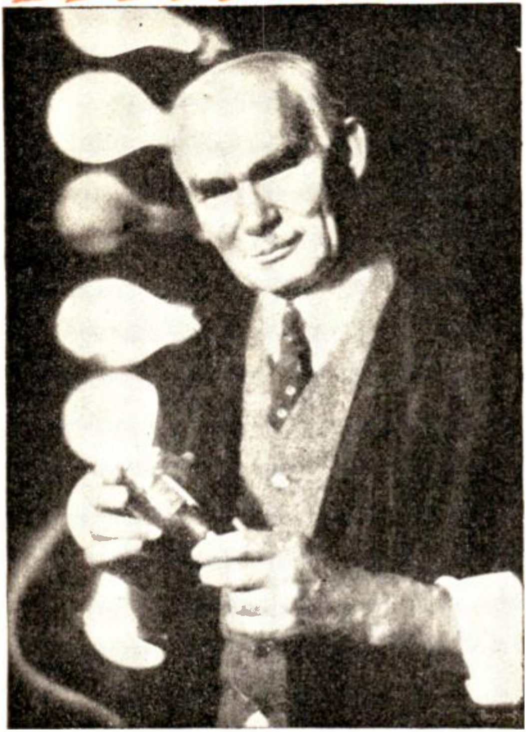
RADIO simplified

by

Dr. Lee de Forest



DR. LEE DE FOREST

who in 1906 invented the radio vacuum tube which has made radio possible

de Forest

Foreword

LONG ago, in 1909, I transmitted the first broadcast programs from a little laboratory on the top floor of an office building in New York City. Later that year I essayed broadcasting direct from the stage of the Metropolitan Opera House. Even though I had already invented the three-element vacuum tube, which I named the Audion, it was not until 1915 that this device received proper recognition when Bell System engineers spoke across the Atlantic and the Pacific oceans.

And so broadcasting represents my fond dreams come true. I am happy indeed to see radio telephony developed to its present unbelievable efficiency. I am more than pleased to take further part in broadcast progress by contributing at this time a better Audion. And I am gratified at this opportunity of addressing just a few words to the audience which my inventions have helped to create.

Lee de Forest

Radio Waves in Oceans of Space

RADIO is simply a cause and an effect. The *cause* is the radio transmitter. It makes an electromagnetic splash that sets up radio waves. These waves travel through space in all directions. The *effect* is the setting up of delicate currents in the antenna or loop. These delicate currents are detected and converted into audible sounds by means of the radio receiving set.

Imagine a boy operating a paddle at one end of a pond of still water. Ripples are set up in the water. They travel farther and farther from the paddle, getting weaker as they move along, until they reach a piece of wood which bobs up and down as it rides the waves. Put a bell on the piece of wood, so that it will ring with the action of the waves. And there you have the mechanical parallel of radio communication.

Now if we could differentiate between small and large waves in our pond of water, we would have different wave lengths or frequencies. Both these terms mean the same thing eventually, for long waves represent low frequency, and short waves represent high frequency.

We refer to wave length in meters rather than yards, because the meter is a scientific measure of length. We say a station has a wave length of 302 meters, instead of 1,000 feet. That means the waves transmitted are 302 meters from crest to crest, or, to put it another way, the wave travels 302 meters before the next wave starts. The wave, of course, has a definite number of vibrations which determines the frequency. A wave having a length of 300 meters represents 1,000,000 vibrations or cycles per second. Instead of having a long train of ciphers, the radio engineer uses the term kilocycles, or a unit of

1,000 cycles. Hence one million cycles is called 1,000 kilocycles, and that is the frequency designation.

Broadcasting is conducted in the wave band between 200 meters, or 1,499 kilocycles, and 550 meters, or 545.1 kilocycles. In order to prevent interference between signals on adjacent wave lengths or frequencies, the broadcast air is divided into channels 10 kilocycles wide. Therefore, there is a channel every ten kilocycles. For that reason, the frequency is a more convenient expression than wave length, and is therefore extensively employed for receiver tuning dials.

Supposing, returning to our pond once more, a mischievous boy on the side throws a rock into the water. What happens? Big, meaningless waves are set up. They interfere with the paddle waves. They cause the detector float to bob up and down, but in an irregular and meaningless manner. That, precisely, represents the effects of atmospheric electricity, or *static*, on our broadcast reception. The only way to overcome the undesired waves in the pond is to increase the power of our transmitting paddle, so as to create larger waves which will be less affected. Likewise with radio, we must have more powerful signals to get away from the effect of static. It is a question of relativity.

An Aladdin's Lamp Called the Audion

THE genii of broadcasting could never have been summoned to serve the public but for the possession of that Aladdin's Lamp named by me the Audion, and popularly known as the vacuum tube.

In appearance, the Audion is a simple thing—a glass bulb containing three elements, namely, a lighted filament, a surrounding lattice or grid, and a flattened cylinder or plate, operating in a high vacuum. Yet never has modern engineering and production undertaken a more difficult task than making Audions at a popular price.

Unfortunately, appearance means nothing. A good tube looks no different than a poor tube. The only guidance is the reputation of the engineer and the producer.

The three outstanding factors in the Audion are: first, the filament; secondly, the degree of vacuum throughout life; thirdly, mechanical accuracy and rigidity.

The filament must be carefully prepared in order to provide a steady and unfailing stream of tiny particles of matter called electrons, so as to form the electrical bridge across which signal traffic may flow, controlled by the grid or electrical traffic cop. The vacuum is essential, since only in the absence of gases can the electrical bridge be kept free and clear for the ready passage of signal traffic. Furthermore, gases, like the elements in our everyday life, soon attack the filament and cause premature deterioration.

An exceptionally high vacuum is obtained by better and longer pumping than is customary. The metal parts, which are in reality metal sponges soaked with air, are baked to incandescence in a hydrogen furnace, driving out air and water vapor, and filling the pores with inactive or harmless hydrogen. Wherever possible, molybdenum, rather than the far cheaper nickel, is employed, since the former is far less "spongy" than the latter, and therefore insures a better vacuum.

What is a vacuum? Well, it is absolutely nothing, if we can conceive of such a thing. The degree of vacuum is measured in microns. One micron represents one-millionth part of the usual atmospheric pressure, which is 15 pounds per square inch. Thus a perfect vacuum would be zero microns, but such a state is a theoretical ideal that can never be realized even with the most intricate laboratory technique. Even a partial vacuum represents a bitter struggle between nature and the engineer.

The usual incandescent lamp exhaust represents a vacuum of about 150 microns. In usual vacuum tube production, pumping is carried to a far greater degree. The usual pumping produces a vacuum of about 90 microns in 72 seconds, which is considered the economical compromise between sufficient vacuum and production speed in competitive vacuum tubes. At this point a virtual chemical broom or "getter" is employed to sweep out as much of the remaining gas as possible. This getter is usually magnesium, which, during pumping, is fired to form a vapor. The magnesium vapor later condenses on the cool glass tube walls to form the characteristic silver lining of many vacuum tubes. The getter in the usual vacuum tube brings the evacuation to 2 or 3 microns, in which process the getter is exhausted and therefore not available for further service. In other words, the getter is made to do most of the work of exhausting the tube.

In developing high-quality Audions, the DeForest engineering staff has not been hampered by a rigid cost basis imposed by competitive prices. Instead, the best materials and methods have been sought. Thus the DeForest Audions are pumped for 300 seconds (as against the usual 72 seconds). An initial vacuum of 15 microns is obtained (as against the usual 90 microns). Furthermore, the thorough heating or bombardment of the metal elements during pumping, as well as the firing of the chemical getter followed by prompt sealing, reduces the vacuum to 1 micron, which is an exceptional vacuum tube for economical production. The small amount of gas to be cleaned up at the time of sealing means that the getter is far from exhausted. The getter is consequently available throughout the life of the Audion, to clean up any gas that may be given off by the heated elements.

To a good filament and a satisfactory vacuum is added staunch mechanical construction. Mica spacers in most types of DeForest Audions keep the elements separated at the exact spacing required. There is no chance of vibration, and hence no microphonic or extraneous noises. Careful production methods, together with rigid step-by-step inspection, insures a uniform product. Finally, an improved method of aging or seasoning the filament results in a high and uniformly maintained emission from the start to the end of the long life of DeForest Audions.

I am proud to place my name on these present Audions which represent true craftsmanship rather than an attempt to produce scientific devices at a price.

Making Big Signals Out of Little Ones

THE radio waves that reach the antenna or loop of the radio receiver represent but an infinitesimal percentage of the power employed at the transmitter. Indeed, we start with kilowatts or thousands of watts yet end with millionths of a watt. So weak is the energy induced in the wave-intercepting system that we are compelled to build up, magnify or amplify the signals before we can even detect them properly. This process is known as radio-frequency amplification, because the signals are still in their radio-frequency or high-vibration state *preceding* detection. Audio-frequency amplification, contrariwise, refers to amplification *following* detection.

The all-important thing in radio-frequency amplification is large step-up or "gain" from one stage to the next, so that our delicate radio-frequency signals may be magnified without danger of distortion due to an oscillating condition. By an oscillating condition we mean that state when the tube begins vibrating electrically of its own accord, which interferes with its normal function.

DeForest Audions are made to the standard tube specifications followed by all radio engineers in designing receiving circuits. Furthermore, the high uniformity and rigidity assured by the mica spacer construction, together with close tolerances and rigid test, insure the utmost efficiency from any radio-frequency circuit calling for the 401-A, 426 or 427 type.

Aside from good vacuum tubes or Audions of correct characteristics, the remaining essentials in radio-frequency amplification are correct B or plate voltages, as well as the most efficient stabilization to assure the nearest approach to the oscillating state without actually breaking into oscillation.

The B or plate voltage on radio-frequency Audions has a marked effect on the sensitivity, selectivity and volume of the receiver. Radio enthusiasts, out to squeeze the last ounce of efficiency out of their sets, often insert a variable high resistance of some 200 to 100,000 ohms in the "B plus r.f." lead, shunted by a 1 or 2 mfd. fixed condenser.

From Radio Signals to Broadcast Programs

RADIO waves, while carrying the dormant sound values, have no perceptible effect on the human senses. Therefore, some means of extracting the latent sound values from the carrier radio wave must be employed, and so we come to the detector in your receiving set. The detector tube is the most delicate form of rectifier known to the electrical art. It serves to sort over the radio-frequency energy coming to it so as to separate all the sound-bearing portion. This portion lacks the power necessary to operate a loud-speaker, although it will operate a pair of sensitive head-phones. Therefore, the weak energy is passed on to the audio-frequency amplifier for the necessary magnification until powerful enough to operate the loud-speaker.

There is no longer need for a super-sensitive detector, as in the days before radio-frequency amplification and powerful broadcast signals. Rather today the requirement is a rugged detector capable of handling powerful signals without being overloaded. Much of the distortion in radio reproduction may be traced to the inability of the detector to handle the load of signals passed through it.

DeForest Audions of the 427 A-C type or the 401-A battery type, are especially intended for use as detectors. They have a high vacuum at all times, so as to handle a sufficiently high plate or B voltage to insure ample handling capacity without choking or distorting. The high vacuum assures noiseless operation, without the hissing so often indicative of a low vacuum or "soft" tube. The filament, made by chemists in our own laboratory, maintains the necessary high emission throughout life. Lastly, the special rigid mechanical construction with mica spacer assures a non-microphonic tube, which is of utmost importance in enjoying good radio loud-speaker reproduction at full volume.

A spare Audion of correct type should always be at hand, so as to check up the performance of the detector tube in order that it may be replaced just as soon as it shows signs of failing.

An Electrical Microscope Called Audio Amplifier

THE output of the usual detector, even on loud signals, is just sufficient to operate a pair of head-phones, or perhaps a loud-speaker very, very weakly. Hence some means of magnifying these signals, now called audio signals since they are in "hearable" form if fed to a suitable device, must be employed. The means is an ultra-powerful electrical microscope, capable of enormous sound magnification and called the audio amplifier.

There are just three factors in the audio amplifier that go to make for good or bad results: first, the vacuum tubes, which must be capable of the necessary amplification, without flinching or choking up to cause distortion, and without introducing A-C hum in the case of A-C tubes;

secondly, there must be ample voltage and current available to feed the hungry tubes which cannot do heavy work without a substantial diet; thirdly, a coupling means for transferring the output of one tube to the input side of the next tube, which will be a true translator, as it were, without bias and without oversight, so as to handle all frequencies or sound values with equal willingness. If the coupling means tends to emphasize certain frequencies to the exclusion of others, we have unbalanced radio music.

Fortunately, practically all radio receivers today, even among the most popular-priced offerings, have good audio-frequency components, whether of the transformer, impedance or resistance coupled category.

Good audio amplification, therefore, comes down to the question of good amplifier tubes or Audions, properly supplied with sufficient voltage and current.

One of the prime requisites in a good audio-frequency tube is a good vacuum. We must have "hard" tubes, first, last and always. Many tubes may start out well as amplifiers, only to become "soft" or gassy after a short while in service, due to improper degasification of the metal parts in production, and the absence of an active getter. DeForest Audions, as explained earlier in this booklet, are high-vacuum tubes, with ample active getter at all times to clean up any gas given off by heated elements. Especially if high B or plate voltage is to be applied on the amplifier tubes, the tubes must be hard.

Good filament emission is also a prerequisite in the amplifier tube, which must handle real loads. In this respect the DeForest engineering staff is fortunate in having a recognized specialist in vacuum tube chemistry, who has charge of preparing the filaments. While most tube manufacturers purchase their filament materials from common sources, the DeForest Audions are provided with unique filaments made in our own laboratory.

The need for a power tube Audion in the last stage is too well known today to require elaboration. Suffice it to state that the power Audion is simply one capable of handling the necessary B or plate current to operate the loud-speaker at maximum efficiency, without causing distortion in the reproduction. The power tube should have an exceptionally high vacuum and good filament emission, because of the high B or plate voltages applied, as well as the heavy current to be handled.

The life of the power tube or Audion depends largely on proper use rather than abuse. For one thing, the filament should be operated at the rated voltage, for there is nothing to be gained in running it at excessive voltage. The B or plate voltage should be kept within the specified limit. In fact, if full volume is not required, it is well to operate the vacuum tube or Audion at a lower plate voltage, so as to obtain a very considerable increase in useful life. In the case of the 471-A Audion, for instance, the operation of this tube at 135 volts provides three times the useful life than when operated at 180 volts. The C or grid bias voltage should be carefully observed, for no greater strain can be placed on an Audion than operating it with insufficient bias. Too much bias, contrariwise, may increase life but hamper tone quality and volume.

DeForest Audions have excess life built into them. They are of tougher fibre than the usual vacuum tube built to meet a competitive price.

Consequently, even under abuse, the DeForest Audion will invariably outlast the usual vacuum tube.

Poor tone quality and insufficient volume in any radio set can generally be traced first to poor audio tubes and particularly the power tube; secondly, to incorrect voltages or insufficient current supply; and thirdly to faulty coupling means.

The Voice of Your Set

THE output of the audio amplifier is delivered to the loud-speaker. This member translates powerful electrical variations into correspondingly powerful sound waves more or less duplicating the original voice or music at the distant microphone.

Since the loud-speaker is the final link in the long chain of broadcasting which begins at the microphone, it should be as good a link as possible. The radio enthusiast is urged to secure the best possible loud-speaker.

When using B or plate voltage higher than 135 volts, a suitable coupling device between power tube and loud-speaker should be employed. This coupling device serves to maintain a high plate voltage on the power tube, and to prevent unnecessary strain on the loud-speaker. Better tone and greater volume are obtained.

Do not blame the loud-speaker for poor tone quality. It is but one factor in a long series of functions. A choking or veiling of the loud-speaker rendition is usually traceable to poor audio tubes, unable to handle the signals. Badly distorted tone is often the result of an overworked detector tube.

The location of the loud-speaker in the home plays an important part in the reproduction. It should be tried in various places, such as near the wall, away from the wall, on the floor, high upon a bookcase, in a corner, and so on. In summer, the loud-speaker may be brought out on the porch or lawn, by means of a long extension cord.

All in all, loud-speaker tone begins with Audions in all tube sockets. Make sure of the goodness of your vacuum tubes. Then check up transformers and other components, and finally climax your quest for tone quality by securing the best possible loud-speaker.

Harnessing the Electric Light Socket for Radio

IN our quest for utmost simplicity, economy and natural volume and tone, we have outgrown batteries in broadcast reception. Quite naturally, we have turned to the electric light socket or outlet as an inexhaustible supply of current.

Some time back I spoke of the Audion as a rectifier. Once more we ask the versatile Audion to serve as a rectifier, this time in converting alternating current into smooth, direct current for our B and C voltages. If it were not rectified, the alternating current, with its never-ending waves or cycles, would cause serious hum in our broadcast reception.

The first step in harnessing the usual socket current is to step up the voltage. Obviously, if we require, say 180 volts, for our power tube, we must have at least as high or higher voltage available at the beginning of the rectifying process. Therefore, we begin with the power transformer, which may also have windings for operating A-C Audions and power tube filaments at greatly reduced voltage. The power transformer supplies the high voltage to the rectifier. which is nothing more than an electric turnstile capable of turning in but one direction. The alternating current swings through the turnstile freely in one direction, but when it reverses and attempts to flow in the opposite direction, the turnstile locks and blocks the current flow. Thus we secure all the plus or positive impulses on one wire, and all the minus or negative impulses on the other. However, we still have the waves or half cycles. Our current from the rectifier is called pulsating direct current. If fed to the radio set, it would cause about as much hum as raw alternating current. We still have a bumpy road to travel, in other words, and must put on shock absorbers.

This rectified current is passed through what is caller the filter circuit, comprising big coils called choke coils, and condenser blocks. The choke coils, as their name indicates, serve to hold back or choke the mad rush of pulsating current. The condensers act as electrical reservoirs, storing up energy at the peak of the electric waves, and then feeding out or discharging that energy as the waves reach their periodic ebb tide. In this manner, we secure a uniform flow of current. A good filter system has a minimum of ripple or hum in the output current.

So far, we have dealt with what is known as the half-wave rectifier Audion or 481 type, utilizing one-half of the alternating current wave or cycle. It is a single electrical turnstile. In some instances it is preferable to have a double turnstile, or one handling both halves of the alternating current wave at one time. This is called the full-wave rectifier Audion or 480 type.

While all rectifier tubes of the filament type may look alike, there is a vast difference in electrical characteristics. One of the prime requisites of a good rectifier is a good filament, so as to secure the heavy emission for our electric turnstile. In the DeForest rectifier Audions 480 and 481, a special ribbon filament, coated with rare chemicals, is employed. The DeForest coating is the result of long research and practice, not only insuring ample and uniform emission during a long life, but proof against flaking or dropping off of the coating, thereby guarding against uneven emission and early termination of useful service.

Following standard DeForest practice, the DeForest rectifier Audions are highly evacuated. An absolute minimum of residual gases is the result. Such gases as may be driven out of heated metal parts during service are cleaned up during actual service by an ample quantity of *active getter* left in the bulb.

—And Try This on Your Radio

CHECK over the antenna. Be sure it is of the proper length and height, as called for in the instructions that came with the radio set. Avoid contact with foliage, walls, cornices and so on. Solder all splices if possible; otherwise, wrap them with waterproof tape.

The ground connection is of even greater importance than the antenna. Preferably, it should be made to the cold water pipe, and on the street side of the water meter and shut-off valve. A ground clamp should be used on a pipe that has been sandpapered clean.

A lightning arrestor should be installed to protect the receiving set from the heavy surges induced in the antenna system by lightning striking in the vicinity. A good make of lightning arrestor should be used, for cheap lightning arrestors are often a serious source of noisy reception and even short-circuited antenna-ground connections.

If batteries are used, they should be checked at frequent intervals. Discard 45-volt B batteries when the total voltage reads 38. Going below that point means noisy reception as well as reduced volume. B batteries should be tested with a meter. The readings of cheap meters often are several volts off the true value.

The storage battery, when fully charged, should read 1.275 to 1.300 with a hydrometer depending on the age and condition of the cell. When the reading is below 1.200, the battery should be placed on charge. Always make sure the plates of each cell are covered with the liquid, by adding distilled water.

Corroded storage battery terminals introduce considerable "static" in reception. Prevent such noises by cleaning off the terminals, and coating with ordinary vaseline to prevent further corosion.

Check the rectifier tube in the power supply unit by having a fresh Audion rectifier on hand in the case of the filament type. Rectifiers fall off in output voltage as they become exhausted. The gradual fading of radio rendition over a period of weeks is usually a sign that the rectifier is becoming exhausted, even though the rectifier tube still lights.

After the receiver has been in use for a time, and particularly if the parts are exposed, dust will collect between the plates of the condensers. This is not serious, except that if it gathers too thickly, it will result in leakage and noises similar to static. To clean the condenser plates, use a feather or a pipe cleaner. Care should be exercised not to bend the light condenser plates.

Never use oil to lubricate variable condenser bearings. If the condenser turns hard, make the necessary bearing or friction adjustment, or ask your service man to do so for you.

A .01 mfd. condenser across the loud-speaker terminals reduces static background in summertime, and mellows the loud-speaker tone.

Noise in a receiving set is often traceable to a defective grid leak. Try another grid leak of the same value. A leaky grid condenser, if of a poor make, may also be responsible.

Buzzing of the loud-speaker is not always an indication of mechanical trouble. Check up the C battery and see if it is still up to voltage and properly connected. Loose laminations in the transformer cores, particularly in poor transformers passing low frequencies, may also be responsible for loud-speaker rattle. However, the mechanical condition of the loud-speaker should also be checked up. Screws and nuts should be tightened. If an old cone-speaker begins to rattle, it is an indication of rust forming on the armature, which now strikes the pole pieces.

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AUDION 401-A

Detector and amplifier for 5-volt battery or rectified socket-power operation. A hard or highly evacuated tube for radio-frequency amplification, detection or audio-frequency amplification. Mica spacer at top insures positive spacing of elements for extreme uniformity of characteristics.

AUDION 410

Power amplifier for socket-power operation of magnetic or dynamic loud-speakers. A favorite tube for high-power, push-pull amplification. Highly evacuated, with active "getter" constantly present to insure positive operation at extreme plate voltages. Special filament for maximum emission and long life.

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AUDION 412-A

Detector, amplifier and power amplifier. A good detector, a better amplifier, and an excellent power amplifier for battery operation. Highly evacuated, with active "getter" always present. Special DeForest oxide-coated filament provides maximum emission and long life.

AUDION 426

Amplifier (A. C. filament type) for use in electric sets or with adaptor harness. Highly evacuated, with active "getter" constantly on guard against gas. Special filament for maximum emission and long life. Minimum of hum because of high heat inertia of filament.

AUDION 427

New improved Detector and Amplifier of the A-C heater type. New engineering design and construction assures elimination of hum, buzz and crackle. The improved tone quality will establish new standards for broadcast reception from A. C. radio sets.

AUDION 450

Super-power amplifier for operation of most powerful magnetic or dynamic type loud-speaker, and also groups of loud-speakers. Highly evacuated, with active "getter" always present for gas clean-up. Special heavy ribbon filament with oxide coating for high emission and long life, together with requisite mechanical strength.

deForest

AUDION 471-A

Power amplifier of the most popular type for average home use, either in battery-operated or socket-power receiver. Highly evacuated, with active "getter" always present. Special DeForest filament insures maximum emission and long life.

AUDION 471-B

The Audion 471-B is designed for use as a power tube in the last output stage of an Audion Amplifier. Its characteristics are similar to the DeForest 471-A excepting for filament current consumption, being rated at .25 amps instead of .50. The filament is designed to be operated by storage batteries, A-eliminators, or from the direct current mains through the proper step-down resistance. It can be used on A. C. current, but the 471-A is recommended when operation on A.C. current is required.

AUDION 480

Full-wave rectifier, 125 milliamperes at 250 volts. Most popular rectifier in modern electric sets. Special DeForest ribbon type filament, heavily oxide coated for maximum emission, long life and mechanical strength. Careful balance between two sets of elements insures a smoother output and easier filtering.

AUDION 481

Half-wave rectifier of 110 milliamperes 425 volt output. Popular in power plants for the largest magnetic or dynamic loud-speakers. Highly evacuated, with ample active "getter" for gas clean up. Special DeForest ribbon type filament with heavy-duty oxide coating. Long life. Remarkable mechanical strength.

de Forest

AUDION 424

A 4 element, screen grid, humless detector — amplifier having the improved DeForest features of design and construction. It is specially designed to meet the requirements of the new radio sets using screen grid tubes that leading manufacturers are featuring. A Feature of Audion 424 is its unusual amplification factor of 420.

AUDION 445

The latest Power tube development of the DeForest laboratories. The freedom from distortion under heavy loads with Audion 445, establishes a new standard in broadcast reception. Like Audion 424 it can only be used in sets or circuits designed for its use. It is interchangeable with CX345 or UX245.

GLOSSARY

Alternating Current—An electric current that reverses in direction at regular intervals of time.

Ammeter—A meter that measures the strength of electric current in amperes.

Antenna—A single wire or system of wires for radiating or intercepting radio waves.

Atmospherics—Noises produced by stray waves of natural origin, causing clicks, rattles or hissing sounds in radio receivers; also called "static."

Audio Frequency—A frequency vibration that is within the normal audible range; usually taken between 16 and 16,000 cycles per second.

Audion—A vacuum tube containing a filament, a plate, and a screen or grid interposed between them.

"B" Battery—A battery for the plate circuit of a vacuum tube; usually made up in blocks of fifteen small dry cells connected in series.

By-Pass Condenser—A condenser of sufficient capacitance to offer low impedance to radio-frequency current, but much higher impedance to audio-frequency current than does the instrument across which it is connected.

Cage Antenna—An antenna in which the wires are arranged to outline a cylinder.

Cascade Amplifier—A series of two or more amplifiers connected to magnify in succession.

Choke—A coil of relatively low resistance to direct current, but of high impedance to alternating current.

Circuit—The path in which electric current will flow.

Coil Antenna—An antenna in coil form, both ends of the coil being connected to opposite terminals of the receiver.

Condenser—An instrument possessing substantial and useful capacitance.

Continuous Waves—Successive waves having, at any given point in space, uniform intensity.

Coupler—An apparatus used to transfer electric energy between two circuits.

Detector—An instrument or audion that rectifies radio-frequency energy of received waves into audible form.

Dielectric—The insulating medium separating the plates of a condenser usually air or mica.

Direct Current—An electric current that does not change in direction of flow.

Electrolyte—A conductive liquid, such as the sulphuric acid solution in a storage battery cell.

Electron—The smallest electric charge, and negative in potential. A drift of electrons proceeds from negative to positive parts of a circuit.

Farad—The "practical unit" of CAPACITANCE. As the farad is a unit of very large value, radio workers usually measure capacitance by the MICROFARAD or millionth part of a farad.

Filter—A system of condensers, coils and resistors, offering low impedance to certain frequencies but high impedance to others, and generally used in A. C. eliminators to filter out the A. C. hum.

Frequency—The number of cycles of oscillation in each unit of time, usually given in terms of cycles per second.

Grid—The screenlike electrode of an AUDION that is between the filament and plate.

Grid Leak—A resistor connected across a condenser in the grid-filament circuit of an audion, acting as a gate to the output of the detector.

Hard Tube—An audion from which practically all gas and air has been exhausted.

Henry—The practical unit for the measure of INDUCTANCE.

Impedance—The quality that tends to hold back the flow of current produced by an alternating electromotive force. It includes the effects of RESISTANCE, CAPACITANCE and INDUCTANCE.

Inductance—The magnetic energy-storing property exhibited by coils of wire.

Interference—The disturbance produced when undesired radio waves are received along with the desired signals.

Ion—An atom or molecule having an electric charge, either positive or negative.

Jack—A spring-contact receptacle into which a plug may be inserted for completion of one or more circuits.

Kilocycle—One thousand cycles. Radio frequencies are conveniently expressed in kilocycles per second. A frequency of 100,000 cycles per second may be written 100 kc.

Loud-Speaker—A device for producing sounds of sufficient volume to be heard throughout a room; usually a horn or cone.

Megohm—a unit of electrical resistance equal to one million ohms.

Microfarad—A unit of electrical capacitance equal to one millionth of a FARAD.

Microhenry—A unit of electrical inductance equal to one millionth of a HENRY.

Milliampere—A unit of electric current equal to one-thousandth of an ampere, or to one thousand microamperes.

Ohm—The practical unit for the measuring of electrical RESISTANCE and IMPEDANCE.

Plate—The output electrode of an AUDION.

Plug—A connecting device for use in conjunction with a JACK for convenient and rapid alteration of circuits or transfers of instruments.

Potentiometer—A potential divider; a resistor arranged for convenient alteration of the electro-motive force applied to a circuit.

Primary—The input coil or circuit of a transformer.

Radio Frequency—A frequency of vibration that is within the range normally used in radio waves; usually taken as above the audible range and is between 16,000 and 300,000,000 cycles per second.

Rectifier—A device capable of producing direct-current effects when supplied with alternating current.

Relay—A device by means of which electric power in one circuit controls electric power in another circuit.

Resistance—A device to oppose the passage of current which a conductor exhibits when acted upon by an electromotive force.

Resistor—A unit or element in which resistance is prominent.

Rheostat—A resistor used to control the current in a circuit.

Selectivity—The ability of a radio receiver to discriminate between waves having different frequencies.

Series—The successive connection of several electrical devices in one circuit, such as battery cells having the positive of one cell connected to the negative of the next.

Shield—A plate or casing, usually connected to ground, for preventing changes in capacitance.

Soft Tube—A vacuum tube containing a small amount of gas and not so thoroughly exhausted, as a HARD TUBE.

Static—Interference-producing natural discharges in an antenna system, generally caused by contact of charged snowflakes, water particles, or dust, sometimes used as synonymous with ATMOSPHERICS and STRAYS.

Stopping Condenser—A by-pass condenser used to block the passage of direct current in a circuit.

Tickler—The primary coil of an inductive coupler used to feed back power from the plate to the grid circuit of a regenerative audion.

Transformer—An alternating-current device for changing the ratio of the voltage.

Tuner—The portion of a radio receiver which is used in adjusting circuits in resonance.

Tuning Coil—A variable inductor used in adjusting circuits in resonance.

Variocoupler—An inductive coupler of variable mutual inductance, usually having a primary coil fixed in position and a secondary coil that may be rotated.

Volt—A practical unit for measuring the pressure of electric current.

Watt—A unit for measuring the power of electric current.

Wavelength—The distance a radio frequency wave travels in the time of one cycle.