RADIOTRON

REFERENCE BOOK

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1940

RADIO TUBE REFERENCE BOOK

1940

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RCA Manufacturing Co., Inc.
CAMDEN, N. J.

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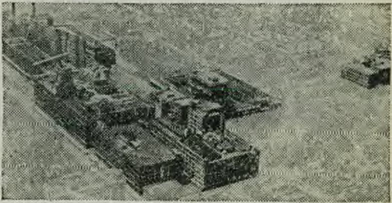
RCA
AND THE RADIO SERVICE BUSINESS



Realizing that there is a world of information that must be immediately available to the radio service man, RCA takes pride in presenting this, the 1940 edition of the RCA Reference Book, to the radio service men of America. To the best of our knowledge this is the only book of its kind ever issued. It consists of a complete and carefully compiled list of terms, technical charts, diagrams and statistics which are bound to play an important part in the business activity of every radio service dealer and every radio engineer.

It is important, however, not to conclude that all information used in radio servicing is compiled herein, but everything possible has been done to condense this information without sacrificing its effectiveness.

Undoubtedly you will find valuable information which will be helpful in your business. Indeed if that much is done for you, then this booklet will have amply justified itself.

In these highly competitive days success in radio service business requires more than a sound technical knowledge and up-to-date efficient service equipment. Even expertly trained service engineers who work on the theory that radio owners will "build a path to their door" will fall short of capitalizing on existing opportunities if they fail to recognize the importance of selling their services aggressively. RCA offers radio service men this opportunity.

As prominently as the RCA trade-mark stands for leadership in every phase of the radio business, so the achievements of RCA engineers stand out in the field of radio research. Service men who have studied radio know that to catalog the contributions of RCA to the radio and television art is to write much of its history. So, too, RCA can contribute as much and even more to the radio service profession.

When you offer RCA Radio Tubes and Parts to your customers in connection with your professional services, you are associating *your* name with the greatest name in radio — RCA. When you use RCA Test Equipment, you are using products backed by the only organization that is active in every phase of radio and television — from the microphone in the studio to the radio set in the home — from the television camera iconoscope in the studio to the television receiver kinescope in the home.

This handy reference book is evidence of the close cooperation between RCA and radio service men. Our interests and problems are mutual and it is this, together with the close cooperation in technical matters which has always linked us and always will.

U. S. POPULATION BY STATES
RADIO SETS BY STATES

STATE	POPULATION	FAMILIES	RADIO SETS
Alabama	2,895,000	670,000	375,000
Arizona	412,000	104,000	79,600
Arkansas	2,048,000	501,000	254,800
California	6,154,000	1,818,000	1,719,000
Colorado	1,071,000	288,000	233,500
Connecticut	1,741,000	437,000	402,100
Delaware	261,000	67,000	57,600
Dist. Columbia	627,000	168,000	152,900
Florida	1,670,000	443,000	297,900
Georgia	3,085,000	716,000	370,800
Idaho	493,000	124,000	98,700
Illinois	7,878,000	2,063,000	1,857,100
Indiana	3,474,000	934,000	816,800
Iowa	2,552,000	680,000	577,800
Kansas	1,864,000	501,000	367,800
Kentucky	2,920,000	708,000	494,900
Louisiana	2,132,000	510,000	297,400
Maine	856,000	221,000	201,100
Maryland	1,679,000	410,000	355,100
Massachusetts	4,426,000	1,104,000	1,019,200
Michigan	4,830,000	1,220,000	1,122,000
Minnesota	2,652,000	652,000	556,900
Mississippi	2,023,000	494,000	207,000
Missouri	3,989,000	1,072,000	822,800
Montana	539,000	142,000	114,600
Nebraska	1,364,000	352,000	284,100
Nevada	101,000	30,000	28,500
New Hampshire	510,000	136,000	124,400
New Jersey	4,343,000	1,098,000	1,022,500
New Mexico	422,000	102,000	62,300
New York	12,959,000	3,382,000	3,132,300
North Carolina	3,492,000	736,000	408,600
North Dakota	706,000	156,000	119,600
Ohio	6,733,000	1,777,000	1,641,500
Oklahoma	2,548,000	619,000	454,300
Oregon	1,027,000	299,000	285,400
Pennsylvania	10,176,000	2,452,000	2,206,400
Rhode Island	681,000	169,000	155,500
South Carolina	1,875,000	407,000	207,300
South Dakota	692,000	167,000	132,900
Tennessee	2,893,000	689,000	459,900
Texas	6,172,000	1,516,000	1,033,500
Utah	519,000	123,000	111,000
Vermont	383,000	99,000	88,600
Virginia	2,706,000	613,000	400,200
Washington	1,658,000	468,000	443,300
West Virginia	1,865,000	417,000	348,300
Wisconsin	2,926,000	735,000	612,700
Wyoming	235,000	62,000	49,800

Technical Definitions*

"A" Power Supply A power supply device providing heating current for the cathode of a vacuum tube.

Alternating Current A current, the direction of which reverses at regularly recurring intervals, the algebraic average value being zero.

Amplification Factor A measure of the effectiveness of the grid voltage relative to that of the plate voltage in affecting the plate current.

Amplifier A device for increasing the amplitude of electric current, voltage or power, through the control by the input power of a larger amount of power supplied by a local source to the output circuit.

Anode An electrode to which an electron stream flows.

Antenna A conductor or a system of conductors for radiating or receiving radio waves.

Atmospherics Strays produced by atmospheric conditions.

Attenuation The reduction in power of a wave or a current with increasing distance from the source of transmission.

Audio Frequency A frequency corresponding to a normally audible sound wave. The upper limit ordinarily lies between 10,000 and 20,000 cycles.

Audio-Frequency Transformer A transformer for use with audio-frequency currents.

Autodyne Reception A system of heterodyne reception through the use of a device which is both an oscillator and a detector.

Automatic Volume Control A self-acting device which maintains the output constant within relatively narrow limits while the input voltage varies over a wide range.

"B" Power Supply A power supply device connected in the plate circuit of a vacuum tube.

Baffle A partition which may be used with an acoustic radiator to impede circulation between front and back.

Band-Pass Filter A filter designed to pass currents of frequencies within a continuous band limited by an upper and a lower critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies outside of that band.

Beat A complete cycle of pulsations in the phenomenon of beating.

Beat Frequency The number of beats per second. This frequency is equal to the difference between the frequencies of the combining waves.

Beating A phenomenon in which two or more periodic quantities of different frequencies react to produce a resultant having pulsations of amplitude.

Broadcasting Radio transmission intended for general reception.

By-Pass Condenser A condenser used to provide an alternating-current path of comparatively low impedance around some circuit element.

"C" Power Supply A power supply device connected in the circuit between the cathode and grid of a vacuum tube so as to apply a grid bias.

Capacitive Coupling The association of one circuit with another by means of capacity common or mutual to both.

Carbon Microphone A microphone which depends for its operation upon the variation in resistance of carbon contacts.

Carrier A term broadly used to designate carrier wave, carrier current, or carrier voltage.

Carrier Frequency The frequency of a carrier wave.

Carrier Suppression That method of operation in which the carrier wave is not transmitted.

Carrier Wave A wave which is modulated by a signal and which enables the signal to be transmitted through a specific physical system.

Cathode The electrode from which the electron stream flows. (See Filament.)

Choke Coil An inductor inserted in a circuit to offer relatively large impedance to alternating current.

Class A Amplifier A class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

Class AB Amplifier A class AB amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle.

Class B Amplifier A class B amplifier is an amplifier in which the grid bias is approximately equal to the cut-off value so that the plate current is approximately zero when no exciting grid voltage is applied, and so that plate current in a specific tube flows for approximately one-half of each cycle when an alternating grid voltage is applied.

Class C Amplifier A class C amplifier is an amplifier in which the grid bias is appreciably greater than the cut-off value so that the plate current in each tube is zero when no alternating grid voltage is applied, and so that plate current flows in a specific tube for appreciably less than one-half of each cycle when an alternating grid voltage is applied.

Note:—To denote that grid current does not flow during any part of the input cycle, the suffix 1 may be added to the letter or letters of the class identification. The suffix 2 may be used to denote that grid current flows during some part of the cycle.

Condenser Loud Speaker A loud speaker in which the mechanical forces result from electrostatic reactions.

Condenser Microphone A microphone which depends for its operation upon variations in capacitance.

Continuous Waves Continuous waves are waves in which successive cycles are identical under steady state conditions.

Conversion Transconductance is the ratio of the magnitude of a single beat-frequency component $(f_1 + f_2)$ or $(f_1 - f_2)$ of the output current to the magnitude of the input voltage of frequency f_1 under the conditions that all direct voltages and the magnitude of the second input alternating voltage f_2 must remain constant. As most precisely used, it refers to an infinitesimal magnitude of the voltage of frequency f_1.

Converter (generally, in superheterodyne receivers.) A converter is a vacuum-tube which performs simultaneously the functions of oscillation and mixing (first detection) in a radio receiver.

Coupling The association of two circuits in such a way that energy may be transferred from one to the other.

Cross Modulation A type of intermodulation due to modulation of the carrier of the desired signal in a radio apparatus by an undesired signal.

Current Amplification The ratio of the alternating current produced in the output circuit of an amplifier to the alternating current supplied to the input circuit for specific circuit conditions.

Cycle One complete set of the recurrent values of a periodic phenomenon.

Damped Waves Waves of which the amplitude of successive cycles, at the source, progressively diminishes.

Decibel The common transmission unit of the decimal system, equal to $^1/_{10}$ bel.

$$1 \text{ bel} = 2 \log_{10} \frac{E_1}{E_2} = 2 \log_{10} \frac{I_1}{I_2}$$

(See Transmission Unit)

Detection is any process of operation on a modulated signal wave to obtain the signal imparted to it in the modulation process.

Detector A detector is a device which is used for operation on a signal wave to obtain the signal imparted to it in the modulation process.

Diaphragm A diaphragm is a vibrating surface which produces sound vibrations.

Diode A type of thermionic tube containing two electrodes which passes current wholly or predominantly in one direction.

Direct Capacitance (C) between two conductors—The ratio of the charge produced on one conductor by the voltage between it and the other conductor, divided by this voltage, all other conductors in the neighborhood being at the potential of the first conductor.

Direct Coupling The association of two circuits by having an inductor, a condenser, or a resistor common to both circuits.

Direct Current A unidirectional current. As ordinarily used, the term designates a practically non-pulsating current.

Distortion A change in wave form occurring in a transducer or transmission medium when the output wave form is not a faithful reproduction of the input wave form.

Double Modulation The process of modulation in which a carrier wave of one frequency is first modulated by the signal wave and is then made to modulate a second carrier wave of another frequency.

Dynamic Amplifier The RCA Dynamic Amplifier is a variable gain audio amplifier, the gain of which is proportional to the average intensity of the audio signal. Such an amplifier compensates for the contraction of volume range required because of recording or transmission line limitations.

Dynamic Sensitivity of a Phototube The alternating-current response of a phototube to a pulsating light flux at specified values of mean light flux, frequency of pulsation, degree of pulsation, and steady tube voltage.

Electro-Acoustic Transducer A transducer which is actuated by power from an electrical system and supplies power to an acoustic system or vice versa.

Electron Emission The liberation of electrons from an electrode into the surrounding space. In a vacuum tube it is the rate at which the electrons are emitted from a cathode. This is ordinarily measured as the current carried by the electrons under the influence of a voltage sufficient to draw away all the electrons.

Electron Tube A vacuum tube evacuated to such a degree that its electrical characteristics are due essentially to electron emission.

Emission Characteristic A graph plotted between a factor controlling the emission (such as the temperature, voltage, or current of the cathode) as abscissas, and the emission from the cathode as ordinates.

Facsimile Transmission The electrical transmission of a copy or reproduction of a picture, drawing or document. (This is also called picture transmission.)

Fading The variation of the signal intensity received at a given location from a radio transmitting station as a result of changes occurring in the transmission path. (See Distortion.)

Fidelity The degree to which a system, or a portion of a system, accurately reproduces at its output the signal which is impressed upon it.

Filament A cathode in which the heat is supplied by current passing through the cathode.

Filter A selective circuit network, designed to pass currents within a continuous band or bands of frequencies or direct current, and substantially reduce the amplitude of currents of undesired frequencies.

Frequency The number of cycles per second.

Full-Wave Rectifier A double element rectifier arranged so that current is allowed to pass in the same direction to the load circuit during each half cycle of the alternating-current supply, one element functioning during one-half cycle and the other during the next half cycle, and so on.

Fundamental Frequency The lowest component frequency of a periodic wave or quantity.

Fundamental or Natural Frequency (of an antenna). The lowest resonant frequency of an antenna, without added inductance or capacity.

Gas Phototube A type of phototube in which a quantity of gas has been introduced, usually for the purpose of increasing its sensitivity.

Grid An electrode having openings through which electrons or ions may pass.

Grid Bias The direct component of the grid voltage.

Grid Condenser A series condenser in the grid or control circuit of a vacuum tube.

Grid Leak A resistor in a grid circuit, through which the grid current flows, to affect or determine a grid bias.

Grid-Plate Transconductance The name for the plate current to grid voltage transconductance. (This has also been called mutual conductance.)

Ground System (of an antenna) That portion of the antenna system below the antenna loading devices or generating apparatus most closely associated with the ground and including the ground itself.

Ground Wire A conductive connection to the earth.

Half-Wave Rectifier A rectifier which changes alternating current into pulsating current, utilizing only one-half of each cycle.

Harmonic A component of a periodic quantity having a frequency which is an integral multiple of the fundamental frequency. For example, a component the frequency of which is twice the fundamental frequency is called the second harmonic.

Heater An electrical heating element for supplying heat to an indirectly heated cathode.

Heterodyne Reception The process of receiving radio waves by combining in a detector a received voltage with a locally generated alternating voltage. The frequency of the locally generated voltage is commonly different from that of the received voltage. (Heterodyne reception is sometimes called beat reception.)

Homodyne Reception A system of reception by the aid of a locally generated voltage of carrier frequency. (Homodyne reception is sometimes called zero-beat reception.)

Hot-Wire Ammeter, Expansion Type An ammeter dependent for its indications on a change in dimensions of an element which is heated by the current to be measured.

Indirectly Heated Cathode A cathode of a thermionic tube, in which heat is supplied from a source other than the cathode itself.

Induction Loud Speaker is a moving coil loud speaker in which the current which reacts with the polarizing field is induced in the moving member.

Inductive Coupling The association of one circuit with another by means of inductance common or mutual to both.

Interelectrode Capacitance The direct capacitance between two electrodes.

Interference Disturbance of reception due to strays, undesired signals, or other causes; also, that which produces the disturbance.

Intermediate Frequency, in Superheterodyne Reception A frequency between that of the carrier and the signal, which results from the combination of the carrier frequency and the locally generated frequency.

Intermodulation The production, in a non-linear circuit element, of frequencies corresponding to the sums and differences of the fundamentals and harmonics of two or more frequencies which are transmitted to that element.

Interrupted Continuous Waves Interrupted continuous waves are waves obtained by interruption at audio frequency in a substantially periodic manner of otherwise continuous waves.

Kilocycle When used as a unit of frequency, is a thousand cycles per second.

Lead-In That portion of an antenna system which completes the electrical connection between the elevated outdoor portion and the instruments or disconnecting switches inside the building.

Linear Detection That form of detection in which the audio output voltage under consideration is substantially proportional to the modulation envelope throughout the useful range of the detecting device.

Loading Coil An inductor inserted in a circuit to increase its inductance but not to provide coupling with any other circuit.

Loud Speaker A telephone receiver designed to radiate acoustic power into a room or open air.

Magnetic Loud Speaker One in which the mechanical forces result from magnetic reactions.

Magnetic Microphone A microphone whose electrical output results from the motion of a coil or conductor in a magnetic field.

Master Oscillator An oscillator of comparatively low power so arranged as to establish the carrier frequency of the output of an amplifier.

Megacycle When used as a unit of frequency, is a million cycles per second.

Mercury-Vapor Rectifier. A mercury-vapor rectifier is a two electrode, vacuum-tube rectifier which contains a small amount of mercury. During operation, the mercury is vaporized. A characteristic of mercury-vapor rectifiers is the low-voltage drop in the tube.

Microphone A microphone is an electro-acoustic transducer actuated by power in an acoustic system and delivering power to an electric system, the wave form in the electric system corresponding to the wave form in the acoustic system. This is also called a telephone transmitter.

Mixer Tube (generally, in superheterodyne receivers.) A mixer tube is one in which a locally generated frequency is combined with the carrier-signal frequency to obtain a desired beat frequency.

Modulated Wave A modulated wave is a wave of which either the amplitude, frequency, or phase is varied in accordance with a signal.

Modulation is the process in which the amplitude, frequency, or phase of a wave is varied in accordance with a signal, or the result of that process.

Modulator A device which performs the process of modulation.

Monochromatic Sensitivity The response of a phototube to light of a given color, or narrow frequency range.

Moving-Armature Speaker A magnetic speaker whose operation involves the vibration of a portion of the ferromagnetic circuit. (This is sometimes called an electromagnetic or a magnetic speaker.)

Moving Coil Loud Speaker A moving coil loud speaker is a magnetic loud speaker in which the mechanical forces are developed by the interaction of currents in a conductor and the polarizing field in which it is located. This is sometimes called an Electro-Dynamic or a Dynamic Loud Speaker.

Mu-Factor A measure of the relative effect of the voltages on two electrodes upon the current in the circuit of any specified electrode. It is the ratio of the change in one electrode voltage to a change in the other electrode voltage, under the condition that a specified current remains unchanged.

Mutual Conductance (See Grid-Plate Transconductance.)

Oscillator A non-rotating device for producing alternating current, the output frequency of which is determined by the characteristics of the device.

Oscillatory Circuit A circuit containing inductance and capacitance, such that a voltage impulse will produce a current which periodically reverses.

Pentode A type of thermionic tube containing a plate, a cathode, and three additional electrodes. (Ordinarily the three additional electrodes are of the nature of grids.)

Percentage Modulation The ratio of half the difference between the maximum and minimum amplitudes of a modulated wave to the average amplitude, expressed in per cent.

Phonograph Pickup An electromechanical transducer actuated by a phonograph record and delivering power to an electrical system, the wave form in the electrical system corresponding to the wave form in the phonograph record.

Phototube A vacuum tube in which electron emission is produced by the illumination of an electrode. (This has also been called photo-electric tube.)

Plate A common name for the principal anode in a vacuum tube.

Power Amplification (of an amplifier)—The ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit.

Power Detection That form of detection in which the power output of the detecting device is used to supply a substantial amount of power directly to a device such as a loud speaker or recorder.

Pulsating Current A periodic current, that is, current passing through successive cycles, the algebraic average value of which is not zero. A pulsating current is equivalent to the sum of an alternating and a direct current.

Push-Pull Microphone One which makes use of two functioning elements 180 degrees out of phase.

Radio Channel A band of frequencies or wavelengths of a width sufficient to permit of its use for radio communication. The width of a channel depends upon the type of transmission. (See Band of Frequencies.)

Radio Compass A direction finder used for navigational purposes.

Radio Frequency A frequency higher than those corresponding to normally audible sound waves. (See Audio Frequency.)

Radio-Frequency Transformer A transformer for use with radio-frequency currents.

Radio Receiver A device for converting radio waves into perceptible signals.

Radio Transmission The transmission of signals by means of radiated electromagnetic waves originating in a constructed circuit.

Radio Transmitter A device for producing radio-frequency power, with means for producing a signal.

Rectifier A device having an asymmetrical conduction characteristic which is used for the conversion of an alternating current into a pulsating current. Such devices include vacuum-tube rectifiers, gas rectifiers, oxide rectifiers, electrolytic rectifiers, etc.

Reflex Circuit Arrangement A circuit arrangement in which the signal is amplified, both before and after detection, in the same amplifier tube or tubes.

Regeneration The process by which a part of the output power of an amplifying device reacts upon the input circuit in such a manner as to reinforce the initial power, thereby increasing the amplification. (Sometimes called "feedback" or "reaction.")

Resistance Coupling The association of one circuit with another by means of resistance common to both.

Resonance Frequency (of a reactive circuit)—The frequency at which the supply current and supply voltage of the circuit are in phase.

Rheostat A resistor which is provided with means for readily adjusting its resistance.

Screen Grid A screen grid is a grid placed between a control grid and an anode, and maintained at a fixed positive potential, for the purpose of reducing the electrostatic influence of the anode in the space between the screen grid and the cathode.

Secondary Emission Electron emission under the influence of electron or ion bombardment.

Selectivity The degree to which a radio receiver is capable of differentiating between signals of different carrier frequencies.

Sensitivity The degree to which a radio receiver responds to signals of the frequency to which it is tuned.

Sensitivity of a Phototube The electrical current response of a phototube, with no impedance in its external circuit, to a specified amount and kind of light. It is usually expressed in terms of the current for a given radiant flux, or for a given luminous flux. In general the sensitivity depends upon the tube voltage, flux intensity, and spectral distribution of the flux.

Service Band A band of frequencies allocated to a given class of radio communication service.

Side Bands The bands of frequencies, one on either side of the carrier frequency, produced by the process of modulation.

Signal The intelligence, message or effect conveyed in communication.

Single-Side-Band Transmission That method of operation in which one side band is transmitted, and the other side band is suppressed. The carrier wave may be either transmitted or suppressed.

Static Strays produced by atmospheric conditions.

Static Sensitivity of a Phototube The direct current response of a phototube to a light flux of specified value.

Stopping Condenser A condenser used to introduce a comparatively high impedance in some branch of a circuit for the purpose of limiting the flow of low-frequency alternating current or direct current without materially affecting the flow of high frequency alternating current.

Strays Electromagnetic disturbances in radio reception other than those produced by radio transmitting systems.

Superheterodyne Reception—Superheterodyne reception is a method of reception in which the received voltage is combined with the voltage from a local oscillator and converted into voltage of an intermediate frequency which is usually amplified and then detected to reproduce the original signal wave. (This is sometimes called double detection or supersonic reception.)

Swinging The momentary variation in frequency of a received wave.

Telephone Receiver An electro-acoustic transducer actuated by power from an electrical system and supplying power to an acoustic system, the wave form in the acoustic system corresponding to the wave form in the electrical system.

Television The electrical transmission of a succession of images and their reception in such a way as to give a substantially continuous reproduction of the object or scene before the eye of a distant observer.

Tetrode A type of thermionic tube containing a plate, a cathode, and two additional electrodes. (Ordinarily the two additional electrodes are of the nature of grids.)

Thermionic Relating to electron emission under the influence of heat.

Thermionic Emission Electron or ion emission under the influence of heat.

Thermionic Tube An electron tube in which the electron emission is produced by the heating of an electrode.

Thermocouple Ammeter An ammeter dependent for its indications on the change in thermo-electromotive force set up in a thermo-electric couple which is heated by the current to be measured.

Total Emission The value of the current carried by electrons emitted from a cathode under the influence of a voltage such as will draw away all the electrons emitted.

Transconductance The ratio of the change in the current in the circuit of an electrode to the change in the voltage on another electrode, under the condition that all other voltages remain unchanged.

Transducer A device actuated by power from one system and supplying power to another system. These systems may be electrical, mechanical, or acoustic.

Transmission Unit A unit expressing the logarithmic ratios of powers, voltages, or currents in a transmission system. (See Decibel.)

Triode A type of thermionic tube containing an anode, a cathode, and a third electrode, in which the current flowing between the anode and the cathode may be controlled by the voltage between the third electrode and the cathode.

Tuned Transformer A transformer whose associated circuit elements are adjusted as a whole to be resonant at the frequency of the alternating current supplied to the primary, thereby causing the secondary voltage to build up to higher values than would otherwise be obtained.

Tuning The adjustment of a circuit or system to secure optimum performance in relation to a frequency; commonly, the adjustment of a circuit or circuits to resonance.

Vacuum Phototube A type of phototube which is evacuated to such a degree that the residual gas plays a negligible part in its operation.

Vacuum Tube A device consisting of a number of electrodes contained within an evacuated enclosure.

Vacuum-Tube Transmitter A radio transmitter in which vacuum tubes are utilized to convert the applied electric power into radio-frequency power.

Vacuum-Tube Volt-Meter A device utilizing the characteristics of a vacuum tube for measuring alternating voltages.

Voltage Amplification The ratio of the alternating voltage produced at the output terminals of an amplifier to the alternating voltage impressed at the input terminals.

Voltage Divider A resistor provided with fixed or movable contacts and with two fixed terminal contacts;

Signal Tracing in Receiver Circuits

By John F. Rider

Signal tracing is a means of locating a defect by observing the performance of the receiver when a test signal is fed into the antenna input system of the receiver. To accomplish this end, signal tracing calls for observation of the presence, absence, and character of the test signal at key points of the receiver system. Supplementing this test is the measurement of those control voltages which are in any way associated with the signal. Final conclusions are reached by measurement of the operating voltages in those circuits where the signal tracing process has localized the fault.

The signal test is considered the primary or fundamental test. Secondary tests are those associated with the control and operating voltages, the former being considered to be the more important, although both are placed in the same category. As a follow-up of the voltage tests, we also employ, when necessary, a d-c resistance test. If the results of the signal-tracing test localize the defect to a certain component, it is possible to dispense with the voltage test and to apply the d-c resistance test to the component in question. Thus the actual routine subsequent to the signal-tracing test depends entirely upon existing conditions.

The sequence of signal-tracing, expressed in its simplest terms, is as follows: The test signal is traced through the receiver until some point is reached where it is no longer normal. Then supplementary tests are made at the point where the signal departs from normal, or in that portion of the system that is related to the particular section of the receiver where the signal first departs from normal. As is to be expected, however, there are instances when this sequence of operation is modified, but such variation does not occur frequently enough to interfere with the identification of the system as being of a certain general character.

Establishes Conditions of Signal

When we speak about the signal we include a number of items. Tracing the signal means all of the items to follow, but not necessarily a progressive test to check all of these conditions. For example, it might be necessary to establish whether the signal exists in those circuits where it should exist, whether it is absent from those circuits where it should not exist, and, furthermore, whether the signal has the proper level or intensity at certain specific points in the system in accordance with the manner in which the units operating upon the signal are intended to perform. Added to the above are such items as frequency, the presence of interfering signals, distortion, overload, hum, unbalanced signal voltages, etc.

Working with the signal-tracing routine as a means of localizing the defect, we embrace all of the components utilized in the receiver. This is so because the function of all of the components of a radio receiver is to secure proper operation of that receiver with respect to the signal, and hence, to show some effect, direct or indirect, upon the signal. Therefore, the process of signal tracing makes possible a definite indentification of the manner in which individual components function in addition to an identification of the manner in which complete sections of a receiver operate. Signal tracing, therefore, becomes a functional test of a complete receiver, of complete sections of a receiver, and of the individual components of a receiver,—all with respect to the signal.

Why do we select the signal as a basis of test? There is one very definite and sound reason for this choice. Expressed in simple words, it is because the signal is the *common denominator* of all communication systems. The simplest of all radio receivers has one thing in common with the most complicated of radio receivers. That common factor is the signal.

The signal is the fundamental, elemental, basic factor in all of these systems. Any number of defects may develop in a communication system, but if they do not influence the signal, the presence of the defect will never be known. On the other hand, the simplest defect is instantly recognized if of such character as to influence the signal so that it departs from normal. There is nothing mysterious about this close relation between the signal and operating condition. It is quite natural since the components used in the communication system—the receiver or transmitter—are employed in order to develop a certain signal.

Checked Under Operating Conditions

The first major advantage of signal tracing is that the receiver being tested is checked in *actual operation* or at least under operating conditions. This is of tremendous importance because of the large number of possible defects in a receiver which manifest themselves only when the system is in an operative state. The state of operation may not be productive of a normal signal because of the defect, but in order to be able to locate the defect it is necessary that the receiver power be "on."

Defects of the above variety do not always interfere with the operating potentials or the d-c resistance values in the various circuits, since they are not necessarily associated with open circuits or short circuits. All the connections are normal, yet the defect exists. Troubles of this type, in the past, have been representative of major service problems, essentially because of the absence of a trouble localizing technique which was capable of establishing the location of such defects without interfering with the operation of the receiver.

No matter what the function of the tube in a communication system, the signal-tracing process provides for a test of this tube right in the system without removing the tube from the circuit. Even if a tube is removed for a supplementary test in a tube checker, if such a test is considered necessary by the operator, a tremendous amount of time is saved in the process because the necessity for removing and checking each tube in a tube checker is eliminated. Only the tube under suspicion, as established by the signal-tracing test, is removed from its regular socket for a supplementary test.

It might be of incidental interest to briefly mention the tremendous superiority of a signal-tracing or functional test of a tube in its normal circuit rather than the conventional emission of mutual-conductance test. All receivers are not designed in exactly the same manner with respect to circuit constants, and, in many instances, tubes which are exceptionally good for one specific purpose may be unsuited for the r-f or i-f systems because of the regeneration introduced into the receiver. A new tube with slightly higher than normal mutual conductance may result in excessive regeneration and thereby interfere with the normal operation of the receiver. Then again, certain tubes with normal emission and mutual conductance values within the stated tolerance limits may oscillate over a certain portion of the frequency range of the receiver, but not over the complete frequency range. Thus, while the tube checker would show this tube to be normal and in good condition it may still not be suitable for the receiver in question.

Tubes Change Characteristics

Last, but by far not the least, are those cases of tubes which develop gas after a certain period of use and after the tube has reached a sufficiently high temperature. In some instances this period of use may be ten minutes, while in other cases it may take one or two hours. The routine test of such tubes is a tube checker for the required period of time and under the exact conditions,

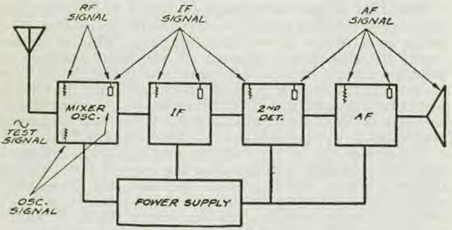


Figure 1

Block Diagram of Typical Receiver Circuit showing various stages.

prevailing in the receiver. Not knowing which tube is at fault, such tests in a tube checker would require expenditure of hours of testing time. On the other hand, a functional test of the receiver would indicate the development of a defect and would quickly enable the determination of the offending tube. Therefore, not only is the signal-tracing system independent of tube types, but it affords definite advantages over routine tube tests made with tube checkers.

An extremely important advantage of the signal-tracing method of trouble localization over other methods is its complete freedom from limitations due to circuit design. By circuit design we mean such items as *type of receiver*, that is, t-r-f, superheterodyne reflex, etc.; the *age of the receiver*, old or new; the *number of tubes*, which means systems ranging from those which employ no tubes as in a crystal receiver to a modern 25- or 30-tube receiver. It also covers the *origin of the receiver* which means receivers made in any part of the world.

It is possible to supplement the reference to "type" as contained in the foregoing paragraph by including a comment relating to individual specialized control circuits, as for example, automatic frequency control, automatic volume control, automatic bass compensation, automatic volume expansion, automatic selectivity control, and the like. Still another item associated with the comment that signal tracing as a means of localizing trouble is independent of circuit design, is *utility of the receiver*, which means classification of service, as, for example, the frequency range covered in the conventional multi-waveband home broadcast receiver, auto radio receiver, television receiver or facsimile receiver, and whether it embraces the police band, the commercial aircraft bands, the army and navy channels, carriers telephony, ship-to-shore channels as used by tugs and fishing fleets, etc.

All receivers, all circuits, revolve either directly or indirectly around some sort of a signal voltage, because all components in every receiver, no matter what the

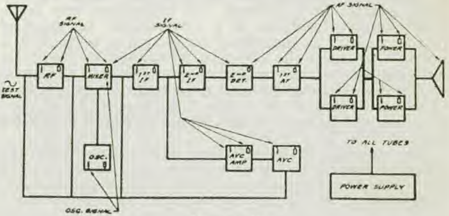


Figure 2

Block Diagram of Typical Receiver Circuit showing various stages.

nature of the circuit, have some bearing upon the signal passing through that receiver.

It might be well to investigate this statement. It can be described simply by saying that every circuit contains certain test points or locations where information relating to the signal, if not the signal itself, can be obtained. Any change in circuit design, in the number of tubes, in the type of circuit—in general, any difference among receivers—resolves itself into the number of test points or locations and the kind of information desired at these points.

It might be well at this time to illustrate these points with a few examples. Suppose that we consider Figs. 1 and 2. The former illustrates a comparatively simple superheterodyne receiver. The circuit is simple and few tubes are used. Special circuits are conspicuous by their absence. The latter receiver, however, is more elaborate. The number of tubes is greater, for separate oscillator and mixer tubes are used and an automatic volume control circuit with a separate AVC amplifier also is incorporated in the system. The number of i-f and a-f stages are increased. In general the receiver in Fig. 2 is more complex than in Fig. 1.

With signal tracing as the primary test, we have identified the major signal test points or test locations. The input circuits of the respective stages are indicated by the symbol for the grid and the output circuit is indicated by the symbol for the plate.

Signal Testing Routine Identical

Now if you compare these two block diagrams, you will note that there is no difference in signal-testing routine. In other words, the increased number of tubes and the change in circuits does not alter the general test locations. All that is changed is the *number* of signal test points at radio frequencies, intermediate frequencies, audio frequencies, etc. Even this statement is subject to qualifications, for while we show the increased number of signal test points, it does not necessarily mean that the signal is checked at each of these points. If you recall, the statement was made that complete sections of a receiver can be checked just as readily as individual components, so that it is possible to check the complete i-f system in Fig. 2 by working between the output of the mixer and the input of the demodulator (second detector), a test which is identical to that made in Fig. 1, although the number of tubes and individual test points in Fig. 2 is greater than in Fig. 1.

The routine of establishing facts concerning the signal is exactly the same in both cases, although the man who works upon the receiver must recognize certain inherent differences between the two receivers.

If you recall, we made mention of the fact that checking the control voltages was a vital function in the process of locating a defect by tracing the signal. Defining a control voltage so as to distinguish it from other d-c voltages found in receivers, we describe it as being *that d-c voltage which is developed as the result of a signal* and is employed to control the amplification provided in a tube or in a section of a radio receiver. Accordingly, we may encounter control voltages and control circuits in every portion of the receiver, as, for example, the r-f amplifier, the i-f amplifier and the a-f amplifier.

The process of testing control voltages is identical to that used to check signal voltages. Of course, there is a difference between the two voltages, the control voltage being of d-c character and the signal voltage being of a-c character, but the process of checking these voltages and interpreting them in terms of the action upon the signal consists of nothing more than establishing four essential facts. These are: (1) the function of the control voltage, (2) the source of the signal applied to the input of the control tube, (3) the control tube itself, and (4) the manner in which the control voltage is distributed to the various control points.

Checks Variation in Control Circuits

As in the previously mentioned cases of signal tracing, variations in control circuits mean nothing more than variations in the source of the signal voltage fed into the tube that develops the control voltage. It might be an i-f signal secured from any number of places in an i-f system and by various coupling means, or it might be an a-f signal secured from some place in the demodulator or audio system. Hence, a variation in the control system means a variation in the kind of signal being checked at the input of the tube which generates the control voltage and the point at which this signal is checked. Also, it may mean a variation in the number of points at which the control voltage developed in a tube is fed to the other tubes. Expressed differently, this would be a variation in the number of places where the control voltage is measured, depending entirely upon the design of the individual receiver.

For example, in Fig. 2, a tube marked "AVC" is used to develop the automatic-volume-control voltage. The i-f signal is secured from the second intermediate-frequency amplifier and the control voltage is fed to the r-f, mixer, and first i-f tubes. The exact type of tube being used to develop the AVC voltage is of no consequence. The AVC voltage is developed at the output circuit of this AVC tube and this voltage is then distributed to the various tubes under control. In a circuit such as this, there are four basic control-voltage test points: the source and the three control grids which receive the control voltage. We of course assume, as has been stated before, that the device used to measure these control voltages is of such design as not to interfere in any way with the normal operation of the circuits, that is, it does not load the circuits. In the event that the control voltage does not appear at the end of the various distribution points, then additional test points may be found in the distribution channels so as to identify the exact point where the interruption of the circuit occurs.

TELEVISION DEFINITIONS

Aspect Ratio: The Aspect Ratio of a frame is the numerical ratio of the frame width to frame height.

Audio (Latin, "I hear"): Pertaining to the transmission of sound.

Blanking Pulse: Pulses produced during the return time of the cathode-ray beam from the bottom to the top of the picture to "blank out" the undesirable signals produced by the return lines in both the Iconoscope and Kinescope.

Brightness Control: Brightness Control is the control which varies the average illumination of the reproduced image.

Coaxial Cable: Special telephone cable suitable for conveying television signals.

Contrast Control: A device on the receiver for adjusting the range of brightness between highlights and shadows in a picture.

D. C. Transmission: D. C. Transmission means the transmission of a television signal with the direct current component represented in the picture signal.

Field Frequency: Field Frequency is the number of times per second the frame area is fractionally scanned in interlaced scanning.

Focus Control: This control is used for adjustment of spot definition.

Frame: One complete picture. Thirty of these in the present system are shown in one second on a television screen.

Framing Control: This control is used for centering and adjusting the height and width of pictures.

Frame Frequency: Frame Frequency is the number of times per second the picture area is completely scanned.

Ghost: An unwanted image appearing in a television picture as a result of signal reflection.

Gobo: A light-deflecting fin used to direct light in the studio and protect the camera lens from glare.

Horizontal Centering: Adjustment of the picture position in the horizontal direction.

Horizontal Hold Control: This control is used for adjustment of the free-running period of the horizontal oscillator.

Height Control: This control is used for adjustment of the picture size in the vertical direction.

Iconoscope: A type of electronic cathode-ray pickup tube which has been developed by RCA.

It serves the dual purpose of analyzing the visible picture projected on its mosaic into elements and producing electrical impulses for each of these picture elements.

Interference: Disturbance of reception due to strays, undesired signals, or other causes; also, that which produces the disturbance.

Interlacing: A technique of dividing each picture into two sets of lines to reduce flicker.

Keystone: Shape of a reproduced image which is wider at the top than at the bottom or vice versa. This shape is caused by the method used in scanning mosaic of the Iconoscope.

Kinescope: A type of electronic cathode-ray receiver tube which has been developed by RCA.

It converts electrical impulses into picture elements which are visible to the eye.

Line: A single line across a picture, containing highlights, shadow, and half-tones.

Linearity Control: Adjustment of scanning wave shapes. May be qualified by the adjectives "Top," "Bottom," "Right," "Left."

Mosaic: Photo-sensitive plate mounted in the Iconoscope. The picture is imaged upon it and scanned by electron gun.

Negative Transmission (Modulation): Negative Transmission (Modulation) occurs when a decrease in initial light intensity causes an increase in the radiated power.

Panning: A horizontal sweep of the camera. (From "panorama.")

Pedestal: Pulse which "blanks out" the return line in the Kinescope.

Polarization: The particular property of an antenna system which determines its radiation characteristics. i.e.—Vertical or horizontal polarization.

Positive Transmission (Modulation): Positive Transmission (Modulation) occurs when an increase in initial light intensity causes an increase in the radiated power.

Progressive Scanning: Progressive Scanning is that in which the scanning lines trace one dimension substantially parallel to a side of the frame in which successively traced lines are adjacent.

Radio Channel: A band of frequencies or wavelengths of a width sufficient to permit of its use for radio communication. The width of a channel depends upon the type of transmission.

Return Line: Trace of the cathode-ray beam in returning from bottom to top of the picture.

Sawtooth: A wave of electric current or voltage employed in scanning.

Scanning: Scanning is the process of analyzing successfully, according to a predetermined method, the light values of picture elements constituting the total picture area.

Scanning Line: A Scanning Line is a single continuous narrow strip which is determined by the process of scanning.

Shading: Reduces the undesired signals produced by the Iconoscope in the process of scanning.

Side-Bands: The bands of frequencies, one on either side of the carrier frequency produced by the process of modulation.

Signal: The intelligence, message or effect conveyed in communication.

Spot: The visible spot of light formed by the impact of the electron beam on the screen as it scans the picture.

Spottiness: Spottiness is the effect of a television picture resulting from the variation of the instantaneous light value of the reproduced image due to electrical disturbances between the scanning and reproducing devices.

Television: Television is the electrical transmission and reception of transient visual images.

Tilting: A vertical sweep of the camera.

Vertical Centering: Adjustment of the picture position in the vertical direction.

Vertical Hold: Adjustment of the free-running period of the vertical oscillator.

Vestigial-Side-Band Transmitter: A Vestigial-Side-Band Transmitter is one in which one side band and a portion of the other are intentionally transmitted.

Video Frequency: The Video Frequency is the frequency of the voltage resulting from television scanning.

Width Control: This control is used for adjustment of the picture size in the horizontal direction.

Yoke: Produces magnetic deflection of an Iconoscope or Kinescope when supplied with sawtooth currents of proper voltage and phase.

RCA Victor Model TRK-12 Television Receiver

RCA CATHODE RAY TUBES

Type	Class	Bulb	Deflection	Phosphor		Maximum Anode No. 2 Volts
				Color	Persistence	
3AP1/906-P1	Oscillograph	3″	Electrostatic	Green	Medium	1500
3AP4/906-P4	Kinescope	3″	Electrostatic	White	Television	1500
5AP4/1805-P4	Kinescope	5″, Short	Electrostatic	White	Television	2000
5BP1/1802-P1	Oscillograph	5″	Electrostatic	Green	Medium	2000
5BP4/1802-P4	Kinescope	5″	Electrostatic	White	Television	2000
7AP4	Kinescope	7″, Short	Magnetic	White	Television	3500
9AP4/1804-P4	Kinescope	9″	Magnetic	White	Television	7000
12AP4/1803-P4	Kinescope	12″	Magnetic	White	Television	7000
902	Oscillograph	2″	Electrostatic	Green	Medium	600
904	Oscillograph	5″	Electrostatic-Magnetic	Green	Medium	4600
905	Oscillograph	5″	Electrostatic	Green	Medium	2000

(Continued on Page 24)

RCA CATHODE RAY TUBES (Continued)

Type	Class	Bulb	Deflection	Phosphor		Maximum Anode No. 2 Volts
				Color	Persistence	
907	Oscillograph	5″	Electrostatic	Blue	Short	2000
908	Oscillograph	3″	Electrostatic	Blue	Short	1500
909	Oscillograph	5″	Electrostatic	Blue	Long	2000
910	Oscillograph	3″	Electrostatic	Blue	Long	1500
913	Oscillograph	1″	Electrostatic	Green	Medium	500
914	Oscillograph	9″	Electrostatic	Green	Medium	7000
1800	Kinescope	9″	Magnetic	Yellow	Television	7000
1801	Kinescope	5″	Magnetic	Yellow	Television	3000
1898	Monoscope	3″	Electrostatic	Pattern	is Girl's Head	1200
1899	Monoscope	5″	Magnetic	Pattern testing to 500	is chart for resolution up lines.	1500

Calculation and Use of Shunts and Multipliers

Primarily, all electric meters of the indicating type having only two terminals are essentially current measuring devices and in fact are ammeters or milliammeters, as it is only the current flowing through the meter that causes mechanical motion and deflection of the needle.

However, we may calibrate the meter scale so that the needle deflection will accurately read ohms, volts, microfarads, etc., or any one of the electrical factors which if varied would create a change in current flow provided the other characteristics of the circuit would remain constant.

Let us consider a DC milliammeter (0-1) which gives full scale deflection when 1 milliampere flows through the meter. We desire to use this meter as a multirange voltmeter having scales (0-10) (0-100) (0-500) and (0-1000) volts respectively. The resistance of many such meters in commercial use ranges from 20 to 105 ohms. In the extreme case considering a meter of 105 ohms resistance the voltage drop across the meter at full scale current would be, according to Ohms Law, $E_m = R_m \times I_m$, R_m = resistance of meter = 105 ohms I_m = full scale current = 1 milliampere = .001 ampere E_m = 105 x .001 = 0.105 volts.

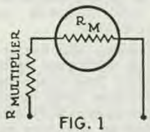


FIG. 1

As the maximum voltage drop across the meter is only about 1/10 volt under extreme conditions we can disregard this in our calculations as the error will be negligible.

Referring to Figure 1 we see that the meter can be used as a 0-10 voltmeter if a resistance or multiplier is connected in series with it. The resistance must be of such value that if 1 milliampere of current (which is full scale deflection of the meter) flows through it the voltage across the resistance will be 10 volts. Figure 1.

The multiplier, $R_1 = \frac{E}{I} = \frac{10}{.001} = 10{,}000$ ohms.

Half scale deflection means that ½ milliampere is flowing through the meter, therefore half scale deflection indicates

$$E = R\,I = 10{,}000 \times .0005 = 5 \text{ volts.}$$

Accordingly any fractional indication on the 0-1 mil scale will read the corresponding fraction of 10 volts which means the milliammeter scale is multiplied by 10 to get the actual reading in volts.

Similarly the multiplier for the (0-100) volt scale

$$R_2 = \frac{E}{I} = \frac{100}{.001} = 100{,}000 \text{ ohms.}$$

and the milliammeter scale readings are multiplied by 100.

Likewise the multipliers for the (0-500) and (0-1000) volt scales would be 500,000 and 1,000,000 ohms respectively and the scale multiples would be correspondingly 500 and 1000.

If a 0-10 milliammeter was used in place of the 0-1 the multipliers in each case would of course be only 1/10 of their respective values in the previous example. This would also apply to the scale multiples. However, the 10 milliampere meter would consume appreciable current in itself and may in certain circuits introduce a considerable error particularly where the resistance of the multiplier is not considerably higher than the voltage supply system. The voltage to be measured may be seriously affected when its source is called upon to supply an additional 10 milliamperes to operate the voltmeter.

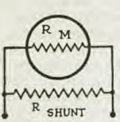


FIG. 2

This emphasizes the importance of a high resistance voltmeter; in the first example the resistance was 1000 ohms per volt while in the second instance it was only 100 ohms per volt. For the proper degree of accuracy in radio work, a 1000 ohm per volt voltmeter will be generally suitable.

To use the 0-1 milliammeter as a higher scale milliammeter, it is necessary to provide a shunt as in Figure 2. In this case it is essential to know accurately the resistance of the meter. Assume that it has a resistance of 27 ohms and that we want to have a scale reading of (0-10), (0-50), (0-100) and (0-500) milliamperes.

Referring to Figure 2 it is evident that with a meter for 0-10 mil measurements the meter would carry 1/10 of the total current and the shunt 9/10 or the shunt resistance would be 1/9 of the meter resistance. If the meter resistance was 27 ohms the shunt resistance would be 3 ohms; correspondingly the shunt resistance for use as an 0-50 milliammeter would be 1/49 x 27 = .551 ohms. For 0-100 and 0-500 scales the shunt resistance must be 0.2727 ohms and 0.0541 ohms respectively.

The general formula is

$$R = \frac{R_m \times I_m}{I - I_m}$$

where R = resistance of shunt in ohms
R_m = resistance of meter in ohms
I_m = full scale current for meter
I = full scale current for new calibration

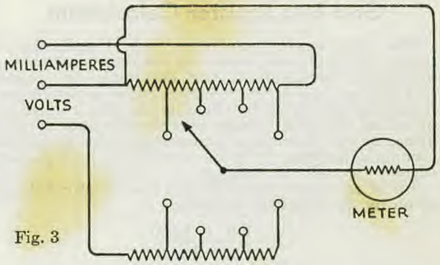


Fig. 3

By the use of a star or multipole switch as shown in Figure 3, one meter can be used as a voltmeter or milliammeter at any desired range. The accompanying chart shows the resistance of the shunt or multiplier as the case may be.

Shunt and Multiplier Values

105 Ohm (0-1) Milliammeter

Scale	Use as	Ohms of Resistance in Series or in Shunt with Meter	Multiply old scale by
0-10	Voltmeter	10,000	10
0-50	"	50,000	50
0-100	"	100,000	100
0-250	"	250,000	250
0-500	"	500,000	500
0-1000	"	1,000,000	1000
0-10	Milliammeter	11.7	10
0-50	"	2.14	50
0-100	"	1.06	100
0-500	"	0.21	500

35 Ohm (0-1.5) Milliammeter

Scale	Use as	Ohms of Resistance in Series or in Shunt with Meter	Multiply old scale by
0-15	Voltmeter	10,000	10
0-150	"	100,000	100
0-750	"	500,000	500
0-15	Milliammeter	3.89	10
0-75	"	0.714	50
0-150	"	0.354	100
0-750	"	0.0701	500

Grid Bias Resistor Calculations

The radio service man often finds it necessary to replace the grid bias resistor in receivers employing a self-biasing arrangement for obtaining the proper grid voltage. When the resistance value is not known, it may be calculated by dividing the grid voltage required at the plate voltage at which the tube is operating, by the plate current in amperes plus the screen current in amperes times the number of tubes passing current through the resistor.

Under the above rule, the grid bias resistor value is given by the following formula:

$$R = \frac{E_{C1} \times 1{,}000}{(I_B + I_{C2})\, n}$$

where: R = Grid bias resistor value in ohms.

E_{C1} = The grid bias required in volts.

I_B = The plate current of a single tube in *milliamperes*.

I_{C2} = The screen-grid current of a single tube in *milliamperes*.

n = The number of tubes passing current through the resistor.

Example:

It is desired to determine the value of bias resistor used to obtain the proper value of grid bias on three type '35 tubes working in the radio frequency stages of a receiver. First determine the plate and screen voltages employed in this set. Suppose, in this case, it is found that the plate supply voltage is 250 and the screen voltage is 90. Looking in the characteristics chart, it is found that the proper grid bias for the '35 under these conditions is —3.0 volts. In addition, the plate current is 6.5 milliamperes and the screen current is 2.5 milliamperes. Substituting in the formula,

$$R = \frac{3.0 \times 1{,}000}{(6.5 + 2.5)\, 3} = 111 \text{ ohms.}$$

The value of grid bias resistors can be calculated in this manner for any type and any number of tubes. In the case of triodes, the screen current term drops out entirely.

Be sure to determine the plate voltage at which the tubes are working, the number of tubes being supplied from the bias resistor, the screen voltage, (if a tetrode or pentode), the correct value of grid bias voltage required, and the plate and screen current for the given plate voltage.

In the case of resistance-coupled amplifiers which employ high resistance in the plate circuit, it must be remembered that the plate voltage is equal to the plate supply voltage minus the voltage drop in the plate load resistance caused by the plate current. The net plate voltage alone determines the correct value of grid bias.

The foregoing methods of calculations cannot be used in connection with receivers employing a bleeder circuit to obtain grid bias.

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG.	Diameter Mils	Area, Circular Mils	Weight, Bare Wire: Pounds per 1000 Ft.	Weight, Bare Wire: Pounds per Mile	Resistance at 25°C. (77°F.): Ohms per 1000 Ft.	Resistance at 25°C. (77°F.): Ohms per Mile	Resistance at 25°C. (77°F.): Feet per Ohm
0000	460.	211,600.	641.	3385.	0.0499	0.2638	20,040.
000	410.	167,800.	508.	2683.	0.0630	0.3325	15,870.
00	364.8	133,100.	403.	2126.	0.0794	0.419	12,590.
0	324.9	105,500.	319.5	1687.	0.1003	0.529	9,980.
1	289.3	83,700.	253.3	1337.	0.1262	0.666	7,930.
2	257.6	66,400.	200.9	1061.	0.1591	0.840	6,290.
3	229.4	52,600.	159.3	841.	0.2008	1.062	4,980.
4	204.3	41,700.	126.4	668.	0.2533	1.338	3,950.
5	181.9	33,100.	100.2	529.	0.3193	1.685	3,134.
6	162.0	26,250.	79.5	419.	0.403	2.127	2,485.
7	144.3	20,820.	63.0	332.6	0.507	2.682	1,971.
8	128.5	16,510.	50.0	264.0	0.640	3.382	1,562.
9	114.4	13,090.	39.63	208.3	0.807	4.26	1,238.
10	101.9	10,380.	31.43	165.9	1.017	5.37	983.
11	90.7	8,230.	24.92	131.6	1.284	6.78	779.
12	80.8	6,530.	19.77	104.3	1.618	8.55	618.
13	72.0	5,180.	15.68	82.8	2.040	10.77	490.
14	64.1	4,110.	12.43	65.6	2.575	13.60	388.2
15	57.1	3,257.	9.86	52.1	3.244	17.13	308.4
16	50.8	2,583.	7.82	41.3	4.09	21.62	244.3
17	45.3	2,048.	6.20	32.73	5.16	27.24	193.9
18	40.3	1,624.	4.92	26.00	6.51	34.34	153.7
19	35.89	1,288.	3.899	20.57	8.20	43.3	121.9
20	31.96	1,022.	3.092	16.33	10.34	54.6	96.6
21	28.46	810.	2.452	12.93	13.04	68.9	76.6
22	25.35	642.	1.945	10.27	16.44	86.9	60.8
23	22.57	509.	1.542	8.14	20.75	109.5	48.2
24	20.10	404.	1.223	6.46	26.15	138.1	38.25
25	17.90	320.4	0.970	5.12	33.00	174.3	30.30
26	15.94	254.1	0.769	4.06	41.6	219.5	24.04
27	14.20	201.5	0.610	3.220	52.4	276.8	19.07
28	12.64	159.8	0.484	2.556	66.01	349.2	15.13

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG	Diameter Mils	Area, Circular Mils	Weight, Bare Wire: Pounds per 1000 Ft.	Weight, Bare Wire: Pounds per Mile	Resistance at 25°C. (77°F.): Ohms per 1000 Ft.	Resistance at 25°C. (77°F.): Ohms per Mile	Resistance at 25°C. (77°F.): Feet per Ohm
29	11.26	126.7	0.3836	2.025	83.4	441.	11.98
30	10.03	100.5	0.3042	1.606	105.4	556.	9.48
31	8.93	79.7	0.2413	1.273	132.6	700.	7.55
32	7.95	63.2	0.1913	1.011	167.2	883.	5.98
33	7.08	50.1	0.1517	0.807	210.8	1113.	4.74
34	6.30	39.75	0.1203	0.636	265.8	1403.	3.762
35	5.61	31.52	0.0954	0.504	335.5	1772.	2.980
36	5.00	25.00	0.0757	0.400	423.0	2232.	2.366
37	4.45	19.83	0.0600	0.3168	533.	2814.	1.877
38	3.965	15.72	0.0476	0.2514	673.	3553.	1.487
39	3.531	12.47	0.03774	0.1991	847.	4470.	1.180
40	3.145	9.89	0.02993	0.1579	1068.	5640.	0.936

ALLOWABLE CARRYING CAPACITIES OF COPPER WIRE AND CABLE

(Regulations of the National Board of Fire Underwriters)

No. AWG	Circular Mils	Amperes: Rubber Insulation	Amperes: Other Insulation	Circular Mils	Amperes: Rubber Insulation	Amperes: Other Insulation
18	1,624	3	5	250,000	250	350
16	2,583	6	10	300,000	275	400
14	4,107	15	20	350,000	300	450
12	6,530	20	25	400,000	325	500
10	10,380	25	30	450,000	362	550
8	16,510	35	50	500,000	400	600
6	26,250	50	70	600,000	450	680
4	41,740	70	90	700,000	500	760
2	66,370	90	125	800,000	550	840
1	83,690	100	150	1,000,000	650	1000
0	105,500	125	200	1,250,000	750	1180
00	133,100	150	225	1,500,000	850	1360
000	167,800	175	275	1,750,000	950	1520
0000	211,600	225	325	2,000,000	1050	1670

TEMPERATURE CORRECTIONS FOR COPPER WIRE

(Based on A.I.E.E. Standards)

Temperature Coefficient of Resistance. At a temperature of 25 degrees Centigrade the "constant mass" temperature coefficient of resistance of standard annealed copper, measured between potential points rigidly fixed to the wire is 0.00385 or 1/259.5 per Centigrade degree.

Resistance values of copper wire given in table on preceding pages may be corrected for any temperature by means of the formula given below.

Correction for Change in Temperature

$R_t = R_{25} [1 + 0.00385 (t - 25)]$, where
R_t = the resistance in ohms at a temperature, t.
R_{25} = the resistance in ohms at 25 degrees, Centigrade
t = the temperature of wire in degrees, Centigrade

Temp. C.=5/9 (Temp. F.−32)
Temp. F.=9/5 (Temp. C.)+32.

SPECIFIC RESISTANCE OF METALS AND ALLOYS AT ORDINARY TEMPERATURES

SUBSTANCE	Specific Resistance Microhms per Cm. Cube	Relative Conductance	SUBSTANCE	Specific Resistance Microhms per Cm. Cube	Relative Conductance
Aluminum	2.94	54.	Lead	20.8	6.64
Brass	6–9	26–17	Manganin	43.	3.7
Climax	87.	1.83	Mercury	95.7	1.66
Cobalt	9.7	16.3	Molybdenum	4.8	33.2
Constantan	49.	3.24	Nickel	10.5	11.8
Copper, U.S. std.	1.78	89.5	Nichrome	110.	1.45
Copper, annealed	1.59	100.	Platinum	10.8	14.6
Ger. Silver (18X)	30–40	5.3–4	Silver	1.5	106.
Iron, pure	9.	17.7	Superior 23.	86.	1.85
Iron, wrought	13.9	11.4	Tungsten	5.4	28.9

USEFUL CONVERSION RATIOS

Multiply	by	to obtain
Diam. Circle	3.1416	Circumference Circle
Diam. Circle	0.886	Side Equal Square
U. S. Gallons	0.8333	Imperial Gallons
U. S. Gallons	0.1337	Cubic Feet
Inches Mercury	0.4912	Pounds per Sq. In.
Feet of Water	0.4335	Pounds per Sq. In.
Cubic Feet	62.4	Pounds of Water
U. S. Gallons	8.343	Pounds of Water
U. S. Gallons	3.785	Liters
Knots	1.152	Miles
Inches	2.540	Centimeters
Yards	0.9144	Meters
Miles	1.609	Kilometers
Cubic Inches	16.39	Cubic Centimeters
Ounces	28.35	Grams
Pounds	0.4536	Kilograms

Winding Turns per Linear Inch

Gauge No. B & S	Enamel	S. S. C.	D. S. C. or S. C. C.	D. C. C.
8	7.6	——	7.4	7.1
9	8.6	——	8.2	7.8
10	9.6	——	9.3	8.9
11	10.7	——	10.3	9.8
12	12.0	——	11.5	10.9
13	13.5	——	12.8	12.0
14	15.0	——	14.2	13.3
15	16.8	——	15.8	14.7
16	18.9	18.9	17.9	16.4
17	21.2	21.2	19.9	18.1
18	23.6	23.6	22.0	19.8
19	26.4	26.4	24.4	21.8
20	29.4	29.4	27.0	23.8
21	33.1	32.7	29.8	26.0
22	37.0	36.5	34.1	30.0
23	41.3	40.6	37.6	31.6
24	46.3	45.3	41.5	35.6
25	51.7	50.4	45.6	38.6
26	58.0	55.6	50.2	41.8
27	64.9	61.5	55.0	45.0
28	72.7	68.6	60.2	48.5
29	81.6	74.8	65.4	51.8
30	90.5	83.3	71.5	55.5
31	101.	92.0	77.5	59.2
32	113.	101.	83.6	62.6
33	127.	110.	90.3	66.3
34	143.	120.	97.0	70.0
35	158.	132.	104.	73.5
36	175.	143.	111.	77.0
37	198.	154.	118.	80.3
38	224.	166.	126.	83.6
39	248.	181.	133.	86.6
40	282.	194.	140.	89.7

Conversion

Factors for Conversions—alphabetically arranged

Ampere	= 1,000,000,000,000 micromicro-amperes
Ampere	= 1,000,000 microamperes
Ampere	= 1,000 milliamperes
Cycle	= .000,001 megacycle
Cycle	= .001 kilocycle
Farad	= 1,000,000,000,000 micromicrofarads
Farad	= 1,000,000 microfarads
Farad	= 1,000 millifarads
Henry	= 1,000,000 microhenrys
Henry	= 1,000 millihenrys
Kilocycle	= 1,000 cycles
Kilovolt	= 1,000 volts
Kilowatt	= 1,000 watts
Megacycle	= 1,000,000 cycles
Mho	= 1,000,000 micromhos
Mho	= 1,000 millimhos
Microampere	= .000,001 ampere
Microfarad	= .000,001 farad
Microhenry	= .000,001 henry
Micromho	= .000,001 mho
Micro-ohm	= .000,001 ohm
Microvolt	= .000,001 volt
Microwatt	= .000,001 watt
Micromicrofarad	= .000,000,000,001 farad
Micromicro-ohm	= .000,000,000,001 ohm
Milliampere	= .001 ampere
Millihenry	= .001 henry
Millimho	= .001 mho
Milliohm	= .001 ohm
Millivolt	= .001 volt
Milliwatt	= .001 watt
Ohm	= 1,000,000,000,000 micromicro-ohms
Ohm	= 1,000,000 micro-ohms
Ohm	= 1,000 milliohms
Volt	= 1,000,000 microvolts
Volt	= 1,000 millivolts
Watt	= 1,000,000 microwatts
Watt	= 1,000 milliwatts
Watt	= .001 kilowatt

METRIC EQUIVALENTS

Length

Cm. = .3937 In.	In. = 2.54 Cm.
Meter = 3.28 Ft.	Ft. = .305 Meter
Meter = 1.094 Yd.	Yd. = .914 Meter
Kilom. = .621 Mile	Mile = 1.61 Kilom.

Area

Sq. Cm. = 0.1550 Sq. in.	Sq. in. = 6.452 Sq. Cm.
Sq. M. = 10.764 Sq. ft.	Sq. ft. = .0929 Sq. M.
Sq. M. = 1.196 Sq. yd.	Sq. yd. = .836 Sq. M.
Hectare = 2.47 Acres	Acre = 0.405 Hectare
Sq. Kilom. = .386 Sq. mi.	Sq. mi. = 2.59 Sq. Kilom

Volume

Cu. Cm. = .061 Cu. in.	Cu. in. = 16.4 Cu. Cm.
Cu. M. = 35.31 Cu. ft.	Cu. ft. = .028 Cu. M.
Cu. M. = 1.308 Cu. yd.	Cu. yd. = .765 Cu. M.

Capacity

Litre = .0353 Cu. ft.	Cu. ft. = 28.32 Litres
Litre = .2642 Gal. (U. S.)	Gal. = 3.785 Litres
Litre = 61.023 Cu. in.	Cu. in. = .0164 Litre

Litre = 2.202 lb. of fresh water at 62° F.

Weight

Gram = 15.423 Grains	Grain = .0684 Gram
Gram = .0353 Ounce	Ounce = 28.35 Gram
Kilogram = 2.205 Lb.	Lb. = .454 Kilog'm
Kilogram = .0011 Ton(Sht)	Ton(Sht) = 907.03 Kilog'm
Met. Ton = 1.1025 Ton(Sht)	Ton(Sht) = .907 Met. Ton

Ton(Sht) = 2,000 Lb.

Pressure

Kilograms per square centimeter = 14.225 pounds per square inch.
Pounds per square inch = .0703 kilograms per square cm.
Kilograms per square meter = .205 pounds per square foot.
Pounds per square foot = 4.88 kilograms per square meter
Kilograms per square centimeter = .968 atmosphere.
Atmosphere = 1.033 kilograms per square cm.

Miscellaneous

Kilogrammeter = 7.233 foot pounds.
Foot pound = .1383 kilogrammeter.
Metric horse power = .986 horse power.
Horse power = 1.014 metric horse power.
Litre per second = 2.12 cubic feet per minute.
Litre per second = 15.85 U. S. gallons per minute.

TYPE NUMBERS OF PLUG-IN RESISTORS AND BALLAST UNITS

The internal connections and voltage characteristics of many plug-in resistors used in AC/DC receivers are indicated by the type number and its arrangement. An example is type BK-36-C.

"B" indicates that a ballast section is provided for one or more pilot lamps.

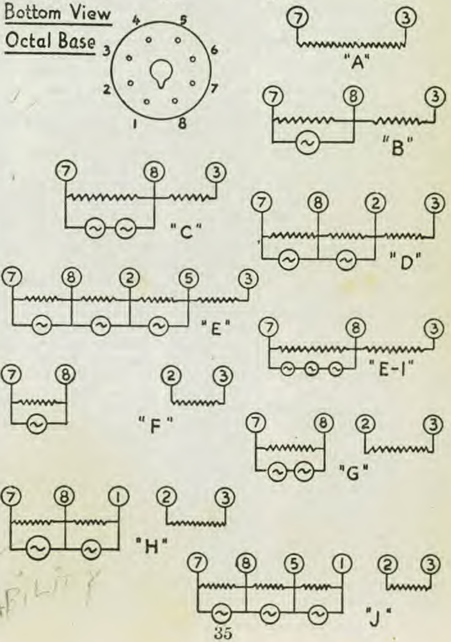
"K" indicates the characteristics of the pilot lamp or lamps in accordance with the table below.

"36" implies that a 36 volt drop occurs across the entire unit in normal operation with pilot lamps connected.

"C" or the final letter refers to the terminal arrangement; arrangements are shown in the diagrams below.

Pilot Lamp Designation

Designating Letter	Mazda No.	Rated Ma.	Rated Volts
K	40	150	6.3
L	46	250	6-8
M	51	200	6-8



U. S. Broadcasting Stations . . .

Station	Location	Kilo-cycles	Station	Location	Kilo-cycles
KALE	Portland, Ore.	1300	KMMJ	Clay Center, Nebr.	740
KCMO	Kansas City, Mo.	1370	KMO	Tacoma, Wash.	1330
KDKA	Pittsburgh, Pa.	980	KMOX	St. Louis, Mo.	1090
KDYL	Salt Lake Cy, Utah	1290	KMTR	Los Angeles, Calif.	570
KECA	Los Angeles, Calif.	1430	KNX	Los Angeles, Calif.	1050
KEHE	Los Angeles, Calif.	780	KOA	Denver, Colo.	830
KEX	Portland, Ore.	1180	KOAC	Corvallis, Ore.	550
KFAB	Lincoln, Nebr.	770	KOB	Albuquerque, N.M.	1180
KFAC	Los Angeles, Calif.	1300	KOIL	Omaha, Nebr.	1260
KFAR	Fairbanks, Alaska	610	KOIN	Portland, Ore.	940
KFBB	Great Falls, Mont.	1280	KOL	Seattle, Wash.	1270
KFBI	Abilene, Kans.	1050	KOMA	OklahomaCy, Okla.	1480
KFBK	Sacramento, Calif.	1490	KOMO	Seattle, Wash.	920
KFH	Wichita, Kans.	1300	KOY	Phoenix, Ariz.	1390
KFI	Los Angeles, Calif.	640	KPMC	Bakersfield, Calif.	1550
KFKU	Lawrence, Kans.	1220	KPO	S. Francisco, Calif.	680
KFNF	Shenandoah, Iowa	890	KPOF	Denver, Colo.	880
KFOX	Long Beach, Calif.	1250	KPRC	Houston, Texas	920
KFPY	Spokane, Wash.	890	KQW	San Jose, Calif.	1010
KFRC	S. Francisco, Calif.	610	KRGV	Weslaco, Texas	1260
KFSD	San Diego, Calif.	600	KRLD	Dallas, Texas	1040
KFVD	Los Angeles, Calif.	1000	KRNT	Des Moines, Iowa	1320
KFWB	Hollywood, Calif.	950	KROW	Oakland, Calif.	930
KFYR	Bismarck, N. D.	550	KSCJ	Sioux City, Iowa	1330
KGA	Spokane, Wash.	1470	KSD	St. Louis, Mo.	550
KGB	San Diego, Calif.	1330	KSFO	S. Francisco, Calif.	560
KGCX	Wolf Point, Mont.	1450	KSL	Salt Lake Cy, Utah	1130
KGER	Long Beach, Calif.	1360	KSO	Des Moines, Iowa	143
KGGF	Coffeyville, Kans.	1010	KSOO	Sioux Falls, S. D.	111
KGGM	Albuquerque, N.M.	1230	KSTP	St. Paul, Minn.	146
KGHL	Billings, Mont.	780	KTAR	Phoenix, Ariz.	62
KGIR	Butte, Mont.	1340	KTAT	Fort Worth, Texas	124
KGKO	Fort Worth, Tex.	570	KTBC	Austin, Texas	112
KGMB	Honolulu, Hawaii	1320	KTBS	Shreveport, La.	1450
KGNC	Amarillo, Tex.	1410	KTFI	Twin Falls, Idaho	1240
KGO	S. Francisco, Calif.	790	KTHS	Hot Springs, Ark.	1060
KGU	Honolulu, Hawaii	750	KTRH	Houston, Texas	1290
KGVO	Missoula, Mont.	1260	KTSA	San Antonio, Tex.	550
KGW	Portland, Ore.	620	KTUL	Tulsa, Okla.	1400
KHJ	Los Angeles, Calif.	900	KTW	Seattle, Wash.	1220
KHQ	Spokane, Wash.	590	KUOA	Siloam Sprgs, Ark.	1260
KIDO	Boise, Idaho	1350	KVI	Tacoma, Wash.	570
KIRO	Seattle, Wash.	710	KVOA	Tucson, Ariz.	1260
KITE	Kansas City, Mo.	1530	KVOO	Tulsa, Okla.	1140
KJR	Seattle, Wash.	970	KVOR	Colo.Springs, Colo.	1270
KLO	Ogden, Utah	1400	KWK	St. Louis, Mo.	1350
KLRA	Little Rock, Ark.	1390	KWKH	Shreveport, La.	1100
KLX	Oakland, Calif.	880	KWSC	Pullman, Wash.	1220
KLZ	Denver, Colo	560	KWTO	Springfield, Mo.	560
KMA	Shenandoah, Ia.	930	KXA	Seattle, Wash.	760
KMBC	Kansas City Mo.	950	KXOK	St. Louis, Mo.	1250
KMJ	Fresno, Calif.	580	KXYZ	Houston, Texas	1440

Station	Location	Kilo-cycles	Station	Location	Kilo-cycles
KYA	S. Francisco, Calif.	1230	WGR	Buffalo, N. Y.	550
KYW	Philadelphia, Pa.	1020	WGST	Atlanta, Ga.	890
WABC	New York, N. Y.	860	WGY	Schenectady, N. Y.	790
WADC	Akron, Ohio	1320	WHAM	Rochester, N. Y	1150
WAPI	Birmingham, Ala.	1140	WHAS	Louisville, Ky.	820
WAVE	Louisville, Ky.	940	WHAZ	Troy, N. Y.	1300
WAWZ	Zarephath, N J.	1350	WHBF	Rock Island, Ill.	1240
WBAL	Baltimore, Md.	1060	WHBI	Newark, N. J.	1250
WBAP	Fort Worth, Texas	800	WHIO	Dayton, Ohio	1260
WBBM	Chicago, Ill.	770	WHIP	Hammond, Ind.	1480
WBBR	Brooklyn, N. Y.	1300	WHK	Cleveland, Ohio	1390
WBEN	Buffalo, N. Y.	900	WHN	New York, N. Y.	1010
WBIG	Greensboro, N. C.	1440	WHO	Des Moines, Iowa	1000
WBIL	New York, N. Y.	1100	WHP	Harrisburg, Pa.	1430
WBNS	Columbus, Ohio	1430	WIBA	Madison, Wis.	1280
WBNX	New York, N. Y.	1350	WIBW	Topeka, Kans.	580
WBRC	Birmingham, Ala.	930	WILL	Urbana, Ill.	580
WBRY	Waterbury, Conn.	1530	WIND	Gary, Ind.	560
WBT	Charlotte, N .C.	1080	WINS	New York, N. Y.	1180
WBZ	Boston, Mass.	990	WIOD	Miami, Fla.	610
WBZA	Springfield, Mass.	990	WIP	Philadelphia, Pa.	610
WCAE	Pittsburgh, Pa.	1220	WIRE	Indianapolis, Ind.	1400
WCAL	Northfield, Minn.	760	WIS	Columbia, S. C.	560
WCAU	Philadelphia, Pa.	1170	WJAG	Norfolk, Nebr.	1060
WCBD	Chicago, Ill.	1080	WJAR	Providence, R. I.	890
WCCO	Minneapois, Minn.	810	WJAS	Pittsburgh, Pa.	1290
WCFL	Chicago, Ill.	970	WJAX	Jacksonville, Fla.	900
WCKY	Covington, Ky.	1490	WJDX	Jackson, Miss.	1270
WCOC	Meridien, Miss.	880	WJJD	Chicago, Ill.	1130
WCSH	Portland, Maine	940	WJR	Detroit, Mich.	750
WDAE	Tampa, Fla.	1220	WJSV	Washington, D C	1460
WDAF	Kansas City, Mo.	610	WJZ	New York, N. Y.	760
WDAY	Fargo, N. D.	940	WKAQ	San Juan, P. R.	1240
WDBJ	Roanoke, Va.	930	WKAR	E. Lansing, Mich.	850
WDBO	Orlando, Fla.	580	WKBH	La Crosse, Wis.	1380
WDGY	Minneapolis, Minn.	1180	WKBW	Buffalo, N. Y.	1480
WDOD	Chattanooga, Tenn.	1280	WKRC	Cincinnati, Ohio	550
WDRC	Hartford, Conn.	1330	WKY	Okla. City, Okla.	900
WDSU	New Orleans, La.	1250	WLAC	Nashville, Tenn.	1470
WEAF	New York, N. Y.	660	WLB	Minneapolis, Minn.	760
WEAN	Providence R. I.	780	WLBL	Stevens Pt., Wisc.	900
WEAU	Eau Claire, Wis.	1050	WLS	Chicago, Ill.	870
WEBC	Duluth, Minn.	1290	WLW	Cincinnati, Ohio	700
WEEI	Boston, Mass.	590	WMAQ	Chicago, Ill.	670
WENR	Chicago, Ill.	870	WMAZ	Macon, Ga.	1180
WEVD	New York, N. Y.	1300	WMBD	Peoria, Ill.	1440
WFAA	Dallas, Texas	800	WMBI	Chicago, Ill.	1080
WFBC	Greenville, S. C.	1300	WMC	Memphis, Tenn.	780
WFBL	Syracuse, N. Y.	1360	WMCA	New York, N. Y.	570
WFBM	Indianapolis, Ind.	1230	WMEX	Boston, Mass.	1470
WFBR	Baltimore, Md.	1270	WMMN	Fairmont, W. Va.	890
WFIL	Philadelphia, Pa.	560	WMT	Cedar Rapids, Ia.	600
WFLA	Tampa, Fla.	620	WNAC	Boston, Mass.	1230
WGAR	Cleveland, Ohio	1450	WNAD	Norman, Okla.	1010
WGN	Chicago, Ill.	720	WNAX	Yankton, S. D.	570

Station	Location	Kilo-cycles	Station	Location	Kilo-cycles
WNBX	Springfield, Vt.	1260	WSAI	Cincinnati, Ohio	1330
WNEL	San Juan, P. R.	1290	WSAR	Fall River, Mass.	1450
WNEW	New York, N. Y.	1250	WSAZ	Huntington, W. Va.	1190
WNOX	Knoxville, Tenn.	1010	WSB	Atlanta, Ga.	740
WOAI	San Antonio, Tex.	1190	WSM	Nashville, Tenn.	650
WOI	Ames, Iowa	640	WSMB	New Orleans, La.	1320
WOL	Washington, D. C.	1230	WSPD	Toledo, Ohio	1340
WOR	Newark, N. J.	710	WSUN	St. Petersburg, Fla.	620
WORK	York, Pa.	1320	WSYR	Syracuse, N. Y.	570
WOV	New York, N. Y.	1130	WTAG	Worcester, Mass.	580
WOW	Omaha, Nebr.	590	WTAM	Cleveland, Ohio	1070
WOWO	Fort Wayne, Ind.	1160	WTAQ	Green Bay, Wis	1330
WPEN	Philadelphia, Pa.	920	WTAR	Norfolk, Va.	780
WPG	Atlantic City, N. J.	1100	WTCN	Minneapolis, Minn.	1250
WPTF	Raleigh, N. C.	680	WTIC	Hartford, Conn.	1040
WQAM	Miami, Fla.	560	WTMJ	Milwaukee, Wis.	620
WQXR	New York, N. Y.	1550	WTOC	Savannah, Ga	1260
WRC	Washington, D. C.	950	WWJ	Detroit, Mich.	920
WREC	Memphis, Tenn.	600	WWL	New Orleans, La.	850
WREN	Lawrence, Kans.	1220	WWNC	Asheville, N. C	570
WRUF	Gainesville, Fla.	830	WWVA	Wheeling, W. Va.	1160
WRVA	Richmond, Va.	1110	WXYZ	Detroit, Mich.	1240

RADIO LOG

Call Letters	Location	Dial Setting
2506	[illegible]	$2.00
		$5.90
		[illegible]
	TG2X	$2.52

Principal Short Wave Stations

Meg.	Call	Place	Schedule
4.11	HCJB	Quito, Ecuador	ex. Mon.
4.76	HJ2ABJ	Santa Marta, Col.	ex. Sun.
4.78	HJ1ABB	Barranquilla, Col.	ex. Sun.
4.80	HJ1ABE	Cartagena, Col.	Daily
4.82	HJ7ABB	Bucaramanga, Col.	ex. Sun.
4.84	HJ3ABD	Bogota, Col.	Daily
4.88	HJ4ABP	Medellin, Col.	ex. Sun.
4.90	HJ3ABH	Bogota, Col.	Daily
5.80	YV5RC	Caracas, Venez.	Daily
5.83	TIGPH	San Jose, C. R.	ex. Sun.
5.85	YV1RB	Maracaibo, Ven.	ex. Sun.
5.85	HI1J	San Pedro, D. R.	Daily
5.86	YV4RH	Valencia, Ven.	ex. Sun.
5.87	HRN	Tegucigalpa, Hon.	Daily
5.88	HI9B	Santiago, D. R.	ex. Sun.
5.90	T1LS	San Jose, R. D.	ex. Sun.
5.90	YV3RA	Barquisimeto, Ven.	ex. Sun.
5.93	HH2S	Port-au-Pr., Haiti	ex. Sun.
5.93	YV1RL	Maracaibo, Ven.	ex. Sun.
5.94	TG2X	Guatamela City	M. W. Sat.
6.00	HP5K	Colon, Panama	Daily
6.01	HJ3ABX	Bogota, Col.	Daily
6.02	DJC	Berlin, Ger.	Daily
6.03	HP5B	Panama City	Daily
6.04	HJ1ABG	Barranquilla, Col.	Daily
6.05	HJ6ABA	Pereira, Col.	ex. Sun.
6.05	GSA	London, Eng.	Daily
6.07	OAX4Z	Lima, Peru	ex. Sun.
6.11	HJ6ABB	Manizales, Col.	ex. Sun.
6.11	GSL	London, Eng.	Daily
6.15	HJ4ABE	Medellin, Col.	Daily
6.15	H15N	Moca City, R. D.	ex. Sun.
6.15	YV5RD	Caracas, Ven.	Daily
6.21	TG2	Guatemala City	ex. Sun.
6.22	YV1RG	Valera, Venez.	Daily
6.24	HRD	LaCeiba, Honduras	ex. Sun.
6.24	HIN	Trujillo, R. D.	ex. Sun.
6.25	YV5RJ	Caracas, Ven.	ex. Sun.
6.27	YV5RP	Caracas, Ven.	ex. Sun.
6.29	HIG	Trujillo City, R. D.	ex. Sun.
6.30	YV4RD	Maracay, Venez.	ex. Sun.
6.31	HIZ	Trujillo, R. D.	ex. Sun.

Short Wave Stations (cont.)

Meg.	Call	Place	Schedule
6.34	HI1X	Trujillo, R. D.	Tu. & Fri.
6.36	YV1RH	Maracaibo, Ven.	ex. Sun.
6.38	YV5RF	Caracas, Ven.	ex. Sun.
6.40	YV5RH	Caracas, Venez.	ex. Sun.
6.40	TGQA	Quezaltenango, Guat.	ex. Sun.
6.41	TiPG	San Jose, C. R.	Daily
6.42	YV6RC	Bolivar, Venez.	ex. Sun.
6.47	YV3RD	Barquismento, Ven.	Daily
6.50	HIL	Trujillo City, R. D.	ex. Sun.
6.52	YV4RB	Valencia, Venez.	Daily
6.55	YV6RB	Bolivar, Venez.	ex. Sun.
6.63	HIT	Trujillo, R. D.	ex. Sun.
6.63	HC2RL	Guayaquil, Ec.	Sun. & Tu.
6.68	TIEP	San Jose, C. R.	Daily
7.80	HBP	Geneva, Switz.	Mon.
7.89	HC1RB	Quito, Ecuador	ex. Sun.
9.12	HAT-4	Budapest, Hung.	Sun. & W.
9.23	HC2CW	Guayaquil, Ecu.	ex. Sun.
9.34	OAX4J	Lima, Peru	Daily
9.49	EAR	Madrid, Spain	Sun., Tu. & Th.
9.51	VK3ME	Melbourne, Aus.	ex. Sun.
9.51	HJU	Buenaventura, Col.	M. W. & F.
9.51	GSB	London, Eng.	Daily
9.52	HJ6ABH	Armenia, Col.	Daily
9.52	ZBW-3	HongKong, China	Daily
9.52	OZF	Copenhagen, Den.	Daily
9.53	LKC	Oslo, Norway	Daily
9.54	DJN	Berlin, Ger.	Daily
9.55	OLR3A	Prague	M. T. T. & F.
9.56	DJA	Berlin, Ger.	Daily
9.57	KZRM	Manila, P. I.	Daily
9.58	VLR	Melbourne, Aus.	ex. Sun.
9.58	GSC	London, Eng.	Daily
9.59	PCJ	Eindhoven, Holland	Irr.
9.60	RAN	Moscow, USSR.	Daily
9.60	HP5J	Panama City	Daily
9.62	HJ1ABP	Cartagena, Col.	Daily
9.62	ZRK	Johannesburg, S. Af.	ex. Sun.
9.63	HJ7ABD	Bucaramanga, Col.	Daily
9.63	I2RO3	Rome, Italy	Daily
9.64	HH3W	Port-au-Pr., Haiti	ex. Sun.
9.65	CS2WA	Lisbon, Port.	T.T. & Sat.

Short Wave Stations (cont.)

Meg.	Call	Place	Schedule
9.66	LRX	Buenos Aires, Arg.	Daily
9.67	T14-NRH	Heredia, CR.	Tu. Th. & Sat.
9.68	TGWA	Guatemala City	Daily
9.68	VK2ME	Sydney, Aus.	Sun.
9.70	Fort de Fracne, Martinique		Daily
9.83	IRF	Rome, Italy	Daily
9.86	EAQ	Madrid, Spain	Daily
9.93	JDY	Darien, Manchukuo	Daily
9.95	CSW	Lisbon, Port.	Daily
9.95	TPB11	Paris, France	Daily
10.22	PSH	Rio de Janeiro, Brazil	ex. Sun.
10.37	EAJ-43	Santa Cruz, Can. Is.	Daily
11.00	PLP	Bandoeng, Java	Daily
11.04	CSW	Lisbon, Port.	Daily
11.53	SPD	Warsaw, Poland	Daily
11.70	HP5A	Panama City	Daily
11.71	TPA4	Paris, France	Daily
11.75	GSD	London, Eng.	Daily
11.77	DJD	Berlin, Ger.	Daily
11.80	OER3	Vienna, Ger.	Daily
11.80	JZJ	Tokyo, Japan	Daily
11.81	2RO	Rome, Italy	Daily
11.84	OLR4A	Prague	M. Tu. Th. & F.
11.85	DJP	Berlin, Germany	Daily
11.86	GSE	London, Eng.	Daily
11.88	TPB 7	Paris, France	Daily
11.91	CD1190	Valdivia, Chile	Daily
12.00	RNE	Moscow, USSR.	Daily
13.63	SPW	Warsaw, Poland	ex. Sat.
15.11	DJL	Berlin, Ger.	Daily
15.14	GSF	London, Eng.	Daily
15.15	YDC	Sourabaya, Java	Daily
15.18	GSO	London, Eng.	Daily
15.19	OFB	Lahte, Finland	ex. Sun.
15.20	DJB	Berlin, Germany	Daily
15.24	TPA 2	Paris, France	Daily
15.28	DJQ	Berlin, Germany	Daily
15.34	DJR	Berlin, Germany	Daily
15.37	HAS 3	Budapest, Hungary	Sun.
17.76	DJE	Berlin, Germany	Daily
17.77	PHI2	Huisin, Holland	Mon. to Fr.
17.79	GSG	London, Eng.	Daily
21.47	GSH	London, Eng.	Daily
21.53	GSJ	London, Eng.	Daily

RADIO TUBE CHART

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) µMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
		DIMEN.	S. C.	C. T.	VOLTS	AMP.												
00-A	DETECTOR TRIODE	D12	4D	D.C. F	5.0	0.25	GRID-LEAK DETECTOR	45	Grid Return to (−) Filament			1.5	30000	666	20	——	——	00-A
01-A	DETECTOR★ AMPLIFIER	D12	4D	D.C. F	5.0	0.25	CLASS A AMPLIFIER	90 135	− 4.5 − 9.0	——	——	2.5 3.0	11000 10000	725 800	8.0 8.0	——	——	01-A
0A4-G	GAS-TRIODE	D3	G-4V	Cold	——	——	RELAY SERVICE	Peak Cathode Current, 100 max. ma. D-C Cathode Current, 25 max. ma. Starter-Anode Drop, 60 approx. volts. Anode Drop, 70 approx. volts.										0A4-G
0Z4	FULL-WAVE GAS RECTIFIER	B3	4R	Cold	——	——	RECTIFIER	Starting-Supply Voltage per Plate, 300 min. peak volts. Peak Plate Current, 200 max. ma. D-C Output Current, 75 max., 30 min. ma. D-C Output Voltage, 300 max. volts.										0Z4
0Z4-G	FULL-WAVE GAS RECTIFIER	B1	G-4R ◆	Cold	——	——	RECTIFIER											0Z4-G
1A4-P	SUPER-CONTROL R-F AMPLIFIER PENTODE	D9	4M	D.C. F	2.0	0.06	AMPLIFIER	For other characteristics, refer to Type 1D5-GP.										1A4-P
1A5-G	POWER AMPLIFIER PENTODE	D1	G-6X	D.C. F	1.4	0.05	CLASS A AMPLIFIER	85 90	− 4.5 − 4.5	85 90	0.7 0.8	3.5 4.0	300000 300000	800 850	——	25000 25000	0.100 0.115	1A5-G
1A6	PENTAGRID CONVERTER ◘	D9	6L	D.C. F	2.0	0.06	CONVERTER	For other characteristics, refer to Type 1D7-G.										1A6
1A7-G	PENTAGRID CONVERTER ◘	D8	G-7Z	D.C. F	1.4	0.05	CONVERTER	90	0	45♣	0.6	0.55	600000	Anode-Grid (#2): 90 max. volts, 1.2 ma. Oscillator-Grid (#1) Resistor, 0.2 meg. Conversion Transcond., 250 micromhos.				1A7-G
1A7-GT	PENTAGRID CONVERTER ◘	C3	G-7Z	D.C. F	1.4	0.05	CONVERTER	For other characteristics, refer to Type 1A7-G.										1A7-GT
1B4-P	R-F AMPLIFIER PENTODE	D9	4M	D.C. F	2.0	0.06	AMPLIFIER	For other characteristics, refer to Type 1E5-GP.										1B4-P
1B5/25S	DUPLEX-DIODE TRIODE	D5	6M	D.C. F	2.0	0.06	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 1H6-G.										1B5/25S
1C5-G	POWER AMPLIFIER PENTODE	D1	G-6X	D.C. F	1.4	0.10	CLASS A AMPLIFIER	83 90	− 7.0 − 7.5	83 90	1.6 1.6	7.0 7.5	110000 115000	1500 1550	——	9000 8000	0.20 0.24	1C5-G
1C6	PENTAGRID CONVERTER ◘	D9	6L	D.C. F	2.0	0.12	CONVERTER	For other characteristics, refer to Type 1C7-G.										1C6

1C7-G	PENTAGRID CONVERTER■	D8	G-7Z	D.C. F	2.0	0.12	CONVERTER	135 180	− 3.0 − 3.0	67.5 67.5	2.5 2.0	1.3 1.5	600000 700000	Anode-Grid (#2): 180■ max. volts, 4.0 ma. Oscillator-Grid (#1) Resistor●. Conversion Transcond., 325 micromhos				1C7-G
1D5-GP	SUPER-CONTROL R-F AMPLIFIER PENTODE	D3	G-5Y	D.C. F	2.0	0.06	CLASS A AMPLIFIER	90 180	{− 3.0 min.}	67.5 67.5	0.9 0.8	2.2 2.3	600000 1000000	720 750	——	——	——	1D5-GP
1D7-G	PENTAGRID CONVERTER■	D8	G-7Z	D.C. F	2.0	0.06	CONVERTER	135 180	{− 3.0 min.}	67.5 67.5	2.5 2.4	1.2 1.3	400000 500000	Anode-Grid (#2): 180■ max. volts, 2.3 ma. Oscillator-Grid (#1) Resistor●. Conversion Transcond., 300 micromhos.				1D7-G
1D8-GT	DIODE-TRIODE-POWER AMPLIFIER PENTODE	C3	G-8AJ	D.C. F	1.4	0.1	PENTODE UNIT AS CLASS A AMPLIFIER	45 90	− 4.5 − 9.0	45 90	0.3 1.0	1.6 5.0	300000 200000	650 925	——	20000 12000	0.035 0.200	1D8-GT
							TRIODE UNIT AS CLASS A AMPLIFIER	45 90	0 0	——	——	0.3 1.1	77000 43500	325 575	25 25	——	——	
1E5-GP	R-F AMPLIFIER PENTODE	D8	G-5Y	D.C. F	2.0	0.06	CLASS A AMPLIFIER	90 180	− 3.0 − 3.0	67.5 67.5	0.7 0.6	1.6 1.7	1000000 1500000	600 650	——	——	——	1E5-GP
1E7-G	TWIN PENTODE POWER AMPLIFIER	D3	G-8C	D.C. F	2.0	0.24	CLASS A AMPLIFIER	135	− 7.5	135	——	Power Output is for one tube at stated plate-to-plate load.				24000	0.575	1E7-G
1F4	POWER AMPLIFIER PENTODE	D12	5K	D.C. F	2.0	0.12	AMPLIFIER	For other characteristics, refer to Type 1F5-G.										1F4
1F5-G	POWER AMPLIFIER PENTODE	D10	G-6X	D.C. F	2.0	0.12	CLASS A AMPLIFIER	90 135	− 3.0 − 4.5	90 135	1.1 2.4	4.0 8.0	240000 200000	1400 1700	——	20000 16000	0.11 0.31	1F5-G
1F6	DUPLEX-DIODE PENTODE	D9	6W	D.C. F	2.0	0.06	PENTODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 1F7-GV.										1F6
1F7-GV	DUPLEX-DIODE PENTODE	D8	G-7AD	D.C. F	2.0	0.06	PENTODE UNIT AS R-F AMPLIFIER	180	− 1.5	67.5	0.7	2.2	1000000	650	——	——	——	1F7-GV
							PENTODE UNIT AS A-F AMPLIFIER	135✖	− 2.0	Screen Supply, 135 volts applied through 0.8-megohm resistor. Grid Resistor,** 1.0 megohm. Voltage Gain, 46.								
1G4-G	DETECTOR AMPLIFIER TRIODE	D1	G-5S	D.C. F	1.4	0.05	CLASS A AMPLIFIER	90	− 6.0	——	——	2.3	10700	825	8.8	——	——	1G4-G
1G5-G	POWER AMPLIFIER PENTODE	D10	G-6X	D.C. F	2.0	0.12	CLASS A AMPLIFIER	90 135	− 6.0 −13.5	90 135	2.5 2.5	8.5 8.7	133000 160000	1500 1550	——	8500 9000	0.25 0.55	1G5-G
1G6-G	TWIN TRIODE AMPLIFIER	D1	G-7AB	D.C. F	1.4	0.10	CLASS B AMPLIFIER	90	0	——	——	Power Output is for one tube at stated plate-to-plate load.				12000	0.675	1G6-G
1H4-G	DETECTOR★ AMPLIFIER	D3	G-5S	D.C. F	2.0	0.06	CLASS A AMPLIFIER	90 135 180	− 4.5 − 9.0 −13.5	——	——	2.5 3.0 3.1	11000 10300 10300	850 900 900	9.3 9.3 9.3	——	——	1H4-G
							CLASS B AMPLIFIER	157.5	−15.0	——	——	1.0♠	——	——	——	8000	2.1†	
1H5-G	DIODE HIGH-MU TRIODE	D8	G-5Z	D.C. F	1.4	0.05	TRIODE UNIT AS CLASS A AMPLIFIER	90	0	——	——	0.15	240000	275	65	——	——	1H5-G
1H5-GT	DIODE HIGH-MU TRIODE	C3	G-5Z	D.C. F	1.4	0.05	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 1H5-G.										1H5-GT
1H6-G	DUPLEX-DIODE TRIODE	D3	G-7AA	D.C. F	2.0	0.06	TRIODE UNIT AS CLASS A AMPLIFIER	135	− 3.0	——	——	0.8	35000	575	20	——	——	1H6-G

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) μMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
		DIMEN.	S.C.	C.T.	VOLTS	AMP.												
1J6-G	TWIN TRIODE AMPLIFIER	D3	G-7AB	D.C. F	2.0	0.24	CLASS B AMPLIFIER	135 135	0 − 3.0	——	——	Power Output is for one tube at stated plate-to-plate load.				10000 10000	2.1 1.9	1J6-G
1N5-G	R-F AMPLIFIER PENTODE	D8	G-5Y	D.C. F	1.4	0.05	CLASS A AMPLIFIER	90	0	90	0.3	1.2	1500000	750	——	——	——	1N5-G
1N5-GT	R-F AMPLIFIER PENTODE	C3	G-5Y	D.C. F	1.4	0.05	AMPLIFIER	For other characteristics, refer to Type 1N5-G.										1N5-GT
1Q5-GT	BEAM POWER AMPLIFIER	C3	G-6AF	D.C. F	1.4	0.1	CLASS A AMPLIFIER	90	− 4.5	90	1.6	9.5	——	2100	——	8000	0.27	1Q5-GT
1T5-GT	BEAM POWER AMPLIFIER	C3	G-6X	D.C. F	1.4	0.05	CLASS A AMPLIFIER	90	− 6.0	90	1.4	6.5	——	1150	——	14000	0.17	1T5-GT
1-V	HALF-WAVE RECTIFIER	D5	4G	H	6.3	0.3	WITH CONDENSER-INPUT FILTER	Max. A-C Plate Volts (RMS), 325 Max. D-C Output Ma., 45				Min. Total Effective Plate-Supply Impedance: Up to 117 volts, 0 ohms; at 150 volts, 30 ohms; at 325 volts, 75 ohms.						1-V
2A3	POWER AMPLIFIER TRIODE	E3	4D	F	2.5	2.5	CLASS A AMPLIFIER	250	−45.0	——	——	60.0	800	5250	4.2	2500	3.5	2A3
							PUSH-PULL CLASS AB_1 AMPLIFIER	300 300	Cath. Bias, 780 ohms♣ −62 volts, fixed bias			80.0♣ 80.0♣	——	——	——	5000 3000	10.0† 15.0†	
2A5	POWER AMPLIFIER PENTODE	D12	6B	H	2.5	1.75	AMPLIFIER	For other characteristics, refer to Type 6F6.										2A5
2A6	DUPLEX-DIODE HIGH-MU TRIODE	D9	6G	H	2.5	0.8	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6SQ7.										2A6
2A7	PENTAGRID CONVERTER ◘	D9	7C	H	2.5	0.8	CONVERTER	For other characteristics, refer to Type 6A8.										2A7
2B7	DUPLEX-DIODE PENTODE	D9	7D	H	2.5	0.8	PENTODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6B8-G.										2B7
3Q5-GT	BEAM POWER AMPLIFIER	C3	G-7AQ	F	1.4 2.8	0.1 0.05	CLASS A AMPLIFIER	90 90	− 4.5 − 4.5	90 90	1.6 1.0	9.5 7.5	100000 110000	2100 1800	——	8000 8000	0.27 0.25	3Q5-GT
5T4	FULL-WAVE RECTIFIER	D7	5T	F	5.0	2.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Total Effect. Supply Imped. per Plate, 150 ohms			5T4
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 550 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Value of Input Choke, 3 henries			
5U4-G	FULL-WAVE RECTIFIER	E2	G-5T‡	F	5.0	3.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Total Effect. Supply Imped. per Plate, 75 ohms			5U4-G
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 550 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Value of Input Choke, 3 henries			
5V4-G	FULL-WAVE RECTIFIER	D10	G-5L‡	H	5.0	2.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 375 Max. Peak Inverse Volts, 1400				Max. D-C Output Ma., 175 Max. Peak Plate Ma., 1050			Min. Total Effect. Supply Imped. per Plate, 65 ohms			5V4-G
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 500 Max. Peak Inverse Volts, 1400				Max. D-C Output Ma., 175 Max. Peak Plate Ma., 1050			Min. Value of Input Choke, 4 henries			

5W4	FULL-WAVE RECTIFIER	C2	5T	F	5.0	1.5	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 350 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 100 Max. Peak Plate Ma., 600				Min. Total Effect. Supply Imped. per Plate, 25 ohms			5W4
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 500 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 100 Max. Peak Plate Ma., 600				Min. Value of Input Choke, 6 henries			
5X4-G	FULL-WAVE RECTIFIER	E2	G-5Q	F	5.0	3.0	For other ratings, refer to Type 5U4-G.											5X4-G
5Y3-G	FULL-WAVE RECTIFIER	D10	G-6T‡	F	5.0	2.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 350 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 125 Max. Peak Plate Ma., 750				Min. Total Effect. Supply Imped. per Plate, 10 ohms			5Y3-G
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 500 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 125 Max. Peak Plate Ma., 750				Min. Value of Input Choke, 5 henries			
5Y4-G	FULL-WAVE RECTIFIER	D10	G-5Q	F	5.0	2.0	For other ratings, refer to Type 5Y3-G.											5Y4-G
5Z3	FULL-WAVE RECTIFIER	E3	4C	F	5.0	3.0	For other ratings, refer to Type 5U4-G.											5Z3
5Z4	FULL-WAVE RECTIFIER	C2	5L	H	5.0	2.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 350 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 125 Max. Peak Plate Ma., 750				Min. Total Effect. Supply Imped. per Plate, 30 ohms			5Z4
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 500 Max. Peak Inverse Volts, 1400			Max. D-C Output Ma., 125 Max. Peak Plate Ma., 750				Min. Value of Input Choke, 5 henries			
6A4/LA	POWER AMPLIFIER PENTODE	D12	5B	F	6.3	0.3	CLASS A AMPLIFIER	100 180	− 6.5 −12.0	100 180	1.6 3.9	9.0 22.0	83250 45500	1200 2200	——	11000 8000	0.31 1.40	6A4/LA
6A6	TWIN TRIODE AMPLIFIER	D12	7B	H	6.3	0.8	AMPLIFIER	For other characteristics, refer to Type 6N7.										6A6
6A7	PENTAGRID CONVERTER ◘	D9	7C	H	6.3	0.3	CONVERTER	For other characteristics, refer to Type 6A8.										6A7
6A8	PENTAGRID CONVERTER ◘	C1	8A	H	6.3	0.3	CONVERTER	100 250	− 1.5 − 3.0	50 100	1.3 2.7	1.1 3.5	600000 360000	Anode-Grid (#2): 250◆ max. volts, 4.0 ma. Oscillator-Grid (#1) Resistor ●. Conversion Transcond., 550 micromhos.				6A8
6A8-G	PENTAGRID CONVERTER ◘	D8	G-8A‡	H	6.3	0.3	CONVERTER	For other characteristics, refer to Type 6A8.										6A8-G
6A8-GT	PENTAGRID CONVERTER ◘	C3	G-8A‡	H	6.3	0.3	CONVERTER	100 250	− 1.5 min. − 3.0 min.	50 100	1.5 3.2	1.2 3.3	600000 360000	Anode-Grid (#2): 250◆ max. volts, 4.0 ma. Oscillator-Grid (#1) Resistor ●. Conversion Transcond., 500 micromhos.				6A8-GT
6AB7/ 1853	TELEVISION AMPLIFIER PENTODE	B3	8N	H	6.3	0.45	CLASS A AMPLIFIER	300	− 3.0	200	3.2	12.5	700000	5000	——	——	——	6AB7/ 1853
6AC5-G	HIGH-MU POWER AMPLIFIER TRIODE	D3	G-6Q‡	H	6.3	0.4	CLASS B AMPLIFIER	250	0	——	——	5.0♠	——	——	——	10000	8.0†	6AC5-G
							DYNAMIC-COUPLED AMPLIFIER WITH TYPE 6P5-G DRIVER	250	Bias for both 6AC5-G and 6P5-G is developed in coupling circuit. Average Plate Current of Driver = 5.5 milliamperes. Average Plate Current of 6AC5-G = 32 milliamperes.							7000	3.7	
6AC7/ 1852	TELEVISION AMPLIFIER PENTODE	B3	8N	H	6.3	0.45	CLASS A AMPLIFIER	300	Cath. Bias	150	2.5	10.0	750000	9000	Cathode-Bias Resistor, 160 ohms			6AC7/ 1852
6AE5-GT	AMPLIFIER TRIODE	C3	G-6Q‡	H	6.3	0.3	CLASS A AMPLIFIER	95	−15.0	——	——	7.0	3500	1200	4.2	——	——	6AE5-GT

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY	GRID BIAS ■	SCREEN SUPPLY	SCREEN CURRENT	PLATE CURRENT	A-C PLATE RESISTANCE	TRANSCONDUCTANCE (GRID-PLATE)	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT	POWER OUTPUT	TYPE
		DIMEN.	S. C.	C. T.	VOLTS	AMP.		VOLTS	VOLTS	VOLTS	MA.	MA.	OHMS	µMHOS		OHMS	WATTS	
6AF6-G	ELECTRON-RAY TUBE Twin Indicator Type	B2	G-7AG	H	6.3	0.15	VISUAL INDICATOR	Target Voltage, 100 volts. Control-Electrode Voltage, 0 volts; Shadow Angle, 100°; Target Current, 0.9 ma. Control-Electrode Voltage, 60 volts; Angl-, 0°. Target Voltage, 135 volts. Control-Electrode Voltage, 0 volts; Shadow Angle, 100°; Target Current, 1.5 ma. Control-Electrode Voltage, 81 volts; Angle, 0°.										6AF6-G
6AG7	VIDEO BEAM POWER AMPLIFIER	C2	8Y	H	6.3	0.65	CLASS A AMPLIFIER	250	− 2.0	140	8.5	33.0	Load Resistance, 1700 ohms. Peak-to-Peak Volts Output, 70 approx.					6AG7
6B5	DIRECT-COUPLED POWER AMPLIFIER	D12	6AS	H	6.3	0.8	CLASS A AMPLIFIER	For other characteristics, refer to Type 6N6-G.										6B5
6B6-G	DUPLEX-DIODE HIGH-MU TRIODE	D8	G-7V‡	H	6.3	0.3	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6SQ7.										6B6-G
6B7	DUPLEX-DIODE PENTODE	D9	7D	H	6.3	0.3	PENTODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6B8-G.										6B7
6B8	DUPLEX-DIODE PENTODE	C1	8E	H	6.3	0.3	PENTODE UNIT AS R-F AMPLIFIER	250	− 3.0	125	2.3	10.0	600000	1325	——	——	——	6B8
							PENTODE UNIT AS A-F AMPLIFIER	90✖ 300✖	Cath. Bias, 3500 ohms. Screen Resistor = 1.1 meg. Cath. Bias, 1600 ohms. Screen Resistor = 1.2 meg.					Grid Resistor,** 0.5 megohm.		Gain per stage = 55 Gain per stage = 79		
6B8-G	DUPLEX-DIODE PENTODE	D8	G-8E‡	H	6.3	0.3	PENTODE UNIT AS R-F AMPLIFIER	100 250	− 3.0 − 3.0	100 125	1.7 2.3	5.8 9.0	300000 600000	950 1125	——	——	——	6B8-G
							PENTODE UNIT AS A-F AMPLIFIER	90✖ 300✖	Cath. Bias, 3500 ohms. Screen Resistor = 1.1 meg. Cath. Bias, 1600 ohms. Screen Resistor = 1.2 meg.					Grid Resistor,** 0.5 megohm.		Gain per stage = 55 Gain per stage = 79		
6C5	DETECTOR★ AMPLIFIER TRIODE	B3	6Q	H	6.3	0.3	CLASS A AMPLIFIER	250	− 8.0	——	——	8.0	10000	2000	20	——	——	6C5
								90♥ 300♥	Cath. Bias, 6400 ohms. Cath. Bias, 5300 ohms.			Grid Resistor,** 0.25 megohm.				Gain per stage = 11 Gain per stage = 13		
							BIAS DETECTOR	250	−17.0 approx.	Plate current to be adjusted to 0.2 milliampere with no signal.								
6C5-G	DETECTOR★ AMPLIFIER TRIODE	D3	G-6Q‡‡	H	6.3	0.3	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6C5.										6C5-G
6C6	TRIPLE-GRID DETECTOR AMPLIFIER	D13	6F	H	6.3	0.3	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6J7.										6C6
6C8-G	TWIN TRIODE AMPLIFIER	D8	G-8G	H	6.3	0.3	EACH UNIT AS AMPLIFIER	250	− 4.5	——	——	3.2	22500	1600	36	——	——	6C8-G
6D6	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D13	6F	H	6.3	0.3	AMPLIFIER MIXER	For other characteristics, refer to Type 6U7-G.										6D6

6D8-G	PENTAGRID CONVERTER◘	D8	G-8A‡	H	6.3	0.15	CONVERTER	135 250	− 3.0 − 3.0	67.5 100	—— ——	—— ——	600000 400000	Anode-Grid (#2): 250 ■ max. volts, 4.3 ma. Oscillator-Grid (#1) Resistor ■. Conversion Transcond., 550 micromhos.				6D8-G
6E5	ELECTRON-RAY TUBE	D5	6R	H	6.3	0.3	VISUAL INDICATOR	Plate & Target Supply = 100 volts. Triode Plate Resistor = 0.5 meg. Target Current = 1.0 ma. Grid Bias, −3.3 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.19 ma. Plate & Target Supply = 250 volts. Triode Plate Resistor = 1.0 meg. Target Current = 4.0 ma. Grid Bias, −8.0 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.24 ma.										6E5
6F5	HIGH-MU TRIODE	C1	5M	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6SF5.										6F5
6F5-G	HIGH-MU TRIODE	D8	G-5M‡	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6SF5.										6F5-G
6F5-GT	HIGH-MU TRIODE	C3	G-5M‡	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6SF5.										6F5-GT
6F6	POWER AMPLIFIER PENTODE	C2	7S	H	6.3	0.7	PENTODE CLASS A AMPLIFIER	250 285	−16.5 −20.0	250 285	6.5 7.0	34.0 38.0	80000 78000	2500 2550	——	7000 7000	3.2 4.8	6F6
							TRIODE ◘ CLASS A AMPLIFIER	250	−20.0	——	——	31.0	2600	2600	6.8	4000	0.85	
							PENTODE PUSH-PULL CLASS A AMPLIFIER	315 315	Cath. Bias −24.0	285 285	12.0♠ 12.0♠	62.0♠ 62.0♠	Cath. Bias Resistor, 315 ohms♠ ——	 ——	 ——	10000 10000	11.0† 11.0†	
							PENTODE PUSH-PULL CLASS AB_1 AMPLIFIER	375 375	Cath. Bias −26.0	250 250	8.0♠ 5.0♠	54.0♠ 34.0♠	Cath. Bias Resistor, 340 ohms♠ ——	 ——	 ——	10000 10000	19.0† 18.5†	
							TRIODE PUSH-PULL ◘ CLASS AB_2 AMPLIFIER	350 350	Cath. Bias −38.0	——	——	50.0♠ 48.0♠	Cath. Bias Resistor, 730 ohms♠ ——	 ——	 ——	10000 6000	9.5† 13.0†	
6F6-G	POWER AMPLIFIER PENTODE	D10	G-7S‡	H	6.3	0.7	AMPLIFIER	For other characteristics, refer to Type 6F6.										6F6-G
6F7	TRIODE-PENTODE	D9	7E	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	100	− 3.0	——	——	3.5	16000	500	8	——	——	6F7
							PENTODE UNIT AS CLASS A AMPLIFIER	100 250	− 3.0 min.	100 100	1.6 1.5	6.3 6.5	290000 850000	1050 1100	——	——	——	
							PENTODE UNIT AS MIXER	250	−10.0	100	0.6	2.8	Oscillator Peak Volts = 7.0. Conversion Transcond. = 300 micromhos.					
6F8-G	TWIN TRIODE AMPLIFIER	D8	G-8G	H	6.3	0.6	EACH UNIT AS AMPLIFIER	90 250	0 − 8.0	——	——	10.0 9.0	6700 7700	3000 2600	20 20	—— ——	—— ——	6F8-G
6G6-G	POWER AMPLIFIER PENTODE	D3	G-7S‡	H	6.3	0.15	PENTODE CLASS A AMPLIFIER	135 180	− 6.0 − 9.0	135 180	2.0 2.5	11.5 15.0	170000 175000	2100 2300	——	12000 10000	0.6 1.1	6G6-G
							TRIODE ◘ CLASS A AMPLIFIER	180	−12.0	——	——	11.0	4750	2000	9.5	12000	0.25	
6H6	TWIN DIODE	A1	7Q	H	6.3	0.3	DETECTOR RECTIFIER	Maximum A-C Voltage per Plate........117 Volts, RMS Maximum D-C Output Current........4 Milliamperes										6H6
6H6-G	TWIN DIODE	D3	G-7Q‡‡	H	6.3	0.3	DETECTOR RECTIFIER	For other ratings, refer to Type 6H6.										6H6-G
6J5	DETECTOR AMPLIFIER TRIODE	E3	6Q	H	6.3	0.3	CLASS A AMPLIFIER	90	0	——	——	10.0	6700	3000	20	——	——	6J5

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS DIMEN.	S.C.	CATHODE TYPE AND RATING C.T.	VOLTS	AMP.	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) μMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
6J5-G	DETECTOR AMPLIFIER TRIODE	D3	G-6Q‡	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6J5.										6J5-G
6J5-GT	DETECTOR AMPLIFIER TRIODE	C3	G-6Q‡	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6J5.										6J5-GT
6J7	TRIPLE-GRID DETECTOR AMPLIFIER	C1	7R	H	6.3	0.3	PENTODE CLASS A R-F AMPLIFIER	100 250	− 3.0 − 3.0	100 100	0.5 0.5	2.0 2.0	1000000 1.0 +§	1185 1225	——	——	——	6J7
							PENTODE CLASS A A-F AMPLIFIER	90 ✖ Cath. Bias, 2600 ohms. Screen Resistor = 1.2 meg. 300 ✖ Cath. Bias, 1200 ohms. Screen Resistor = 1.2 meg.						Grid Resistor,** 0.5 megohm.		Gain per stage = 85 Gain per stage = 140		
							PENTODE BIAS DETECTOR	250	− 4.3	100	Cathode Current 0.43 ma.		——	Plate Resistor, 500000 ohms. Grid Resistor,** 250000 ohms.				
	)						TRIODE ✢ CLASS A AMPLIFIER	180 250	− 5.3 − 8.0	——	——	5.3 6.5	11000 10500	1800 1900	20 20	——	——	
6J7-G	TRIPLE-GRID DETECTOR AMPLIFIER	D8	G-7R‡‡	H	6.3	0.3	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6J7.										6J7-G
6J7-GT	TRIPLE-GRID DETECTOR AMPLIFIER	C3	G-7R ✖	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 3.0 − 3.0	100 100	0.5 0.5	2.0 2.0	1000000 1.5 +§	1185 1225	——	——	——	6J7-GT
6K5-G	HIGH-MU TRIODE	D8	G-5U	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 1.5 − 3.0	—— ——	—— ——	0.35 1.1	78000 50000	900 1400	70 70	—— ——	—— ——	6K5-G
6K6-G	POWER AMPLIFIER PENTODE	D3	G-7S‡	H	6.3	0.4	CLASS A AMPLIFIER	100 250 315	− 7.0 −18.0 −21.0	100 250 250	1.6 5.5 4.0	9.0 32.0 25.5	104000 68000 75000	1500 2300 2100	——	12000 7600 9000	0.35 3.40 4.50	6K6-G
6K6-GT	POWER AMPLIFIER PENTODE	C3	G-7S‡	H	6.3	0.4	CLASS A AMPLIFIER	180 250	−13.5 −18.0	180 250	3.0 5.7	18.5 34.0	81000 68000	1850 2200	——	9000 7600	1.50 3.40	6K6-GT
6K7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	C1	7R	H	6.3	0.3	CLASS A AMPLIFIER	90 250	− 3.0 − 3.0	90 125	1.3 2.6	5.4 10.5	300000 600000	1275 1650	——	——	——	6K7
							MIXER IN SUPERHETERODYNE	250	−10.0	100	——	——	Oscillator Peak Volts = 7.0					
6K7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D8	G-7R‡	H	6.3	0.3	AMPLIFIER MIXER	For other characteristics, refer to Type 6K7.										6K7-G
6K7-GT	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	C3	G-7R ✖	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 3.0 min.	100 100	1.6 1.7	6.5 7.0	250000 800000	1325 1450	——	——	——	6K7-GT

6K8	TRIODE-HEXODE CONVERTER	C1	8K	H	6.3	0.3	TRIODE UNIT AS OSCILLATOR	100	Triode-Grid Resistor ●			3.8	Triode-Grid & Hexode-Grid Current, 0.15 ma.					6K8
							HEXODE UNIT AS MIXER	100 250	− 3.0 − 3.0	100 100	6.2 6.0	2.3 2.5	400000 600000	Conversion Transcond., 325 micromhos. Conversion Transcond., 350 micromhos.				
6L5-G	DETECTOR AMPLIFIER TRIODE	D3	G-6Q‡	H	6.3	0.15	CLASS A AMPLIFIER	135 250	− 5.0 − 9.0	—— ——	—— ——	3.5 8.0	11300 9000	1500 1900	17 17	——	——	6L5-G
6L6	BEAM POWER AMPLIFIER	D7	7AC	H	6.3	0.9	SINGLE-TUBE CLASS A AMPLIFIER	250 250	−14.0 Cath. Bias	250 250	5.0 5.4	72.0 75.0	—— Cath. Bias Resistor, 170 ohms.	——	——	2500 2500	6.5 6.5	6L6
							PUSH-PULL CLASS A AMPLIFIER	270 270	−17.5 Cath. Bias	270 270	11.0♠ 11.0♠	134.0♠ 145.0♠	—— Cath. Bias Resistor, 125 ohms.♠	——	——	5000 5000	17.5 18.5†	
							PUSH-PULL CLASS AB_1 AMPLIFIER	360 360	−22.5 Cath. Bias	270 270	5.0♠ 5.0♠	88.0♠ 88.0♠	—— Cath. Bias Resistor, 248 ohms.♠	——	——	6600 9000	26.5† 24.5†	
							PUSH-PULL CLASS AB_2 AMPLIFIER	360 360	−18.0 −22.5	225 270	3.5♠ 5.0♠	78.0♠ 88.0♠	——	——	——	6000 3800	31.0† 47.0†	
							SINGLE TRIODE□ CLASS A AMPLIFIER	250 250	−20.0 Cath. Bias	——	——	40.0 40.0	1700 Cath. Bias Resistor, 490 ohms.	4700	8.0	5000 6000	1.4 1.3	
6L6-G	BEAM POWER AMPLIFIER	E2	G-7AC‡	H	6.3	0.9	AMPLIFIER	For other characteristics, refer to Type 6L6.										6L6-G
6L7	PENTAGRID MIXER & AMPLIFIER	C1	7T	H	6.3	0.3	MIXER IN SUPERHETERODYNE	250	− 3.0	100	7.1	2.4	Oscillator-Grid (#3) Bias, −10 volts. Grid #3 Peak Swing, 12 volts minimum. Conversion Transcond., 375 micromhos.					6L7
							CLASS A AMPLIFIER	250	{− 3.0 min.¶}	100	6.5	5.3	600000	1100	——	——	——	
6L7-G	PENTAGRID MIXER & AMPLIFIER	D8	G-7T‡	H	6.3	0.3	MIXER AMPLIFIER	For other characteristics, refer to Type 6L7.										6L7-G
6N5	ELECTRON-RAY TUBE	D5	6R	H	6.3	0.15	VISUAL INDICATOR	Plate & Target Supply = 135 volts. Triode Plate Resistor = 0.25 meg. Target Current = 2.0 ma. Grid Bias, − 12.0 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.5 ma.										6N5
6N6-G	DIRECT-COUPLED POWER AMPLIFIER	D12	G-7AU	H	6.3	0.8	CLASS A AMPLIFIER	Output Triode: Plate Volts, 300; Plate Ma., 42; Load, 7000 ohms. Input Triode: Plate Volts, 300; Grid Volts, 0; A-F Signal Volts (RMS), 15; Plate Ma., 9.									4.0	6N6-G
6N7	TWIN TRIODE AMPLIFIER	C2	8B	H	6.3	0.8	CLASS A AMPLIFIER (As Driver)○	250 294	− 5.0 − 6.0	——	——	6.0 7.0	11300 11000	3100 3200	35 35	20000 or more	exceeds 0.4	6N7
							CLASS B AMPLIFIER	250 300	0 0	——	——	Power Output is for one tube at stated plate-to-plate load.				8000 8000	8.0 10.0	
6N7-G	TWIN TRIODE AMPLIFIER	D10	G-8B‡	H	6.3	0.8	AMPLIFIER	For other characteristics, refer to Type 6N7.										6N7-G
6P5-G	DETECTOR AMPLIFIER TRIODE	D3	G-6Q	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 5.0 −13.5	——	——	2.5 5.0	12000 9500	1150 1450	13.8 13.8	——	——	6P5-G
								90♥ 300♥	Cath. Bias, 6500 ohms. Cath. Bias, 6400 ohms.	Grid Resistor,** 0.25 megohm.						{Gain per stage = 9 Gain per stage = 10}		
							BIAS DETECTOR	250	{− 20.0 approx.}	——	——	Plate current to be adjusted to 0.2 milliampere with no signal.						

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY	GRID BIAS ■	SCREEN SUPPLY	SCREEN CURRENT	PLATE CURRENT	A-C PLATE RESISTANCE	TRANSCONDUCTANCE (GRID-PLATE)	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT	POWER OUTPUT	TYPE
		DIMEN.	S. C.	C. T.	VOLTS	AMP.		VOLTS	VOLTS	VOLTS	MA.	MA.	OHMS	µMHOS		OHMS	WATTS	
6Q7	DUPLEX-DIODE HIGH-MU TRIODE	C1	7V	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	100 250	− 1.5 − 3.0	—	—	0.35 1.1	87500 58000	800 1200	70 70	—	—	6Q7
								90✖ 300✖	Cath. Bias, 7600 ohms. Cath. Bias, 3000 ohms.	Grid Resistor,** 0.5 megohm.					Gain per stage = 32 Gain per stage = 45			
6Q7-G	DUPLEX-DIODE HIGH-MU TRIODE	D8	G-7V‡	H	6.3	0.3	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6Q7.										6Q7-G
6Q7-GT	DUPLEX-DIODE HIGH-MU TRIODE	C3	G-7V‡	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	100 250	0 − 3.0	—	—	2.3 1.1	43000 58000	1400 1200	60 70	—	—	6Q7-GT
6R7	DUPLEX-DIODE TRIODE	C1	7V	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	250	− 9.0	—	—	9.5	8500	1900	16	—	—	6R7
								90♥ 300♥	Cath. Bias, 4400 ohms. Cath. Bias, 3800 ohms.	Grid Resistor,** 0.25 megohm.					Gain per stage = 10 Gain per stage = 10			
6R7-G	DUPLEX-DIODE TRIODE	D8	G-7V‡	H	6.3	0.3	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6R7.										6R7-G
6S7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	C1	7R	H	6.3	0.15	CLASS A AMPLIFIER	135 250	− 3.0 − 3.0	67.5 100	0.9 2.0	3.7 8.5	1000000 1000000	1250 1750	—	—	—	6S7
6S7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D8	G-7R‡	H	6.3	0.15	AMPLIFIER	For other characteristics, refer to Type 6S7.										6S7-G
6SA7	PENTAGRID CONVERTER▲	B3	8R	H	6.3	0.3	MIXER	100 250	− 2.0 − 2.0	100 100	8.0 8.0	3.2 3.4	500000 800000	Grid # 1 Resistor, 20000 ohms. Conversion Transcond., 450 micromhos.				6SA7
6SC7	TWIN TRIODE AMPLIFIER	B3	8S	H	6.3	0.3	EACH UNIT AS AMPLIFIER	250	− 2.0	—	—	2.0	53000	1325	70	—	—	6SC7
6SF5	HIGH-MU TRIODE	B3	6AB	H	6.3	0.3	CLASS A AMPLIFIER	100 250	0 − 2.0	—	—	1.8 0.9	50000 66000	1520 1500	80 100	—	—	6SF5
								90✖ 300✖	Cath. Bias, 8800 ohms. Cath. Bias, 3200 ohms.	Grid Resistor,** 0.5 megohm.					Gain per stage = 43 Gain per stage = 63			
6SJ7	TRIPLE-GRID DETECTOR AMPLIFIER	B3	8N	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 3.0 − 3.0	100 100	0.9 0.8	2.9 3.0	700000 1500000	1575 1650	—	—	—	6SJ7
								90✖ 300✖	Cath. Bias, 1700 ohms. Cath. Bias, 860 ohms.	Grid Resistor,** 0.5 megohm.					Gain per stage = 93 Gain per stage = 167			
6SK7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	B3	8N	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 3.0 min.	100 100	2.6 2.4	8.9 9.2	250000 800000	1900 2000	—	—	—	6SK7

6SQ7	DUPLEX-DIODE HIGH-MU TRIODE	B3	8Q	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	250	− 2.0	——	——	0.9	91000	1100	100	——	——	6SQ7
								90✖ 300✖	Cath. Bias, 11000 ohms. Cath. Bias, 3900 ohms.			Grid Resistor, ** 0.5 megohm.				Gain per stage = 40 Gain per stage = 53		
6T7-G	DUPLEX-DIODE HIGH-MU TRIODE	D8	G-7V‡	H	6.3	0.15	TRIODE UNIT AS CLASS A AMPLIFIER	250	− 3.0	——	——	1.2	62000	1050	65	——	——	6T7-G
								90✖ 300✖	Cath. Bias, 8300 ohms. Cath. Bias, 4580 ohms.			Grid Resistor,** 0.5 megohm.				Gain per stage = 30 Gain per stage = 40		
6U5/6G5	ELECTRON-RAY TUBE	D4	6R	H	6.3	0.3	VISUAL INDICATOR	Plate & Target Supply = 100 volts. Triode Plate Resistor = 0.5 meg. Target Current = 1.0 ma. Grid Bias, −8 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.19 ma.										6U5/6G5
								Plate & Target Supply = 250 volts. Triode Plate Resistor = 1.0 meg. Target Current = 4.0 ma. Grid Bias, −22 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.24 ma.										
6U7-G	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D8	G-7R‡	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 3.0 − 3.0	100 100	2.2 2.0	8.0 8.2	250000 800000	1500 1600	——	——	——	6U7-G
							MIXER IN SUPERHETERODYNE	100 250	−10.0 −10.0	100 100	——	——	Oscillator Peak Volts = 7.0					
6V6	BEAM POWER AMPLIFIER	C2	7AC	H	6.3	0.45	SINGLE-TUBE CLASS A AMPLIFIER	180 250	− 8.5 −12.5	180 250	3.0 4.5	29.0 45.0	58000 52000	3700 4100	—— ——	5500 5000	2.0 4.5	6V6
							PUSH-PULL CLASS AB₁ AMPLIFIER	250	−15.0	250	5.0♠	70.0♠	——	——	——	10000	10.0†	
6V6-G	BEAM POWER AMPLIFIER	D10	G-7AC‡	H	6.3	0.45	AMPLIFIER	For other characteristics, refer to Type 6V6.										6V6-G
6V6-GT	BEAM POWER AMPLIFIER	C3	G-7AC	H	6.3	0.45	SINGLE-TUBE CLASS A AMPLIFIER	180 250	− 8.5 −12.5	180 250	3.0 4.5	29.0 45.0	—— 52000	—— 4100	—— ——	5500 5000	2.00 4.25	6V6-GT
							PUSH-PULL CLASS AB₁ AMPLIFIER	250 300	−15.0 −20.0	250 300	5.0♠ 5.0♠	70.0♠ 78.0♠	—— ——	—— ——	—— ——	10000 8000	8.5† 13.0†	
6W7-G	TRIPLE-GRID DETECTOR AMPLIFIER	D8	G-7R‡	H	6.3	0.15	CLASS A AMPLIFIER	250	− 3.0	100	0.5	2.0	1500000	1225	——	——	——	6W7-G
6X5	FULL-WAVE RECTIFIER	C2	6S	H	6.3	0.6	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 325 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 70 Max. Peak Plate Ma., 420			Min. Total Effect. Supply Imped. per Plate, 150 ohms			6X5
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 70 Max. Peak Plate Ma., 420			Min. Value of Input Choke, 8 henries			
6X5-G	FULL-WAVE RECTIFIER	D3	G-6S‡	H	6.3	0.6	For other ratings, refer to Type 6X5.											6X5-G
6Y6-G	BEAM POWER AMPLIFIER	D10	G-7AC‡	H	6.3	1.25	SINGLE-TUBE CLASS A AMPLIFIER	135 200	−13.5 −14.0	135 135	3.5 2.2	58.0 61.0	9300 18300	7000 7100	—— ——	2000 2600	3.6 6.0	6Y6-G
6Z7-G	TWIN TRIODE AMPLIFIER	D3	G-8B‡	H	6.3	0.3	CLASS B AMPLIFIER	135 180	0 0	——	——	Power Output is for one tube at stated plate-to-plate load.				9000 12000	2.5 4.2	6Z7-G
6ZY5-G	FULL-WAVE RECTIFIER	D3	G-6S‡	H	6.3	0.3	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 325 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 40 Max. Peak Plate Ma., 240			Min. Total Effect. Supply Imped. per Plate, 225 ohms			6ZY5-G
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 40 Max. Peak Plate Ma., 240			Min. Value of Input Choke, 13.5 henries			

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) µMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
		DIMEN.	S. C.	C. T.	VOLTS	AMP.												
7A6	TWIN DIODE	B5	7AJ	H	6.3☒	0.15	DETECTOR RECTIFIER	Maximum A-C Voltage per Plate........150 Volts, RMS Maximum D-C Output Current........10 Milliamperes										7A6
7A7-LM	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	B4	8V	H	6.3◆	0.3	CLASS A AMPLIFIER	250	{− 3.0 min.}	100	2.0	8.6	800000	2000	—	—	—	7A7-LM
7A8	OCTODE CONVERTER	B5	8U	H	6.3☒	0.15	CONVERTER	250	− 3.0	100	2.8	3.0	700000	Anode-Grid (#2): 250▲ max. volts, 4.5 ma. Oscillator-Grid (#1) Resistor ●. Conversion Transcond., 600 micromhos.				7A8
7B7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	B5	8V	H	6.3☒	0.15	CLASS A AMPLIFIER	250	− 3.0	100	2.0	8.5	700000	1700	—	—	—	7B7
7C6	DUPLEX-DIODE HIGH-MU TRIODE	B5	8W	H	6.3☒	0.15	TRIODE UNIT AS CLASS A AMPLIFIER	250	− 1.0	—	—	1.3	100000	1000	100	—	—	7C6
7Y4	FULL-WAVE RECTIFIER	B5	5AB	H	6.3 ◆	0.5	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 350 Max. Peak Inverse Volts, 700						Max. D-C Output Ma., 60 Max. Peak Plate Ma., 250				7Y4
10	POWER AMPLIFIER TRIODE	E4	4D	F	7.5	1.25	CLASS A AMPLIFIER	350 425	−32.0 −40.0	—	—	16.0 18.0	5150 5000	1550 1600	8.0 8.0	11000 10200	0.9 1.6	10
11 12	DETECTOR★ AMPLIFIER TRIODE	D2 D11	4F 4D	D.C. F	1.1	0.25	CLASS A AMPLIFIER	90 135	− 4.5 −10.5	—	—	2.5 3.0	15500 15000	425 440	6.6 6.6	—	—	11 12
12A7	RECTIFIER-PENTODE	D-9	7K	H	12.6	0.3	PENTODE UNIT AS CLASS A AMPLIFIER	135	−13.5	135	2.5	9.0	102000	975	—	13500	0.55	12A7
							HALF-WAVE RECTIFIER	Maximum A-C Plate Voltage........125 Volts, RMS Maximum D-C Output Current........30 Milliamperes										
12A8-GT	PENTAGRID CONVERTER●	C3	G-8A‡	H	12.6	0.15	CONVERTER	For other characteristics, refer to Type 6A8-GT.										12A8-GT
12C8	DUPLEX-DIODE PENTODE	C1	8E	H	12.6	0.15	PENTODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6B8.										12C8
12F5-GT	HIGH-MU TRIODE	C3	G-5M‡	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6SF5.										12F5-GT
12J5-GT	DETECTOR AMPLIFIER TRIODE	C3	G-6Q‡	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6J5.										12J5-GT
12J7-GT	TRIPLE-GRID DETECTOR AMPLIFIER	C3	G-7R✕	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6J7-GT.										12J7-GT

12K7-GT	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	C3	G-7R ✱	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6K7-GT.										12K7-GT
12Q7-GT	DUPLEX-DIODE HIGH-MU TRIODE	C3	G-7V‡	H	12.6	0.15	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6Q7-GT.										12Q7-GT
12SA7	PENTAGRID CONVERTER▲	B3	8R	H	12.6	0.15	MIXER	For other characteristics, refer to Type 6SA7.										12SA7
12SC7	TWIN TRIODE AMPLIFIER	B3	8S	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6SC7.										12SC7
12SF5	HIGH-MU TRIODE	B3	6AB	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6SF5.										12SF5
12SJ7	TRIPLE-GRID DETECTOR AMPLIFIER	B3	8N	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6SJ7.										12SJ7
12SK7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	B3	8N	H	12.6	0.15	AMPLIFIER	For other characteristics, refer to Type 6SK7.										12SK7
12SQ7	DUPLEX-DIODE HIGH-MU TRIODE	B3	8Q	H	12.6	0.15	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 6SQ7.										12SQ7
12Z3	HALF-WAVE RECTIFIER	D5	4G	H	12.6	0.3	WITH CONDENSER-INPUT FILTER	Max. A-C Plate Volts (RMS), 235 Max. D-C Output Ma., 55				Min. Total Effective Plate-Supply Impedance: Up to 117 volts, 0 ohms; at 150 volts, 30 ohms; at 235 volts, 75 ohms.						12Z3
15	R-F AMPLIFIER PENTODE	D9	6F	D.C. H	2.0	0.22	CLASS A AMPLIFIER	67.5 135	− 1.5 − 1.5	67.5 67.5	0.3 0.3	1.85 1.85	630000 800000	710 750	——	——	——	15
19	TWIN TRIODE AMPLIFIER	D5	6C	D.C. F	2.0	0.26	AMPLIFIER	For other characteristics, refer to Type 1J6-G.										19
20	POWER AMPLIFIER TRIODE	D2	4D	D.C. F	3.3	0.132	CLASS A AMPLIFIER	90 135	−16.5 −22.5	——	——	3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	0.045 0.110	20
22	R-F AMPLIFIER TETRODE	E1	4K	D.C. F	3.3	0.132	SCREEN-GRID R-F AMPLIFIER	135 135	− 1.5 − 1.5	45 67.5	0.6* 1.3*	1.7 3.7	725000 325000	375 500	——	——	——	22
24-A	R-F AMPLIFIER TETRODE	E1	5E	H	2.5	1.75	SCREEN-GRID R-F AMPLIFIER	180 250	− 3.0 − 3.0	90 90	1.7* 1.7*	4.0 4.0	400000 600000	1000 1050	——	——	——	24-A
							BIAS DETECTOR	250●	−5.0 approx.	20 to 45	——	Plate current to be adjusted to 0.1 milliampere with no signal.						
25A6	POWER AMPLIFIER PENTODE	C2	7S	H	25.0	0.3	CLASS A AMPLIFIER	95 160	−15.0 −18.0	95 120	4.0 6.5	20.0 33.0	45000 42000	2000 2375	——	4500 5000	0.9 2.2	25A6
25A6-G	POWER AMPLIFIER PENTODE	D10	G-7S‡	H	25.0	0.3	AMPLIFIER	For other characteristics, refer to Type 25A6.										25A6-G
25A7-G	RECTIFIER-PENTODE	D10	8F	H	25.0	0.3	PENTODE UNIT AS CLASS A AMPLIFIER	100	−15.0	100	4.0	20.5	50000	1800	——	4500	0.77	25A7-G
							HALF-WAVE RECTIFIER	Maximum A-C Plate Voltage..........125 Volts, RMS Maximum D-C Output Current.......... 75 Milliamperes										

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS DIMEN.	S.C.	CATHODE TYPE AND RATING C.T.	VOLTS	AMP.	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) μMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
25AC5-GT	HIGH-MU POWER AMPLIFIER TRIODE	C3	G-6Q‡	H	25.0	0.3	CLASS B AMPLIFIER	180	0	—	—	4.0♠	—	—	—	4800	6.0	25AC5-GT
							DYNAMIC-COUPLED AMP. WITH TYPE 6AE5-GT DRIVER	110	Bias for both 25AC5-GT and 6AE5-GT developed in circuit. Average Plate Current of Driver = 7 milliamperes. Average Plate Current of 25AC5-GT = 45 milliamperes.							2000	2.0	
25B6-G	POWER AMPLIFIER PENTODE	D10	G-7S‡	H	25.0	0.3	CLASS A AMPLIFIER	95 135	−15.0 −22.0	95 135	1.5 2.5	41.0 61.0	— —	4600 5000	—	2000 1700	1.9 4.3	25B6-G
25L6	BEAM POWER AMPLIFIER	C2	7AC	H	25.0	0.3	SINGLE-TUBE CLASS A AMPLIFIER	110 110	− 7.5 − 7.5	110 110	4.0 4.0	49.0 49.0	10000 10000	8200 8200	—	1500 2000	2.1 2.2	25L6
25L6-G	BEAM POWER AMPLIFIER	D10	G-7AC‡	H	25.0	0.3	AMPLIFIER	For other characteristics, refer to Type 25L6.										25L6-G
25L6-GT	BEAM POWER AMPLIFIER	C3	G-7AC‡	H	25.0	0.3	AMPLIFIER	For other characteristics, refer to Type 25L6.										25L6-GT
25Z5	RECTIFIER-DOUBLER	D5	6E	H	25.0	0.3	RECTIFIER-DOUBLER	For other ratings, refer to Type 25Z6.										25Z5
25Z6	RECTIFIER-DOUBLER	C2	7Q	H	25.0	0.3	VOLTAGE DOUBLER	Max. A-C Volts per Plate (RMS), 117 Max. Peak Inverse Volts, 700						Max. D-C Output Ma., 75 Max. Peak Plate Ma., 450				25Z6
							HALF-WAVE RECTIFIER	Max. A-C Volts per Plate (RMS), 235 Max. D-C Output Ma. per Plate, 75				Min. Total Effect. Supply Imped. per Plate: Up to 117 volts, 0 ohms; at 150 volts, 40 ohms; at 235 volts, 100 ohms.						
25Z6-G	RECTIFIER-DOUBLER	D3	G-7Q‡	H	25.0	0.3	RECTIFIER-DOUBLER	For other ratings, refer to Type 25Z6.										25Z6-G
25Z6-GT	RECTIFIER-DOUBLER	C3	G-7Q‡	H	25.0	0.3	VOLTAGE DOUBLER	Maximum A-C Voltage per Plate .... 125 Volts, RMS Maximum D-C Output Current .... 85 Milliamperes										25Z6-GT
							HALF-WAVE RECTIFIER	Maximum A-C Voltage per Plate .... 125 Volts, RMS Maximum D-C Output Current per Plate .... 85 Milliamperes										
26	AMPLIFIER TRIODE	D12	4D	F	1.5	1.05	CLASS A AMPLIFIER	90 180	− 7.0 −14.5	—	—	2.9 6.2	8900 7300	935 1150	8.3 8.3	—	—	26
27	DETECTOR★ AMPLIFIER TRIODE	D5	5A	H	2.5	1.75	CLASS A AMPLIFIER	135 250	− 9.0 −21.0	—	—	4.5 5.2	9000 9250	1000 975	9.0 9.0	—	—	27
							BIAS DETECTOR	250	−30.0 approx.	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
30	DETECTOR★ AMPLIFIER TRIODE	D5	4D	F	2.0	0.06	AMPLIFIER	For other characteristics, refer to Type 1H4-G.										30

31	POWER AMPLIFIER TRIODE	D5	4D	F	2.0	0.13	CLASS A AMPLIFIER	135 180	−22.5 −30.0	—	—	8.0 12.3	4100 3600	925 1050	3.8 3.8	7000 5700	0.185 0.375	31
32	R-F AMPLIFIER TETRODE	E1	4K	F	2.0	0.06	SCREEN-GRID R-F AMPLIFIER	135 180	− 3.0 − 3.0	67.5 67.5	0.4* 0.4*	1.7 1.7	950000 1200000	640 650	—	—	—	32
							BIAS DETECTOR	180♥	− 6.0 approx.	67.5	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
33	POWER AMPLIFIER PENTODE	D12	5K	F	2.0	0.26	CLASS A AMPLIFIER	180	−18.0	180	5.0	22.0	55000	1700	—	6000	1.4	33
34	SUPER-CONTROL R-F AMPLIFIER PENTODE	E1	4M	D.C. F	2.0	0.06	SCREEN-GRID R-F AMPLIFIER	135 180	− 3.0 min.	67.5 67.5	1.0 1.0	2.8 2.8	600000 1000000	600 620	—	—	—	34
35	SUPER-CONTROL R-F AMPLIFIER TETRODE	E1	5E	H	2.5	1.75	SCREEN-GRID R-F AMPLIFIER	180 250	− 3.0 min.	90 90	2.5* 2.5*	6.3 6.5	300000 400000	1020 1050	—	—	—	35
35A5-LT	BEAM POWER AMPLIFIER	C5	6AT	H	35.0	0.15	SINGLE-TUBE CLASS A AMPLIFIER	110	− 7.5	110	3.0	40.0	14000	5800	—	2500	1.5	35A5-LT
35L6-GT	BEAM POWER AMPLIFIER	C3	G-7AC‡	H	35.0	0.15	SINGLE-TUBE CLASS A AMPLIFIER	110	− 7.5	110	3.0	40.0	13800	5800	—	2500	1.5	35L6-GT
35Z3-LT	HALF-WAVE RECTIFIER	C6	4Z	H	35.0	0.15	WITH CONDENSER-INPUT FILTER	Max. A-C Plate Volts (RMS), 250♣ Max. D-C Output Ma., 100 Max. Peak Inverse Volts, 700 Max. Peak Plate Ma., 600										35Z3-LT
35Z4-GT	HALF-WAVE RECTIFIER	C3	G-5AA	H	35.0	0.15	WITH CONDENSER-INPUT FILTER	Max. A-C Plate Volts (RMS), 250♥ Max. D-C Output Ma., 100 Max. Peak Inverse Volts, 720 Max. Peak Plate Ma., 600										35Z4-GT
35Z5-GT	HALF-WAVE RECTIFIER Heater Tap for Pilot	C3	G-6AD	H	35.0	0.15	WITHOUT PILOT	Max. A-C Plate Volts (RMS), 125 • Max. D-C Output Ma., 100										35Z5-GT
							WITH PILOT	Max. A-C Plate Volts (RMS), 125 Max. D-C Output Ma., 50										
36	R-F AMPLIFIER TETRODE	D9	5E	H	6.3	0.3	SCREEN-GRID R-F AMPLIFIER	100 250	− 1.5 − 3.0	55 90	— 1.7*	1.8 3.2	550000 550000	850 1080	—	—	—	36
							BIAS DETECTOR	100● 250●	− 5.0 − 8.0	55 90	—	Grid-bias values are approximate. Plate current to be adjusted to 0.1 milliampere with no signal.						
37	DETECTOR★ AMPLIFIER TRIODE	D5	5A	H	6.3	0.3	CLASS A AMPLIFIER	90 250	− 6.0 −18.0	—	—	2.5 7.5	11500 8400	800 1100	9.2 9.2	—	—	37
							BIAS DETECTOR	90 250	−10.0 −28.0	—	—	Grid-bias values are approximate. Plate current to be adjusted to 0.2 milliampere with no signal.						
38	POWER AMPLIFIER PENTODE	D9	5F	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 9.0 −25.0	100 250	1.2 3.8	7.0 22.0	140000 100000	875 1200	—	15000 10000	0.27 2.50	38
39/44	SUPER-CONTROL R-F AMPLIFIER PENTODE	D9	5F	H	6.3	0.3	CLASS A AMPLIFIER	90 250	− 3.0 min.	90 90	1.6 1.4	5.6 5.8	375000 1000000	960 1050	—	—	—	39/44
40	VOLTAGE AMPLIFIER TRIODE	D12	4D	D.C. F	5.0	0.25	CLASS A AMPLIFIER	135✱ 180✱	− 1.5 − 3.0	—	—	0.2 0.2	150000 150000	200 200	30 30	—	—	40
41	POWER AMPLIFIER PENTODE	D5	6B	H	6.3	0.4	AMPLIFIER	For other characteristics, refer to Type 6K6-G.										41

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS DIMEN.	S. C.	CATHODE TYPE AND RATING C. T.	VOLTS	AMP.	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) μMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
42	POWER AMPLIFIER PENTODE	D12	6B	H	6.3	0.7	AMPLIFIER	For other characteristics, refer to Type 6F6.										42
43	POWER AMPLIFIER PENTODE	D12	6B	H	25.0	0.3	AMPLIFIER	For other characteristics, refer to Type 25A6.										43
45	POWER AMPLIFIER TRIODE	D12	4D	F	2.5	1.5	CLASS A AMPLIFIER	180 275	−31.5 −56.0	——	——	31.0 36.0	1650 1700	2125 2050	3.5 3.5	2700 4600	0.82 2.00	45
							PUSH-PULL CLASS AB_2 AMPLIFIER	275 275	Cath. Bias, 775 ohms♠ −68.0 volts, fixed bias			36.0♠ 28.0♠	——	——	——	5060 3200	12.0† 18.0†	
45Z5-GT	HALF-WAVE RECTIFIER Heater Tap for Pilot	C3	G-6AD	H	45.0	0.15	WITHOUT PILOT	Max. A-C Plate Volts (RMS), 250 ♦	Max Peak Plate Ma., 600	Max. D-C Output Ma., 100								45Z5-GT
							WITH PILOT	Max. A-C Plate Volts (RMS), 250 ♦	Max. D-C Output Ma., 60									
46	DUAL-GRID POWER AMPLIFIER	E3	5C	F	2.5	1.75	CLASS A AMPLIFIER □	250	−33.0	——	——	22.0	2380	2350	5.6	6400	1.25	46
							CLASS B AMPLIFIER ♦	300 400	0 0	——	——	8.0♠ 12.0♠	——	——	——	5200 5800	16.0† 20.0†	
47	POWER AMPLIFIER PENTODE	E3	5B	F	2.5	1.75	CLASS A AMPLIFIER	250	−16.5	250	6.0	31.0	60000	2500	——	7000	2.7	47
48	POWER AMPLIFIER TETRODE	E3	6A	D.C. H	30.0	0.4	TETRODE CLASS A AMPLIFIER	96 125	−19.0 −20.0	96 100	9.0 9.5	52.0 56.0	—— ——	3800 3900	—— ——	1500 1500	2.0 2.5	48
							TETRODE PUSH-PULL CLASS A AMPLIFIER	125	−20.0	100	——	100.0♠	——	——	——	3000	5.0†	
49	DUAL-GRID POWER AMPLIFIER	D12	5C	D.C. F	2.0	0.12	CLASS A AMPLIFIER □	135	−20.0	——	——	6.0	4175	1125	4.7	11000	0.17	49
							CLASS B AMPLIFIER ♦	180	0	——	——	4.0♠	——	——	——	12000	3.5†	
50	POWER AMPLIFIER TRIODE	F1	4D	F	7.5	1.25	CLASS A AMPLIFIER	300 400 450	−54.0 −70.0 −84.0	——	——	35.0 55.0 55.0	2000 1800 1800	1900 2100 2100	3.8 3.8 3.8	4600 3670 4350	1.6 3.4 4.6	50
50L6-GT	BEAM POWER AMPLIFIER	C3	G-7AC‡	H	50.0	0.15	CLASS A AMPLIFIER	For other characteristics, refer to Type 25L6.										50L6-GT
53	TWIN TRIODE AMPLIFIER	D12	7B	H	2.5	2.0	AMPLIFIER	For other characteristics, refer to Type 6N7.										53
55	DUPLEX-DIODE TRIODE	D9	6G	H	2.5	1.0	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 85.										55
56	SUPER-TRIODE AMPLIFIER DETECTOR★	D5	5A	H	2.5	1.0	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6P5-G.										56

57	TRIPLE-GRID DETECTOR AMPLIFIER	D13	6F	H	2.5	1.0	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6J7.										57
58	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D13	6F	H	2.5	1.0	AMPLIFIER MIXER	For other characteristics, refer to Type 6U7-G.										58
59	TRIPLE-GRID POWER AMPLIFIER	E3	7A	H	2.5	2.0	TRIODE ¶ CLASS A AMPLIFIER	250	−28.0	——	——	26.0	2300	2600	6.0	5000	1.25	59
							PENTODE** CLASS A AMPLIFIER	250	−18.0	250	9.0	35.0	40000	2500	——	6000	3.0	
							TRIODE@ CLASS B AMPLIFIER	300 400	0 0	——	——	20.0♠ 26.0♠	——	——	——	4600 6000	15.0† 20.0†	
71-A	POWER AMPLIFIER TRIODE	D12	4D	F	5.0	0.25	CLASS A AMPLIFIER	90 180	−19.0 −43.0	——	——	10.0 20.0	2170 1750	1400 1700	3.0 3.0	3000 4800	0.125 0.790	71-A
75	DUPLEX-DIODE HIGH-MU TRIODE	D9	6G	H	6.3	0.3	AMPLIFIER	For other characteristics, refer to Type 6SQ7.										75
76	SUPER-TRIODE AMPLIFIER DETECTOR★	D5	5A	H	6.3	0.3	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6P5-G.										76
77	TRIPLE-GRID DETECTOR AMPLIFIER	D9	6F	H	6.3	0.3	CLASS A AMPLIFIER	100 250	− 1.5 − 3.0	60 100	0.4 0.5	1.7 2.3	600000 1.0+§	1100 1250	——	——	——	77
							BIAS DETECTOR	250	− 1.95	50	Cathode current 0.65 ma.		——	Plate Resistor, 250000 ohms. Grid Resistor,** 250000 ohms.				
78	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	D9	6F	H	6.3	0.3	AMPLIFIER MIXER	For other characteristics, refer to Type 6K7.										78
79	TWIN TRIODE AMPLIFIER	D6	6H	H	6.3	0.6	CLASS B AMPLIFIER	180 250	0 0	——	——	Power Output is for one tube at stated plate-to-plate load.				7000 14000	5.5 8.0	79
80	FULL-WAVE RECTIFIER	D12	4C	F	5.0	2.0		For other ratings, refer to Type 5Y3-G.										80
81	HALF-WAVE RECTIFIER	F1	4B	F	7.5	1.25	WITH CONDENSER-INPUT FILTER	Maximum A-C Plate Voltage .... 700 Volts, RMS Maximum D-C Output Current .... 85 Milliamperes										81
82	FULL-WAVE▶ RECTIFIER	D12	4C	F	2.5	3.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 115 Max. Peak Plate Ma., 690			Min. Total Effect. Supply Imped. per Plate, 50 ohms.			82
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 550 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 115 Max. Peak Plate Ma., 690			Min. Value of Input Choke, 6 henries			
83	FULL-WAVE▶ RECTIFIER	E3	4C	F	5.0	3.0	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Total Effect. Supply Imped. per Plate, 50 ohms.			83
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 550 Max. Peak Inverse Volts, 1550				Max. D-C Output Ma., 225 Max. Peak Plate Ma., 1350			Min. Value of Input Choke, 3 henries			

TYPE	NAME	DIMENSIONS SOCKET CONNECTIONS		CATHODE TYPE AND RATING			USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY	GRID BIAS ■	SCREEN SUPPLY	SCREEN CURRENT	PLATE CURRENT	A-C PLATE RESISTANCE	TRANSCONDUCTANCE (GRID-PLATE)	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT	POWER OUTPUT	TYPE
		DIMEN.	S. C.	C. T.	VOLTS	AMP.		VOLTS	VOLTS	VOLTS	MA.	MA.	OHMS	μMHOS		OHMS	WATTS	
83-v	FULL-WAVE RECTIFIER	D12	4AD	H	5.0	2.0	For other ratings, refer to Type 5V4-G.											83-v
84/6Z4	FULL-WAVE RECTIFIER	D5	5D	H	6.3	0.5	WITH CONDENSER-INPUT FILTER	Max. A-C Volts per Plate (RMS), 325 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 60 Max. Peak Plate Ma., 360			Min. Total Effect. Supply Imped. per Plate, 65 ohms.			84/6Z4
							WITH CHOKE-INPUT FILTER	Max. A-C Volts per Plate (RMS), 450 Max. Peak Inverse Volts, 1250				Max. D-C Output Ma., 60 Max. Peak Plate Ma., 360			Min. Value of Input Choke, 10 henries			
85	DUPLEX-DIODE TRIODE	D9	6G	H	6.3	0.3	TRIODE UNIT AS CLASS A AMPLIFIER	135 250	−10.5 −20.0	——	——	3.7 8.0	11000 7500	750 1100	8.3 8.3	25000 20000	0.075 0.350	85
89	TRIPLE-GRID POWER AMPLIFIER	D9	6F	H	6.3	0.4	AS TRIODE ¶ CLASS A AMPLIFIER	160 250	−20.0 −31.0	——	——	17.0 32.0	3300 2600	1425 1800	4.7 4.7	7000 5500	0.30 0.90	89
							AS PENTODE ■■ CLASS A AMPLIFIER	100 250	−10.0 −25.0	100 250	1.6 5.5	9.5 32.0	104000 70000	1200 1800	——	10700 6750	0.33 3.40	
							AS TRIODE ● CLASS B AMPLIFIER	180	0	——	——	6.0♠	——	——	——	13600 9400	2.50† 3.50†	
V-99 X-99	DETECTOR★ AMPLIFIER TRIODE	C4 D1	4E 4D	D.C. F	3.3	0.063	CLASS A AMPLIFIER	90	− 4.5	——	——	2.5	15500	425	6.6	——	——	V-99 X-99
112-A	DETECTOR★ AMPLIFIER TRIODE	D12	4D	D.C. F	5.0	0.25	CLASS A AMPLIFIER	90 180	− 4.5 −13.5	——	——	5.0 7.7	5400 4700	1575 1800	8.5 8.5	——	——	112-A
874	VOLTAGE REGULATOR	E4	4S	——	——	——	Minimum D-C Starting Supply Voltage.......125 Volts D-C Operating Voltage.......90 Volts					D-C Operating Current.......10-50 Ma. Maximum Current (Continuous).......50 Ma.						874
876	CURRENT REGULATOR	G1	——	F	——	——	Voltage Range.......40 to 60 Volts					Operating Current.......1.7 Amperes						876
886	CURRENT REGULATOR	G1	——	F	——	——	Voltage Range.......40 to 60 Volts					Operating Current.......2.05 Amperes						886
1851	TELEVISION AMPLIFIER PENTODE	C7	7R	H	6.3	0.45	CLASS A AMPLIFIER	For other characteristics, refer to Type 6AC7/1852.										1851

★ For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.

■ Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D.C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.

➘ Supply voltage applied through 20000-ohm voltage-dropping resistor.

➤ Mercury-Vapor Type.

▪▪ Grid #1 is control grid. Grid #2 is screen. Grid #3 tied to cathode.

¶ Grid #1 is control grid. Grids #2 and #3 tied to plate.

❁ Grids #1 and #2 connected together. Grid #3 tied to plate.

◘ Grids #3 and #5 are screen. Grid #4 is signal-input control grid.

▲ Grids #2 and #4 are screen. Grid #1 is signal-input control grid.

•• For grid of following tube.

° Both grids connected together; likewise, both plates.

† Power output is for two tubes at stated plate-to-plate load.

♣ For two tubes.

‡ This diagram is like the one having the same designation without the prefix G, except that Pin No. 1 has no connection.

♦ This diagram is like the one having the same designation without the prefix G, except that Pin No. 2 is omitted and Pin No. 1 has no connection.

♣ Obtained preferably by using 70000-ohm voltage-dropping resistor in series with a 90-volt supply.

✖ This diagram is like the one having the same designation without the prefix G, except that base sleeve is connected to Pin No. 1.

✠ Grids #2 and #3 tied to plate.

‡‡ This diagram is like the one having the same designation without the prefix G, except that Pin No. 1 is connected to internal shield.

● Applied through plate resistor of 250000 ohms or 500-henry choke shunted by 0.25-megohm resistor.

♥ Applied through plate resistor of 100000 ohms.

✖ Applied through plate resistor of 250000 ohms.

☁ 50000 ohms.

✎ Requires different socket from small 7-pin.

□ Grid #2 tied to plate.

◆ Grids #1 and #2 tied together.

❢ Plate voltages greater than 125 volts RMS require 100-ohm (minimum) series-plate resistor.

°° Applied through plate resistor of 150000 ohms.

◀ For signal-input control-grid (#1); control-grid #3 bias, −3 volts.

▣ Applied through 200000-ohm plate resistor.

▲ Grids #2 and #4 are screen. Grid #3 is signal-input control grid.

☒ Nominal voltage: 7.0 volts; current: 0.16 ampere.

◀ Nominal voltage: 7.0 volts; current: 0.32 ampere.

◆ Nominal voltage: 7.0 volts; current: 0.53 ampere.

✦ Plate voltages greater than 117 volts RMS require 100-ohm (minimum) series-plate resistor.

Note 1: Types with octal bases have *Miniature Metal Cap;* all others have *Small Metal Cap*

Note 2: Subscript 1 on class of amplifier service (as AB_1) indicates that grid current does not flow during any part of input cycle.
Subscript 2 on class of amplifier service (as AB_2) indicates that grid current flows during some part of the input cycle.

*Maximum.

§ Megohms.

KEY TO TUBE DIMENSIONS

Symbol	Maximum Overall Length x Diameter	Symbol	Maximum Overall Length x Diameter	Symbol	Maximum Overall Length x Diameter	Symbol	Maximum Overall Length x Diameter	Symbol	Maximum Overall Length x Diameter
A1	1¾″ x 1 5/16″	C2	3¼″ x 1 5/16″	D2	4⅛″ x 1 3/16″	D9	4 17/32″ x 1 9/16″	E3	5⅜″ x 2 1/16″
B1	2⅝″ x 1 1/16″	C3	3 5/16″ x 1 5/16″	D3	4⅛″ x 1 9/16″	D10	4⅝″ x 1 13/16″	E4	5⅝″ x 2 3/16″
B2	2 5/16″ x 1 3/16″	C4	3⅛″ x 1 1/16″	D4	4 3/16″ x 1 3/16″	D11	4 11/16″ x 1 7/16″	F1	6¼″ x 2 7/16″
B3	2⅝″ x 1 3/16″	C5	3⅜″ x 1¼″	D5	4 3/16″ x 1 9/16″	D12	4 11/16″ x 1 13/16″	G1	8″ x 2 1/16″
B4	2⅝″ x 1¼″	C6	3 5/32″ x 1¼″	D6	4 5/16″ x 1 3/16″	D13	4 13/16″ x 1 9/16″		
B5	2 25/32″ x 1 3/16″	C7	3⅜″ x 1 5/16″	D7	4 5/16″ x 1⅝″	E1	5 1/32″ x 1 13/16″		
C1	3½″ x 1 3/16″	D1	4″ x 1 3/16″	D8	4 13/32″ x 1 9/16″	E2	5 5/16″ x 2 1/16″		

SOCKET CONNECTIONS

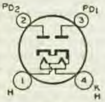
Bottom Views

KEY TO TERMINAL DESIGNATIONS OF SOCKETS

Alphabetical subscripts D, P, T, and HX indicate, respectively, diode unit, pentode unit, triode unit, and hexode unit in multi-unit types.

BP = Bayonet Pin	H = Heater	P_I = Starter-Anode	S_I = Interlead Shield
BS = Base Shell	K = Cathode	P_{BF} = Beam-Forming Plates	SL = Base Sleeve
F = Filament	NC = No Connection	RC = Ray-Control Electrode	TA = Target
G = Grid	P = Plate (Anode)	S = Shell	U = Unit

● = Gas-Type Tube



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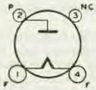
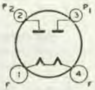


4B



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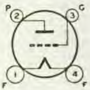

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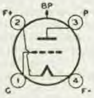

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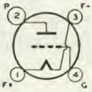

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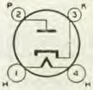
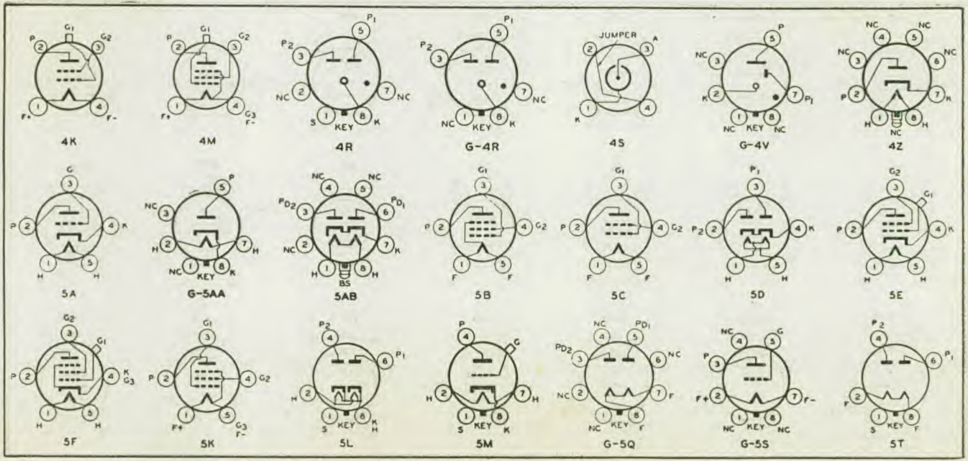
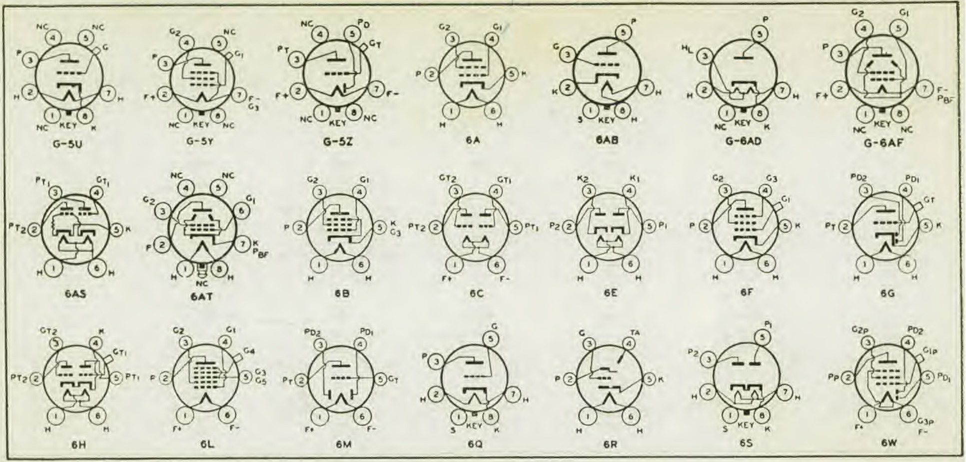


4G


4K
4M
4R
G-4R
4S
G-4V
4Z
5A
G-5AA
5AB
5B
5C
5D
5E
5F
5K
5L
5M
G-5Q
G-5S
5T


G-5U
G-5Y
G-5Z
6A
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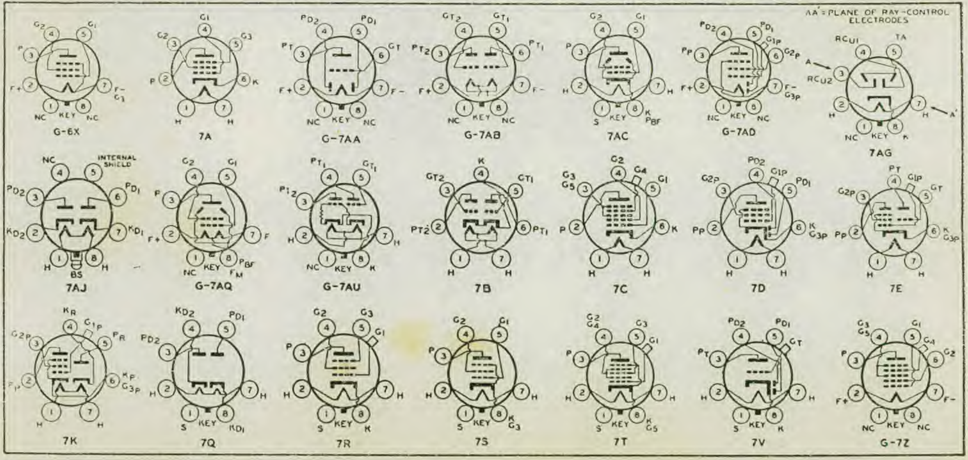
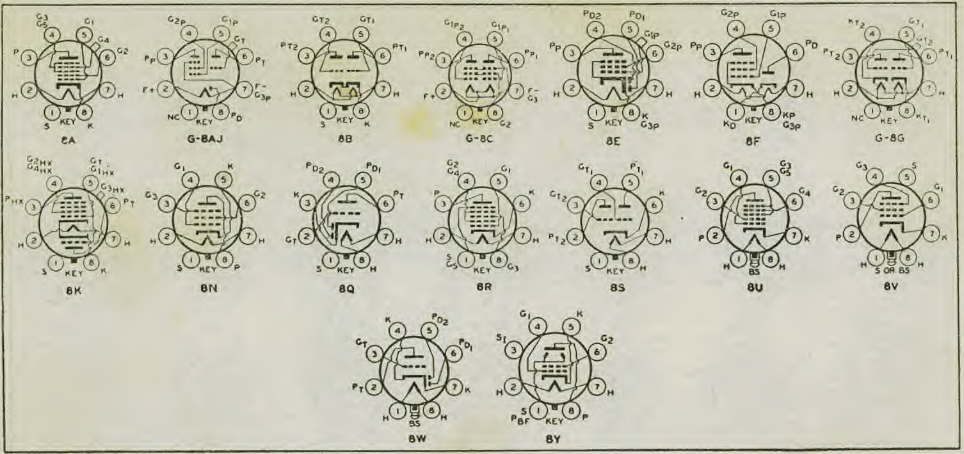
6W


AA' = PLANE OF RAY-CONTROL ELECTRODES
G-6X
7A
G-7AA
G-7AB
7AC
G-7AD
7AG
7AJ
G-7AQ
G-7AU
7B
7C
7D
7E
7K
7Q
7R
7S
7T
7V
G-7Z


8A
G-8AJ
8B
G-8C
8E
8F
G-8G
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8N
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8U
8V
8W
8Y


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Caspian Sea
Aral Sea
Red Sea
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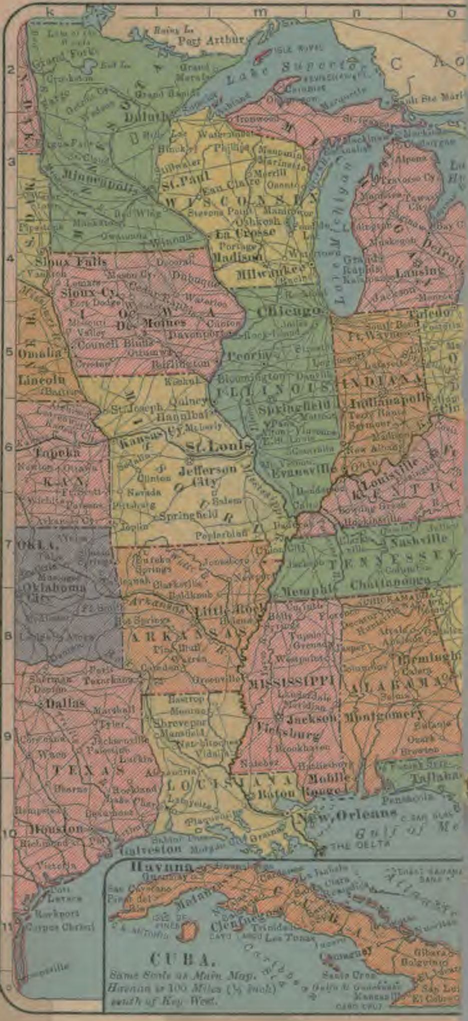

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Vicksburg
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Mobile
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Gulf of Mexico
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Cienfuegos
CUBA.
Same Scale as Main Map.
Havana is 100 Miles (½ inch)
south of Key West.

Lake Superior
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West Duluth
Superior
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St. Paul
Hayward
Spooner
Phillips
Rice Lake
Cameron
Medford
Chippewa Falls
Eau Claire
Marshfield
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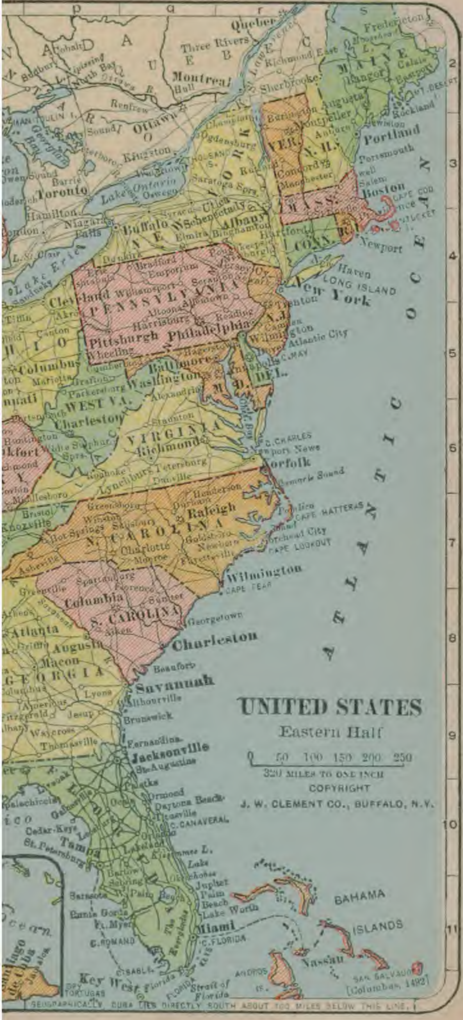
Cairo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Titusville
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Franklin
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Scranton
Wilkes-Barre
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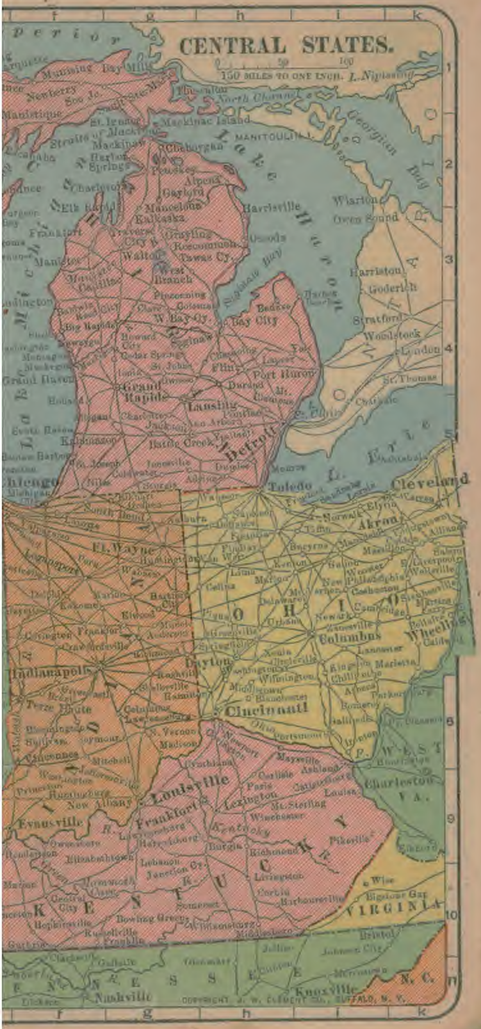

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Utica
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Paterson
Trenton
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Orizaba
Salina Cruz
Progreso
Campeche
Merida
Belize
Gulf of Mexico
Gulf of California
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Havana
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CURACAO (Du.)
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IONIAN SEA
AEGEAN SEA
Sea of Candia
CRETE
Istanbul
Stockholm
BALTIC
Breslau
Prague
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RIO DE ORO (Sp.)
Tropic of Cancer
C. Blanco
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C. Verde
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Mozambique Channel
Tananarive
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RÉUNION I.
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Ulan Ude
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Hobart
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NORTH I.
Wellington
SOUTH I.
BOUNTY IS. (N. Z.)
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SUN. 21

SEPTUAGESIMA SUNDAY

MON. 22

TUES. 23

WED. 24

THUR. 25

FRI. 26

SAT. 27

JANUARY, 1940

SUN. 14

MON. 15

TUES. 16

WED. 17

THUR. 18

FRI. 19

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SUN. 28

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TUES. 30

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THUR. 1 FEBRUARY

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SAT. 3