, entering the set through the power pack; etc.

KILOCYCLES

(Q) I see stations rated according to kilocycles. Does this mean their power?

(A) No. A station's wave is A.C., and kilocycles refers to the frequency, or number of times this current alternates from Zero to maximum positive to Zero to maximum negative to Zero each second. Each complete alternation described is one cycle; 1000 cycles per second is one kilocycle. Frequency (of cycles per second) has nothing to do with power; power is rated in watts or kilowatts (a kilowatt is 1000 watts).

MEANING OF MEG.

(Q) I know what ohms and cycles are, but what are megohms and megacycles? Are they larger or smaller than ohms and cycles?

(A) Larger. The prefix "meg" or "mega" means 1,000,000. Thus 1 megohm is 1,000,000 ohms, etc. Other prefixes and their common abbreviations will be found at the beginning of this chapter.

MERCURY VAPOR RECTIFIERS

(Q) What is the difference between a mercury vapor rectifier and other rectifiers?

(A) The mercury vapor rectifier, as the name implies, contains a little mercury which becomes vaporised when the tube is in operation. This decreases the internal resistance of the tube, so that there is less voltage drop in it.

MICROPHONES

(Q) What is a microphone, and how does it work?

(A) A microphone is simply a device for converting sound waves to pulsating D.C. or A.C., of corresponding frequency and proportional amplitude. There are five principle types in general use; dynamic, crystal, ribbon, condenser and carbon. The latter is merely a variable resistance, varied by movement of a diaphragm, actuated by sound waves, and controlling contact between the carbon grains in a small container. The dynamic is a diaphragm moving a coil in a magnetic field, and thus generating currents; the crystal is a diaphragm applying torque (twist) to a piezo-electric crystal, and thus generating currents; the ribbon is a metal strip cutting a magnetic field, and thus generating currents. The condenser makes use of the diaphragm as one of its plates, and thus varies the grid charge of a pre-amplifier.

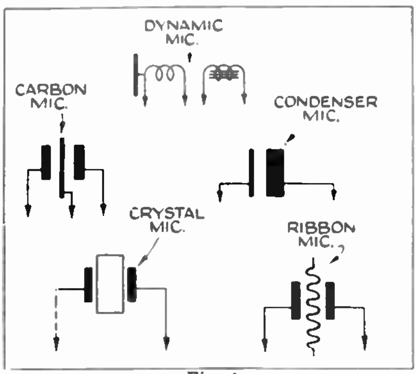


Fig. 4

MODULATION

(Q) When they say that a radio wave is modulated, what do they mean?

(A) They mean that the wave is "shaped" in accordance with an audio signal. This is done by decreasing the amplitude, phase or frequency of some of the waves in the carrier.

PULSATING D. C.

(Q) Is there any difference between A.C. and pulsating D.C.?

(A) Yes. A definition of A.C. is given at the beginning of this chapter. Pulsating D.C. is current which flows in but one direction; it may be interrupted, coming to a full stop at intervals, or may simply be flowing with greater and lesser force. It is as though an equal or lesser A.C. were flowing in the same circuit as the D.C.

PUSH-PULL

(Q) What does push-pull mean?

(A) It is generally used to refer to a stage of audio amplification, in which two tubes operate 180 degrees out of phase, the grid of one being maximum negative when that of the other is maximum positive. It may also refer to a microphone in which the two elements are similarly out of phase, as the double-button carbon microphone.

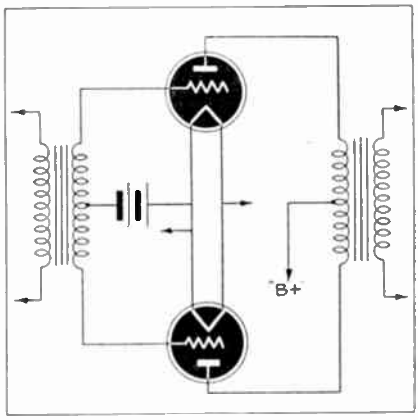


Fig. 5

SELECTIVITY

(Q) What is the selectivity of a radio set?

(A) It is the ability of the set's circuits to tune to a desired carrier wave, while rejecting all others.

SENSITIVITY

(Q) And what is a set's sensitivity?

(A) The set's ability to respond to the signal to which it is tuned. A sensitive set will pick up and reproduce signals which a less sensitive set will miss.

SIDE BANDS

(Q) I know what a carrier wave is, but what are the side bands? And what is single-side-band transmission?

(A) The side bands are the frequencies on either side of the carrier wave's frequency and result from modulation. If a set is too selective, part of these side bands may be cut off, with resulting loss of fidelity. In single side band transmission, one of the side bands (and sometimes the carrier) is suppressed.

SUPERHETERODYNES

(Q) How is a superheterodyne different from other radio sets?

(A) In most other circuits, the signal is amplified at radio frequencies, detected, and amplified at audio frequencies. In superheterodynes, it may be amplified at radio frequencies, but must be "mixed" with a locally generated frequency, the resulting intermediate frequency being amplified in I.F. (intermediate frequency) stages, then detected and amplified at audio frequencies. (See Heterodyne). The mixer tube is also known as a modulator, frequency changer or first detector; the detector tube then being second detector.

WAVELENGTH

(Q) What is a wavelength, and how can these invisible things be measured in meters?

(A) Elsewhere in this chapter, there is a description of radio waves. The distances between the peaks of two cycles may be measured in meters or fractions thereof. If the distance between two such peaks is, say, 20 meters, the wave may be called a 20-meter wave.

Ridiculous as it may sound, a wave-length may be measured with an ordinary ruler. The output of a transmitter may be fed into two parallel wires. An electrict light bulb connected across these two wires will, if the connections are shifted along the wires, glow brightly at the positive and negative peaks of the wave, and fade gradually as it passes them, going out entirely when it reaches the Zero points. If a measurement is made from one Zero point to the next, it will show one half a wavelength.

LINEAR POWER DETECTION

(Q) What is meant by "linear power detection"?

(A) The older methods of detector connection resulted in distortion on high power, due to the fact that the signal input exceeded the grid-bias potential. By raising the grid bias to a value not exceeded by the signal, operation on the "straight (linear) portion" of the tube's "characteristic" curves results.

OSCILLATOR COUPLER

(Q) What is an "oscillator coupler"?

(A) This term is applied to the oscillator coil of a superheterodyne receiver and usually comprises a grid winding, a plate (feed-back or tickler) winding, and a coupling or pick-up winding of but a few turns. The grid and plate inductance are coupled to produce circuit oscillation, and the pick-up coil transfers a small portion of this high-frequency current to the frequency-changer.

ZERO BEAT TUNING

(Q) What is "zero beat" tuning

(A) With an oscillator or oscillating detector circuit, it means tuning exactly to the center of a station's carrier wave. Adjusting the tuning dial a hair's breadth left or right will start a howl, heard in the reproducer first as a growl and then, as the dial motion is continued, as a note rising in intensity and pitch to a powerful shriek, in most cases, going finally beyond the limits of hearing. Figure 5A illustrates this in exaggerated form.

COMPUTING THE DECIBEL

(Q). What is the "decibel" and how is the term used in connection with radio equipment?

(A.) Since the decibel indicates a geometric relation between two figures, it may be used to indicate a rate of change either in sound energy or in electrical units.

The ear responds not in linear but in logarithmic proportion to changes in sound intensity. For example, although the energy ratio of a band playing soft or loud is 1,000,000/1, the ear appreciates it only as about 60/1; the figure 60 also is the "db" value.

The decibel, so often used in the work of audio amplification, transmission and reproduction, is simply the ratio between the strengths of any two signals, or the ratio of change in the energy of a signal when it is amplified or attenuated.

Ten decibels "up" on a signals means that the power has been increased tenfold; ten decibels down, that it has been divided by ten. The steps are unequal, but the peculiarities of this method of rating are based on physiological and engineering reasons. The decibel, as a mathematician would instantly see from the table given here, is a **logarithmic** unit (the number of decibels is represented by ten times the "common" logarithm of the ratio of change.)

Since the sound energy of the reproducer should be, approximately, in proportion to the electrical output power, and since electric power is measured by "voltage times current," the power varies as the square of the voltage (or current). Therefore, the ratio of energy change corresponding to ten decibels is as much as the ratio of voltage (or current) change, corresponding to twenty decibels.

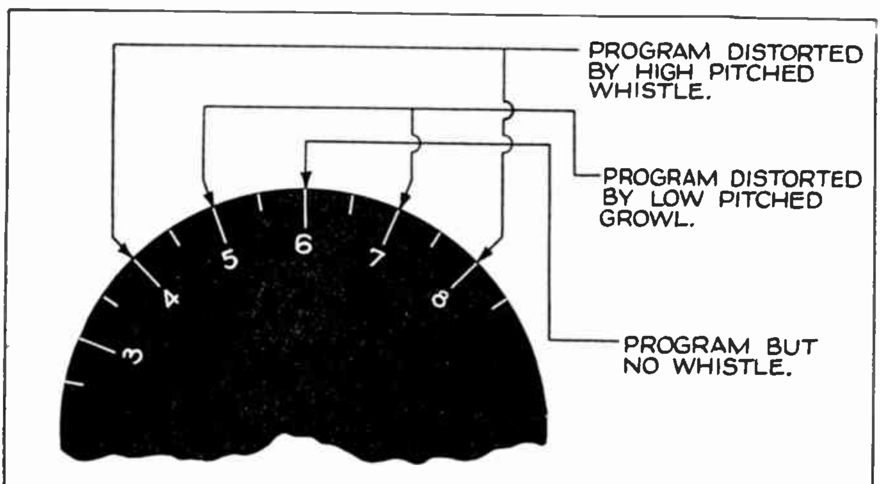


Fig. 6

Any signal strength may be taken as the base (or zero) in computing relative intensities. However, for voice-transmission measurements, six milli-watts (1.73 volts across a 500-ohm line) is a standard used by engineers.

The ratio of change in power, and in voltage (or current) corresponding to any number of decibels, may be quickly found from the following table. Multiply the signal strength (or voltage) which is taken as the base, by the factor given in the proper column, opposite the appropriate number of decibels.

"UP"		DECIBELS	"DOWN"	
ENERGY	VOLTAGE	NO.	ENERGY	VOLTAGE
1.26	1.12	1	0.794	0.891
1.69	1.26	2	.631	.794
2.00	1.41	3	.501	.708
2.51	1.59	4	.398	.631
3.16	1.79	5	.316	.562
3.98	2.00	6	.251	.501
5.01	2.24	7	.199	.447
6.31	2.51	8	.158	.398
7.94	2.82	9	.126	.355
10.00	3.16	10	.100	.316
12.59	3.55	11	.079	.282
16.85	3.98	12	.063	.251
19.96	4.47	13	.050	.224
25.12	5.01	14	.040	.200
31.62	5.62	15	.032	.178
39.81	6.31	16	.025	0.158
50.12	7.08	17	.020	.141
63.10	7.94	18	.016	.126
79.43	8.91	19	.013	.112
100.00	10.00	20	.010	.100
125.90	11.22	21	.0079	.089
158.50	12.59	22	.0063	.079
199.60	14.13	23	.0050	.071
251.20	15.85	24	.0040	.063
316.20	17.78	25	.0032	.066
398.10	19.96	26	.0025	.050
501.20	22.39	27	.0020	.047

"UP"		DECIBELS	"DOWN"	
ENERGY	VOLTAGE	NO.	ENERGY	VOLTAGE
631.0	25.12	28	.0016	.040
794.3	28.18	29	.0013	.035
1,000.0	31.62	30	.0010	.032
1,259	35.48	31	.0008	.028
1,585	39.81	32	.0006	.025
1,996	44.67	33	.0005	.022
2,512	50.12	34	.0004	.020
3,162	56.23	35	.00032	.018
3,981	63.10	36	.00025	.016
5,012	70.80	37	.00020	.014
6,310	79.43	38	.00016	.013
7,943	89.13	39	.00013	.011
10,000	100.00	40	.00010	.010
12,590	112.1	41	.00008	.0089
15,850	125.9	42	.00006	.0076
19,960	141.3	43	.00005	.0071
25,120	158.5	44	.00004	.0063
31,620	177.8	45	.000032	.0056
39,810	199.6	46	.000025	.0050
50,120	223.9	47	.000020	.0045
63,100	251.2	48	.000016	.0040
79,430	282.0	49	.000013	.0036
100,000	316.0	50	.000010	.0032
1,000,000	1,000	60	.000001	.001
10,000,000	3,162	70	.0000001	.0003
100,000,000	10,000	80	.00000001	.00001
1,000,000,000	31,620	90	.000000001	.00003
10,000,000,000	100,000	100	.0000000001	.00001

Fig. 7

CHAPTER II

Vacuum Tubes

INACTIVE TUBES

(Q) My set stopped playing and I called a service man in. He tested my tubes and said I needed two new ones. He installed them and my set played all right . But what I cannot understand is why my old tubes were no good; they lit. Will you explain this?

(A) The filament or cathode of a tube is coated or impregnated with a substance which emits electrons when heated by the passage of filament or heater current. These electrons, being negative. are attracted by the positively charged plate. Their flow—the plate current—is controlled by the signal reaching the grid (among other factors). When the substance is used up to some

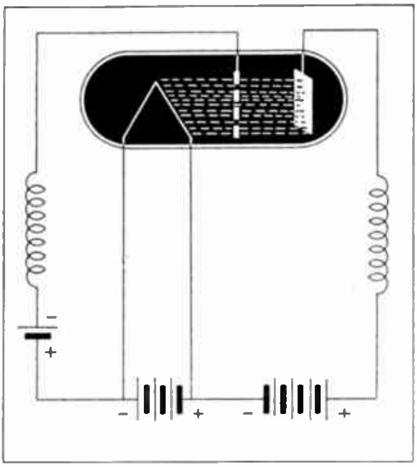


Fig. 8

degree, the flow of electrons is greatly decreased, so the electronic stream which the grid controls is greatly cut down, and the signal has little effect. The tube must then be discarded.

INTERNAL RESISTANCE

(Q) In a table of tube characteristics, is the plate resistance an A.C. or a D.C. value?

(A) The values are the A.C. resistances of the tubes. For three-element tubes this may be considered approximately the same for D.C. measurements. Four-element (screen-grid) tubes do not come within this class; their plate circuits' resistances (in ohms) are A.C. values, and are above the D.C. value.

TUBE CONNECTIONS

(Q) Please tell me how to know which are the plate, grid, screen-grid, suppressor-grid, filament, heater and cathode prongs on the more common tubes, by looking at them.

(A) It cannot be done with any degree of success, for tube types now vary so widely. You must refer to a chart, such as that given in Fig. 10. This chart also shows recommended plate, filament and grid voltages, the various tubes' uses, and their electrical characteristics.

"BLUE" TUBES

(Q) In the old days, when a tube showed a blue light around the plate, we were told it was no good and must be thrown away. Now when I buy certain tubes, I see a blue haze around the plate and the dealer tells me this is all right. What's the truth about this?

(A) The blue glow is caused by the ionisation of gases in the tube. In certain types of tubes, there is supposed to be a high vacuum, no gas being present; when such tubes show the effect, they are defective. Other types of tubes, however, have minute quantities of certain gases purposely sealed within their envelopes; it is perfectly normal for these tubes to show the effect.

BLOCKING TUBE

(Q) Does a "blocking" tube amplify?

(A) Ordinarily, yes; but the input and output coupling circuits may be so poorly matched as to amplify and pass only a small portion of the signal current; and the effect of a reduction in volume may in fact be obtained.

By using the new pentode-type tubes and correct resistors it is possible to obtain very effective amplification from one of these connected as a blocking tube.

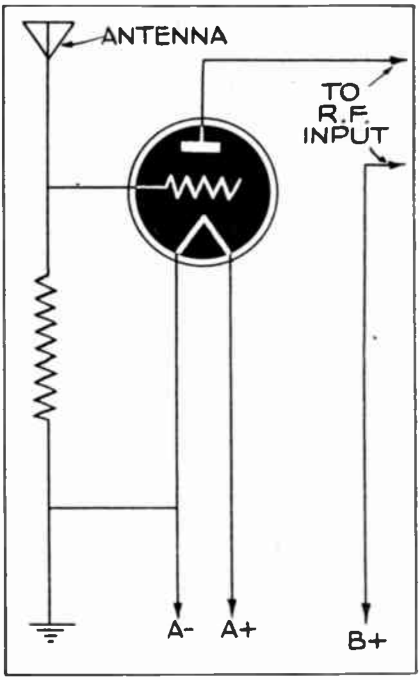


Fig. 9

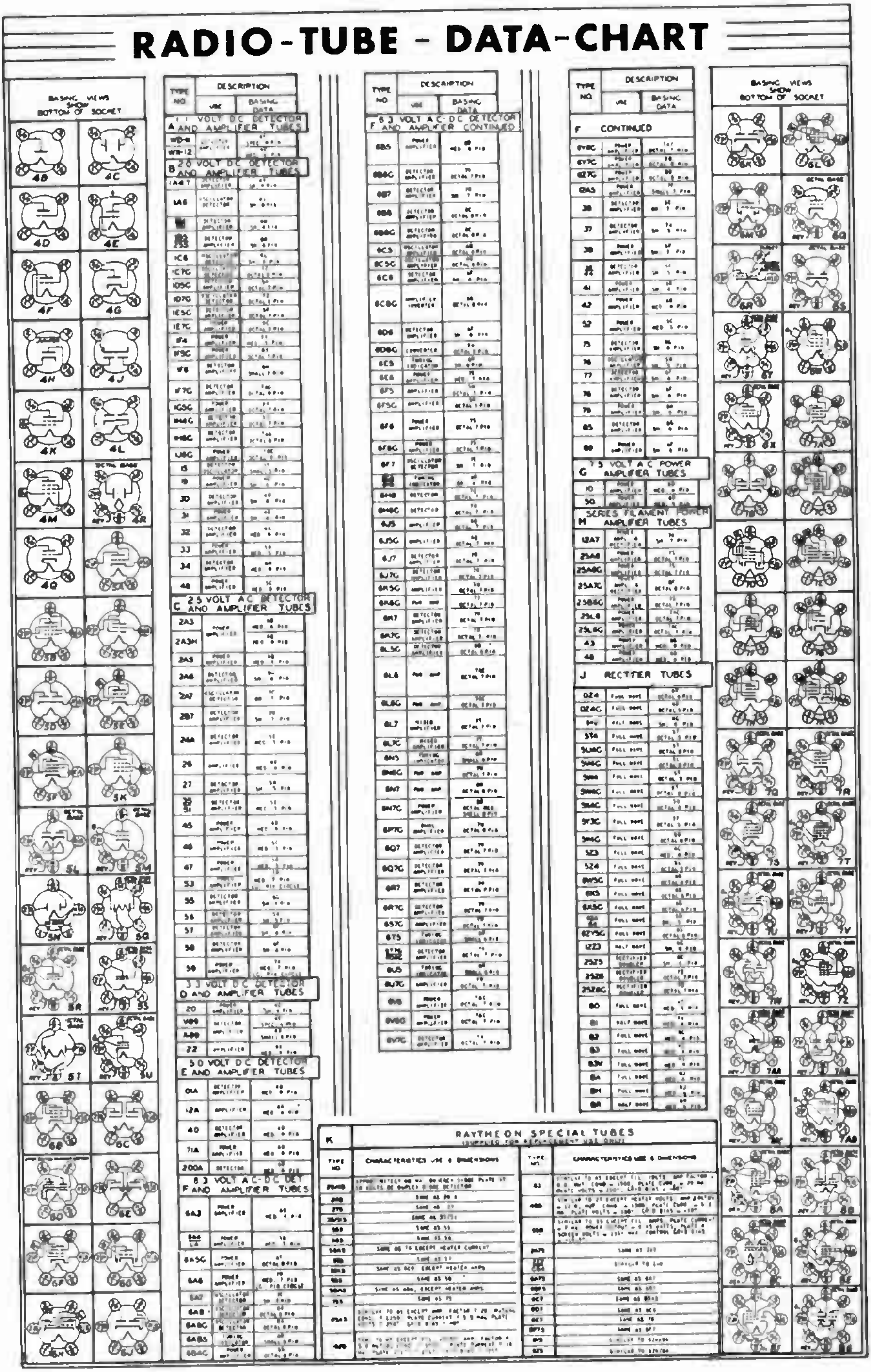

RADIO-TUBE - DATA-CHART
BASING VIEWS SHOW BOTTOM OF SOCKET
TYPE NO.
DESCRIPTION
USE
BASING DATA
A 1.1 VOLT D.C. DETECTOR AND AMPLIFIER TUBES
B 2.0 VOLT D.C. DETECTOR AND AMPLIFIER TUBES
C 2.5 VOLT A.C. DETECTOR AND AMPLIFIER TUBES
D 3.3 VOLT D.C. DETECTOR AND AMPLIFIER TUBES
E 5.0 VOLT D.C. DETECTOR AND AMPLIFIER TUBES
F 6.3 VOLT A.C.-D.C. DET. AND AMPLIFIER TUBES
F 6.3 VOLT A.C.-D.C. DETECTOR AND AMPLIFIER CONTINUED
F CONTINUED
G 7.5 VOLT A.C. POWER AMPLIFIER TUBES
H SERIES FILAMENT POWER AMPLIFIER TUBES
J RECTIFIER TUBES
K RAYTHEON SPECIAL TUBES (SUPPLIED FOR REPLACEMENT USE ONLY)
CHARACTERISTICS USE & DIMENSIONS

Fig. 10

CHAPTER III

The Antenna System

GOOD GROUNDS

(Q) What is the best way to ground my radio set?

(A) The best ground is a cold-water pipe. If none is convenient, the next-best ground is the BX cable in your house wiring system. The third-best is the steampipe; it is far more convenient to use than the BX and is safer to install. If you live in a private house, and can get to the water meter, it is well to put a heavy wire lead (or "jumper") from the pipe that enters the meter to the pipe that leaves the meter, when using a waterpipe ground. In using a steampipe, it is best to put a jumper from it to a good ground, such as the waterpipe. In making all ground connections to piping, use an approved ground clamp, and sandpaper the pipe bright before applying it. Should you live in the country where no piping is available, a good ground can be made by driving a piece of pipe (iron will do, but brass or bronze is better, being less affected by corrosion) at least 6 feet into moist soil. Burying a large metal plate, of the same metal, at a similar depth in moist soil in equally good. Solder connections to the outdoor pipe or plate, and use at least a No. 8 wire for the ground lead. The ground wire to an indoor ground is preferably No. 8, but wires as small as No. 14 are perfectly satisfactory. It does not matter whether the ground lead is insulated or not.

TYPES OF ANTENNAS

(Q) Will you please tell me the difference between doublet and other good antennas? What types of antennas do you recommend? Please describe each.

(A) The writer favors the "zep," the single wire, the doublet and the spider-web, in the order named. The "zep," shown in Fig. 11A, is much like the straight (or inverted L) antenna, save that a pair of twisted wires is used as the lead-in to decrease the pick-up of local interference. The lower end of the twisted pair is connected to a coil placed in inductive relationship to the grid coil of the first stage in the set; one side of the upper end is connected to the antenna wire, the other side, between two insulators. The straight antenna is equally good in areas where there is little or no locally generated interference. If interference exists, the zep is better, or the lead-in may be a shielded line, as shown. In this case, impedance-matching transformers must be used at both ends of the lead, as shown in Fig. 11B if good results are to be obtained. The doublet is similar to the zep, in that it uses a twisted pair lead-in. It consists of two separate antennas, each usually half as long as the wave most desired, and arranged end to end. The twisted pair is connected to the inner ends, as shown in Fig. 11C. Best results are obtained if impedance-matching transformers are used at both ends of the lead-in. The spider-web, Fig. 11D, is best described as a number of different length doublets, connected to the same lead-in. It is efficient, but somewhat more costly than the other systems.

NOISY ANTENNA

(Q) My set is very noisy when connected to my antenna. When the antenna is disconnected, the signals come in much more weakly, but without noise. Is there something the matter with my aerial?

(A) Most likely there is a bad joint somewhere in the system, or defective insulation. The bad joints are most likely to occur between (1) ground and ground clamp; (2) ground clamp and ground wire; (3) ground wire and ground post on set; (4) Antenna post on set and lead-in to window; (5) lead-in and window lead-in strip; (6) lead-in strip and external lead-in; (7) lead-in and antenna. All these joints (except the first, when made with an approved ground clamp) must be cleaned and soldered for best results. If antenna coupling transformers are used, joints to them should likewise be soldered. Leaky insulation may occur where a lead-in comes in contact with anything besides an insulator; see that this does not occur. It may also happen at a defective window lead-in strip, or at a dirty or cracked strain insulator on the antenna proper. The most usual cause of noise, however, is a twisted (instead of soldered) joint somewhere in the circuit.

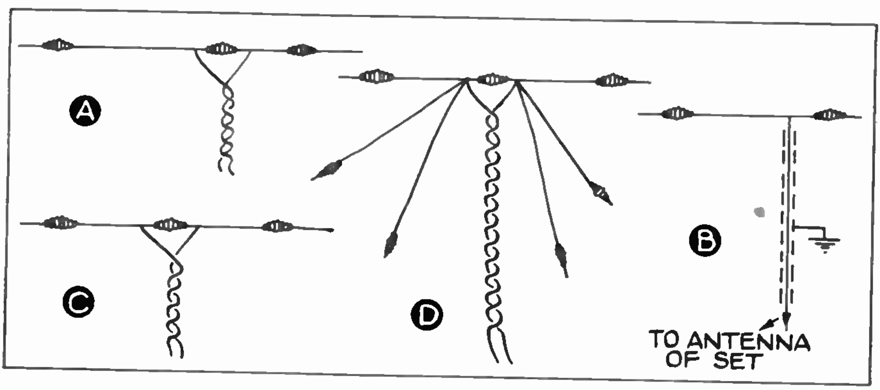


Fig. 11

PROTECTIVE CONDENSERS

(Q) What size condenser do you recommend for insulating aerial and ground against causing D.C. line fuses to blow?

(A) About 0.1-mf. will be quite large enough. The "operating voltage" rating should be at least 250 volts and preferably higher.

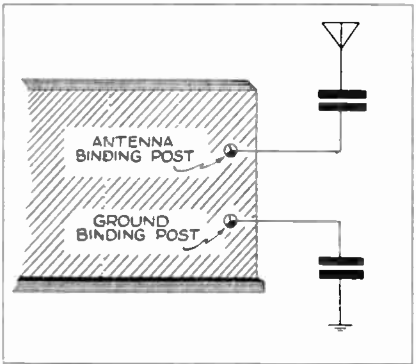


Fig. 12

LIGHTNING ARRESTERS

(Q) Are lightning arresters really necessary? I understand that they are not used as much as formerly.

(A) It is quite true that a lower percentage of antenna installations use arresters for, if lightning ever really strikes an antenna, the whole system is likely to fuse. But the writer strongly recommends the use of these devices for two reasons. First, Underwriters' regulations call for them. Second, a thunderstorm may induce a sufficient charge in the antenna to burn out the R.F. primary coil, without lightning actually striking the antenna; in this case, the arrester bypasses the charge harmlessly to ground.

ENERGY PICK-UP

(Q) What proportion of the energy radiated from a station actually reaches my antenna?

(A) This depends upon a number of factors, including your distance from the station, the placement of your antenna, and the directive effect of the station's signal, if any. A good analogy is: Consider a big stone dropped into the middle of the ocean. It causes ripples to spread out in all directions, growing weaker as their distance from the source of disturbance increases. Stick a pin into the surface of the water, and the ripples caused by the stone will affect it with about as much power as the signals of a station fifty miles away affect your antenna.

LENGTH OF ANTENNA

(Q) I want to put up a plain, inverted L antenna. Which is best, a long one or a short one?

(A) In general, a long antenna makes the set more sensitive; a short one makes it more selective. You will have to strike a happy medium, getting the best possible sensitivity without sacrificing selectivity to the extent that the signals of two stations interfere with each other. In general, if you are distant from powerful local stations, use a long antenna; if such stations are nearby, use a short one. If you have an instruction sheet with your set, follow it.

MINIMIZING INTERFERENCE

(Q) A power line runs near my house. How can I cut down interference from it?

(A)Use a twisted pair or shielded lead-in, as described earlier in this chapter. Also, locate your antenna at right angles to the power line, with the lead-in at the end furthest from the line, if this can be done conveniently.

TREE ANTENNA

(Q) Is there a "correct" way of "hanging" an antenna between a house and a tree? It seems those installed without due regard for the swaying of the tree do not stay up very long.

(A) Apropos of this subject here is some interesting information furnished by the Davey Tree Expert Co., as follows:

"Where radio antennas are attached to trees, the manner in which the attachment is made may determine whether the tree or part of it will be killed. Too often the antenna is fastened by means of a wire that encircles a branch or perhaps the main trunk. In those cases where the encircling wire is used, no immediate harm will result aside from a certain amount of chafing which may or may not damage the living bark tissue. But, as the trunk or branch grows in diameter, the wire begins to press against the bark. In a relatively short time it becomes deeply imbedded and strangulation results, for the sap that flows in the inner bark is cut off by the wire barrier. The death of the branch or trunk quickly follows.

"To avoid the possibility of injury, the safe method is to use either a lag hook or a pulley with a screw end. These should be attached in the manner shown in the illustration," (Reproduced here as Fig. 13), "using first a bit to make the holes in which threaded attachments are to be turned. The hole bored by the bit should, of course, be a little smaller than the diameter of the lag or screw, in order that the threads will hold firmly.

"The system suggested will not interfere with the life functions or normal growth of trees. It will prevent much of the needless injury that has often been done to fine shade trees in the past."

Certainly this is valuable data for the Service Man who wants his installation to be as good as possible. We might add that it is well to keep the aerial itself about ten feet from the leaves of the trees; this may necessitate the use of an insulator at this distance from the tree end of the antenna. Of the two methods illustrated above, the weight seems preferable, as most springs, through the action of strong winds, gradually lose their elasticity and become inefficient.

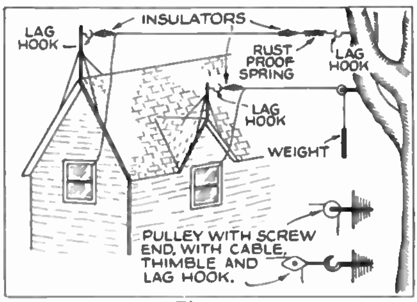


Fig. 13

"COMPENSATING" THE ANTENNA COIL

(Q) Is it possible to balance the antenna circuit of a receiver by taking turns from the antenna coil only?

(A) It is best to balance all the inductances first.

It is preferable to balance a coil by removing or adding turns until resonance at a particular frequency is obtained when a given value of tuning capacity is used in shunt. Small "trimmer" condenser may then be placed in shunt with the tuning condenser and coil when assembled as a unit, and the minimum capacity of the circuit matched to the minimum of the other circuits. If the placement and design of the parts have been correct, the circuits should tune correctly throughout the tuning range. If they do not, the origin of the fault should be determined.

CHAPTER IV

Radio Frequency Circuits

HAND-CAPACITY EFFECT

(Q) I cannot seem to eliminate "hand capacity" effect in a receiver I have. I can tune stations in and out by moving my hands in relation to the tuning dials (metal). Have grounded everything in sight, including condenser rotors and the dials. What is the cause?

(A) Probably high ground lead resistance.

1. Ground lead may be too long;
2. Ground wire may have a high resistance or be open;
3. Earth to which grounding conductors lead may be dry;
4. Defective ground clamp;
5. Open at the set "ground" binding post;
6. If house piping is used, this may have several high-resistance joints. (In many gas or electric piping systems, remember that "insulating couplings" are used; employ "jumpers.")

DUSTING OF CONDENSERS

(Q) Isn't it carrying things to extremes, to dust between the plates of variable condensers?

(A) Not at all. During dry weather the dust may not cause much trouble but as soon as the air becomes damp, the dust absorbs moisture and becomes very conductive. These hundreds of conductive paths from rotor to stator form a resistance network of very low value. The observable results are broad tuning, crackling sounds and loss of sensitivity. Modern radio sets are well shielded instruments and are seldom affected by dust.

BLOCKING-TUBE USAGE

(Q) What is the reason for using a "blocking" tube?

(A) The inductance and capacity values of the aerial, and the primary of the input transformer form a circuit having frequency-discrimination characterictics, resulting in uneven operation over the tuning band. "Dead spots," these are called. (This effect is particularly pronounced on the waves below 200 meters.) The use of a blocking tube greatly reduces this effect; and it accomplishes two other results.

First, it makes "ganging" of the tuned stages a more convenient and satisfactory proposition. Second, it greatly reduces the radiation of interfering signals when circuit oscillation results due to a "spill-over" of a regenerative circuit.

ALIGNING T.R.F.

(Q) What is the best way to align the T.R.F. stages of a set? I have no oscillator equipment.

(A) Pick the range (i.e., upper or lower end of the dial) that is most used. Take a station about the midpoint in that range—preferably a rather weak station—and tune it in. Adjust the trimmer condensers on the first, second and third stages, going back to each one several times if necessary, until the station is received with maximum clarity and volume. About 850 kc. is a good frequency if the upper end of the dial is most wanted; about 1200 if the lower end. Then tune in several stations, making "compromise" adjustments if any can not be heard. Reset the dial scale to conform to the new trimmer settings, if necessary.

STANDARD R.F. CHOKE

(Q) What size and kind of wire and number of turns should be used in winding an 85-millihenry choke coil of small dimensions for use in a radio-frequency circuit?

(A) An R.F. choke of this rating may be made by winding three "pies" of number 34 S.C.C. wire on a form ¼-in. in diameter; each section should be 3/16-in. wide. (A wooden rod with three grooves turned in it will be a convenient method of obtaining this form.) In one end section, wind 550 turns; next, 700; and last, 800. The end of the 800-turn section should be connected to the plate (or high-potential) side of the circuit for best results as this construction results in a "polarized" unit having greater choking action in one direction.

T.R.F. REGENERATION

(Q) Would the sensitivity of a tuned-radio-frequency receiver be increased by adding regeneration to the R. F. stage, as per marked diagram?

(A) This circuit, which we reproduce as Fig. 14, is quite practical, if the operator does not object to the difficulty of tuning. This arrangement is only for those who have infinite patience, and due appreciation of what happens in a neighbor's radio set when circuits such as this are adjusted.

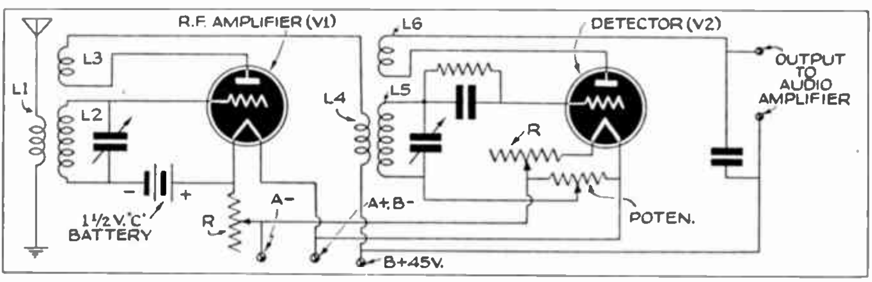


Fig. 14

As to the sensitivity; it is no greater than would be that of the standard circuit if the number of turns in L4 were increased to the point of oscillation, and some oscillation control incorporated in the set. As the rotors L3 and L6 unbalance the tuning of circuits L2 and L5, a critical condition obtains; varying L3 or L6 disturbs the stability of the system again, and causes everything to go out of adjustment.

COIL ALIGNMENT

(Q) Is it harmful practice to compensate, for capacity between turns in an R.F. coil that has been space-wound, by forcing together a few turns at one end in order to increase or decrease the turn-to-turn capacity? Will this practice result in a change in the over-all capacity and prove detrimental to the operation of a radio receiver?

(A) It is presumed that operation of a gang condenser is the objective; otherwise, such accurate balancing of coil characteristics would not be necessary. The first point to be considered is that each tuned circuit should have its inductance and capacity distributed in the same proportions. For best results, the self (turn-to-turn) capacity of the coil should be evenly distributed along the length of the winding; however, if it is "lumped" at one end or the other of one coil, it should be similarly lumped in the other coils. If the turns are forced out of their original positions the wire is usually loosened slightly, and then the entire coil becomes loose in a fairly short time, since temperature variations cause expansion and contraction of the tube on which the wire is wound. See Fig. 15.

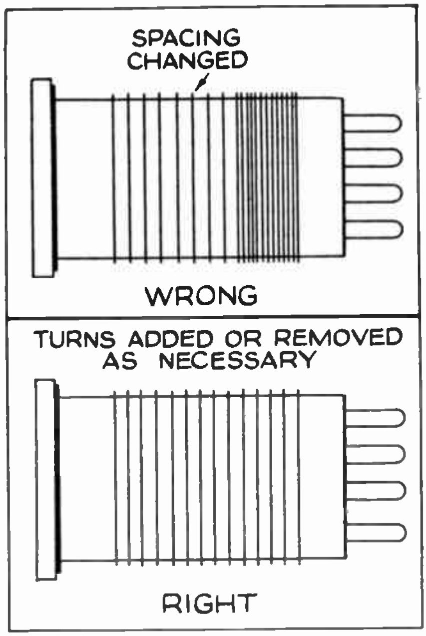


Fig. 15

MULTI-STAGE T.R.F.

(Q) Is it possible to build a receiver with six or seven stages of tuned R.F.?

(A) Receivers having this number of stages have been built. They are impractical for ordinary commercial production because it is too difficult to maintain circuit resonance and selectivity throughout the tuning band, with one-dial control, except as a laboratory job.

D.C. COILS—A.C. TUBES

(Q) Can D.C. screen-grid coils be used with A.C. tubes? Can coils designed for type '26, '27 and '24 tubes be used with equivalent battery tubes?

(A) Coils designed for A.C. operation may be used in battery sets, but coils designed for battery operation may cause circuit oscillation when used in conjunction with A.C. tubes, because of the higher amplification and the higher inter-element capacity of the latter.

CHAPTER V

Audio Frequency Circuits

PUSH-PULL OR PARALLEL

(Q) I am planning to build an amplifier, and want maximum output. What do you suggest, push-pull or parallel? The latter will cost me less. As it uses two tubes, it should give the same output as push-pull, but I have heard this is not the case. What are the facts?

(A) Push-pull, by all means, for it will afford, in many cases, about 40% more undistorted output than the same two tubes in parallel. Unless cost is a factor, consider push-pull parallel, which uses a pair of tubes in parallel in each side of the push-pull stage. You might also consider the use of "beam" power tubes, if the circuit you have in mind is suited to them, as to available voltages, etc.

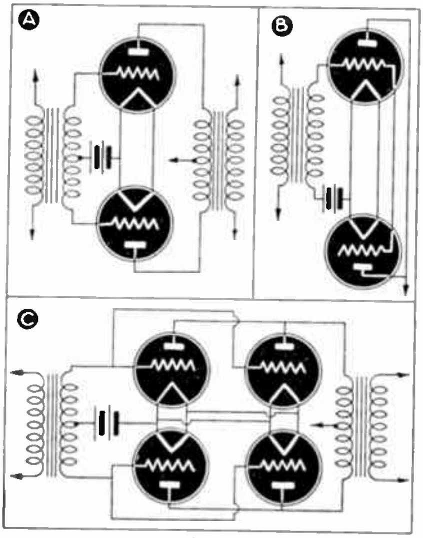


Fig. 16

TRANSFORMER DEFECTS

(Q) In a set having low volume, I found that placing my fingers across the first A.F. primary brought the volume up to normal. Continuity tests, etc., failed to indicate any defect in the transformer. Condensers and resistors across the primary failed to be of any use. Could you explain such a case?

(A) You're lucky you didn't get a shock! It is probable that the correct voltages were not being supplied to the tubes. Whenever a signal of even moderate amplitude reached the grid of the first A.F. tube it overloaded the grid which, operating at the wrong point on the characteristic (for lack of sufficient "B" or "C" potential) choked up. Reducing the input by shunting the primary with a resistance kept the input to the tube within the working limits of the first stage of A.F.

Also, a defective transformer might cause such a condition by leakage between primary and secondary, whereby the signal energy transferred is in inverse proportion to the amount of energy in the input circuit. A similar effect is sometimes caused by a defective socket. It is assumed that the tube has been tested, or replaced, to see that it is not the source of trouble.

Connect an R.F. choke coil in the detector plate and bypass it to ground with a fixed condenser; this unit may have a capacity of about .0005-mf. or .001-mf. The purpose is to prevent R.F. energy getting into the A.F. circuits.

Another cause of trouble may be an open circuit, in the primary, that is partially closed through a high resistance. Testing for continuity with a high-resistance voltmeter would give an indication that might seem to indicate a perfect winding; while under the load of the tube the current passed through the circuit would be too little. Of course, a simple "cut-and-try" method of proving the case is to substitute another transformer for the questionable one. If this remedies the trouble, the defective unit may be sent to the makers for test and report by their laboratories.

TONE CONTROL

(Q) What is a tone control, and how does it work?

(A) It is a method of by-passing or blocking certain audio frequencies to prevent their reaching the reproducer. A common means of attenuating or weakening the highs is to connect a fixed condenser and variable resistor (values may be .01 mf. and 500,000 ohms) across the primary of the first audio transformer. The lows may be blocked by means of a fixed condenser in series with a speaker lead. A switching system, used with a number of fixed condensers of various values, permits the degree of bass attenuation to be controlled. See Fig. 17.

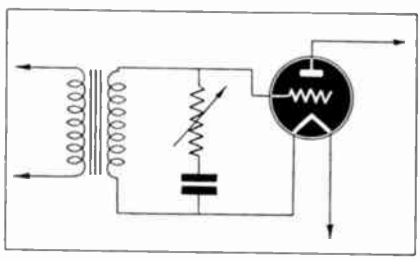


Fig. 17

SCRATCH FILTER

(Q) In a radio phonograph, what is a scratch filter, to remove needle noise?

(A) It is merely a fixed tone control or filter, set to cut off the highs. A .02-mf. condenser in series with a 25,000-ohm resistor, connected across the pick-up will do it. It will also eliminate the high notes, however, and it is suggested that a variable resistor of 250,000 ohms be used in placed of the fixed one.

A.F. AMPLIFIERS

(Q) Please print several diagrams of amplifiers that can be used as separate units, apart from the radio set; and adaptable to operation on dry cells.

(A) We are showing two circuits, in Figs. 16 and 18, which may be what you desire.

The use of two tubes in parallel is illustrated at 16B, while A shows the manner in which the output tubes would be connected in push-pull, for still greater output. In 18A, transformers T1 and T2 are of the standard type. If high ratio parts are used, high volume will result at the expense of quality; using relatively low-ratio units will result in relatively better quality. The voltages are as indicated. This is the arrangement for a single stage of audio amplification. It may be desirable to shunt the input, or primary winding, of the first A.F. transformer with a fixed condenser of .001-mf. capacity, as indicated in

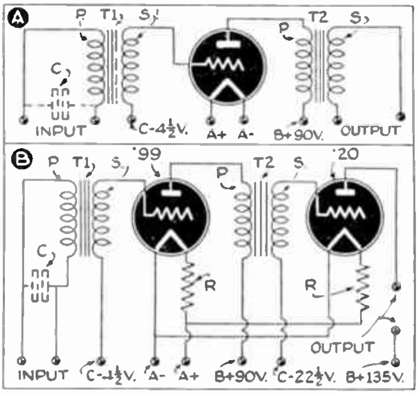


Fig. 18

dotted lines; the output of the tube may connect to a pair of headphones or to the primary of a matching transformer, T2.

A two-tube circuit is illustrated at 18B. A power tube in the last stage is recommended and illustrated; it is of the dry-cell type. Resistors are ballasts designed for the particular tubes in the filament circuits of which they are shown.

In lieu of 3.3-volt tubes, the 2-volt or 6.3-volt type may be used, the "A" supply being changed accordingly.

TUNED A.F. AMPLFICATION

(Q). Is is possible to tune the secondary of an audio transformer to receive only one audio frequency from the primary?

(A) This is common practice in selective, or multiplex, commercial code transmissions; and amateurs have used "peaked" transformers, which respond to only a few frequencies, for a long time for amateur code transmission. (This renders it possible to select one station from several

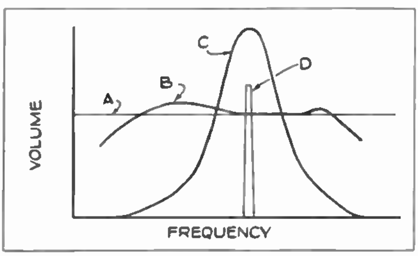


Fig. 19

others on the same wavelength). It is a laboratory feat to select a particular frequency to the almost total exclusion of all others (thus obtaining a "flat-top" characteristic). These degrees of selectivity are illustrated in Fig. 19.

VOLUME CONTROL

(Q) Please mention a few ways in which volume of a set may be controlled.

(A) Potentiometer-type variable resistors are the most usual forms of volume controls. For the purpose of clarity of explanation, consider that one end of the resistance strip is lettered "A," the other end "B" and the slider "C." Common circuits, then, are:—A to Antenna end of antenna coil, B to Ground end of antenna coil, C to antenna lead-in. Or reverse A and B, and connect C to ground (this is not as satisfactory as the foregoing). Or A to one side of first A.F.T. secondary, B to other side of secondary and grid return, C to grid of first audio tube. Or (and this is by no means as satisfactory) A to grid and transformer secondary, B to other side of secondary, C to grid return. Or A to one side of output transformer secondary, B to other side of secondary and one side of speaker, C to other side of speaker. The third method given is generally preferred. It is also possible to use the control between the first and second AF stages. Another method makes use of a variable resistor of the rheostat type, connected in a grid or plate lead. This, however, unless carefully engineered, is likely to cause poor reception by upsetting the characteristic of the tube

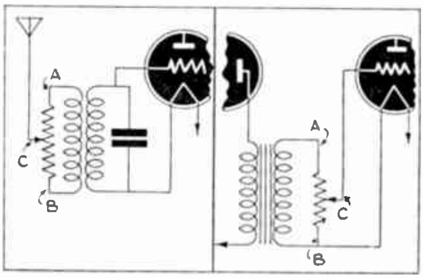


Fig. 20

with which it is employed. Definite values for resistors of either type cannot be given, as they depend upon the tubes used and other circuit details. Normally they will lie between 25,000 and 250,000 ohms.

A.F. TRANSFORMER REACTIVATION

(Q) I have an audio transformer which has a Permalloy core, I understand. The quality did not sound good so I changed it for another of the same type and immediately the beautiful tones I had originally were duplicated. Is it possible for transformers to change with age?

(A) Yes, it is possible and occurs more often than is realized. Age, tube plate current and mechanical shocks can cause it. Particularly, transformers having a special nickel-iron core material are the only ones subject to this condition, so far as we know. It is our guess, that, perhaps unknown to you, the primary of the transformer was shunted across the direct current plate supply.

If, due to a fault in the tube, or to an accidental contact of some tool, the plate contact of the audio tube should be momentarily connected to the "A" circuit, this would result.

Ao reactivate your transformer, connect only the primary winding to the 110 volt A. C. lighting circuit for one minute, with the secondary entirely disconnected. This will rearrange the molecular structure of the special iron which, incidentally, is not Permalloy.

CHAPTER VI

Reproducers

PERMANENT-MAGNET DYNAMICS

(Q) I have always understood that the dynamic loud speaker has a field coil, supplied with current from an external source. Now I understand that there are some dynamic speakers which do not have field coils. Are not these just the inductor-dynamics under another name?

(A) By no means! The regular and permanent magnet dynamics are moving coil speakers; the inductor dynamics are moving armature speakers.

Developments in metallurgy have produced metals which will take and hold a high degree of magnetism. Magnets made of these metals are used in the fields of permanent magnet dynamics. But, as in the field-coil dynamics, the audio currents are fed into a voice coil which is attached to the diaphragm of the speaker. As the magnetic flux set up in the voice coil by the passage of the A.F. currents causes the voice coil to be attracted into or expelled from the field, the diaphragm is caused to vibrate.

The inductor-dynamic is purely a magnetic speaker. It does not have a field coil; and the "voice coils" correspond to the usual two (or four) magnet windings of the ordinary magnetic reproducer. However, in the latter instrument electromagnets are in permanently fixed relation to the armature, and operate to vary the strength of the field of permanent magnets. In the inductor-dynamic construction, the voice-coils, or electromagnets, are mounted on the moving armature. In addition, the armature does not approach and recede from the permanent magnets; instead, it swings past them. Thus, the armature is not limited in its swing (as when reproducing a low note) by the pole-tips of the permanent magnets. This mechanical action is clearly shown in Fig. 21 (A, magnetic; B, inductor; C, dynamic.)

For the sake of simplicity the permanent magnet system of this type reproducer has not been shown. Although experiments have been conducted, to use an electromagnet, mechanical difficulties have prevented this design.

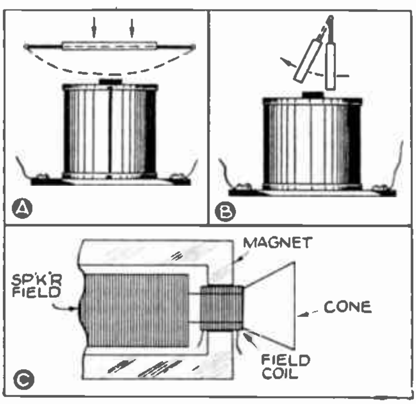


Fig. 21

DYNAMIC REPRODUCER DISTORTION

(Q) What is the cause of low-note distortion in dynamic reproducers when the high notes can be heard without distortion?

(A) If the leather backing is loose, the reproducer will rattle on the lower audio range. If the voice coil goes off-center, the rattling will be noted on the over-tones. Most reproducers are equipped with a central "spider" which is fastened to the voice coil and to the core of the field magnet. If this spider cracks—a not unusual occurrence—high-note distortion will usually result. This distortion will be most evident when certain single high notes are being sounded, as during a solo; when the tone will "go sour."

Lack of good low-note reproduction is sometimes traced to hardening of the leather ring which supports the outer edge of the cone. This ring, in a dynamic reproducer of poor workmanship, is cut from a cheap grade of leather, and often loses its flexibility. A person with a well-trained ear can detect the distortion this causes; for extremely low notes will lack fullness, or "depth," and the harmonics of the low fundamentals will be unduly emphasized.

Distortion caused by the voice coil's touching the walls of the channel, in which it should ride freely, is almost always a very pronounced and loud "rattle"; although an even louder rattle will result if the screw in the center of the spider should loosen.

Another source of distortion, and one usually blamed unjustly on the reproducer, is loose parts within acousti-dynamic range of the loud speaker. In other words, little, unsuspected things like picture frames, screws in the radio cabinet, bric-a-brac on mantel or piano, two pieces of furniture which barely touch each other, a loose grille in the radio cabinet, and loose window panes, may suddenly start to vibrate audibly when their resonant frequency is sounded by the reproducer. The higher the pitch of this resonant frequency, the more difficult it is to localize its origin. In fact, it sometimes has taken hours to find the source of an annoying buzz which the trained Service Man would know, by past experience and listening close to the reproducer, did not originate in the loud speaker. It will be understood why this form of distortion is almost always confined to a single note or two in the audio scale.

Still another form of distortion is the annoying buzz that appears over the greater portion of the high-frequency end of the band. This fault, usually, is due to foreign particles in the air gap between moving coil and fixed pole-piece. If the Service Man has a "lucky break," he may succeed in blowing them out; then again, he may need to "operate." (The latter procedure should not be attempted on a customer's reproducer until the technician has thoroughly familiarized himself with dynamic-reproducer assembly and adjustment, by study and practice on his own experimental equipment.)

A damaged cone will sound very much like the "dusty air-gap" just described. Only experience enables the Service Man to recognize its characteristic sound.

If the primary of the output transformer is not accurately matched to the plate circuit of the power tube, or if the secondary does not accurately match the voice-coil winding, very pronounced distortion may result. This may take the form in insufficient bass reproduction, or "fuzzy" high-register notes.

BINAURAL RECEPTION

(Q) How can two loud speakers at opposite ends of a room be wired and operated to produce a "binaural" ("both ears") effect? I have had the pleasure of listening to two reproducers, at a friend's house, connected this way. There did not seem to be any directional effect and, consequently, a realism resulted which seems quite unattainable with any other arrangement.

(A) The circuits of Fig. 22 may be followed to create the illusion of binaural reception. In A, a 100,000-ohm potentiometer is shown; other sizes may be used for experiment. If lower resistance is used, there will be a proportionate drop in the output volume. The setting of the potentiometer arm will depend upon the reproducers and the location of the listener; the listener

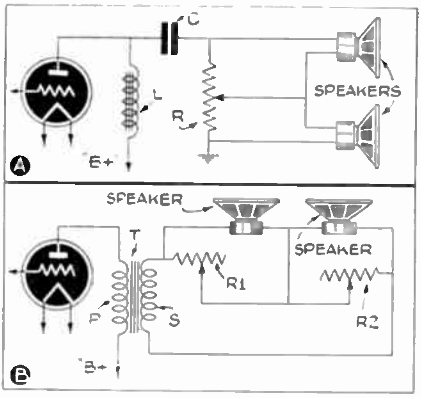


Fig. 22

should, preferably, be about half-way between the two reproducers. These units may have similar, or dissimilar characteristics, as desired. One peaked for the highs, the other for the lows, gives a good effect.

The resistors indicated in B as R1 and R2 may have a value of about 100,000 ohms each. As shown, these need not be of the potentiometer type. This circuit has the advantage that one may obtain a variation in quality and volume, in addition to the binaural effect desired. Unit T is the usual output transformer.

In circuit A, it is necessary to use the radio set controls for volume, after the two speaker outputs have been balanced against each other. The indicated variation of the output connections employs an output impedance L; and C, the usual fixed condenser.

CENTERING VOICE-COIL

(Q) When a loud speaker rattles because of the voice coil's striking the pole-piece of the field winding, what is the easiest way to center it?

(A) Loosen the screw or screws holding the spider which supports the voice coil. Get three shims of the proper thickness (heavy paper or very light cardboard will do) to fit snugly but not tightly between the central pole and the voice coil. Cut these a couple of inches long and about 3/16-inch wide. Space them equidistantly around the pole, to center the voice coil. Tighten the spider screw or screws, and remove the shims.

THREE-DIMENSIONAL SOUND

(Q) What is three-dimensional sound, and how can I make my set give it?

(A) First, you cannot get three-dimensional sound without the proper transmission—and it isn't on the air. You can, however, get "binaural reception," which is somewhat more like three-dimensional sound than straight reception. The means of securing it is given in the answer to the next question.

As to three-dimensional sound— it is a system whereby the sound appears to travel from one side of the room to the other, as a person would move about. That is a simplified explanation. The basis of the system is given in Fig. 23. Each of two microphones is connected to a separate amplifier which feeds a separate speaker. As the actor stands at Microphone A, his voice comes through Speaker A, but as he walks across the studio from Mike A to Mike B, the former picks up his voice with decreasing, and the latter with increasing, volume, the effect being manifested through the respective speakers. When he has reached Microphone B, his voice comes through Speaker B. Increasing the number of microphone-speaker channels improves the effect.

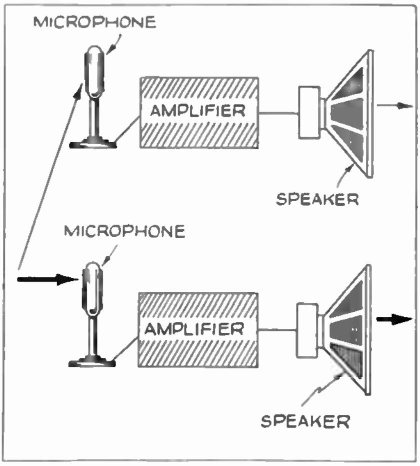


Fig. 23

BASS EMPHASIS

(Q) What causes a dynamic reproducer to "boom out" on the bass notes?

(A) The first question to be settled is, whether the defect causing this form of low-note distortion is in the reproducer, the receiver or in the cabinet.

If the radio set has "mellow" reproduction when a magnetic reproducer is used, it probably is the receiver that is at fault. Many radio sets are designed to operate with a particular loud speaker; and if this reproducer is deficient at the lower end of the audio "spectrum," fixed condensers are so placed by the manufacturer as to "boost" the low-note output of the set.

Incorrect "C" bias or other faults in power pack design may be the reason.

Also, the speaker chamber in the receiver cabinet may be the source of an echo effect. Lining it with thick felt, loosely hung, will often cure this trouble.

The dynamic reproducer works particularly well on the lower end of the audio band and, if it is connected to a radio set having an audio system that over-emphasizes the bass notes, this over-emphasis will then become very evident.

If the fault lies in the reproducer, it is probably due to resonance in the reproducer mounting or to loose parts. If the leather mounting ring loosens, "booming" may result. Should the reproducer be defective in design, it may "boom out" when certain low notes are played, because of resonance of the moving parts to notes of those particular frequencies.

From a consideration of these causes of distortion, the line of procedure becomes evident.

CHAPTER VII

Power Supplies

25 or 60 CYCLES?

(Q) Can an electric set be used on 25-or 60-cycle supply, optionally? If not why not?

(A) A radio set designed to be used with 60-cycle supply cannot, except by special design, be used with 25-cycle current supply.

The 25-cycle supply changes polarity very slowly, as compared to 60-cycle supply and the lower impedance at this frequency permits a much greater current flow in power transformer windings, which causes them to heat to a high degree. In fact, the primary of a transformer designed for 60-cycle operation would probably burn out.

It is easier to filter properly 60-cycle current than 25-cycle current. For the latter, it is necessary to double or triple the capacity values of the units in the filter condenser bank, and generally to increase the inductance of the choke coils.

A power transformer designed for 25-cycle supply must be substituted for the 60-cycle transformer. If a current-regulating line ballast is used, this must be changed for one having the correct value.

Ordinarily, a 25-cycle set will work very well, and usually with less hum than a 60-cycle receiver, when connected to a 60-cycle current supply of the same voltage rating.

CHOKES IN POWER PACKS

(Q) Why do some power packs have choke coils in them and others not? Why don't they all use chokes if chokes are needed, and why do any of them use chokes if chokes are unnecessary?

(A) It is a matter of circuit design. Some sets use chokes, others use the field coil of the dynamic speaker as a choke, and still others merely employ greater capacity condensers. All these systems work satisfactorily.

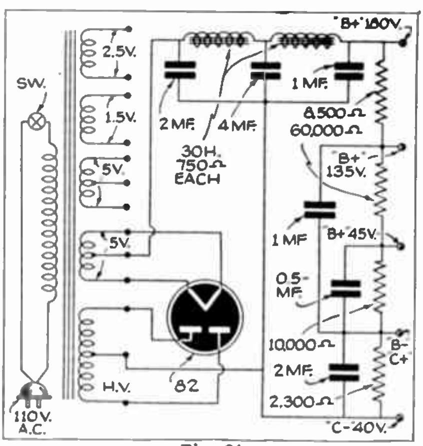


Fig. 24

INCREASING "B" VOLTAGE

(Q). What is necessary to change a "B" eliminator to deliver 250 volts instead of 180?

(A) The solution of that problem is to rebuild it completely. A scheme sometimes employed to increase voltage is to change the rectifier for one of higher output rating. However, this puts an added strain on the transformer, granting that the condenser pack has been changed for one having a higher break-down rating; and a burned-out transformer may result. Use a higher voltage transformer and condensers, and whatever resistors are required for the voltage taps you need. You can still use the same filter chokes, however. A modern rectifier tube, adequate to whatever output you need, should also be used.

CHANGE FROM BATTERIES?

(Q) I have a battery operated radio receiver. Would you advise me to build a power pack to work with it? If so, please give diagram.

(A) You do not state the age or type of your set, so it is hard to answer you. If it is old, by all means buy or build a completely new set. It will be well worth the little more it will cost you. If it is a modern battery-operated set, it will probably be best for you to retain the present "A" battery and powerise for the "B" and "C". Should you be determined to put power into an old battery-operated set, we suggest that you replace the tubes with more modern A.C. tubes, and use a power pack similar to that shown in Fig. 24.

HUM FROM POWER-PACK

(Q) There is an annoying hum in my radio set. How can I test to see whether it is caused by the power pack or one of the stages in the receiver?

(A) Solder two leads to an 0.5-mf. condenser of the non-electrolytic type. Touch these two leads across the primary of the transformer feeding the output stage of your set, while the set is turned on. If the hum ceases, it is probably not caused by the pack, but may originate in the loud speaker. Connect the condenser across the primary of the speaker transformer. If the hum continues, it comes from the speaker (perhaps indirectly from the power pack, but more likely due to poor speaker design). If it stops, it comes from the pack.

CONDENSER BURN-OUTS

(Q) What causes condensers to blow in power packs?

(A) There are a number of reasons: (a) Turning the set on with one or more tubes out of the sockets; the diminished current drain may cause an excessively high voltage to build up in the power pack. (b) Defective or deteriorated apparatus; sometimes wet electrolytic condensers dry out after long service. (c) A sudden surge of line voltage. (d) A burned out bleeder resistance. The effect is similar to that in (a). (e) Incorrect design. The use of condensers incapable of withstanding the voltage normally obtained from the pack (for instance the use of a condenser rated for a peak voltage of 400, where one with a working voltage of 400 should have been used). There are also other causes, but these are the most common.

CONNECTING TWO "B" UNITS

(Q) Can two "B" eliminators, each delivering 180 volts, be hooked up to deliver 360 volts?

(A) Yes, the highest positive lead of the first unit being joined to the negative lead of the second. But be careful not to connect the grounds in such a way that a short circuit may result. For safety, use a .1 mfd. fixed condenser in series with each ground. See Fig. 25.

Before connecting the increased output to a receiver, the latter should be examined to determine whether the by-pass condensers within the set, from "B plus max" to "B—" are capable of operating at the increased potential.

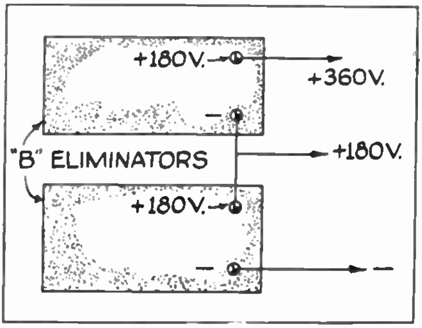


Fig. 25

RECEIVER OPERATION COST

(Q) What is the cost of current per month for operating a 75-watt radio set?

(A) Find the total wattage required to operate the set for an average month, and find the relation this figure bears to 1,000 watts—the usual basis on which the current cost is rated.

For example: the receiver is operated on an average of four hours every day, requiring a total current approximately 9,000 watt-hours (1 watt used for 1 hour equals 1 watt-hour) per month. This is nine times 1,000 watt-hours. In some localities the charge is "ten cents per kilowatt-hour (1,000 watt-hours)" and this would make the cost of operation 90 cents per month.

GASEOUS-RECTIFIER "B" UNIT

(Q) I have a "B" eliminator of the type shown in Fig. 21. Please advise the range of the two variable resistors.

(A) Two "universal range" resistors are used in this "B" eliminator, in the positions shown in the schematic diagram (Fig. 26). The rectifier is a "BH" or gaseous-type tube. The power-line resistor may be set to take care of differences in line-voltage. Resistor R1 measures 200 ohms.

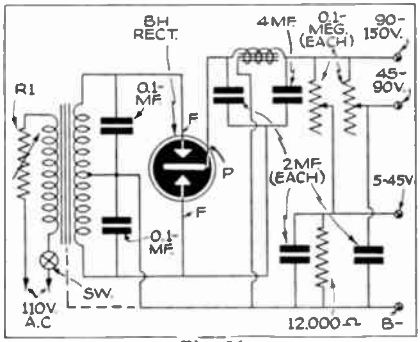


Fig. 26

"C" FROM "B" UNIT

(Q) Please advise me as to whether a "B" eliminator can be wired to supply the "C" bias for a '71A power tube and also a 4½-volt bias. An eliminator in question supplies 60 milliamperes at 180 volts.

(A) A 2000-ohm resistor, connected between the center-tap of the power transformer secondary and the negative terminal of the power unit, will supply the required bias for a '71A tube. The center-tap is now "C" minus and the regular "B" minus post is now also the "C" plus connection. If the resistor is equipped with a sliding contact, the bias may be varied and, if two contacts are provided, the 4½ volts negative required as the bias potential for '01A-type tubes may also be obtained.

When securing a bias voltage in this manner, the "C" voltage is obtained at the expense of the "B" voltage; and causes a corresponding reduction in the total "B" available.

See Fig. 27 for the general idea.

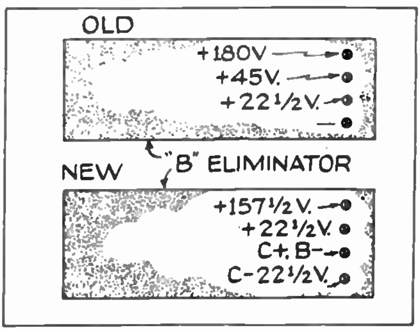


Fig. 27

CHAPTER VIII

Superheterodyne Receivers

ALIGNING I.F. STAGES

(Q) How should I go about aligning the I.F. of a superheterodyne receiver?

(A) For factory-made sets, almost every manufacturer recommends a different method as particularly suited to his set. Procure a manufacturer's service sheet for your set (or look up your set in a Service Manual) and follow instructions. (Fig. 29 is a specimen service sheet.)

If no data are issued on your set, connect an output meter in place of the loud speaker, and connect the output of a modulated R.F. oscillator to the primary of the first I.F. transformer, with the first detector out of its socket. Try a 456-kc. and a 175-kc. signal. Align the I.F. for whichever frequency gives the greater reading on the output meter. Then disconnect the R.F. oscillator from the I.F. transformer, and put the set into operating condition. Connect the output of the R.F. oscillator to the antenna and ground posts of the set, and set it to produce a frequency about 1000 kc. Set the receiver's dial for this frequency, and adjust the trimmers on the tuning condenser for maximum reading on the output meter. Have the output control of the oscillator adjusted for the faintest signal which will give a usable reading on the output meter at all times. Then disconnect the oscillator and meter, and the set is ready to use. If you cannot get an R.F. oscillator, don't try to align the set.

MATCHING I.F. TRANSFORMERS

(Q) How can a set of home-made intermediates be matched?

(A) It is presupposed that the design is approximately correct for the desired frequency. The problem, then, is not to match the coils exactly to a given frequency, but to match one set of coils to the other. The best method involves the use of a calibrated, A.F.-Modulated, R.F. oscillator. Its output is transferred to a detector tube, the intermediate-frequency transformer being introduced between the two units. Maximum deflection on a milliammeter indicates resonance, which is obtained by varying the number of turns on the secondary. Varying the adjustment of the long-wave oscillator until the meter indicates a current will show whether there are too many or too few secondary turns.

A more simple method is to connect antenna and ground to the primary winding, and a detector tube to the secondary; one side of the coil connecting to the grid-condenser and leak, and the other side to "A plus." A pair of headphones, shunted by a .001-mf. fixed condenser, are connected in the plate circuit of the detector tube. A .0005-mf. variable condenser is connected across the secondary coil and varied until a spark signal is heard; if there is no spark signal within this long-wavelength range, a .0005-mf. variable condenser may be connected from detector plate to antenna, and varied until there is circuit oscillation (to obtain this condition it may be necessary to reduce the capacity of the fixed condenser in shunt with the headphones).

When a whistle is heard, as the beat-frequency between a CW signal and the circuit under test becomes audible, the reading of the variable condenser in shunt to the secondary is noted, and the second intermediate-frequency transformer is substituted for the first. The shunt condenser is again varied until the same signal is recognized. Then, turns are removed from (or added to) the secondary coil until the variable condenser's reading is exactly the same as it was when the same signal was heard with the first transformer in circuit.

This is a very accurate method, the only requirements are care and common sense in applying it. In this arrangement, a code station is commandeered to supply the A.F.-modulated R.F. longwave signal (the spark signal); or the R.F. signal may be the code transmissions of the C.W. station (the A.F. modulation being obtained by the heterodyne method as mentioned above).

To facilitate rapid comparison, a circuit, shown at Fig. 28, has been developed.

Although 1, 2 and the antenna may all be connected together, a refinement, an antenna switch, is indicated in the dotted enclosure.

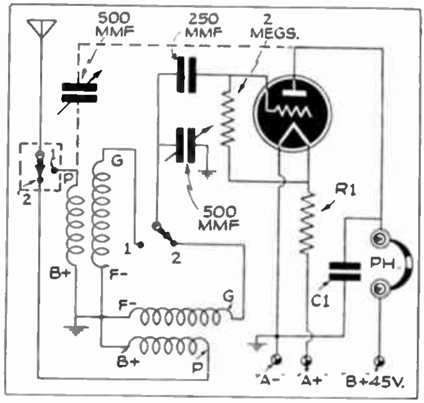


Fig. 28

ANTENNA COUPLER

(Q) Please furnish construction details for an antenna coupler to be used with a superheterodyne. The I.F. coils are peaked at 456 kc.

(A) An essential value, the capacity of the tuning condenser, is lacking. However, no difficulty should be found in making an antenna coupler. There is nothing to it but a primary and secondary winding. The exact number of secondary turns is to be determined by experiment; try 110 turns of No 28 D.C.C. wire on a tube 1½ in. in diameter. Over this coil, at the filament end, bunch 30 turns of the same (or smaller) wire; taking taps at the 10th and 20th turns. This antenna coupler should be shielded, with a minimum of 1 inch between coil and can.

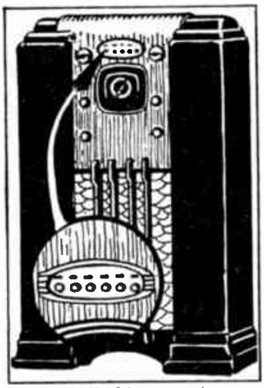
Connect the antenna coupler in an ordinary detector circuit, with antenna and ground connected to the primary, to determine whether turns should be added to, or removed from, the secondary to cover the broadcast band properly. The peak of the I.F. transformers had no bearing on the design of the antenna coupler.

Radio Service Data Sheet 217

SPARTON SELECTRONNE RECEIVERS MODELS 1068 AND 1068X

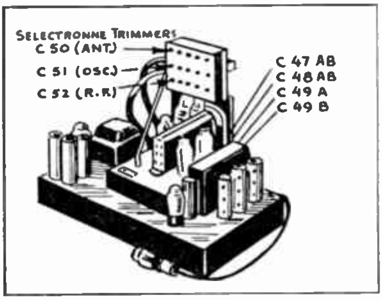
10-tube superheterodyne: three bands: push-button (Selectronne) tuning: automatic frequency control; automatic volume control; discriminator circuit; "vis-o-glow" tuning indicator.

(See Data Sheet 218 for schematic diagram and operating voltages)



Sparton model 1068 Selectronne receiver, a new 1938 model using latest push-button tuning. The photo at extreme right of this page is a rear view of the locations of the trimmers for the tuning buttons shown in the above front view of this receiver.

The 6 buttons of the Selectronne are arranged in 3 groups according to frequency limits—542 to 900 kc., 700 to 1,300 kc., and 1,000 to 1,500 kc. The 6 taps corresponding to the desired stations must be arranged in the steel plate so that each station frequency will be included in the proper frequency group. To align, push in the Selectronne button which corresponds to the desired station and adjust for maximum response as indicated by the Viso-Glo tube. the aligning sequence is: (1) oscillator trimmer (center hole), (2) first R.F. trimmer (button hole), and (3) antenna trimmer (top hole) (The Viso-Glo tube and socket may be removed from its clamp and the tube turned toward the back of the cabinet for observation.) Adjust Selectronne trimmers for equal shaded area with band switch knob either in or out. During above operations the 6H6G discriminator is removed from chassis. In the event that all 6 Selectronne buttons become depressed through improper manipulation they may be



released by applying a slight pressure of the fingers under the latching band which runs across the framework in front of the trimmer box. Care should be taken to prevent loosening the Selectronne adjusting screws to the point where they may become disengaged.

The above-mentioned latching bar is seen in the photograph of the locations of the Selectronne trimmers. This latching bar, on the back of the block that carries the Selectronne trimmers, is in direct line with the arrow that points to Selectronne trimmers C51 (osc.); a corner of the latching bar extends past the rear right edge of the trimmer panel

ALIGNMENT

Viso-Glo tube in socket
AFC Switch "OFF"

OPERATION	ALIGNMENT OF	GENERATOR CONNECTED TO	DUMMY ANTENNA	GENERATOR FREQUENCY	BAND SWITCH SETTING	TUNING COND. SETTING	TRIMMER	REMARKS
1	I.F.	Conv. Grid	.1 mf.	456	BC	Open	C47 A,B	1st I.F. Trans.
							C48 A,B	2nd I.F. Trans.
							C48 A	3rd I.F. (Pri.)
2	Discrim.	Conv. Grid	.1 mf.	456	BC	Open	C49 B	Adjust to minimum
3	Broadcast Band	Ant.	200 mmf.	1500	BC	1500	C8 Osc.	
							C5 RF	
							C2 Ant.	
4		Ant.	200 mmf.	600	BC	600	C11 Pad	
5	(Repeat operation 3)							
6	(Check calibration and sensitivity 1500 KC, 900 KC and 600 KC) *							
7	1st Short Wave	Ant.	100 ohm 200 mmf. series	6 MC.	1st S.W.	6 MC.	C9 Osc.	
							C6 RF	
							C3 Ant.	
8		Ant.	200 mmf.	1.95 MC.	1st S.W.	1.95 MC.	C12 Pad	
9	(Repeat operation 7)							
10	(Check calibration and sensitivity at 6 MC. and 1.95 MC.)							
11	2nd Short-Wave Band	Ant.	100 ohm 200 mmf. series	18 MC.	2nd S.W.	18 MC.	C10 Osc.	Rock dial slightly while adjusting
							C7 R.F.	
							C4 Ant.	
12		Ant.		6 MC.	2nd S.W.	6 MC.	C13 Pad	
13	(Repeat operation 11)							
14	(Check calibration and sensitivity at 18 MC. and 6 MC.)							
15	(Repeat operations 1 to 14 inclusive)							

* Check AFC by connecting generator to converter grid cap and tuning generator and receiver to 1500 KC. Note output meter reading with AFC switch "off". Switch AFC "on" and if output changes appreciably, touch up discriminator trimmer until there is no change in sensitivity.

Fig. 29

I.F. TUNING CAPACITY

(Q) What is the recommended capacity for a variable condenser to be used as a shunt capacity to balance the secondaries of home-made intermediate-frequency transformers?

(A) A small unit (100-mmf. rating) is usually suitable. However, a larger capacity may be required if the transformers were not carefully constructed to close limits. This is usually evident by pronounced lack of resonance in one I.F. stage.

I.F. TRANSFORMER DESIGN

(Q) Numerous issues of Radio-Craft have contained descriptions of service oscillators, designed for use in aligning superheterodynes in which the intermediate frequency is in the neighborhood of 175 or 180 kc. However, I never have seen a description of an I.F. transformer operating in this range. While this may not be a service request, at least, it should be of interest to a large number of set builders; and even, perhaps, to a few Service Men who sometime might be stuck with a badly burned I.F. transformer and have no immediate repair unit on hand for replacement. Please publish construction details for an I.F. transformer of the shielded type, similar to average I.F. transformers. This should be a good item for use in modernizing old superhets.

(A) In Fig. 30 is illustrated a suitable design for an I.F. transformer which, by adjustment of variable condensers C, will operate over the frequency band of 100 to 200 kc. The copper plate is required only when exceptional selectivity is required—as when a limited number of stages are to be used. Selectivity and volume are controlled also by the spacing of coils L. Brass supports may be used, bent as shown. The formers, or spools, may be lathe-turned bakelite or wood, or a job built up of insulating washers and rods. Scramble-wind the coils.

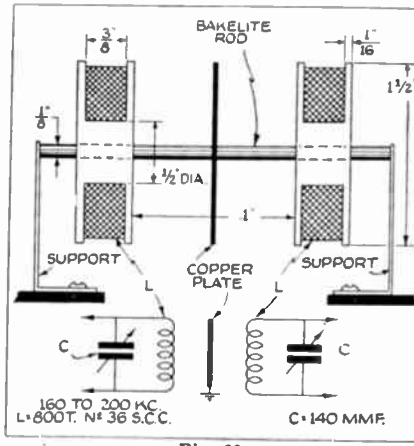


Fig. 30

HETERODYNE CIRCUITS

(Q) What is the difference between a heterodyne receiver, a homodyne receiver, a superheterodyne receiver and an autodyne receiver?

(A) Heterodyne and superheterodyne receivers are defined in the first chapter of this book. A homodyne receiver makes use of a locally generated frequency which is of the same frequency as the carrier wave being received. It employs the familiar "zero beat" method of reception. An autodyne is simply a superheterodyne in which a single tube acts as both oscillator and first detector.

CHAPTER IX

Television & Facsimile

TELEVISION & FACSIMILE

(Q) What is the difference between television and facsimile? Aren't they both used to transmit pictures?

(A) They may be likened to a telescope and a photograph, respectively. Television enables you to see moving images transmitted from a distance, but gives you no permanent record of them. Facsimile gives you printed reproductions on a piece of paper, but these are more like a newspaper; they are motionless.

The systems used for television transmission and reception vary greatly from those used for facsimile work.

OBSOLETE EQUIPMENT

(Q) I have an old Jenkins television receiver, complete with motor, scanner and neon tube. How can I adapt it to work on the 441-line transmissions that are being used today? Can I hook it up to an ultra-shortwave receiver?

(A) You cannot use it. The systems are too radically different.

CATHODE RAY TUBE

(Q) What makes the electronic beam in a cathode ray tube scan the screen from left to right and up and down? In other words, how is the beam controlled?

(A) You are, no doubt, familiar with the way in which a positively charged plate attracts the electrons emitted by the cathode in a standard vacuum tube, as used in radio reception.

Now visualise a cathode ray tube, as shown in Fig. 31.

Below you see a simplified sketch of the tube as viewed from the side. The cathode emits the electrons, which are attracted by the highly-charged target. To reach it, they must pass through the space between the plates, which are arranged as the end-on diagram indicates. A voltage (lower than that of the target) is applied to the plates. When Plate 1 is positive in respect to Plate 2, the beam will be deflected toward Plate 1; but, since the voltage applied to these plates is A.C., their polarity reverses, and the beam is caused to deflect on each half-cycle toward Plate 2, instead. The same is true of voltages applied to Plates 3 and 4. This combination of plates affords both horizontal and vertical scanning, at a frequency which may be controlled by local oscillating tubes, or by the frequency of the video component (similar to an audio component, but generally of far higher frequency) of the signal being received, or by a combination of both. The electronic beam travels at such velocity that it passes the target and strikes the fluorescent screen, which glows where the beam strikes it.

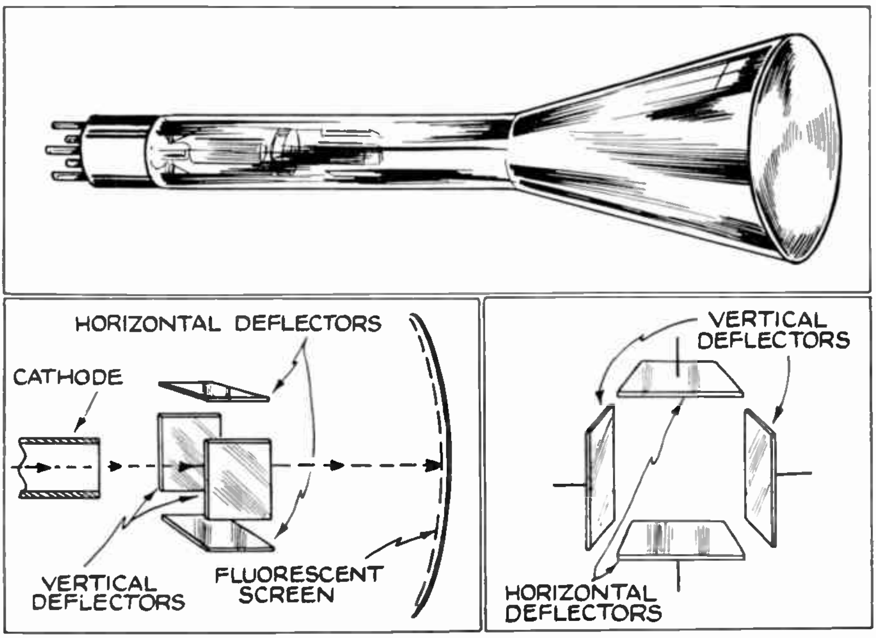


Fig. 31

Fig. 32. Television Image

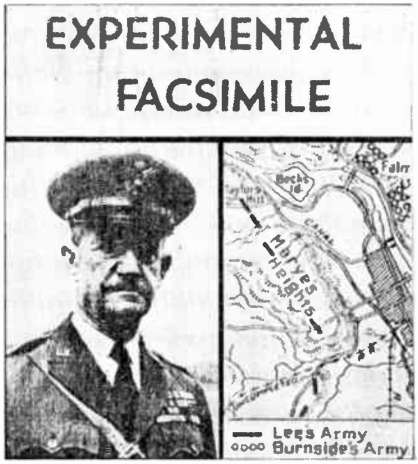


Fig. 33. Facsimile Picture

CAN'T BUILD EQUIPMENT

(Q) How can I build a facsimile reproducer to connect to my present set, so that I can pick up the transmissions of the broadcasting stations that are putting out facsimile programs?

(A) Facsimile equipment is not of a nature adapted to construction in the home workshop. You will have to wait until you can buy the reproducer.

FACSIMILE OPERATION

(Q) How does a facsimile reproducer operate?

(A) There are several systems. In all, assume that there is an electro-mechanical means of causing a stylus, or similar device, to pass across a sheet of paper in synchronism with a scanner at the transmitter, and of causing it to progress one line in relation to the paper at the end of each complete traversal. Various means of securing this action are used in the different systems.

The other function is to cause the stylus to make marks on the paper, in accordance with the signal transmitted. Several methods of achieving this end are in use. One employs a stylus which is similar in action to the drive-rod of a magnetic loud speaker; the vibrating rod, driven by signal impulses, strikes against a piece of carbon paper, causing marks to be imprinted on a plain piece of paper. In other systems, the paper is impregnated with chemicals that are discolored (or eradicated) by the passage of electric current; the stylus forms one pole of a circuit and a plate behind the paper is the other; the current is controlled by the incoming signal. Tiny ink-sprays with electrically controlled deflectors, and other systems, have also been used.

LARGE-PICTURE TELEVISION

(Q) Why is it impossible to have a sheet several feet square and covered with fluorescent material, and to hang this some distant in front of the television receiver, and have a clear glass end in the cathode-ray tube, so that the electrons could be projected right to the big screen? If it is not impossible, why is it not being done?

(A) Air is a complex gas, and electrons cannot pass through it freely. A cathode-ray tube must be highly evacuated, to enable the electronic stream to travel from the cathode to the screen, both of which are sealed within the same envelope.

Projected images are possible, and have been demonstrated; but in this case, the image, small but extremely brilliant, appears on the usual screen in the end of the tube, and is projected by optical means, much in the way that the old-time stereopticon projected the picture from a postcard onto the wall.

CHAPTER X

Short Waves

COIL-WINDING DATA

(Q) Please give me the necessary information for winding T.R.F. and regenerative detector coils for a short-wave receiver?

(A) Coil specifications depend upon the capacity of the tuning condensers used. You do not state what capacity condensers you plan to use. However, the most commonly employed is .00014 mf. Therefore, the data in Fig. 34 are calculated for condensers of that capacity.

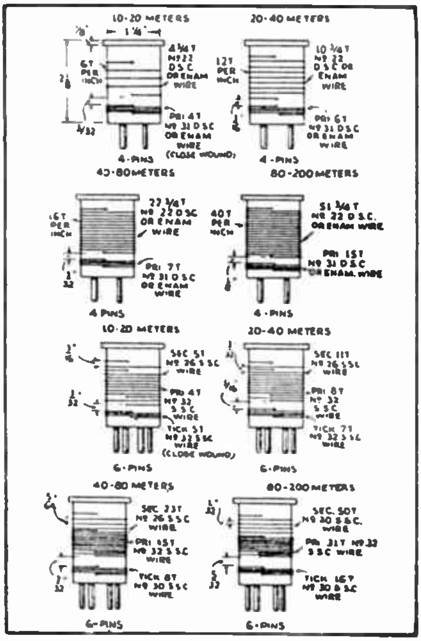


Fig. 34

LACK OF OSCILLATION

(Q) I have a short-wave receiver, the circuit of which will not oscillate at any point, on five coils ranging from 20 to 200 meters. How can this be remedied?

(A) You do not enclose your circuit, so we can give you only a general answer. Granting the circuit is correct, check off the following points:

1. Defective tube.
2. Shorted antenna coupling condenser (antenna coupling too close).
3. Defective detector plate circuit choke.
4. Incorrect grid or plate potentials.
5. Reversed tickler leads.
6. Defective R.F. coil (secondary or primary).
7. Leaky tuning condenser insulation.
8. Corroded connections.
9. Open or shorted tickler coil.
10. Defective tickler control.

BAND SPREAD

(Q) I find it very hard to tune my short-wave receiver, although I am using a vernier dial. How can I make it tune more broadly, so that it will be easier to bring in stations?

(A) It is very unwise to make your set tune more broadly, but here are two methods: couple primaries of R.F. coil windings more closely to secondaries; add 1,000-ohm resistors in grid leads of R.F. coils. Far better than that would be to add vernier condensers (3-plate midgets) in parallel with each section of the tuning condensers.

SHIELDING

(Q) What is the recommended distance between tuning inductances and shields, for short-wave operation?

(A) This depends considerably upon the operating wavelength. For very short waves, it has been suggested that special wire screening be used to overcome certain losses which result when even the best of solid shields are used at very short wavelengths.

In general, copper shielding may be placed not closer than one to one and one-half inches from the sides of coils, and not closer than two to three inches from the ends. However, such figures are a matter of discussion, as many factors enter into the situation. For example, certain coil shapes produce magnetic and electrostatic "fields" with different arrangements of the lines of "flux"; and each type of coil, therefore, is best used with shields of a certain pattern.

ANTENNA DESIGN

(Q) What are the correct length and height of an antenna for best short-wave operation? We are located about thirteen miles west of the down-town district of Chicago.

(A) The correct design of the antenna for short-wave transmission or reception is determined by local conditions, as well as the wave-length, or wavelengths, at which the equipment is to operate, and the circuit design of the instruments.

GRID LEAK VALUE

(Q) Is the grid-leak value on short-waves the same as for broadcast waves?

(A) Usually, higher for the short wavelengths; one or two megohms for 200 meters and up, and two to eight, below.

ADAPTERS AND CONVERTERS

(Q) What is the difference between a short-wave converter and a short-wave adapter, if any? I notice the adapters are usually cheaper than the converters.

(A) The adapter couples directly between the A.F. amplifier of a receiver and the antenna. It is simply a detector (with, occasionally, one or two stages of R.F.) that will tune to the higher frequencies.

A converter normally consists of a first detector (with, sometimes, one or two stages of R.F.) and an oscillator, which tune to the higher frequencies and produce a beat frequency that is fed into the antenna circuit of a set, so that amplification is obtained in the set's R.F. or other pre-audio stages. The converter and set thus form a superheterodyne, in which the set's R.F. stages act as I.F.

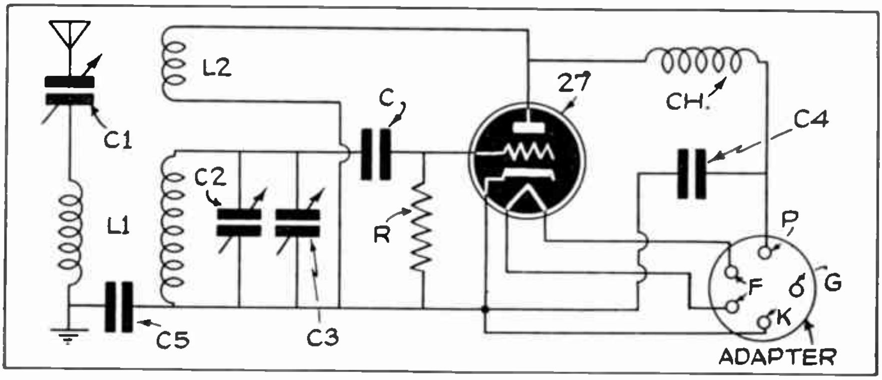


Fig. 35

CONSTRUCTION OF ADAPTER

(Q) Please show, as a matter of interest, the schematic circuit of a short-wave adapter to be used with A.C. sets.

(A) A circuit arrangement of a short-wave adapter using the type '27 tube is depicted, in Fig. 35, in answer to this query.

It must be mentioned, this is a throw-back to the old single-circuit regenerative set of some time ago; and the comparison of results obtained on this arrangement with those of the radio set at the broadcast wavelengths, will not be a good recommendation for the adapter. At the short wavelengths, however, code and phone should be heard. Squeals and whistles and distorted reception generally will result when trying to tune in the harmonics of broadcast stations. This is quite natural, as the harmonics cannot be expected to reproduce as clearly as the fundamental frequencies.

Inductances L1 and L2 are the standard windings, which constitute one of the units of a short-wave kit. The 5-prong plug is a standard tube base. Resistor R is a grid leak with a value of about 3 megohms or more. Condensers C4 and C5 are of .00025-mf. capacity. Condensers C2 and C3 are the usual tuning and regeneration units, the capacities of which may be .00014-mf. each, if used in conjunction with coils shown in this section. The antenna coupling condenser, C1, is very necessary and has a value of about .0001-mf. The grid condenser, C6, is .00015-mf.

CONSTRUCTION OF CONVERTER

(Q) Please print a diagram of a short-wave converter to work with an A.C. set. The simpler the circuit, the better. I would like to get the power for the converter out of the set, so as to save buying parts for a power pack. The filament voltage in the set is 2.5.

(A) See Fig. 36. The band-spread condensers are optional.

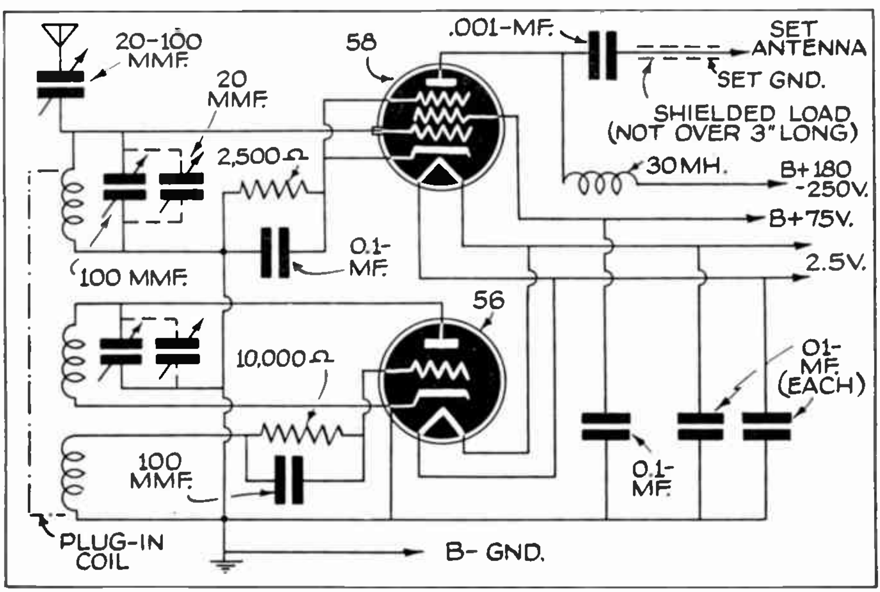


Fig. 36

R.F. CHOKE DESIRABILITY

(Q) How is it possible to tell whether a choke coil is needed in a short-wave receiver?

(A) The purpose of a choke coil is to prevent the passage of alternating current. Its location in a receiver depends upon the design of the receiver. Some sets call for the use of choke coils in dozens of places, while other sets entirely dispense with their use.

The usual place for at least one choke coil, in a short-wave receiver, is in the plate circuit of the detector. In one position, it makes regeneration a possibility; without it, no regeneration or circuit oscillation is possible. This is probably the use you have in mind.

Another action of the choke coil, also in the plate circuit of the detector, is to prevent R.F. currents getting into the A.F. amplifier. In this position, it will be found in a majority of the better commercial broadcast receivers.

These same receivers, as well as the short-wave receivers, use choke coils in the leads which supply plate potential to R.F. stages, as well as bias potentials for the screen-grid of screen-grid tubes. When used to prevent R.F. currents passing into the current supply units, these choke coils are almost always bypassed with fixed condensers, as is seen upon inspection of most any schematic circuit; the R.F. is "led" from the "high potential end" of the R.F. choke to a point at low potential. This is ordinarily the ground or the "-B" circuit.

When it is desired to use the choke as a "load impedance" or coupling unit between stages, the fixed condenser connecting to the high potential end of the choke "leads" the R.F. to the stage which follows, instead of to ground.

Erratic regeneration will result if a choke coil is not used in certain circuits. Without choke coils, a tuned R.F. receiver may operate with only one-half the volume it should. Radio frequency choke coils often prevent R.F. circuits from going into uncontrollable oscillation. In screen-grid circuits they are almost a necessity.

If a choke coil is poorly made, "holes" in tuning result; there will be points at which the short-wave receiver circuit goes out of regeneration or oscillation; or, it may go into oscillation with an uncontrollable "thump."

AMATEUR LICENSES

(Q) How can I go about getting a license for an amateur short-wave transmitter?

(A) The required forms may be obtained from the office of the Supervisor of Radio in the Inspection District where you live. The correct local address may be found in the telephone books of the cities shown in parentheses below. Look under U. S. Government, Federal Communications Commission. Be sure to write the supervisor of the correct district, as given herewith:

First District: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. (Supervisor of Radio, Boston, Mass.)

Second District: New York (New York City, Long Island, and the counties on the Hudson River to and including Schenectady, Albany, and Renssalaer) and New Jersey (counties of Bergen, Passaic, Essex, Union, Middlesex, Monmouth, Hudson and Ocean). (Supervisor of Radio, New York, N. Y.)

Third District: New Jersey (all counties not included in Second District), Pennsylvania (counties of Philadelphia, Delaware, all counties south of the Blue Mountains, and Franklin County), Delaware, Maryland, Virginia, and the District of Columbia. (Supervisor of Radio, Baltimore, Md.)

Fourth District: Alabama, Tennessee, North Carolina, South Carolina, Georgia, Florida and the territory of Porto Rico. (Supervisor of Radio, Atlanta, Ga.)

Fifth District: Mississippi, Louisiana, Texas, Arkansas, Oklahoma, and New Mexico. (Supervisor of Radio, New Orleans, La.)

Sixth District: California, Nevada, Utah, Arizona and the Territory of Hawaii. (Supervisor of Radio, San Francisco, Calif.)

Seventh District: Oregon, Washington, Idaho, Montana, Wyoming and the Territory of Alaska. (Supervisor of Radio, Seattle, Wash.)

Eighth District: New York State (all counties not included in the Second District), Pennsylvania (all counties not included in the Third District), West Virginia, Ohio and Lower Peninsula of Michigan. (Supervisor of Radio, Detroit, Mich.)

Ninth District: Indiana, Illinois, Wisconsin, Michigan (Upper Peninsula), Minnesota, Kentucky, Missouri, Kansas, Colorado, Iowa, Nebraska, North Dakota and South Dakota. (Supervisor of Radio, Chicago, Ill.)

This subject is thoroughly covered in the chapter, "Getting Started," in "The Radio Amateur's Handbook," obtainable from The American Radio Relay League, Hartford, Conn. The prospective "ham" should write to the Government Printing Office, Washington, D. C., for a copy of "Regulations Governing Radio Communication," (10c per copy); and "The Radio Law of 1927," (5c per copy).

Further procedure is explained on the forms, which are obtainable gratis.

CHAPTER XI

Automotive Radio

NOISE REDUCTION

(Q) How may interference be minimised on an auto radio installation?

(A) First, make sure that the set and tubes are in perfect condition, and that all connections to it from power supply and antenna system are well made. Check the vibrator, if one is used, to see that it is not causing interference. If necessary, employ suppressors on the spark plugs and distributor; these may be obtained in kits. There are also means of securing good electrical contact between wheels and axles, to reduce the effects of static generated by the friction of the tires on the pavement. The set, of course, should be shielded, and the shield well grounded.

LAWS ON AUTO-RADIO

(Q) Do I need any special license to install a radio in my car? Are there any laws governing the use of auto radio?

(A) If you refer to a transmitter, you need a license, just as for any other amateur radio transmitting apparatus. If you refer to a receiver, there is no Federal regulation at this writing, but some states have laws prohibiting the use of short-wave equipment. The reason is that police cars receive their alarms by means of short wave, and their usefulness would be impaired if the cars they were pursuing were similarly equipped. Communicate in writing with your state police, to learn whether you can legally install a short-wave set, before putting one into your car, for in some areas the penalties provide for fines up to $1,000, or imprisonment not to exceed 6 months, or both. As there are 48 states in the Union, each with different laws, no general answer can be given.

AUTO RADIO ANTENNAS

(Q) Please tell me about the various types of antennas which may be used in auto-radio installations, mentioning the best features of each. Which do you recommend?

(A) Practically any standard type of auto-radio antenna will give satisfactory results, if carefully installed. Some of the available types are: (1) Plate under one or both running boards; easy to install. (2) Tubular under one or both running boards; easy to install. (3) V-shaped wire under chassis; claim greater freedom from interference. (4) "Fish-pole" on bumper or running board; claim greater sensitivity. (5) Tubular on top of car; claim greater sensitivity. (6) Screening inside top of car; claim good sensitivity and complete concealment. Some makes and models of cars now come equipped with a built-in antenna of some type, generally No. 6. See Fig. 37.

B-POWER SUPPLIES

(Q) What do you think of using storage "B" batteries for auto-radio receiver, and charging them from the auto generator?

(A) There are other methods which are more satisfactory. Among the latter are the vibrator, and the small motor-generator. The vibrator is now used in most installations.

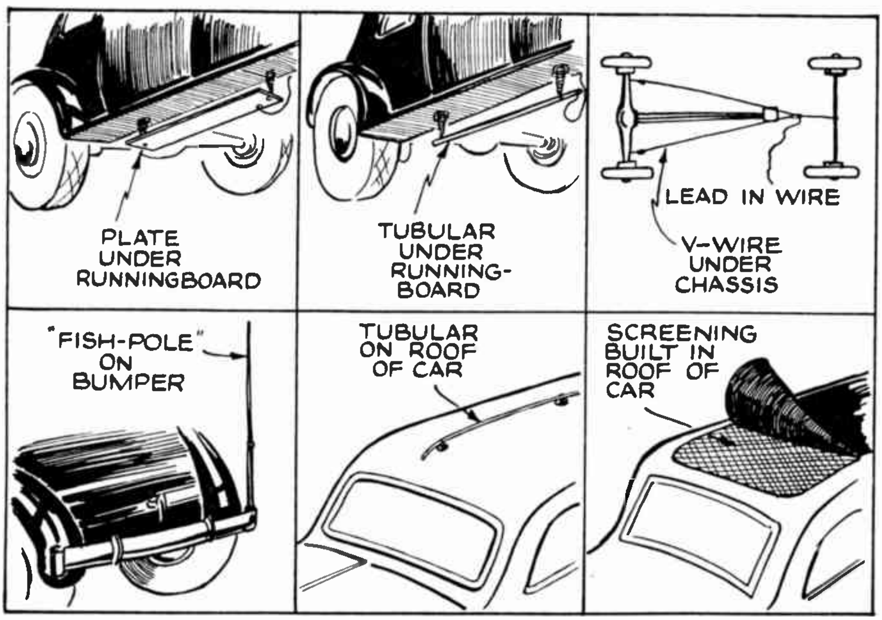


Fig. 37

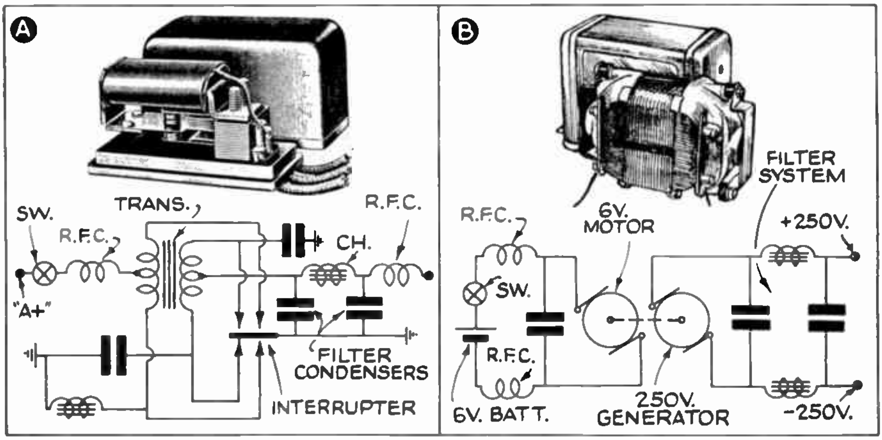


Fig. 38

B-POWER VIBRATOR

(Q) Please explain how a vibrator is used to secure B-power for an auto-radio receiver.

(A) As you know, the B voltage needed by radio receivers is far higher than the voltage supplied by the usual automobile starting and lighting battery. You also know that such a battery supplies smooth direct current, and that it is impossible to step up such direct current by means of a transformer. See Fig. 38.

In order to increase the voltage, the battery current is interrupted by a vibrator, and fed into the primary of a transformer. This pulsating direct current acts much like alternating current, and so induces a current in the transformer secondary. As a step-up transformer is used, the secondary voltage is adequately high for the purpose. It is rectified in the usual way, and supplied to the plates of the tubes in the receiver.

REDUCING INTERFERENCE

(Q) Can you suggest any way of reducing interference, in addition to the use of spark-plug circuit series resistors? The use of these does not entirely eliminate interference from the motor.

(A) Apparently bypass condensers have not been applied to the several radiating circuits of the ignition wiring in the car.

Two bypass condensers, one on each terminal, at the ammeter may reduce certain forms of car interference. The receiver should not be located near the car's ignition coil, due to its strong field. Interchanging its primary connections may reduce interference. Whether the antenna lead-in shield should be grounded to reduce interference should be determined by test.

CHAPTER XII

Sound Equipment

APPLICATIONS

(Q) What are possible markets for a modern "public-address" type of audio amplifier, aside from the generally known ones (a) at parks; (b) at political gatherings; (c) in theatres; (d) in dance halls?

(A) Airplanes, amusement parks, apartment houses, auditoriums, athletic fields, bathing beaches, banquet halls, baseball parks, brokerage offices, cabarets, charitable institutions, churches, clubs, conventions, dancing schools, encampments, factories, fairs, filling stations, flying fields, football games, hockey matches, home entertainments, hospitals, hotels, ice skating rinks, merry-go-rounds, motor cars, open-air assemblies, orphan asylums, paging systems, polo games, railroad depots, race tracks, regattas, receptions, restaurants, roller skating rinks, sanitariums, schools, stores, summer resorts, swimming pools, veterans' homes and carnivals.

The sound requirements of such possible customers vary within wide limits, from one reproducer or pair of headphones to forty or fifty reproducers and perhaps fifteen hundred or two thousand pairs of headphones.

From a study of the above list, it becomes evident that the chances for placing a public-address system are very numerous, for the capable technician with a little sales ability.

SCRATCH FILTERS

(Q) Please furnish construction data for a "scratch filter" to be used in conjunction with a phonograph pickup.

(A) For all practical purposes, it is only necessary to shunt the pickup leads with a fixed condenser of suitable capacity to be determined by test (usually, about .05-mf.) Choke coils are quite unnecessary.

It is recommended, however, that you double this value and connect in series with the condenser a variable resistor of 25,000 ohms. This will result more nearly in a "tone" control; at the same time, "scratch" of any type may be suitably controlled, or eliminated (as found desirable), no matter whether it is due to the use of a needle of incorrect shape, worn records, poor recording, poor matching between the pickup and amplifier, or to peaks in the amplifier, the reproducer, or the pickup.

The precise value of condenser capacity cannot be given, as it will depend upon the above conditions; also, whether the pickup is of low- or high-impedance type.

MIXING PANEL

(Q) I want to install a P.A. system for playing continuous phonograph music for high school dances. Please show a way in which a connection can be made to fade from one phonograph to the other. Also, how a microphone circuit can be added, for making announcements.

(A) The simplest means is to connect a potentiometer, R1, as shown in Fig. 39. The total resistance of this unit may be from 25,000 to 100,000 ohms. The double-pole double-throw switch may be used to cut the microphone in and out of the circuit, the changeover to be made while pickup B is in use. The variable resistor, R2, is optional; it simplifies the task of monitoring. Its resistance may be from 75,000 to 250,000 ohms. The precise values of R1 and R2 will depend upon the pickups and the amplifier input.

REDUCING BASS RESPONSE

(Q) My set is "boomy" when reproducing speech; the speakers sound as though they are talking into a barrel. What can be done to overcome this?

(A) Perhaps an incorrectly designed or matched loud speaker may be causing the distortion. It may also be due to cabinet resonance,

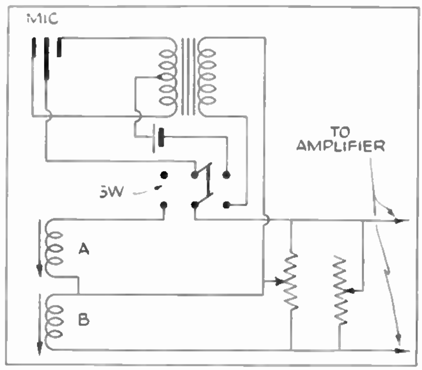


Fig. 39

in which case it can be decreased by draping the inside of the cabinet with heavy cloth.

If, however, it is caused by amplifier design that over-accentuates the bass, it can be decreased by inserting a fixed condenser in series with the speaker. (Note that this can be done only if the speaker is shunt-fed or transformer-fed, so that the condenser will not block the plate current flow.) The smaller the capacity of the condenser, the more the bass response will be decreased. Experiment with an 0.1 mf. condenser, letting your ear determine whether greater or lesser capacity is needed. See Fig. 40.

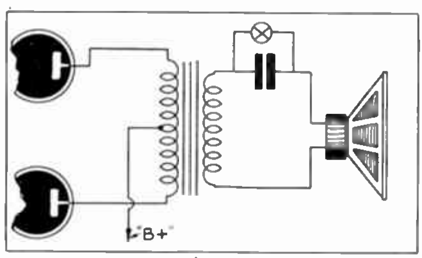


Fig. 40

BAFFLE SIZES

(Q) Is there available any ready reference, which will indicate the size of baffle recommended for various cut-off frequencies?

(A) This information is given in the chart herewith (Fig. 41), which was developed by Mr. A. A. Ghirardi of the Pilot Radio and Tube Company.

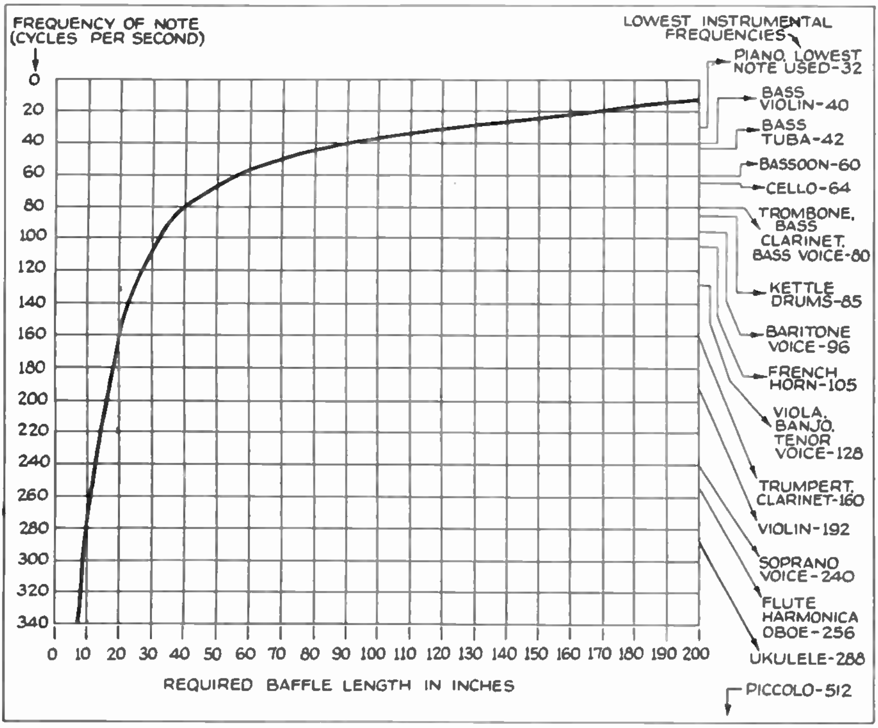


Fig. 41

CHAPTER XIII

Home Recording

HOME RECORDING

RECORDING RADIO PROGRAMS

(Q) What is the way to hook up the least possible amount of apparatus in order to make records of radio broadcasts?

(A) Simply connect a magnetic pick-up to the output of your radio set, by means of a suitable impedance-matching transformer. Use a turntable with a motor powerful enough to drive the disc when the pick-up has a weight of about ¼-pound resting on it. Put a home-recording record on the turntable; put a home-recording needle in the pick-up, attach the weight, and proceed to record, with a good, loud signal. If you use an output meter (a low range A.C. voltmeter or ammeter) you can monitor your recording, after a little practice. A single-pole double-throw switch will enable you to shift from radio to recording. The play-back is accomplished through the phonograph connections of the set, a home-recording needle again being used, but the recording weight being removed.

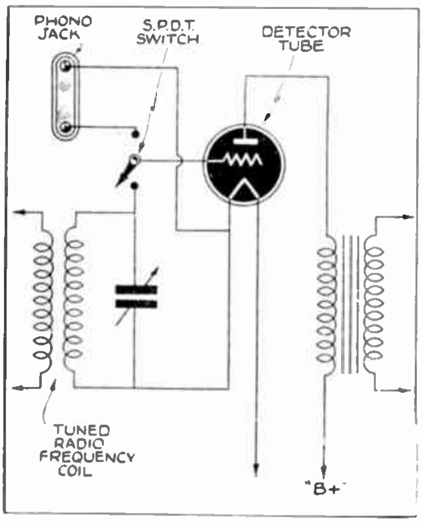


Fig. 42

HOME-STUDIO RECORDING

(Q) I wish to make records of my own voice. How can I connect a microphone to my radio set and do this?

(A) See Fig. 42 and the answer to the preceding question for the recording set-up. The microphone, which may be a single-button carbon one, is connected to the primary of a microphone transformer, the secondary of which connects between grid and cathode of the detector tube (second detector in a super-het.) The regular grid coil is best disconnected while you are recording.

CHOOSING A MICROPHONE

(Q) What sort of microphone is best for home recording?

(A) A crystal microphone or a dynamic microphone, or a velocity microphone will give the most faithful reproduction. However, these require greater amplification than single- or double-button carbon microphones. In other words, if you do not object to having one or more additional stages of pre-amplification, use one of the first three mentioned; if you want to save stages, though at some sacrifice of quality, use a carbon mike.

HOME RECORDING RECORDS

(Q) What is the best type of record—aluminum, celluloid or composition—to use for home recording?

(A) This is largely a matter of taste, and depends to some extent upon the cutting equipment used. The writer's personal preference is for composition, when pre-grooved records are used, and for standard "wax" when blanks are used.

(Q) Do you favor pre-grooved or blank records for home recording?

(A) Better recordings can be had by using blanks, but these necessitate the use of some mechanical means of feeding the cutter. For simplicity's sake, the pre-grooved records may be used—and they are capable of providing acceptable reproduction, too.

LACK OF VOLUME

(Q) I am using a special celluloid for recording and find it difficult to get the grooves deep enough to give sufficient volume. I have seen "electrical transcription" records, that seem to be made on this same material. How is it possible to overcome this lack of volume?

(A) Your lack of volume is not due to the shallow groove. A shallow groove might make it difficult for the reproducing needle to track, but the lack of volume is due to the modulations (the indentations in the sides of the groove) being too small. This can be caused by several things: perhaps the amplifier's gain is not high enough or there is incorrect impedance matching between cutting head and amplifier; or the material might be too resistant for good recording; or the cuttting head may be defective or of poor design; or the cutting needle may be dull or incorrectly set. The transcription records are "processed"—that is, a metal stamper is used to impress the sound track. In that case the hardness of the material is reduced considerably, by heating, so that it will take an impression. Try using records of a different material.

TONE QUALITY

(Q) I am using my radio receiver for recording, and the results are poor. When I reproduce commercial records, the volume is good; but with home-made records the volume is very low. My pickup (when recording) is connected to the plates of the output tubes. Can you tell where my trouble may be?

(A) Evidently your trouble lies in a poor impedance match between the cutter and the amplifier output. A transformer, to match the cutter and the set's output, should solve the problem.

STROBOSCOPE

(Q) How does a stroboscope work to help one to check the speed of a phonograph turntable? How can it be made?

(Q) The stroboscope is a mechanical device which depends for its effectiveness upon the "inertia" of the optic nerve, or, more familiarly, the "persistence of vision." By courtesy of the Marconi Radio Co. of Canada, we are able to reproduce in Fig. 43, a stroboscope designed for 60 cycles per second.

When a disc of this type is rotated at the correct speed by a phonograph turntable, the lines appear to stand still when the disc is illuminated by an electric bulb which is lighted by an A.C. supply of the stated frequency.

MATCHING-TRANSFORMERS

(Q) What are the average impedance values, of the primary and secondary windings of transformers designed to match a carbon-button microphone to a vacuum-tube grid circuit?

(A) The average values are: Primary, 200 ohms (each side, if a double-button microphone is used); secondary, 400,000 ohms. These values are for the usual 1,000-cycle standard.

FREQUENCY RANGE

(Q) Will you tell me if a frequency range of 35 to 6000 cycles will record the highest and lowest frequencies?

(A) A frequency range of 35-6000 cycles is very suitable for average good recording.

RECORDING-POWER FIGURES

(Q) How much gain does it take to make a good recording? What impedances of pickups are suitable for recordings?

(A) For recording on aluminum, the level at the cutting head should be about plus 20 decibels. If a carbon microphone is used, the pickup volume level is down about minus 36 db. It is obvious, therefore, that an amplifier having a gain of at least 56 db. is necessary.

If celluloid is to be used, the required recording level is near plus 36 db. Consequently, an amplifier having a gain of at least 72 db. is necessary. A good three-stage transformer-coupled job will serve the purpose very nicely.

The impedance of the cutting head does not make any difference, so long as it is properly matched to the output of the amplifier. The use of a high-impedance cutter of the order of 4000 ohms is common practice.

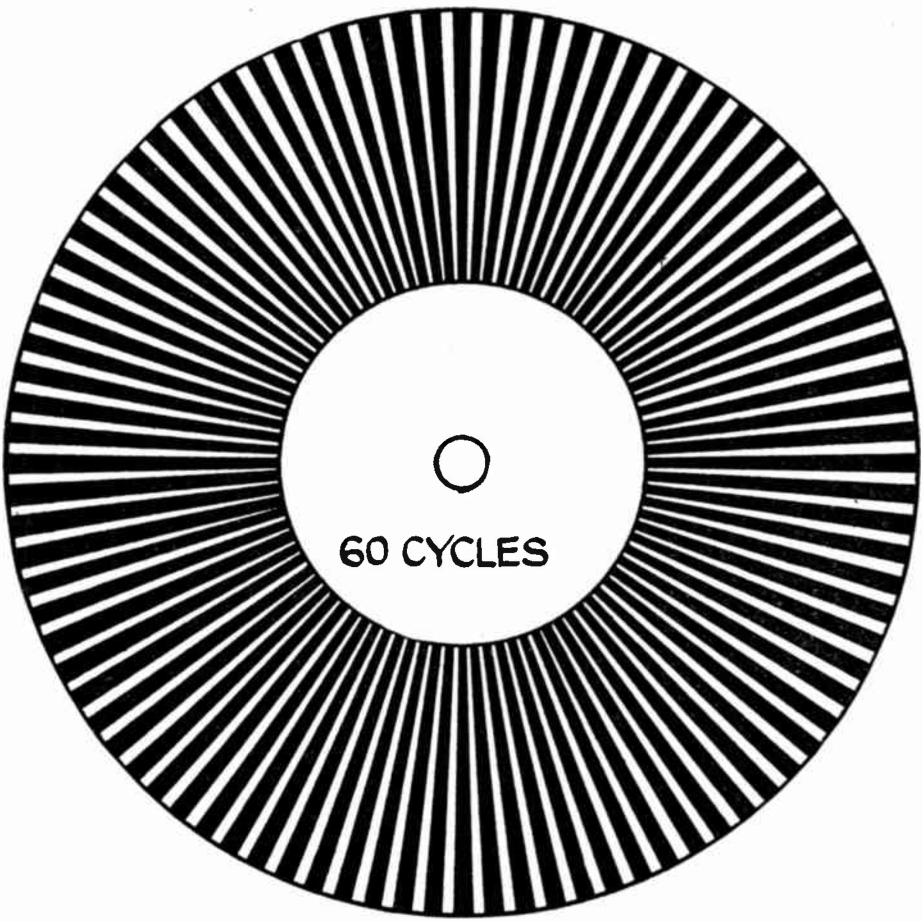


Fig. 43

MICROPHONES

(Q) Are there any convenient corrective measures that may be applied to packed carbon-button microphones? The one in question is noisy and, though sensitive, it is difficult to keep at the best operating point.

(A) If buttons become packed because of moisture, or long standing in one position, it will often be possible to loosen the carbon granules by holding the "mike" with the diaphragm in a horizontal position, in one hand, and striking this hand gently against the other hand. Also, try tapping the edge of the microphone gently against one hand. Note that damage may result if this procedure is followed with the current on. Make certain that the microphone is disconnected from the battery circuit while undergoing this manipulation. Do not strike the diaphragm. See Fig. 43 A.

If the "mike" is located in an excessively moist place it may be advisable to place it under an electric light bulb, in front of an electric heater (at some distance), or in the rays of strong sunlight, to drive out the moisture that has caused the packing of the carbon. Most microphones are, after assembly, tested and balanced with meters; and they should not be opened or tampered with. The diaphragm should never be touched.

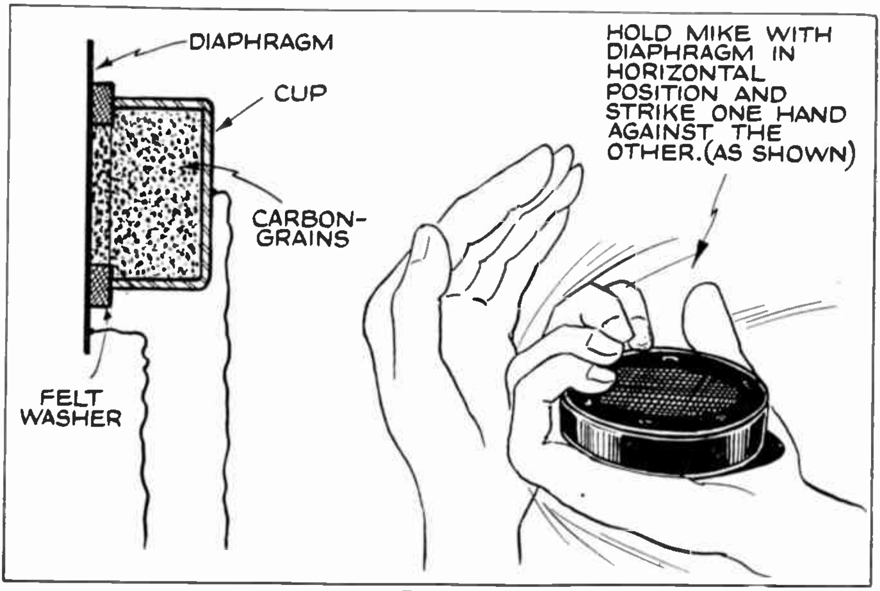


Fig. 43 A

CHAPTER XIV

Test Apparatus

CAPACITY METER

(Q) Please show the circuit arrangement of a simple capacity bridge to use headphones and measure capacities less than one microfarad.

(A) The circuit arrangement of an excellent bridge of this type, developed by Beverly Dudley, is shown in its elementary form in Fig. 44A,

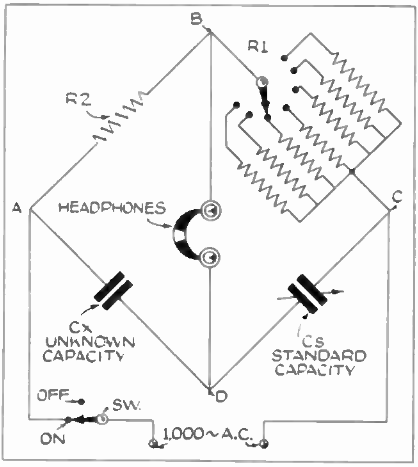


Fig. 44A

and in detail Fig. 44 B. Its capacity range as shown in approximately 10 mmf. to 0.05-mf. Its operating graph in position 1 of the selector switch is shown in C of the same figure. However, this is only approximate, and the completed test instrument must be sent to a laboratory for calibration.

A device of this nature is almost indispensable to the radio Service Man. A test unit of this type eliminates guesswork as to whether condensers of 10 mmf. to 0.05-mf. are open—or have their rated capacity.

METER INTERNAL RESISTANCE

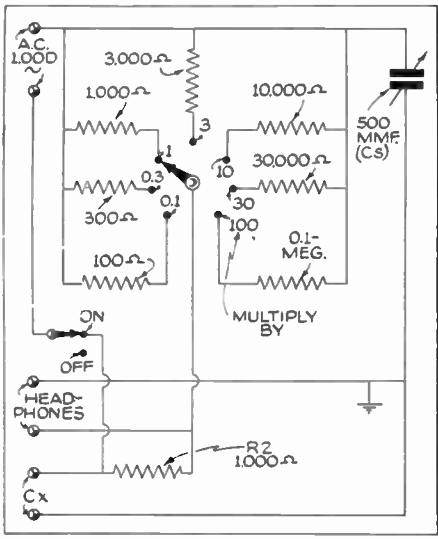
(Q) What is, approximately, the internal resistance of a 0 to 1.-ma. meter?

(A) The internal resistance of a milliammeter of this rating may be from 20 to more than 100 ohms, depending upon make and model. The value may vary five percent, plus or minus. Each instrument is a hand-made unit and this causes slight variations which do not noticeably effect the scale readings. The exact constants of all meters are individually recorded and may be obtained by writing to the makers, if special laboratory work should necessitate the data.

METER ACCURACY

(Q) Using a 0 to 1.-ma. milliammeter with resistors of the correct value in series for operation as a voltmeter, will the accuracy of the meter be as good or better than one of the high-grade standard voltmeters?

(A) If the meter is of good make and in perfect condition, the results will equal those afforded by a standard voltmeter, provided the resistors are of the correct value and do not change their characteristics in use.



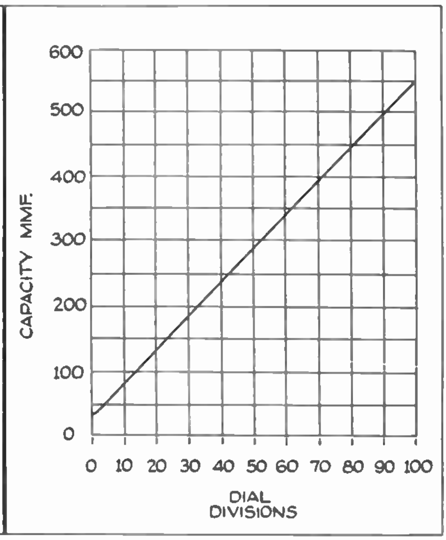


Fig. 44 B

CIRCUITS OF SET

(Q) Please show the various circuits of a radio set and tell how a Service Man may determine what unit is causing bad reception.

(A) The four figures reproduced herewith show the more common connections to triode, tetrode, pentode and other tubes. The accompanying chart indicates how to analyse the various indications of faulty operation. Detailed instructions for using these figures follow, through the courtesy of RCA Mfg. Co., Inc.

Illustrated in this treatise are three fundamental schematic diagrams of the complete filament, plate, grid, and screen-grid circuits for (Fig. 45) filament emitting type tubes; (Fig. 46). cathode-heater type tubes; and (Fig. 47), for output pentodes, filament emitting type; and (Fig. 48) for multi-grid tubes. The various circuits are numbered as Example:

1—grid return from grid of tubes to negative C in grid circuit;

2—plate circuit from positive B on voltage divided to plate of tube; and so forth.

Fig. 49 is a chart listing the effects noted (as compared to the normal readings) when the various circuits or parts are open or shorted. By the use of this chart, knowing what normal conditions are, and how the abnormal conditions compare with them, it is possible for a service man to narrow his tracing of the suspected tube circuit, down to the testing of one or two of the parts of that circuit.

It will be noted that circuit No. 14 (Fig. 47) applies only to the pentode tubes. It represents the connection within the tube itself from the center of the filament to the suppressor grid, located between the space charge grid and the plate. Since there is no external connection to this element on the base of the tube, the only way in which an open connection between these two elements can be determined is by the effects which this condition would have upon the normal analyzer current and voltage readings. These are listed under circuit No. 14 on the chart, Fig. 49.

Circuits No. 1 and 2 apply equally well to triodes of the filament and cathode-heater types by omitting circuit No. 13 and condenser No. 7 which apply to screen-grid types only.

Example:

If it is found that the readings at one tube socket show Eg (grid voltage) equals above normal, Ip (plate current) equals 0, Ek1 (cathode voltage on cathode-heater type tubes) equals above normal, then, referring to the chart we see that when this condition exists it indicates a short in No. 6—the plate by-pass condenser —when its return is connected to positive side of grid bias resistor No. 4; or it indicates an open in the cathode circuit through conductor No. 3 or grid bias resistor No. 4.

The meanings of the symbols in the reference chart are as follows:

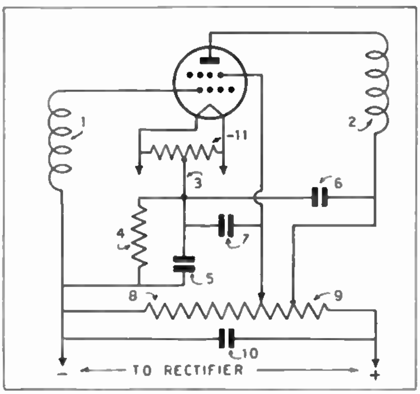


Fig. 45

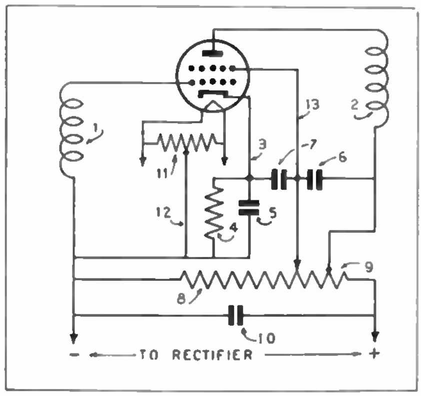


Fig. 46

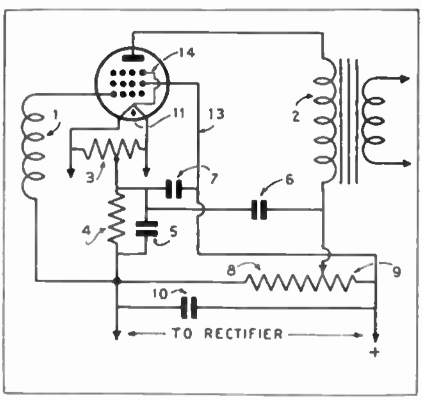


Fig. 47

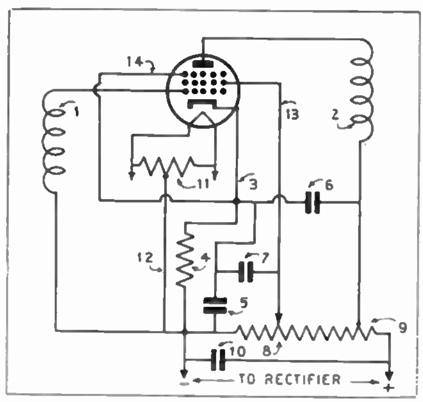


Fig. 48

Eg1—Grid voltage on control grid on S.G. tubes.
Ek1—Cathode voltage on cathode-heater tube.
Ep—Plate Voltage.
Eg2—Screen Grid Voltage.
Ip—Plate Current.
Eg3—Suppressor Grid Voltage.
Ig2—Screen Grid Current.
S—Shorted.
L—Leaking.
Op—Open.
0—Zero Voltage or current.
Lo—Below normal.
Hi—Above normal.
Nor—Normal.
F—Fluctuating.

HANDY CHART FOR QUICK RECEIVER CIRCUIT ANALYSIS

CIRCUIT NO.	CONDITION	Eg1	Eg2	Ig2	Ip	Ep	Ek1	Eg3
1	Op	0	Lo.	Hi.	Hi.	Lo.	Hi.	
*2	Op	0	Nor	Hi.	0	0	0	
†3	Op	Hi.	0	0	0	0	Hi.	
4	Op	Hi.	0	0	0	0	Hi.	
5	S	0	Nor	Hi.	Hi.	Lo.	0	
5	L	F or Lo	Nor	Nor	F or Hi	F or Lo	F or Lo	
5	Op	Nor	Nor	—	Nor	Nor	Nor	
‡6	S	Hi.	Lo.	Lo.	0	0	Hi.	
6	L	F or Hi	F or Lo	F or Lo	F or Lo	F or Lo	F or Hi	
6	Op	Nor	Nor	Nor	Nor	Nor	Nor	
‡7	S	Hi.	0	0	0	Lo.	Hi.	
7	L	F or Hi	F or Lo	F or Lo	F or Lo	F or Lo	F or Hi	
7	Op	Nor	Nor	Nor	Nor	Nor	Nor	
8	Op	Hi.	Hi.	Hi.	Hi.	Hi.	Hi	
9	Op	0	0	0	0	0	0	
10	S	0	0	0	0	0	0	
11	Op	Nor	Nor	Nor	Nor	Nor	Nor	HUM
12	Op	Nor	0	Nor	Nor	Nor	0	HUM
13	Op	0	0	0	0	Hi.	0	
14	Op	Nor	Nor	Hi.	Lo.	Nor	—	Hi.

EXCEPTIONS

* Eg1="0" WHEN INDIVIDUAL BIAS RESISTOR.
Eg1="Lo." WHEN COMMON BIAS RESISTOR.
† Eg1 & Ek1="Hi" WHEN INDIVIDUAL BIAS RESISTOR.
Eg1 & Ek1="Lo" WHEN COMMON BIAS RESISTOR.
‡ Eg1 & Ek1="0" WHEN CONDENSERS RETURN IS TO NEGATIVE END №4 OR NEGATIVE RESISTOR.

Fig. 49

ALIGNING CAGE

(Q) What is meant by the term "aligning cage," and how is the device made?

(A) An aligning cage ("Faraday cage") is used by some radio manufacturers, to prevent the disturbing effect of radiations from powerful local stations, and the static radiations of electric machinery, from affecting the tests and adjustments which are made upon receivers in the final stages of production.

The cage is built of light copper screening, such as would be used in a screen-door. It can be constructed large enough to accommodate the entire cabinet together with the necessary meters and oscillator. See Fig. 49-A.

Although the cage must be built to fit the available space, it should be large enough to permit swinging the chassis, to couple it to the oscillator. The screening should preferably be of copper, 12 meshes to the inch. The sides are carefully bonded together to give maximum screening effect, and the entire screen is grounded. In all cases the open side of the cage should be placed away from the interfering station.

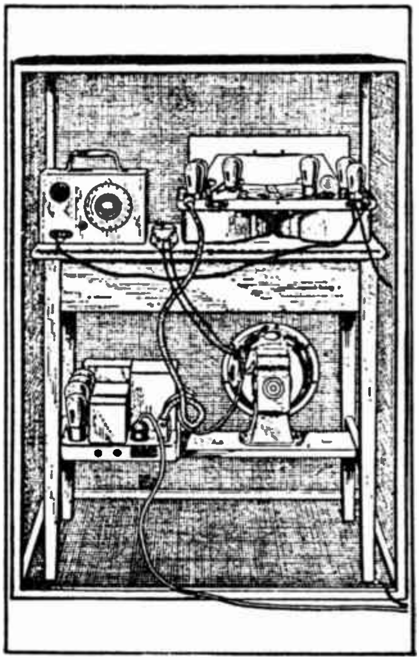


Fig. 49 A

ANALYSER THEORY

(Q) How does an analyser enable the Service Man to tell what is wrong with a set?

(A) An analyser is simply a means of connecting a voltmeter in parallel with (or an ammeter in series with) various circuits of a receiver. The Service Man knows what the meter readings should be on any given circuit, and also knows what the components of the circuit under test are. If the reading on the meters varies from the known normal, he is thus able to reason out which unit is causing the trouble. In most cases, he must use a manufacturer's service notes, or other data sheets, to know the precise circuit under test, and the readings which should be afforded.

VOLT-MILLIAMMETER

(Q) I have an 0-1 mil. meter. How can I make a volt-milliammeter out of it?

(A) See the accompanying Fig. 50. Find the resistance of your meter by asking the manufacturer. The series resistors may be calculated by the formula R equals $\frac{Es}{Im}$. R is the resistance in ohms to be added; Es is the voltage of the scale being made (full scale deflection) Im is the current in amperes that affords full scale deflection (for example, .001 in a 1-mil-meter). The shunt resistors are calculated by the formula

R equals $\frac{Rm \times Im}{Is - Im}$. R is the resistance in ohms to be added in shunt; Rm is the resistance of the meter; Is is the amperage of the scale being added (full scale deflection); Im is the current in amperes that affords full scale deflection of the meter movement, without the added shunt.

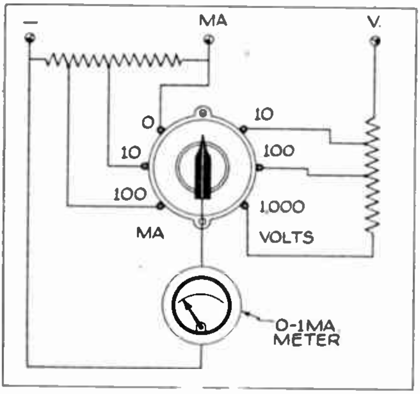


Fig. 50

A.C. VS. D.C. METERS

(Q) How does an A.C. meter work? Why does it indicate, steadily, on A.C.; when the needle of an ordinary D.C. meter on this supply will flutter?

(A) The D.C. meter when measuring D.C. may be represented as shown at the top in Fig. 51 where a moving coil, (indicated by the arrow), carrying the current to be measured, produces a field which reacts against the stationary field of the permanent magnet. This reaction is physical and the coil, being freely suspended, moves in proportion to the amount of current through it. However, alternating current, flowing through this winding, at the rate of, say 60 cycles, changes polarity so rapidly and attracts and repels so quickly, that the coil cannot follow it. If there were some means of changing the field of the permanent magnet, at the same rate as the change in the moving coil, there would be continuous repulsion and the needle would indicate truly.

This action may be obtained by discarding the permanent magnet and substituting two coils (N, S, shown below it). These are connected in series with the moving coil, so that alternating current through these coils changes polarity at the same rate as the current through the single moving coil. This produces continuous repulsion, and indication on the A.C. meter scale.

In radio service work, small metallic rectifiers are often used to adapt D.C. meters to A.C. work.

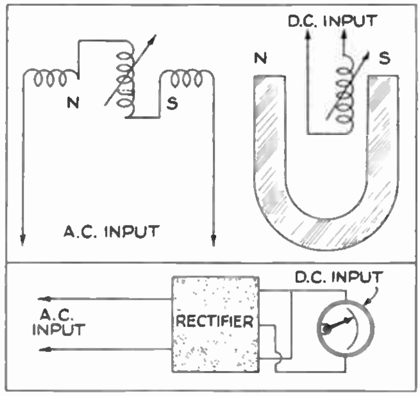


Fig. 51

CHARACTERISTIC GRAPHS

(Q) Please show a schematic circuit for taking the "characteristic curve" of an A.F. transformer, or for determining its comparative value.

(A) The circuit requested is given herewith. As shown, it is of value only for obtaining an approximation of the "gain" or voltage setup of a particular transformer, at 1000 cycles (1 kc.), as compared to another transformer used as a standard. The gain of a complete stage, including such a transformer, at other frequencies may not be in proportion to this volume.

To obtain a true picture, it is necessary to make a graph of the values obtained at other frequencies; this is possible by using an oscillator adjustable to these frequencies.

The constants of T3 will be determined by the design of the oscillator and the characteristics of the tube selected as V1 (the voltages indicated are for an '01A). The milliammeter should read nearly zero, until the oscillator is started.

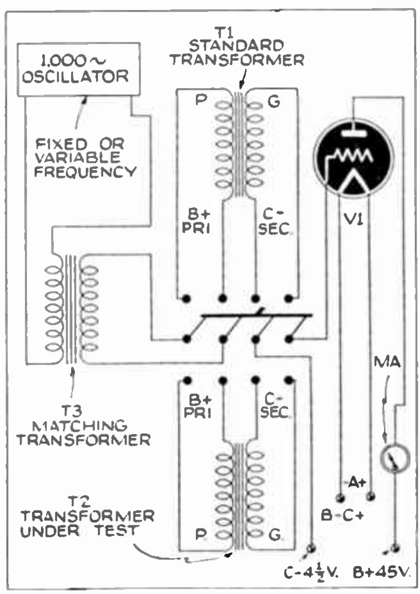


Fig. 52

CHAPTER XV

General Inquiries

STATISTICS

(Q) How many radio sets are there in the United States? In New York City?

(A) Late U. S. census figures indicate that there are approximately 24,500,000 radio sets in operation in the United States; and that nearly five-sixths the population of the country, or a hundred million people, can be classed as "listening public."

It is estimated that in New York, Pennsylvania and Illinois are to be found almost one-third of all the radio sets in the country; and one-fourth New York City is estimated to have about 2,000,000 receivers in use.

SET MODERNIZING

(Q) What is the usual procedure in modernizing radio receivers?

(A) The changes necessary to modernize any given receiver depend upon the characteristics of the individual set. In general, the wiring and components are changed to permit operation with the latest tubes; this may necessitate redesign of the power pack. In some cases the R.F. coils are replaced; a more modern volume control usually becomes necessary; a tone control usually improves the audio quality. Single-dial tuning may replace multi-dial operation; a power detection circuit improves the tone quality, as does the use of a pentode or other high-power output tube. Perhaps the major alteration is the use of A.C. tubes in place of battery-operated types.

HARMONIC PRODUCTION

(Q) I have a coil of 85 turns of No. 26 S.C.C. wire, which is tapped at the 40th turn. I use this in an A.C. oscillator, for balancing purposes, in a unit which covers the broadcast band from 550 to 1500 kc. I now find I am able to use this contraption on the 20-, 40-, and 80-meter amateur bands without the change of coils; thus giving me a range from at least 17300 kc. 17.34 meters, to 560 kc. 535.4 meters.

Would you kindly explain this phenomenon; and could its calibration be relied upon if such is obtained?

(A) It is due to harmonic frequency production. In an oscillatory circuit including an ordinary vacuum tube, there is produced not only the fundamental frequency of that circuit (due to the values of its inductance and capacity) but also numerous other frequencies which are multiples of the fundamental. These "harmonic" frequencies are rated in their numerical sequence; the first multiple being the "second harmonic" or double the fundamental frequency; the second multiple is the third harmonic, or three times the fundamental; and so on.

The practicability of calibration is evident at least for the 200- to 1500-kc. band specified. Further, this method is used in amateur radio transmitting work to calibrate accurately short-wave wavemeters; the signals of crystal-controlled stations are used for the fundamental, to which may be tuned (by zero-beat) a vacuum-tube oscillator, whose harmonics may be logged on graph paper for further reference.

If the oscillator is stable, the calibration of the harmonics will be reliable.

Constancy and accuracy of calibration are largely a matter of obtaining constant current supply and uniform tube characterictics. In general, quite close work may be done.

BATTERY CARBONS

(Q) I would like to use an ordinary battery carbon as a resistance. What is the average value of one which is six inches long?

(A) These vary from about 50 to 60 ohms.

"NEWTON'S DISC"

(Q) I am conducting some experiments in television and would like to duplicate the physics experiment known as "Newton's Disc." By mounting on a rotable shaft and twirling the card, all the colors of the rainbow painted on it merge into almost a clean white. Can you assist me?

(A) A sketch of the card to which you refer is given herewith, in Fig. 53. We suggest you use the following water colors or oils to get approximately the right effect, which may be close enough for your work.

For red, use vermilion with a little permanent violet; orange, orange cadmium; yellow, chrome yellow; green, blue-green viridian plus a small amount of cobalt blue; blue, prussian blue and cerulean blue; violet, permanent violet and a little blue; indigo, permanent indigo. Due to optic nerve lag, the colors will, when rotated, resolve and afford the sensation of white.

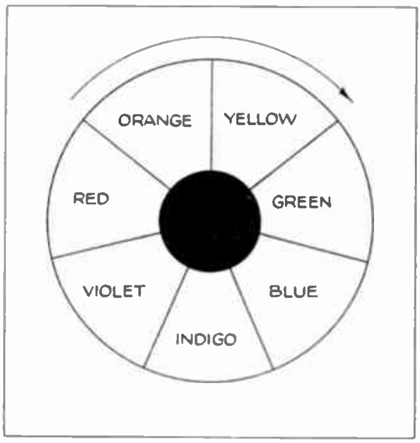


Fig. 53

LONG-WAVE RECEIVER

(Q) As I would like to make up an experimental circuit to receive long-wave stations for code practice, please print details of this arrangement.

(A) The schematic circuit of an easily-built set, a 2-tube "autodyne," is shown in **Fig. 41.**

Although a tuning condenser C1 of .0005-mf. capacity may be used, it is recommended that this part have a capacity of about .001-mf.; which value may be obtained by ganging two .0005-mf. units. The larger capacity will make it easier to tune in a greater number of stations with a lesser number of coils, though the "band-spread" effect will be halved. Any type of 3-element tube may be used at V1 and V2.

Honeycomb coils may be purchased, or home-made coils scramble-wound, with No. 30 enameled S.C.C. wire, on a form an inch wide and about two inches in diameter, to the following number of turns: 25, 80-350 meters; 35, 175-550; 50, 220-750 meters; 75, 330-1030; 100, 450-1460; 150, 660-2200; 200, 1300-4000; 250, 1550-4800; 300, 2050-6300; 500, 3,000-8,500; 600, 4,000-12,000; 750, 5,000-15,000; 1,000, 6,200-19,000; 1,250, 7,000-21,000; 1,500, 8,200-25,000, meters.

The two smallest coils are listed merely for completeness; the ranges are roughly those covered with a .001-mf. condenser. Some form of mounting must be arranged so that the coils may be conveniently interchanged. The coils should be rigidly supported, so that the turns cannot move, even slightly, when the coils are interchanged.

It may be desirable to insert a resistor of about 1,000 ohms in the detector plate lead at X.

Once adjusted for a given coil, tube and plate potential, resistor R1 need not be reset. The adjustment of R3 is critical. Unit R2 controls volume and sensitivity.

Blocking tube V1 prevents radiation of interfering frequencies.

SIGNAL BOOSTER

(Q) Please show the circuit for an A.C. screen-grid booster unit to be added to the average receiver, for use on broadcast wavelengths.

(A) The circuit requested is Fig. 54; connect its "output" to the "Ant." post of the first R.F. tube in the set. The tuning condenser C2 will not "track" closely with the radio set dial unless it is of the same capacity and design of plates; and unless coil L2 has the same effective inductance as the tuned windings in the associated receiver.

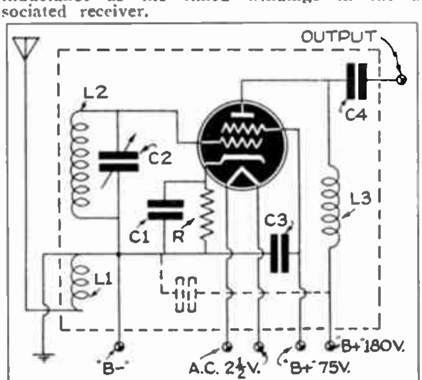


Fig. 54

The experimental constants may be as follows: L1, 10 turns of No. 26 D.C.C. wire on a tube 2 inches in diameter; L2, 80 to 85 turns of the same wire on a tube of the same diameter; L13, standard R.F. choke, C1 and C3, 1 mf. fixed condensers; C2, .00035-mf., variable; C4, .00025-mf., fixed; R, 1200 ohms. Resistor R is for biasing the tube.

Over-all shielding, grounded, is shown in dotted lines. The coils should not approach the can more closely than two inches at any point. It is a good idea to connect a 1 mf. condenser as shown in dotted lines.

COLOR CODE

(Q) Please explain the system used in color-coding fixed resistors.

(A) Herewith is the color code:

	Body or End	Dot
BLACK	0	.0
BROWN	1	0
RED	2	00
ORANGE	3	000
YELLOW	4	0000
GREEN	5	00000
BLUE	6	000000
PURPLE	7	
GRAY	8	
WHITE	9	

The color of the Body of the resistor signifies the first figure; that of the End, the second figure; and that of the Dot, the number of zeros which follow the two figures.

Examples are: Resistor with brown Body, black End and black Dot, 10 ohms. Resistor with yellow Body, green End and orange Dot, 45,000 ohms. Resistor with blue Body, no color on end (blue end on blue body obviously cannot be seen) and red Dot, 6600 ohms. Resistor with red Body, brown End and no Dot (red Dot on red Body cannot be seen), 2100 ohms.

To remember the order of reading—Body, End and Dot—think of the initials; they spell BED.

REMOTE SWITCH

(Q) I want to connect up my radio with a switch so that it can be turned on or off from another room. That is, if I turn it on at the set and then go to another room, I want to be able to turn it off from this other room, and if it is off at the set, I want to be able to turn it on from the other room. Or, if it has been turned on in the other room, I want to be able to turn it off at the set, and vice versa. Switches in series will let me turn it off from both points, but not on if one is open; and switches in parallel will let me turn it on from both points, but not off if both are on. Is there any way in which it can be done?

(A) You will need two single-pole double-throw toggle switches, one at the set, the other at the remote point. Use three-conductor light cord to connect them as shown. Either switch will then turn the set on or off, regardless of the position of the other.

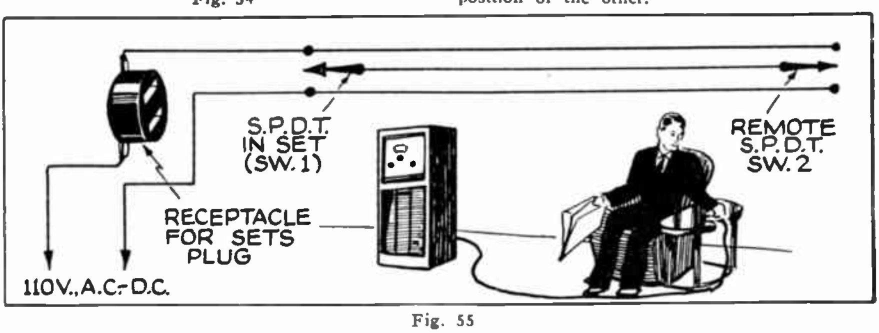


Fig. 55

CHAPTER XVI

Causes of Set Failure

SOURCES OF TROUBLE

(Q) Please list various symptoms of trouble in radio receivers, and state what their causes may be.

(A) The chart herewith, which appeared in Radio-Craft, the magazine for Service Men and experimenters, shows the relation between variout units of the radio receiver and symptoms of trouble which may be caused by defects in them.

WEATHER CONDITIONS

(Q) My set does not play as well in damp weather as in nice weather, and on rainy days it is terrible. Not only is reception noisy, but volume is decreased, and sometimes it whistles. What is the cause of this?

(A) There are a number of possible causes. Dirty or cracked antenna insulators, or an absorbent lead-in strip, or defective insulation of a lead-in wire touching a building can cause weakened and noisy reception on damp days. Coils wound on hygroscopic (moisture-absorbing) material, or insulated with a material that is affected by dampness, may cause the same trouble and, by varying their characteristics, may cause the whistles. Other set components, such as sockets and resistors, may have the same effect, if made of hygroscopic material; though this is most unusual.

BAD WEATHER IMPROVES SET

(Q) My set does not usually play very well, but during and right after a rainstorm, it is wonderful. How can I make it play that way all the time?

(A) Tbe most likely reason for this is a poor ground. If your ground connection is in dry soil, it is not good; but when the rain has soaked the earth, the ground becomes excellent. Change the ground. Also possible, but less likely, is that the coils of the set change their characteristics due to dampness, and that the R.F. or I.F. stages are incorrectly aligned when the coils are dry but, through chance, align more nearly right when the weather causes the change. If this is the case, replace the coils. See Fig. 56.

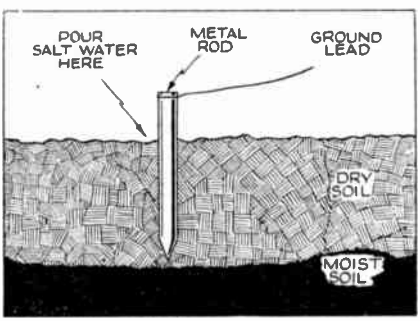


Fig. 56

LINE CORD BURNED-OUT

(Q) The line cord of my AC/DC set has always gotten very hot when the set was playing. The other night, it started to smoke, and the set stopped working. What went wrong?

(A) It is normal for line cords to get quite hot, for they contain resistors to reduce the filament current to the proper degree. In your case, the cord was probably damaged or defective, and so burned out. There is also the chance that a short in the set (most likely in the filament circuit) caused the cord to be overloaded and thus destroyed it. For that reason, check the set before replacing the cord.

BURNED ANTENNA COIL

(Q) In moving my 2-volt battery set from one room to the other, I accidentally connected the "A" battery to the Antenna and Ground leads. Of course the set did not work. I soon found the trouble and connected it up right, but still it will not work. I did not burn out the tubes, because they still light, and I had the "B" connections right all the time. Please advise me.

(A) You probably burned out the primary of the first R.F. transformer (antenna coil). Replace it with a new coil if it appears to be burned, or if it tests open with a flashnight bulb and dry cell, as in Fig. 57.

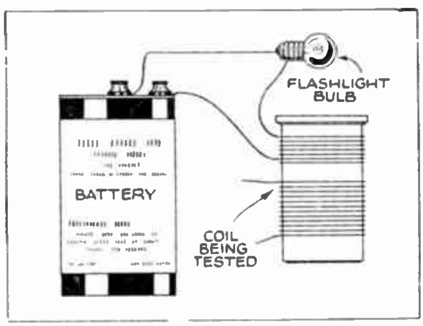


Fig. 57

FUSES BLOW OUT

(Q) My set is plugged into the light lines through a so-called "line noise filter." The fuse in my house circuit blew out the other night. I replaced it and it blew again. This is the circuit that my set is on. It was a 10-amp. fuse, and the fuses in my set are 1-amp. fuses. If there is trouble in my set, why did not the 1-amp. fuses blow before the 10-amp. fuse?

(A) The trouble is probably in the line noise filter, not in the set. Most likely one of the condensers is shorted. Remove the filter and try again. You can test the condensers by connecting them in series with an electric light bulb across the line; if the bulb lights, discard the condenser. There is also the possibility of a short in the set's line-cord or plug; this also may be tested in series with an electric light bulb across the light line. If the bulb lights with the set's switch OFF, the cord or plug should be replaced.

CHAPTER XVII

Service Problems

GROUNDED CIRCUIT

(Q) What is most likely to be the trouble in an A.C. set, when the 110-volt current passes through the ground wire of the set? Set cannot be used with ground lead. Would a condenser in the ground lead help, and what capacity should it be?

(A) This unusual phenomenon is probably due to a "ground" between the windings of the power transformer. If this transformer is carefully tested, it probably will be found that the insulation between windings has broken down. A fixed condenser of 0.25-mf. capacity may be connected in the ground lead; but it is best to have the transformer replaced or repaired. Otherwise, the insulation may break down still more, and eventually arc—setting fire to inflammables in the cabinet.

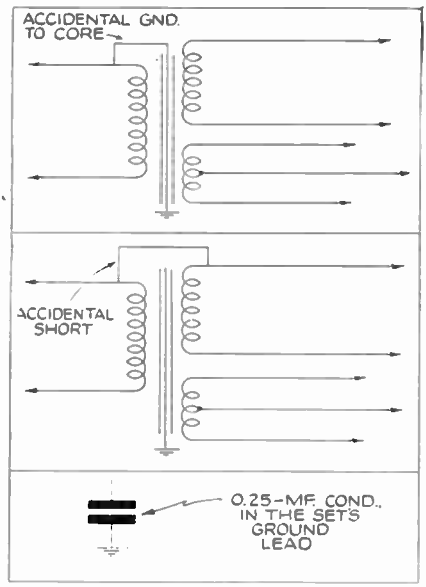


Fig. 58

SHOCKS

(Q) I have a D.C. "mains" set well insulated by antenna and ground series condensers. Why is it that I get a shock when the shield cans and radiator are touched at the same time?

(A) Evidently the shielding of your set is grounded to the set wiring, which is connected to the lighting lines, and contact with it and the ground (radiator) completes the lighting line's circuit to ground, through your body. It is also possible that the condenser used to isolate from the D.C. is broken down, or that the shock is merely due to the condenser's discharging through your body. See Fig. 58.

CRACKLING SOUNDS

(Q) The power pack cable on a radio set produces a loud crackling sound when the cable is moved in a certain position, near the input to the set. I have tested this cable for open or short circuit, but find it OK in every respect; in fact it is a new one. Sometimes merely touching the cable with the finger causes the noise.

(A) This crackling sound is caused by loose connections (perhaps corroded contacts), partial breaks, or partial shorts.

The reason the cable tested perfect is that the tests were not carried sufficiently far, or else the trouble is not in the cable.

It is possible that the fault is due to poor connection at binding posts; perhaps a wire underneath a post is making intermittent contact.

A broken strand of the cable conductor will ocassionally cause this effect, when the strand sticks through the insulation and intermittently touches another lead.

PHONO MOTOR INTERFERENCE

(Q) I replaced the spring in my phonograph with a 110-volt A.C. synchronous electric motor. It was my intention to operate this motor and an electric phonograph pickup in conjunction with my radio set, which is provided with connections for a pickup. However, the motor causes a loud hum in the reproducer when the motor is put in operation although there is no interference when the motor is not turning.

If the pickup head is moved about six inches from the motor, the hum stops. It can also be stopped by turning the pickup to an odd angle. The leads from the pickup are not inductively coupled to the motor, since shielding them does not reduce the hum. How can this trouble be remedied?

(A) If grounding the frame of the motor does not eliminate the interference, it may be necessary to shield the entire motor in the manner shown in Fig. 59. The shield is to be made from soft iron sheeting, of any convenient thickness.

Before making this shield, it may be advisable to try grounding the frame of the phonograph pickup and shielding the A.C. leads to the motor and to the switch controlling the motor.

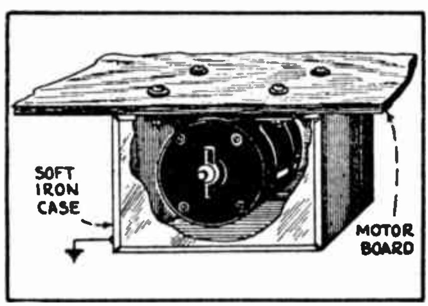


Fig. 59

UNGROUNDED SETS

(Q) What is the explanation for an increase in signal volume when the ground wire is disconnected from a sensitive T.R.F. set. Aerial and ground have been inspected, and both seem to be in a perfect condition; all tubes test up to par.

(A) When the ground wire is removed from a radio set, the chassis no longer serves as a radio-frequency shield since it is ungrounded. Regeneration now takes place in the circuit, thus causing increased sensitivity. Indeed, the circuit may become so highly regenerative as to slip easily into oscillation. Another result of this instability is to decrease the noise-to-signal ratio, bringing in background noises not otherwise heard. Also, the hum level is often raised to an objectionable degree.

Under normal conditions, the various interfering noises picked up by the light-lines and chassis may pass directly to ground through a filter bank consisting of two center-tapped 0.1-mf. capacities, connected inside the amplifier unit. However, when the ground connection is removed, the effectiveness of the ground wire to carry off these static discharges is eliminated. Also, the signal gain obtained by removing the ground is not as noise-free when obtained in this manner, as when the volume control is advanced to obtain the same sensitivity, for it is seldom that a sufficient degree of sensitivity is not obtainable by adjustment of this control—if the receiver is otherwise properly balanced.

Signal pickup via the light-line, no longer bypassed to ground, now may back up through the set. If it is "in phase" with the antenna pickup, volume is increased; otherwise, decreased volume will be experienced.

"SCREEN-GRID" COILS

(Q) Please print details for the construction of R.F. transformers of a design suitable for use as antenna and interstage units in modernizing old '01A- and '27-(tube) type receivers to the use of screen-grids or variable-mu's. The coils should be small as possible.

(A) This is rather a large order. In the first place, the proximity of the shield to the R.F. coil will greatly affect the tuning range of the receivers, as will the characteristics of the particular tubes used. Perhaps the greatest factor with which to contend is the minimum capacity and the capacity range of the tuning condenser.

A common design is illustrated in Fig. 60. The object here has been to obtain good operation, though using coil forms and shield cans of very small dimensions. The values are those of a commercial product.

The primary of the antenna coil fits tightly inside of the form, on the outside of which is wound the secondary. The primary of the screen-grid coils is to be spaced 1/16-in. from the inside of the celluloid winding form. All secondaries have the same number of turns, and each is tuned by a .00035-mf. variable condenser.

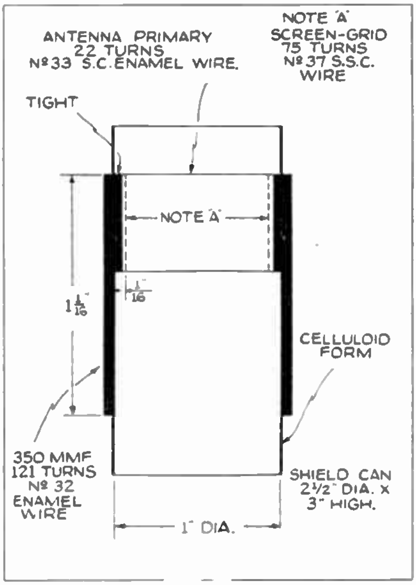


Fig. 60

CHAPTER XVIII

Choosing and Installing a Receiver

"THE BEST SET"

(Q) I am going to get a radio. What is the best set to get?

(A) The best set is the one whose tone you find most pleasing, whose controls you find easiest to manipulate, and whose features you prefer. If there was any one "best" set, no others would be sold. Radios, like automobiles, are largely a matter of personal taste.

HOW MUCH TO SPEND?

(Q) I want to get a real good radio set. How much should I have to spend?

(A) What you want is value for your money. Any set of standard make will give you this. How much you will have to spend is determined solely by your pocketbook and your taste. You can buy a set for about $10; it will be worth $10. You can buy a set for $500; it will be worth $500. Both will enable you to hear broadcasts.

If you plan to listen to the broadcast band only, and are not eager to have tonal quality similar to that heard in the studio, you will have to spend far less than if you want to hear amateur, police, airplane, foreign and domestic short wave stations. Likewise, if you wish to get the full bass of a symphony orchestra, as well as all the high notes of such instruments as violins and flutes, with the harmonics that make the instruments recognisable, you will have to spend more money. If you wish to have a phonograph with automatic record changer in your set, it will cost you more than if you do not want this.

Midget sets cost less than consoles, but the increased baffle area of a big set improves bass response.

You can get good value, no matter how much or how little you spend. The degree of perfection it takes to satisfy you will determine how much you will have to spend for a set which impresses you as "good."

FUSING A SET

(Q) I have bought an inexpensive set which does not have any fuses in it. For safety's sake, I should like to fuse the line. What is the easiest way to do this without taking the set apart?

(A) There is a type of fused plug now on the market which can be used to replace the plug now on the line cord of your set. These plugs come with 5-amp. or 10-amp. fuses in them. Remove these fuses and replace them with 1-amp. or 2-amp. auto fuses. These plugs fuse both sides of the line. If you prefer not to use a plug of this type, simply use a double fuse block, with a plug connected to one end, and an outlet to the other.

INSTALLING A SET

(Q) When buying a new set, what is the best way to install it? I mean, have you any suggestions as to antenna, placement in the room, etc.?

(A) The best thing to do is to follow the manufacturer's instructions exactly. Generally speaking, a 50-foot antenna is sufficient. Some different types are given in the chapter on antennas, which also contains information on grounds. Place the set so that there is a direct line from its speaker to the parts of the room where people sit. In other words, do not hide it behind chairs or other furniture; doing so muffles the high notes. See Fig. 61.

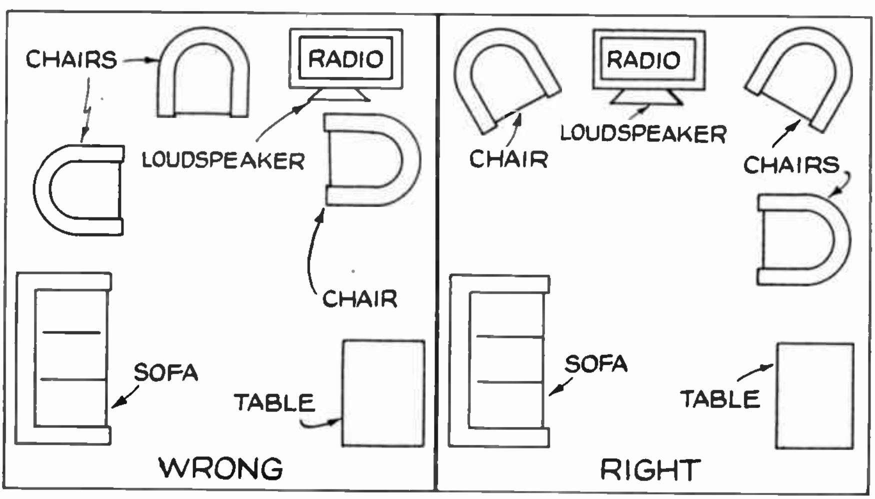


Fig. 61

CHAPTER XIX

How a Set Works

SUPER-HETERODYNE ACTION

(Q) Please explain what happens in a super-heterodyne; that is, how does its action differ from that of a simple T.R.F. or regenerative set?

(A) In a superhet, the incoming signal is amplified at radio frequency in the R.F. stage or stages which are usually present. It is then heterodyned, in a mixer tube or first detector, with a locally-generated frequency from the oscillator. There results a beat frequency (or intermediate frequency) which is amplified in the I.F. stage or stages, then rectified in the second detector. The resulting audio frequencies are amplified in the A.F. stages and fed into the reproducer. This is shown in simplified block diagram form as Fig. 62.

POWER PACK FUNCTIONS

(Q) What goes on in the power pack of a standard A.C. radio receiver?

(A) The line current is passed through the primary of a power transformer, which has two or more secondaries. One secondary steps the voltage up for the plate supply; another steps it down for the filament supply; another may supply the filament of the rectifier. The plate current is rectified (changed into D.C.) in the rectifier tube, and is filtered by means of chokes and condensers, or condensers alone, to remove the ripple from it. It is then fed to a voltage divider, from the taps of which the various voltages needed for the set are taken. In some sets, the voltage divider is omitted, individual resistors in various circuits performing the function. Fig. 63 shows this action.

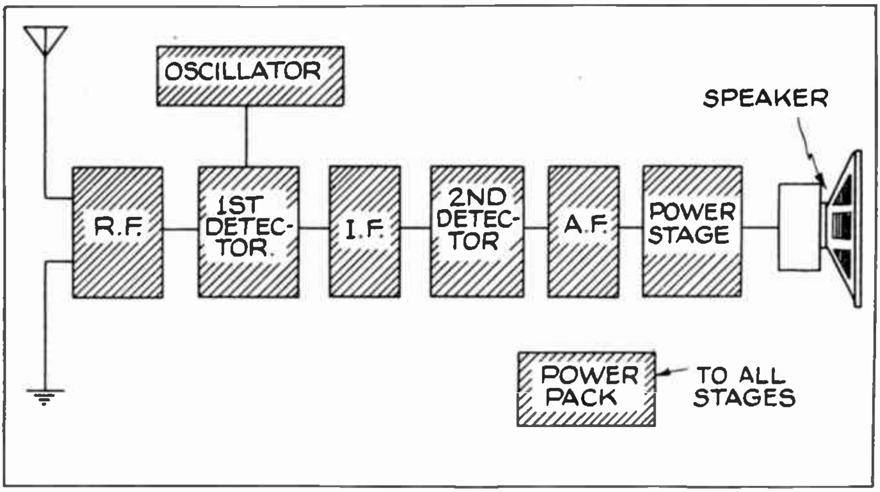


Fig. 62

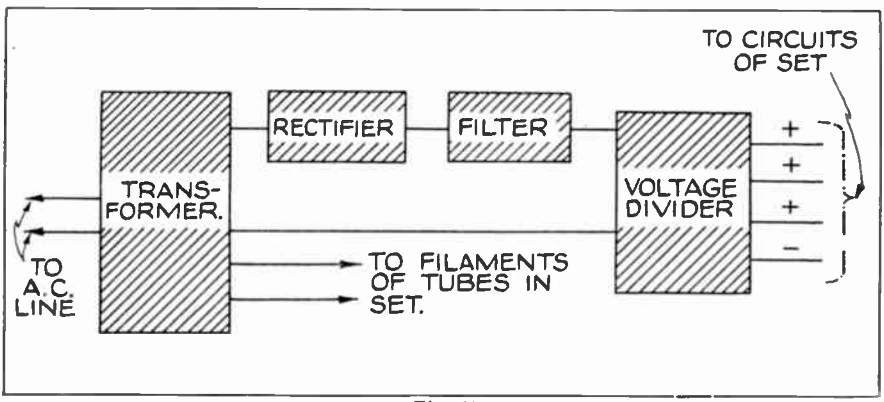


Fig. 63

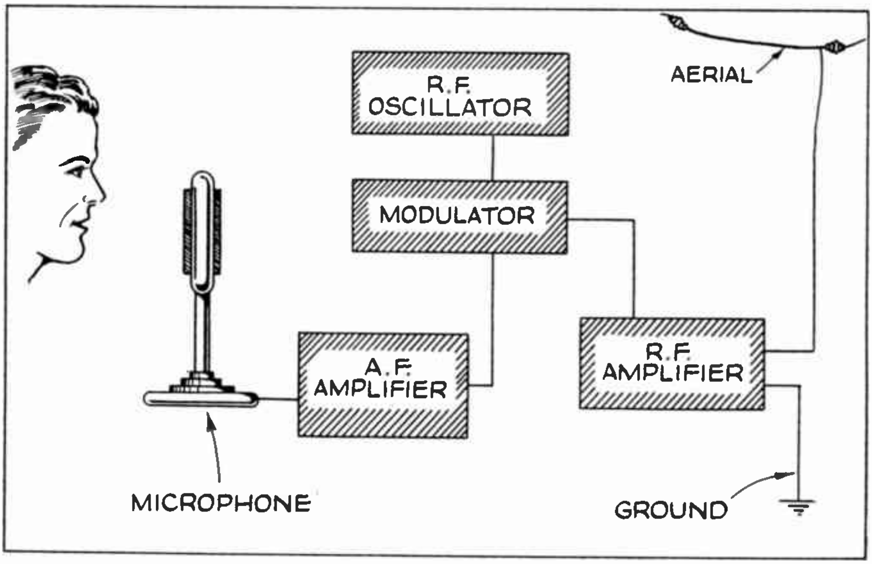


Fig. 64

ACTION AT TRANSMITTER

(Q) What happens to a sound wave from the time it leaves the singer's lips until it reaches the receiver?

(A) It first strikes the diaphragm of a microphone, causing this diaphragm to vibrate. The vibrating diaphragm drives a mechanism which sets up electrical impulses, which are amplified and impressed upon a locally-generated frequency (the carrier wave). This is again amplified and fed into an antenna system, from which it is radiated into space. Part of this wave strikes the antenna system of the receiver and is carried down the lead-in to the first stage of the receiver. For typical receiver action, see the answer to the preceding question. Fig. 64 shows a transmitter layout.

PRINCIPLE OF A.V.C

(Q) Please tell me upon what principle an automatic volume control works.

(A) The I.F. stages of a superhet are so connected that their grids are biased by the same resistor which is used in the cathode-plate circuit of a diode second detector. On a strong signal, there is greater potential drop in the resistor, thus altering the bias on the I.F. grids. See Fig. 65 for diagram.

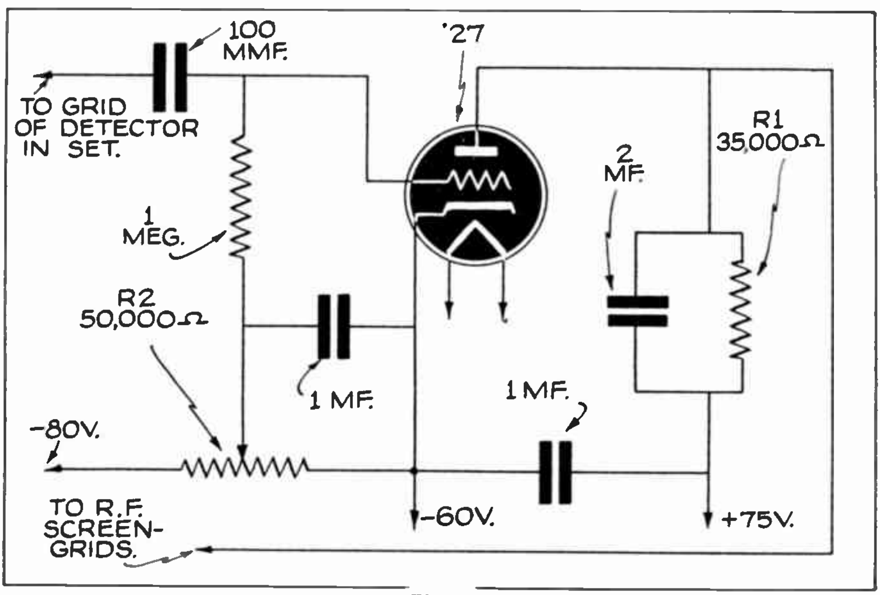


Fig. 65

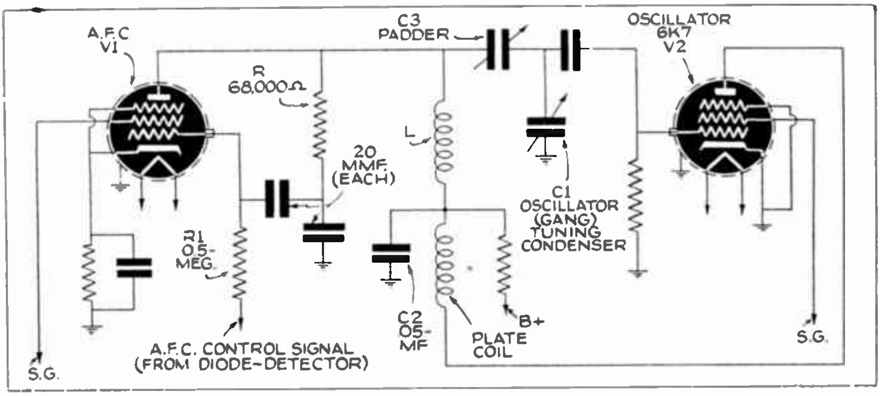


Fig. 66

CONNECTION OF A.F.C.

(Q) Can automatic frequency control be applied to any set? If so, please show a diagram.

(A) It can be, but it amounts to rebuilding the set, and should be done only by one who is thoroughly familiar with radio. The desired diagram is Fig. 66.

METHODS OF PUSH-BUTTON TUNING

(Q) Is it possible to have push-button tuning on a set without using a motor-driven tuning condenser? If so, how? And what is the basis of the condenser motor drive?

(A) It is possible. One such system makes use of a bank of trimmer condensers, each set of which can be adjusted to tune the R.F., desired station. Pressing button "1" puts one desired station. Pressing button "A" puts one set of these condensers into the circuit; button "2" puts in a second set, cutting out the first set; etc. Another system makes use of separate tunable inductances, similarly cut into and out of the circuit. The motor method simply makes use of a motor connected to the condenser by means of a clutch system. The motor is in circuit with a number of adjustable relays, which are closed by means of any of a number of push-buttons, and opened when the condenser shaft turns a disc or discs to a position which opens the relays. Fig. 67 shows various systems.

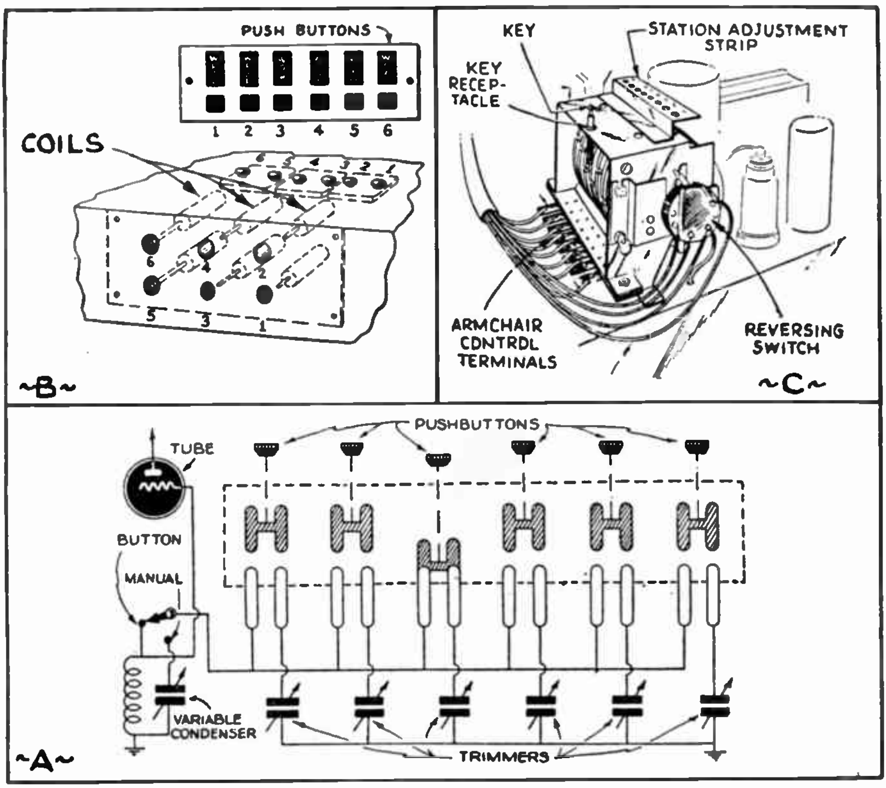


Fig. 67

CHAPTER XX

Handy Reference Data

CONVERSION CHART for WAVELENGTH, FREQUENCY and OSCILLATION CONSTANT

λ Wave length meters	f Multiply values below by 1,000	ω Multiply values below by 1,000	CL C in uf L in cm
1	300000	1884000	0.0003
2	150000	942000	.0011
3	100000	628000	.0018
4	75000	471000	.0045
5	60000	377000	.0057
6	50000	314200	.0101
7	42900	269000	.0138
8	37500	235500	.0180
9	33330	209400	.0228
10	30000	188400	.0282
15	20000	125600	.0635
20	15000	94200	.1129
25	12000	75400	.1755
30	10000	62800	.2530
35	8570	53800	.3446
40	7500	47100	.450
45	6670	41900	.570
50	6000	37700	.704
55	5450	34220	.852
60	5000	31420	1.014
65	4620	28970	1.188
70	4290	26900	1.378
75	4000	25150	1.583
80	3750	23520	1.801
85	3529	22120	2.034
90	3333	20920	2.280
95	3158	19830	2.541
100	3000	18840	2.816
105	2857	17940	3.105
110	2727	17130	3.404
115	2609	16380	3.721
120	2500	15710	4.05
125	2400	15070	4.40
130	2308	14480	4.76
135	2222	13950	5.13
140	2144	13450	5.52
145	2069	12980	5.92
150	2000	12560	6.34
155	1935	12150	6.76
160	1875	11770	7.20
165	1818	11410	7.66
170	1765	11080	8.13
175	1714	10760	8.62
180	1667	10470	9.12
185	1622	10180	9.63
190	1597	9910	10.16
195	1538	9660	10.71
200	1500	9420	11.26
205	1468	9190	11.83
210	1429	8970	12.41
215	1395	8760	13.01
220	1364	8560	13.62
225	1333	8370	14.25
230	1304	8190	14.89
235	1277	8020	15.55
240	1250	7850	16.22
245	1225	7690	16.90
250	1200	7540	17.60
255	1177	7390	18.31
260	1154	7250	19.03
265	1132	7110	19.77
270	1111	6980	20.52
275	1091	6860	21.29
280	1071	6740	22.07
285	1053	6620	22.87
290	1035	6500	23.66
295	1017	6380	24.50

λ Wave length meters	f Multiply values below by 1,000	ω Multiply values below by 1,000	CL C in uf L in cm
300	1000	6280	25.33
310	968	6080	27.05
320	938	5890	28.83
330	909	5700	50.66
340	882	5540	32.55
350	857	5380	34.48
360	833	5230	36.48
370	811	5090	38.54
380	790	4953	40.7
390	769	4830	42.8
400	750	4710	45.0
410	732	4590	47.3
420	714	4480	49.7
430	698	4380	52.0
440	682	4280	54.5
450	667	4190	57.0
460	652	4100	59.6
470	638	4010	62.3
480	625	3920	64.8
490	612	3842	67.6
500	600	3766	70.4
510	588	3692	73.3
520	577	3620	76.0
530	566	3552	79.0
540	556	3485	82.1
550	545	3422	85.2
560	536	3361	88.4
570	526	3302	91.4
580	517	3246	94.7
590	509	3193	98.0
600	500	3140	101.4
610	492	3088	104.7
620	484	3038	108.2
630	476	2990	111.7
640	469	2942	115.4
650	462	2896	118.8
660	455	2852	122.5
670	448	2810	126.3
680	441	2768	130.2
690	435	2730	134.1
700	429	2692	137.8
710	423	2654	141.9
720	417	2616	145.9
730	411	2580	150.0
740	405	2544	154.0
750	400	2510	158.3
760	394.8	2476	162.6
770	389.6	2443	166.8
780	384.6	2412	171.4
790	379.8	2382	175.6
800	375.0	2353	180.1
810	370.4	2325	184.7
820	365.9	2297	189.3
830	361.4	2270	194.0
840	357.1	2242	198.5
850	352.9	2214	203.4
860	348.8	2188	208.2
870	344.8	2162	213.2
880	340.9	2138	217.9
890	337.1	2115	222.9
900	333.3	2092	228.0
910	329.7	2070	233.2
920	326.1	2047	238.1
930	322.6	2024	243.4
940	319.1	2003	248.7
950	315.8	1982	254.1
960	312.5	1962	259.5
970	309.3	1942	264.7
980	306.1	1922	270.4
990	303.0	1902	275.9

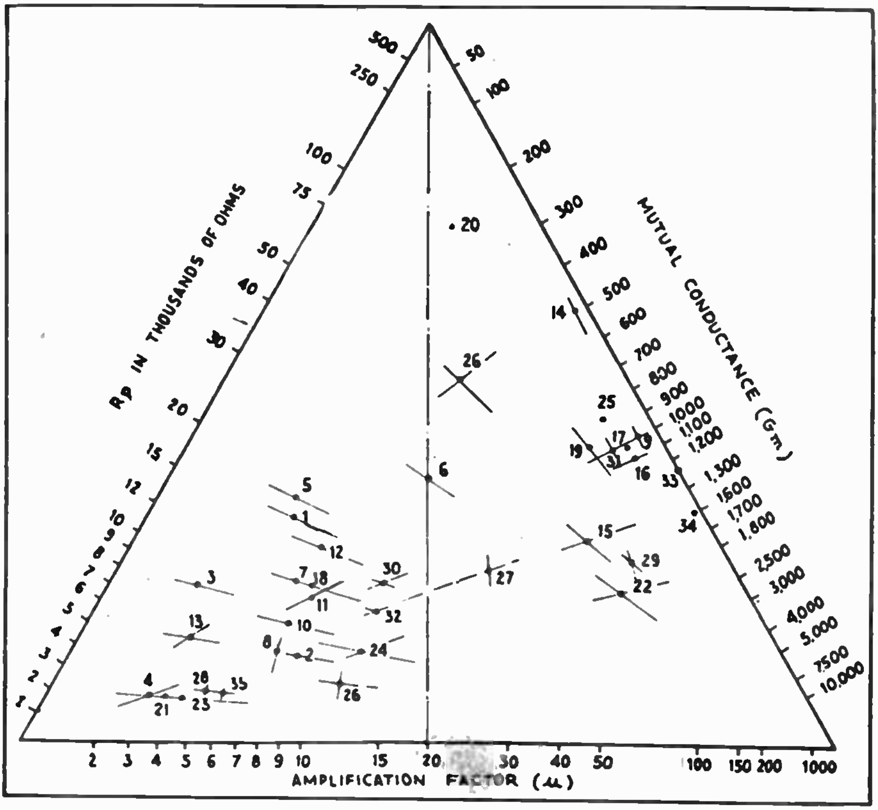
λ Wave length meters	f Multiply values below by 1,000	ω Multiply values below by 1,000	CL C in uf L in cm
1000	300.0	1884	281.6
1050	285.7	1794	310.5
1100	272.7	1712	340.4
1150	260.9	1637	372.1
1200	250.0	1570	405
1250	240.0	1506	440
1300	230.8	1448	478
1350	222.2	1395	512
1400	214.4	1346	552
1450	206.9	1298	592
1500	200.0	1256	634
1550	193.5	1215	676
1600	187.5	1177	720
1650	181.8	1142	766
1700	176.5	1108	813
1750	171.4	1076	862
1800	166.7	1046	912
1850	162.2	1017	963
1900	157.9	990	1010
1950	153.8	965	1071
2000	150.0	942	1126
2050	146.3	920	1183
2100	142.9	898	1241
2150	139.5	876	1301
2200	136.4	856	1362
2250	133.3	838	1425
2300	130.4	819	1489
2350	127.7	801	1555
2400	125.0	784	1622
2450	122.5	768	1690
2500	120.0	755	1760
2550	117.7	738	1831
2600	115.4	724	1903
2650	113.2	710	1977
2700	111.1	697	2052
2750	109.1	684	2129
2800	107.1	672	2207
2850	105.3	660	2287
2900	103.5	648	2366
2950	101.7	638	2450
3000	100.0	628	2533
3500	85.7	538	3448
4000	75.0	471	4500
4500	66.7	418	5700
5000	60.0	377.	7040
5500	54.5	342.2	8520
6000	50.0	314.2	10140
6500	40.2	289.8	11880
7000	42.9	268.8	13780
7500	40.0	251.3	15830
8000	37.50	235.2	18010
8500	35.29	221.4	20340
9000	33.33	209.2	22800
9500	31.58	198.2	25410
10000	30.00	188.4	28160
15000	20.00	125.7	63400
20000	15.00	94.2	112600
25000	12.00	75.4	176000
30000	10.00	62.8	253300
35000	8.57	53.8	344800
40000	7.50	47.1	450000
45000	6.67	41.8	570000
50000	6.00	37.7	704000

TABLE OF "L-C CONSTANTS"

This table, reproduced on this page, shows the relationship which exists between wavelength, frequency, inductance and capacity; the latter two factors are combined under the heading CL —which is generally referred to as the "L-C constant," or the "oscillation constant." The calculations follow the Bureau of Standards figure, for the velocity of light, as 299,820,000 meters per second (instead of the older one—300,000,000 meters).

"TURNS * PER * INCH" of INSULATED WIRE							
B. & S. GAUGE	DCC	SCC	DSC	SSC	ENAM.	ENAM. SCC	and SSC
14	13.7	14.6	14.7	15.0	15.2	14.2	14.7
15	15.0	16.2	16.4	17.0	17.0	15.8	16.5
16	16.7	18.0	18.2	19.0	18.7	17.6	18.4
17	18.5	20.0	20.0	21.2	21.4	19.5	20.5
18	19.6	22.3	22.3	23.6	24.0	21.7	22.9
19	22.5	25.0	25.2	27.0	27.2	24.2	25.8
20	24.5	27.5	27.5	29.5	30.1	26.5	28.4
21	27.5	30.8	30.8	32.8	33.6	29.6	31.5
22	30.0	34.0	34.0	36.6	37.7	32.7	35.0
23	32.7	37.5	37.5	40.7	42.3	36.1	39.0
24	35.5	41.5	41.5	45.3	47.2	39.7	43.1
25	38.5	45.7	45.7	50.3	52.9	43.7	47.9
26	41.8	50.2	50.2	55.7	59.0	47.8	52.8
27	45.0	55.0	55.0	61.7	65.8	52.1	58.1
28	48.5	60.0	60.0	68.3	73.9	57.0	64.4
29	52.0	65.5	65.5	75.4	82.2	61.9	70.6
30	55.5	71.3	71.3	83.1	92.3	67.4	77.9
31	60.0	77.3	77.3	91.6	103.0	72.8	85.3
32	62.7	83.7	83.7	101.0	116.0	79.1	93.9
33	66.3	90.3	90.3	110.0	130.0	85.6	103.0
34	70.0	97.0	97.0	120.0	145.0	91.7	112.0
35	73.4	104.0	104.0	131.0	164.0	98.8	123.0
36	77.0	111.0	111.0	143.0	182.0	105.0	133.0
37	80.3	126.0	126.0	155.0	206.0	113.0	146.0
38	83.5	133.0	133.0	168.0	235.0	120.0	157.0
39	89.7	140.0	140.0	181.0	261.0	128.0	172.0

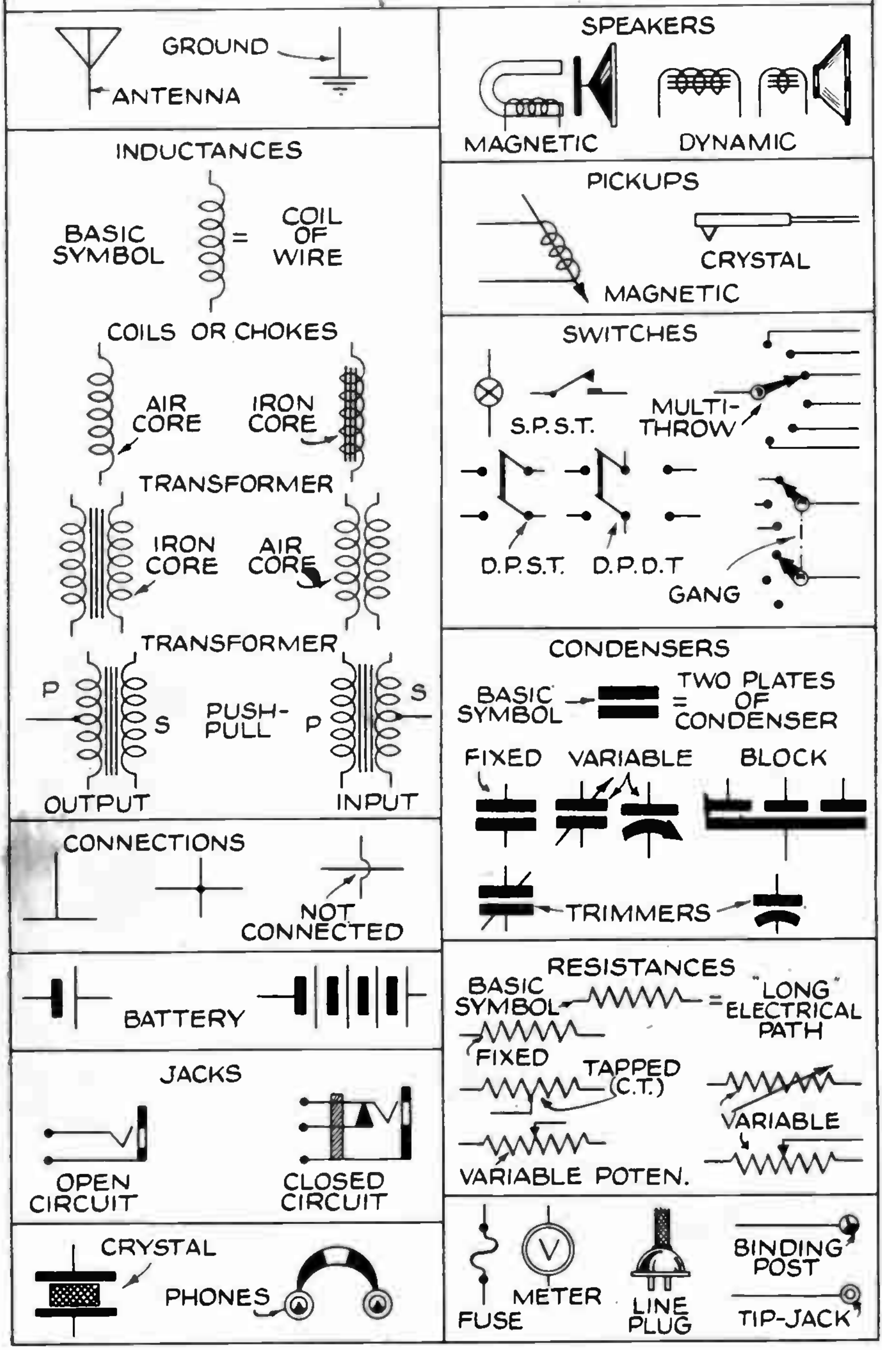
Simply by measuring the length of a coil, you are enabled to calculate the number of turns by using this table.



NOMOGRAPH OF TUBE CHARACTERISTICS

This figure reproduced above represents the following tubes: 1, WD-11, 12; 2, '12A; 3, '20; 4, '71A; 5, '99; 6, '00A; 7, '01A; 8, '10; 9, '24; 10, '26; 11, '27; 12, '30; 13, '31; 14, '32; 15, '33; 16, '35; 17, '36; 18, '37; 19, '38; 20, '40; 21, '45; 22, '47; 23, '50; 24, 852; 25, 865; 26, 211; 27, 841; 28, 845; 29, LA; 30, Wunderlich; 31, 44; 32, 56; 33, 57; 34, 58; 35, 46 (Class A). To read, draw a line from the apex which permits the desired characteristic to be indicated when the particular index dot is bisected. Other data on tubes and other equipment may be similarly plotted.

CHART OF RADIO SYMBOLS



OHM'S LAW--RELATIONS BETWEEN VOLTAGE, RESISTANCE, CURRENT & POWER

DIRECT CURRENT

Where I is CURRENT INTENSITY in AMPERES, R is RESISTANCE in OHMS, E is ELECTROMOTIVE FORCE in VOLTS and W is POWER in WATTS.

then:

$$I = \frac{E}{R} = \frac{W}{E} = \sqrt{\frac{W}{R}} \qquad R = \frac{E}{I} = \frac{W}{I^2} = \frac{E^2}{W}$$

$$E = I \times R = \frac{W}{I} = \sqrt{W \times R} \qquad W = E \times I = I^2 \times R = \frac{E^2}{R}$$

ALTERNATING CURRENT

Where Z is IMPEDANCE in OHMS, E is EFFECTIVE ElectroMotive Force in VOLTS, and I is CURRENT INTENSITY in AMPERES, then:

$$I = \frac{E}{Z} \qquad E = Z \times I \qquad Z = \frac{E}{I}$$

Where L is the INDUCTANCE in HENRIES and C the CAPACITY in FARADS, *f* is the FREQUENCY in CYCLES (per second) the in ohms,

The INDUCTIVE REACTANCE is:----$X_L = 6.283 \times f L$

The CAPACITATIVE REACTANCE is:---$X_C = \dfrac{1}{6.283 \times f C}$

The RESONANT FREQUENCY is:-------- $\dfrac{1}{6.283\sqrt{LC}}$

The IMPEDANCE Z is:

In a CAPACITATIVE Circuit:

$$Z = \sqrt{R^2 + \left(\frac{1}{6.283 \times f C}\right)^2}$$

In an INDUCTIVE Circuit:

$$Z = \sqrt{R^2 + (6.283 \times f \times L)^2}$$

In a Circuit having RESISTANCE, CAPCITY and INDUCTANCE:

$$Z = \sqrt{R^2 + \left(6.283 \times f \times L = \frac{1}{6.283 \times f C}\right)^2}$$

The RESONANT FREQUENCY of a PARALLEL circuit is:

$$fr = 0.159\sqrt{\frac{1}{LC} = \frac{R^2}{L^2}}$$

VACUUM-TUBE FORMULAS

AMPLIFICATION CONSTANT ("mu") $\mu = \dfrac{\text{Change in Plate Voltage (Ep)}}{\text{Change in Grid Voltage (Eg)}}$

PLATE IMPEDANCE (in ohms) $rp = \dfrac{\text{Change in Plate Voltage (Ep)}}{\text{Change in Plate Current (Ip)}}$

MUTUAL CONDUCTANCE $gm = \dfrac{\text{Change in Plate Current (Ip)}}{\text{Change in Grid Voltage (Eg)}}$

When the Plate Current is measured in Amperes; the MUTUAL CONDUCTANCE gm in MICROHMS $= \dfrac{\mu}{rp} \times 1{,}000{,}000$

When Eg is the Input Voltage, rp is the Plate Impedance and Rp is the External Plate Impedance or Load Impedance, the Voltage

Voltage Amplification $= \dfrac{\mu \times Eg^2 \times Rp}{rp + Rp}$

POWER OUTPUT

When Eg expresses the RMS (root-mean-square) Effective Value of the A. C. Input, the

Power Output $= \dfrac{\mu^2 \times Eg^2 \times Rp}{(rp + Rp)^2}$

The MAXIMUM Power Output is: $\dfrac{\mu^2 \times Eg^2}{4rp}$

The MAXIMUM UNDISTORTED Power Output is: $\dfrac{2\mu^2 \times Eg^2}{9rp}$

When Eg is the Maximum (Peak) A. C. Input Value

The Maximum Undistorted Power Output is: $\dfrac{\mu^2 \times Eg^2}{9rp}$

TRANSFORMER RATIOS

$\dfrac{\text{The Voltage across the Secondary}}{\text{The Voltage across the Primary}} = \dfrac{\text{The No. of Secondary Turns}}{\text{The No. of Primary Turns}}$

A. C. VOLTAGE and POWER

The MAXIMUM Voltage E_m is 1.414 x the EFFECTIVE Voltage E_e

The EFFECTIVE Voltage E_e is 0.707 x the MAXIMUM Voltage E_m

The AVERAGE Voltage E_a is 0.636 x the MAXIMUM Voltage E_m

The POWER in an A. C. Circuit $W = I \times E \times \frac{R}{Z}$

Where the ANGLE of LAG or lead, ϕ and the Power Factor $\frac{R}{Z} =$

COSINE ϕ SINE ϕ and TANGENT $\phi = \frac{X}{R}$

COMBINATIONS of RESISTANCES or CAPACITIES

The EFFECTIVE SUM of a COMBINATION of RESISTANCES (R) or of a COMBINATION of CAPACITIES (C) is as follows:

	In SERIES	In PARALLEL
RESISTANCES:	$R = R1 + R2 + R3$	$R = \dfrac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$
CAPACITIES:	$C = \dfrac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3}}$	$C = C1 + C2 + C3$

OSCILLATORY CIRCUIT VALUES

Where λ (lambda) is the WAVELENGTH in METERS, L is the INDUCTANCE in MICROHENRIES and C is the CAPACITY in MICROFARADS

The RESONANT FREQUENCY in CYCLES is: $Fr = \dfrac{159,160}{\sqrt{L \times C}}$

$(\lambda = 1885\sqrt{L \times C})$

The DECREMENT of a Circuit is (Delta) $\delta = \dfrac{R}{2frL} = 3.1416 \times \dfrac{R}{xL}$

Where the POWER FACTOR is: $\dfrac{R}{xL}$

CHAPTER XXI

Running a Radio Servicing Business

Q. How may I succeed in opening and running a radio servicing business?

(NOTE:—This question comes from so many persons, and deals with such an important problem—that of earning a livelihood—that considerable space must be given to its answer. The following data is from "Official Radio Service Handbook," by J. T. Bernsley, Gernsback Publications, N. Y. C.)

The sincere serviceman assiduously reads through all radio periodicals and technical releases, keenly watching for new equipment, new servicing data and new developments, as well as constantly reviewing theory on radio and electrical principles. The laggard in the servicing profession, who has only a mercenary interest in his work and who has no inclination to keep informed on developments in his profession, may have been successful in fooling his customers and himself in the past. In all probability such servicemen are now confronted by numerous difficulties whenever a modern receiver must be serviced, and exist only through the beneficence of their more skillful brethren to whom they "farm out" the more difficult repair jobs.

There is only one salvation for this type of serviceman and, incidentally, for beginners who may not lack for sincerity but require considerable additional practical experience and knowledge. This lies in a re-awakening and concentrated effort to master the principles underlying modern receiver design and servicing. Failure to do this will most certainly result in their elimination from the servicing profession, since the struggle to repair the ever increasingly complicated receiver will prove too arduous and in most cases unsuccessful.

Lest the efficient serviceman be content to rest on his laurels, he too must be warned not to shirk the necessity for continuous improvement in his radio knowledge. The fact that the design of the future receiver promises to become more complicated than ever should serve as a warning that any let-down in his studies will result in a handicap which will be most difficult to overcome.

What To Study. The many complex and diversified circuit arrangements of radio design require that the serviceman have first of all, a thorough grounding in electrical and radio fundamentals. Principles of magnetism, electricity, fundamental laws of electricity, vacuum tube theory, etc., subjects which every self-sufficient serviceman should have at his finger tips. The beginner in servicing will find the small Radio-Craft Library booklets on a number of radio subjects decidedly informative as well as comparatively inexpensive. Elementary text books dealing with the principles of electricity and radio are published by the following: McGraw Hill Book Co., N. Y. C.; John Wiley and Sons, Inc., N. Y. C., and D. Van Nostrand Co., N. Y. C. Pamphlets or listings of these books may be obtained from any of these companies. As an aid to servicemen and radio students, Radio-Craft magazine includes a book review department which describes in outline the contents of all valuable and newly released radio text books.

Many radio manufacturers continually release technical bulletins, pamphlets, service notes and diagrams, booklets and special instruction folders. While some of them are available at no cost to interested parties, those that are charged for are relatively so inexpensive and contain such valuable information that no serviceman should overlook them. For example, the tube manual published by the RCA-Radiotron Co. Inc., may be purchased for a maximum of 25c and contains complete characteristic and application data of all radio tubes as well as a wealth of fundamental data on tube operation. This information is of the greatest help to servicemen, especially when servicing receivers for which service diagrams may not be available. The tube manual released by the Sylvania Tube Corp. may be purchased for only 10c, and while not as elaborate as the RCA tube book, nevertheless contains much useful data on special receiving tubes and replacements. The Volume Control Guide available from Electrad, Inc. (N. Y. C.) is also indispensible for service work, since it contains volume control data such as resistance value, type of control, list price, etc. (which guides the serviceman in estimating the price of the repair) for practically all manufactured receivers. A very interesting and informative bulletin concerning condensers of all types and their application in industrial and radio fields, as well as receiver design fundamentals, may be obtained monthly for a very nominal sum. This bulletin, known as "The Research Worker", is available from the Aerovox Condenser Corp. Up-to-date information on the theory, design and practical servicing of auto receivers is available in "correspondence course" form from the Radiart Corp., Cleveland, Ohio. The course consists of a series of booklets, for which there is a nominal charge, and which contain a wealth of valuable information concerning vibrators, elimination of motor interference, automobile antennas, practical servicing hints, etc. An interesting and extremely valuable, to independent servicemen 'free monthly release is available from the RCA-Victor Co., Inc., Camden, N. J.' its title is "Good News". Besides containing a good deal of helpful servicing information, numerous suggestions are made for improving the servicing business, and frequently descriptions and suggestions are given of new sales helps and dealer display equipment. Many of these suggestions are excellent, and the displays (available for a small sum from this company) are of real help in stimulating tube sales and servicing business. Many other radio manufacturers release informative bulletins of a similar nature to those mentioned. An announcement of their publication and how to obtain them will be found every month in Radio Craft, as they are released.

Personality—Its Importance to the Serviceman. The greatest requirement, next to skill and knowledge, is that of proper *personality*. This is one of the best aids in securing a good position, impressing and satisfying a customer and as a result having a successful business. By "proper personality" the author refers to the demeanor or conduct of the serviceman,—the faculty of being a diplomatic conversationalist as well as having that appearance of sincerity and efficiency. Some servicemen, for example, are loquacious on a service call, engaging the customer in general conversation on every subject from weather to the New Deal while hap-hazardly tinkering with the radio set. Others are overly pompous—stride over to the radio receiver and put on an act of mystery and drama and generally leave the customer either very much befuddled or resentful. Then again we have some servicemen who always either indulge in glib high-pressure salesmanship or else continuously lament over the difficulty of the repair job and the lack of profit, especially when the receiver fails to satisfy and must be reserviced.

The really efficient serviceman with proper personality is the one who quietly goes about his business of servicing the receiver, speaks only when spoken to or else when he has a suggestion to make or is attempting to obtain the case history of the set. He never attempts to "kid" or entertain the customer, and while not reticent is neither verbose. He is especially considerate of the receiver and the surrounding furnishings, and does not spread his tools or servicing equipment all over. When his appraisal of the servicing work necessary is concluded, he specifies his estimate of the repair job to the customer with a satisfactory explanation as to the work involved—without qualms or apology or exaggerated guarantees. Such men are respected and sought after by all who deal with them.

Sales Hints—Improving Business. This subject will naturally interest most the "independent" and dealer-serviceman. Frankly, the author admits that he has some decided views on this subject which may differ from that of other authors and hence may cause some discussion. However, the reasoning is logical and the result of close study. In the first place the "independent" serviceman is only temporarily an independent, until he can either secure a permanent decent-paying position or else accumulate sufficient capital to become a *dealer-serviceman*. The dealer-serviceman is a combination of business man and service technician, and in addition to having the store at which he conducts his business, he must have a stock of parts and receivers the sale of which provides an income that supplements that derived from servicing.

The independent serviceman sells only his services that of repairing receivers, carries no stock and seldom has any overhead. He can improve his business only by being as efficient as possible and aggressive—and, this is the cause of most difficulty in this profession—by underbidding his competitor, the dealer-serviceman, on repair charges. In retaliation, the dealer-serviceman probably initiates free tube testing service, 50c inspection calls, and a host of other tricks which lead to intense friction and generally meagre profits, if any, in the income of each.

Consequently, the first step to improve business should be an alliance between the independent and the dealer-serviceman. Prices on repairs should be agreed upon; the independent serviceman should agree to purchase his parts from the dealer-serviceman, and allow him a reasonable profit to cover expenses, etc. The dealer-serviceman should, in turn, arrange to carry a convenient stock of replacement parts and agree to supply the independent with any material that he may need on a cost-plus-reasonable-profit basis. A spirit of cooperation between the two will not only result in improved business to both, but will also earn the respect of all concerned within the community.

The dealer-serviceman can further his sales by prominent and interesting window displays, generally available at little or no cost from most leading radio manufacturers whose lines he might stock. As a rule, the advertising departments of such manufacturers keep their dealer-servicemen continuously informed regarding the type of displays which are available. Failure to receive any display material from manufacturers whose products the dealer is carrying should result in an inquiry to the main office.

The prestige of the dealer-serviceman will be greatly enhanced if he should employ modern and complete servicing instruments. His workshop should be neatly arranged and include a complete variety of regular and special servicing tools. Hence, if any customer should walk in and observe the appearance of the shop, the impression made will aid in instilling confidence and respect for his servicing ability.

The stock of radio parts, and especially tubes, should be as complete as possible. The impression left with a prospective customer when some conventional item is not in stock is distinctly unpleasand and may result in the permanent loss of a good customer.

Suggestions On Repair Charges. Suggestions relative to repair charges can only be made in a vague and indefinite sense. The reason for this is that economic conditions in various parts of the country are so different that any recommended specific charge cannot possibly be applicable in all localities. John Jones, serviceman in Pine County, Wisconsin, might live very satisfactorily on an income of $20.00 a week. Albert Smith, serviceman in New York City, however, would require a minimum of 35.00 a week to live on the same scale as John Jones in Pine County. Obviously John Jones can afford to charge considerably less for his service than Albert Smith. In addition, the earning capacity of John Jones' neighbors is such as to prohibit a service charge which a New York serviceman might be required to make. Consequently, any recommendations made in regards to service charges must take into consideration these important factors.

Unfortunately both John Jones and Albert Smith must pay the same price for their test instruments and tools. Their education and skill in radio servicing is acquired only after the same laborious study and experience. Replacement parts cost each about the same, although in some cases the rural serviceman must pay slightly more for a hard-to-get item due to the shipping charges which are incurred when ordering from some radio supply house.

The complications and problems of price charging, as a result of the aforementioned, can only be best overcome by making service charges on the following basis: Service charges should be based on the *list price of the material* necessary to repair the set *plus a labor charge based on the time spent* in accomplishing the repair. A suggestion for rural servicemen is that they make a labor charge at the rate of 75c an hour, and to servicemen in large cities, a labor charge of 1.25 an hour.

Of course these suggested charges cannot be rigidly adhered to if irresponsible servicemen should suddenly start a campaign of price-cutting. Until such irresponsible parties and other detrimental factors are completely eliminated from this profession, no standardization of price charging can ever be possible.

Potential Fields For Advancement. If the serviceman was only aware of the numerous possibilities for advancement that exist in this field, then little urging would be necessary to convince him of the advantages of being thoroughly versed and up-to-date in his knowledge of radio principles and equipment.

As a matter of fact, the more skilled and successful servicemen are continuously seeking more information and experience in related branches of the radio industry. Many of them are now sufficiently versed in the complexities of theatre sound equipment and public address to be able to efficiently install and service such equipment. Some are furthering their knowledge by studying the design principles of broadcast transmitter equipment, whereas others are more interested in sound recording apparatus and methods. Obviously the motivating factor behind this interest is a keen desire to branch out into some allied but more remunerative field. In addition, the knowledge, experience and employment in these related industries legitimately entitles the serviceman to the more dignified appellation of "engineer." And few are the sincere servicemen who do not aspire and make every effort towards attaining this goal!

Hence, not only has the skilled and thoroughly versed service technician that greater advantage of being able to service all receivers more efficiently, but as a rule, such men are more successful in obtaining advanced radio positions with leading radio manufacturers. These positions pertain to field service, theatre sound equipment installation and service, lecturing engineer to other servicemen, police radio installation and service, aviation radio installation and service, etc., etc. It is self-evident that the mediocre or haphazard hit-or-miss type of serviceman can never hope for or aspire to such positions, unless of course, he should apply himself diligently to increasing his radio knowledge and skill.

Uplifting The Profession

Since this book is intended chiefly for servicemen or those contemplating entering the servicing field,—a frank and open discussion of the evils which exist in this profession is entirely in order. It will be agreed by all who have been in it for some time that conditions are far from being satisfactory, and that few are making a decent livelihood from radio service work at the present time. The constant necessity for new test instruments to facilitate the servicing of receivers that incorporated tremendous changes in design from year to year, the necessity for laborious and intensive study of the changes made and theory involved, and the constant expense for periodicals and books which furnish the information are all factors which serve as a millstone around the serviceman's neck.

The aforementioned expenses and effort would be gladly tolerated as a necessary evil, if it weren't for the fact that servicemen in general are so poorly paid. This is true regardless of the classification of servicemen, whether independent, dealer-serviceman, or the employed technician. The average salary of men who are employed in this profession in big cities seems to be approximately 30.00 per week. What the independent or dealer-serviceman earns may vary from a mere pittance to as high as $70.00 per week, but the latter figure is not only unusual but is attained only in season and by aggressive and expensive advertising, as well as long hours and hard work. In addition, the prestige of the serviceman is rather low, since he is regarded with contempt by others in the radio industry and, as a rule, distrusted by the average customer.

Cause of Evils in Servicing. What are the reasons for such conditions in this profession? How may they be overcome? What other profession, excepting the medical, requires that its men have such a thorough and diversified knowledge and skill, and such a variety of expensive instruments and tools to enable them to perform their work? The answers to these questions can only be obtained through close analysis and study of all the factors which are associated with the profession.

First of all, how does a man enter the servicing profession? How and where does he serve his apprenticeship and when does he become a full-fledged serviceman? Most would-be servicemen start as constructors or experimenters, and acquire their knowledge through practical experience in building sets and experimenting with circuits and by *constant study of circuit design and radio and electrical theory.* Others are graduates of radio schools and by intensive study can acquire, through this means, quite a bit of radio knowledge. Naturally, these men are anxious to perform service work at any opportunity, despite the fact that their practical training is still insufficient for thorough and efficient work. Each repair job presents a possibility of making some extra money, therefore why not do such work? There are no restrictions, no obstacle placed in their path, especially since replacement parts are available to anyone at wholesale prices from practically any radio mail order house. What does it matter that the repair job may not turn out completely satisfactory and that the stigma of inefficiency may be placed on the profession as a whole? Of course there is always the possibility of the repair being some simple and easy thing to effect, but then this author has seen some samples of simple radio jobs that were performed by auto mechanics or radio salesmen that should never be allowed any closer to a receiver chassis than the tuning controls.

The unfortunate thing about this situation is that there are quite a great many of such pseudo-servicemen. They glut the market by competing in repair quotations, vieing with regular servicemen for positions, and by indulging in all sorts of unethical and nefarious practices which are injurious to both the business and the good name of the profession. To eliminate them entirely is practically impossible, and in some cases impractical since many of these men can be reclaimed and may eventually turn out to be outstanding men in the profession. But their activity in servicing is causing many hardships among legitimate and skilled members of the profession. Hence, to minimize most of the evils in servicing, the author direct's the reader's attention to the following plan.

Proper Organizing—the Means of Overcoming Servicing Evils. The call to organize has undoubtedly been repeatedly heard by all active servicemen. While it has found favor with the majority there are nevertheless a considerable number who are reluctant to join, since previous service associations have consistently failed to accomplish anything towards remedying existing evils. The trouble, in most cases, has been that most organizations were either formulated without any specific plans, or else were gotten up by selfish parties interested only in exploiting the serviceman. The latter type of organization solicits membership applications from *any interested parties willing to pay dues.* It also obtains quite an income from manufacturers willing to have their equipment constantly brought to the attention of servicemen members. Even most so called "lectures", which these organizations supposedly give to educate the serviceman, are nothing but masqueraded publicity talks.

A sincere and bona-fide service organization can accomplish much towards "cleaning-up" in the profession. By mass pressure *radio mail order houses can be made to sell radio parts and equipment at wholesale to legitimate servicemen only.* What manufacturer or mail order house can afford to defy an organization of thousands of men? And, of course, men not deserving of the title of "servicemen" can then be ostracised from the profession by refusing them membership in the organization. Without a membership card they will not be able (if the organization is successful) to obtain replacement parts at wholesale prices, and hence cannot offer competition to legitimate servicemen. Apprentice servicemen (those not thoroughly experienced) should be given a membership card which will allow them to be employed as apprentices at a reduced wage scale. Until they attain the efficiency and knowledge of the skilled technician *they should not be entitled to purchase material at wholesale prices.* This would tend to discourage their activity as independent servicemen and will keep them confined to servicing sets under the supervision of their more skilled brethren.

The Proper Organization to Join. Obviously, for any such organization to be entirely successful it must be directed by sincere and honest men who are really interested in the welfare of the profession. It should preferably be national in scope, although consisting of a number of "chapters" or "locals", since the larger the organization and the greater the number of members, the more successful will be its endeavors to accomplish reforms.

What should prove of great interest, and serve as a model to servicemen in all parts of the country, is the recent success of the Radio Technicians' League of New York City in becoming affiliated with the American Federation of Labor. By obtaining a charter under the International Brotherhood of Electrical Workers with separate autonomy and other privileges, it has made tremendous strides in membership and the elimination of many local professional problems. There can be no question as to the improvement in the morale of its members. While they once waged a lone and almost futile fight for reforms, they now have the support and backing of all affiliated A. F. of L. unions. In addition, they now have the right to organize all metropolitan servicemen under a charter which recognizes them as a union of craftsmen to be governed by themselves.

Their platform consists of combating the policy of mail order houses to sell at wholesale to any Tom, Dick or Harry. They are making every effort to attain increased wages and lower working hours. Technical lectures and instruction talks are held twice a month. Each applicant for membership is given an examination and then graded as either a technician or apprentice. Examinations for grading are held each year, so that to maintain their status all technicians are forced to study and keep abreast with developments. The apprentice becomes a technician if he can pass the technician's examination. There are, of course, many other features which are typical of union organization such as free medical service, insurance, technical aid and advice, etc.

While the author does not meant to imply that success in organization can only be accomplished by affiliation with the American Federation of Labor, there are numerous features or advantages that will result from such an affiliation that will help tremendously in reaching the desired goal of the profession. The formation of individual groups or associations with their petty differences has been tried time and again, and the lack of cooperation and disinterest in the common problems has always resulted in complete failure to accomplish anything for the profession.

On the other hand, an organization of national scope, with all its chapters or locals strongly tied together, and bound to cooperate and work for the common good of all servicemen, must obtain some measure of success since the strength of such a union cannot fail to impress and affect the public, the employer and all other related parties.

How to Organize. It is a comparatively simple matter for a group of servicemen to get together and form an association. However, to do any real good for the profession as a whole, the author strongly advises against the formation of individual and disjointed groups which may pull against each other and thus cause more harm than any common good. It is for this reason that the author is a strong proponent of unionism, since each local or chapter is tied to a parent organization, the officials of which are elected by representatives from each local, and who must strive to do their best for the profession as a whole. There are a number of other features the mention of which should be unnecessary since practically everyone is familiar with the prestige of union labor organizations.

The success of teamsters, laundry-wagon drivers, chauffeurs, electrical workers, machinists, etc., etc., in acquiring decent working hours and substantial increases in salaries due to union organization, serve as splendid examples of this point. In contrast with the radio servicemen, these men require no intensive training or study, no elaborate and expensive equipment and yet make considerably more (with less effort and hours) than the majority of skilled technicians. It is the author's belief that if union organization can do this for the aforementioned trades, then it certainly should be able to accomplish as much for the servicemen of this nation. And, if affiliation with the A. F. of L. will give the serviceman the "break" he is looking for in getting decent working hours and wages, then by all means servicemen should affiliate with the A. F. of L.

On one thing we can all agree, present conditions are far from satisfactory to the majority of men in this profession. Something must and shall be done about it, and that something has its solution in organization of all men who are doing service work. Let us not have disjointed and individual clubs or associations working against each other! We must cease being the football for privately owned and sponsored organizations that are operated for selfish reasons and not for the good of the profession. This applies especially to associations that exact "dues" from its members and give them nothing in return but manufacturer's lectures designed to stimulate the merchandising of the manufacturer's products. Usually that type of association never even pays for the costs of the lecturers, and accomplishes this by working in agreement with the manufacturer who pays for all expenses in return for the publicity and credit that the association gets.

Let us have an organization for the serviceman, run by servicemen, and working in the interests of all servicemen. Avoid joining or affiliating with any club or association just for the sake of obtaining a few bulletins or releases that seldom, if ever, facilitate your work or aid you in your economic problems. Such an affiliation only serves to give that organization undeserving prestige, and helps to minimize the efforts and accomplishments of sincere servicemen associations. Investigate first whether the organization you contemplate joining is doing any real good for the profession. Determine whether the "club" has any interest in some particular radio manufacturer, and whether it runs sponsored lectures paid for by the manufacturer. Ascertain what its plans are in regards to the servicemen of the country, and look up its record for accomplishments in its period of existence. These points are all very important, if members of this profession are to be assured of the organization's sincerity to overcome the many evils that are responsible for the unwarranted and unsatisfactory conditions that exist in servicing today.

Best of all, if there is no sincere and active organized group of servicemen in your locality now, form such an organization as soon as possible. Hold technical or social and economic discussions and keep organized until an opportunity presents itself when you can affiliate with a larger and more active but thoroughly sincere organization that is national in scope. If present organizations are not sufficiently satisfactory to affiliate with, then such a national organization must appear soon. All it requires is the will and the spirit of the servicemen to create its existence.

This author will be pleased to hear from servicemen for comments, suggestions or desiring further advice concerning organization. It is conceded that the suggestions outlined may not be in accord with the beliefs or plans of all concerned in the servicing fraternity.

CHAPTER XXII

Conclusion

These, then, are the questions which seem to bother many radio fans and experimenters. But, of course, there are innumerable other queries which may rise to plague the radio enthusiast.

The most valuable knowledge which can be imparted to him is that which enables him to find the answers to his questions through independent investigation.

The procedure is simple: it consists merely in knowing whom to ask.

For problems involving the installation, operation or repair of factory-built apparatus, the best source of information is the service department of the manufacturer. In seeking information, give all the available data about the receiver in question, being sure to include the make and model number (usually to be found on a plate attached to the cabinet or chassis).

For problems involving the use of parts, the correct source is the manufacturer of the part. He is anxious that it perform to your satisfaction, and his service department will help you in every possible way.

Information relative to amateur requirements, broadcasting regulations, etc., may be obtained from the Federal Communications Commission, in Washington, D. C., or from the U. S. Supervisor of Radio in your district.

Data on schedules of short-wave or broadcast stations is best secured from the stations themselves. Information as to general station listings can be had from any of the call books sold on newsstands.

Technical information can be had by referring to standard text books and technical magazines. This includes circuits for sets which the inquirer wishes to construct.

All other queries (and there are not many which do not fall into the foregoing categories) can be had from the questions and answers departments of various technical radio magazines.

BY-PASS CONDENSER, GRID-BIAS RESISTOR CHART

Type Tube	Purpose	Plate Volts	Screen Volts	Grid Volts	Grid Resistor in OHMS	By-pass Cap. in Mfds.
2A3	A	250	—	—45	750	20.
2A5	A	250	250	—16.5	400	25.
2A6	A	250	—	—2	2500	2.
2A7	C	250	100	—3	500	.1
2B7	A(rf)	100	100	—3	400	.1
2B7	A(rf)	250	100	—3	250	.1
2B7	A(af)	250	50	—4.5	7000	1.
6A7	A	100	100	—6.5	600	25.
6A7	A	180	180	—12	500	25.
6A7	C	250	100	—3	500	.1
6B7	A(rf)	100	100	—3	4000	.1
6B7	A(rf)	250	125	—3	2500	.1
6B7	A(af)	250	50	—4.5	7000	1.
6F7	A	100	—	—3	500	2.
6F7	A	250	100	—3	400	.1
6F7	Mixer	250	100	—10	2500	.1
24A	A(rf)	190	90	—3	500	.1
24A	A(rf)	250	90	—3	500	.1
24A	A(af)	500	75	—4.5	3000	1.
24A	Det	275	30	—5	50000	1.
26	A	90	—	—7	2500	1.
26	A	180	—	—14.5	2250	1.
27	A	135	—	—9	2000	1.
27	A	250	—	—21	4000	1.
27	Det	250	—	—30	50000	1.
35	A(rf)	180	90	—3	350	.1
35	A(rf)	250	90	—3	350	.1
36	A(rf)	100	55	—1.5	800	.1
36	A(rf)	180	90	—3	1000	.1
36	A(rf)	250	90	—3	600	.1
36	Det	100	55	—5	50000	.3
36	Det	250	90	—8	80000	.5
37	A	90	--	—6	2500	1.
37	A	180	--	—13.5	3000	1.

BY-PASS CONDENSER, GRID-BIAS RESISTOR CHART

Type Tube	Purpose	Plate Volts	Screen Volts	Grid Volts	Grid Resistor in OHMS	By-pass Cap. in Mfds.
37	A	250	—	—18	2500	1.
37	Det	90	—	—10	50000	.5
37	Det	250	—	—28	140000	.5
38	A	100	100	—9	1000	10.
38	A	180	180	—18	1000	10.
38	A	250	250	—25	1000	10.
39	A(rf)	90	90	—3	400	.1
39	A(rf)	180	90	—3	400	.1
39	A(rf)	250	90	—3	400	.1
41	A	100	100	—15	600	25.
41	A	180	180	—13.5	600	25.
41	A	250	250	—18	500	25.
42	A	250	250	—16.5	400	25.
43	A	100	100	—15	600	25.
43	A	135	135	—20	500	25.
45	A	250	250	—50	1500	10.
46	A	250	—	—33	1500	10.
47	A	250	250	—16.5	400	25.
48	A	125	100	—22.5	400	10.
49	A	135	—	—20	350	10.
50	A	450	—	—84	1500	10.
55	A	180	—	—13.5	2250	10.
55	A	250	—	—20	2500	10.
56	A	250	—	—13.5	2500	1.
56	Det	250	—	—20	100000	.1
57	A(rf)	250	100	—3	1000	.1
57	Det	250	100	—4	4000	.5
58	A(rf)	250	100	—3	300	.1
59	Triode	250	—	—28	1000	20.
59	Pent	250	250	—18	400	25.
71A	A	180	—	—43	2000	20.
75	A	250	—	—1.5	3500	10.
77	A(rf)	100	60	—1.5	700	.1
77	A(rf)	250	100	—3	1000	.1
77	Det	250	50	—2	3000	1.
78	A(rf)	90	90	—3	400	.1
78	A(rf)	180	75	—3	600	.1
78	A(rf)	250	100	—3	350	.1
85	A	135	—	—10.5	3000	10.
85	A	180	—	—13.5	2250	10.
85	A	250	—	—20	2500	10.
89	Triode	160	—	—20	1000	10.
89	Triode	180	—	—22.5	1000	10.
89	Triode	250	—	—31	1000	20.
89	Pent	100	100	—10	900	25.
89	Pent	180	180	—18	800	25.
89	Pent	250	250	—25	700	20.

Abbreviations:

A—means class A amplifier.
Det—means Detector
af—means audio frequency
rf—means radio frequency
Pent—means Pentode
Mixer—means first detector of a superhet

Resistor values are given in sizes stocked everywhere and are satisfactory for most conditions.

Condenser values are chosen with the question of frequency of signals involved and circuit conditions.

(This tabulation of grid-bias resistors and by-pass condensers used with different tubes at different voltages and in different parts of the radio set circuits should be useful to servicemen and experimenters alike.)

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