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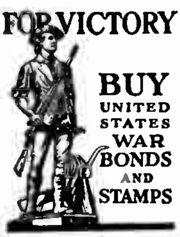

RADIO SERVICE HINTS

Practical Suggestions on Solution of Radio Servicing Problems Encountered in Actual Experience by Servicemen Everywhere

This section, conducted by our servicemen readers, will be a regular feature of the C-D Capacitor, and is intended to provide other servicemen with helpful notes on testing, locating troubles in specific models of sets, repairing them, or any other suggestions to simplify service work.

Cornell-Dubilier will pay $2.00 for each hint published in this section. Notes must be limited to 75 words, or less Any number of hints may be submitted at one time. Unpublished items will not be returned. Be sure to give your name and mailing address. Send hints to: Editor, C-D Capacitor, Cornell-Dubilier Electric Corp., So. Plainfield, N. J.

Distortion in Battery Portable Sets

Distortion in many of the later models of battery portables may in some cases be traced to accoustical resonance from the speaker to the pentode output tube. This condition may be checked by tapping the tube, and is usually due to a loose grid in the tube. Try replacing the output tube, or remedy the condition by wrapping a layer of thick felt around the tube held in place with a rubber band.—*M. D. Rosenblatt, Hoboken, N. J.*

Cleaning and Tinning Soldering Iron

While the method of using a file to brighten the tip of a soldering iron is best for reshaping and dressing an iron for tinning, the writer uses a coarse grade of sandpaper for ordinary cleaning at the bench.

About a dozen pieces of 00 sandpaper, 2 by 4 inches, are nailed to the bench. To tin the iron a few drops of solder are applied on the tip of the iron and rubbed vigorously on the sandpaper. This cleans and tins the iron for better work.—*W. L. Oswald, Kansas City, Mo.*

Tuning Condenser Repair

When plates of variable tuning condensers become slightly shorted, the writer suggests employing the following apparatus and treatment.

Two sharp pointed steel probes with well insulated handles are soldered to the ends of a 6-foot length of twisted-pair of lamp cord. The opposite ends of the cord are connected to a standard line plug.

A 550-600 watt heater unit or the bench soldering iron is then connected in series with one lead of the cord to provide suitable resistance on the 110 volt a.c. line.

All leads from the gang tuning condenser are disconnected and the sharp probes carefully applied across the rotor and stator plates, being sure to avoid grounding the chassis of a set on the bench. The tuning dial is then turned slowly until the shorted parts of plates are burned apart. This improvised method serves well in cases of slight shorts caused by minute metal points of contact. However, in severe cases of warped plates or misadjustment of the complete gang it will not suffice.—*R. L. Bradford, Decatur, Ala.*

Rollaway Aerial and Ground Connections

Here is the way aerial and ground connections are rigged up on a modern test panel in our shop. Two window shade rollers are shortened and mounted on their brackets, one above the other on the back of the test panel directly behind the push switch plate. Flexible wires are connected to the brass roller ends, stapled at the middle of the rollers and pass through two holes in the panel to the front and connected to banana plugs and clips. A piece of spring brass bolted on the roller bracket bears on the roller end pin making contact for the aerial and ground connections.

In use, the leads are pulled out to the desired length and locked as does a window shade, or when not in use, can be wound up out of the way. — *C. R. Williams, Janesville, Wis.*

Color-Code Circuit Leads

A set of colored pencils, the kind that can be moistened to make brilliant colors, serve as ideal markers for identifying transformer capacitor and other circuit leads.

When receivers are held up for repairs awaiting the receipt of parts, circuit leads and terminals can be color-coded by wrapping a small piece of white adhesive type around leads, etc., and color-coded for identification. The color code for each set can be noted on a shipping tag and attached to the chassis with string in order to avoid mistakes when the replacement part is installed.

This method takes little extra time to do in the beginning, but saves lots of time in locating proper connections later.—*Louis Wagner, Canonsburg, Pa.*

Grunow "Teledial" Model

In the event that a high fidelity phono amplifier is desired to be added to the Grunow "Teledial" model 12-B (1291) set many service men may be interested to know that a jack is provided for such purposes in this set. It will be found mounted flush with the chassis behind the dial and may be easily overlooked if one is not familiar with this set.

The writer added a high fidelity amplifier to this model and found it made a radio-phono combination equal to any of the newer models with tone quality which satisfies the most critical recorded music fans. — *Lewis Kanoy, Winston-Salem, N. C.*

Increased Sensitivity of Meissner FM Converters

Owners of Meissner FM converters located at distant points from stations they want to receive may find that the sensitivity to weak signals received by the converter may be greatly increased by removing the three 6SK7 type tubes and substituting 6AC7/1852 type tubes. No circuit changes are necessary, but it may be found an advantage to reset the trimmers slightly. This has been the case in our locality where several of these converters are in use some distance from any of the FM stations.—*E. Kanoy, Winston-Salem, N. C.*

Stewart-Warner 1941 Roto-Selector

If this model set develops a noise which seems to be evident only after the car is in motion check for loose I.F. transformer shields. The noise may very often stop after being on for 20 or 30 minutes. However, tightening of the nuts on the I.F. transformer shields will eliminate the noise caused from this source.—*L. D. Blow, Wyndmere, N. D.*

U. S. SIGNAL CORPS NEEDS ENGINEERS

THE War Department, Aircraft Radio Laboratory at Wright Field, Dayton, Ohio, has a shortage of qualified civilian engineering and inspection personnel. Wright Field is the home of the Materiel Division of the Army Air Corps and there are concentrated all the experimental laboratories which are making such tremendous advances in the development of aircraft and aircraft accessories. The Aircraft Radio Laboratory is responsible for research, development, engineering, and inspection required in the radio field, incident to design, supply, and installation of radio equipment on aircraft.

The basic duties of a radio engineer are to perform or supervise the performance of professional engineering work in design, construction, research, and investigation. Responsibilities and duties are commensurate with the grade.

The Civil Service standards for Junior Radio Engineer, which pays $2,000 per year, are a degree in electrical engineering from an accredited college. The next higher rating, Assistant Radio Engineer, $2,600, has requirements of two years of progressive professional experience, plus substituted experiences year for year for college education that is lacking. A college degree, while very desirable, is not essential. A well qualified engineer without a degree is eligible for consideration.

Inspectors of Signal Corps Equipment are required to make inspections and tests of aircraft radio equipment to determine compliance with specifications, etc. This duty is usually performed at the plants of the contracting manufacturers. The salary range is from $1,620 to $2,000 per year.

The above salary rates are of course initial rates and promotions for higher rates of pay are made commensurate with responsibility and experience.

Engineers and service men who are interested in these positions are invited to submit a letter outlining their education and experience directly to:

DIRECTOR, AIRCRAFT RADIO LABORATORY
Wright Field Dayton, Ohio

A Free Market-Place for Buyers, Sellers, and Swappers.

These advertisements are listed FREE of charge to C-D readers so if there is anything you would like to buy or sell; if you wish to obtain a position or if you have a position to offer to C-D readers, just send in your ad.

These columns are open only to those who have a legitimate, WANTED, SELL or SWAP proposition to offer. The Cornell-Dubilier Electric Corp. reserves the right to edit advertisements submitted, and to refuse to run any which may be considered unsuitable. We shall endeavor to restrict the ads to legitimate offers but cannot assume any responsibility for the transactions involved.

Please limit your ad to a maximum of 40 words, including name and address. Advertisements will be run as promptly as space limitations permit.

FOR SALE — Rider's Manuals vol. 1 to 6 inclusive. A1 condition and with index and supplements. As good as new. $24 F.O.B. Clarence Cheadle, Salem, S. Dak.

WANTED — Radio sets, home and car types, any quantity, late models preferred. Must be reasonably priced for cash. Also want good metal working lathe. Murray E. Main, 250 W. William St. Delaware, Ohio.

TRADE — Have a Weston Oscillator model 692 battery operated in perfect condition. Want condenser analyzer. L. D. Blow, Wyndmere, N. Dak.

FOR SALE — 1 Jackson tube tester model 535A for $20. Robert J. Kuntz 3548 Brighton Rd., N.S., Pittsburgh, Pa.

WANTED — Good VOM high resistance scale 10 megs or more, Triplett, Supreme or Weston or other good brand, reasonable. Royce Saxton, R. 1, Pontiac, Ill.

WANTED — Weston Model, 547, 565, 566 or Jewell Pattern 444 analyzer. State condition and lowest cash price. IRE Proc. 1931 to 1936 inc., 1939. A. R. Satullo, 3407 East 102 St., Cleveland, Ohio.

WANTED — Scott Receiver 30 tube. Have 10 H.P. outboard motor, power lawn mower, Oxweld welding equipment with 8 tips, cutting torch, hoses and regulators, etc. S. P. Osborn, R.R. 3, Box 90, Bristow, Okla.

WANTED — Any one or all Rider's Manuals, Vols. 8 to 11 inclusive, or will swap xmitting tubes: 6 WL 455's, 1 WL 460, as part payment. Bill Wiborg, 1019 E. Jefferson, Fort Worth, Tex.

FOR SALE — Jackson Dynamic Signal Analyzer in A1 condition; price is low. J. Levine, 625 Main St., Worcester, Mass.

TRADE — The following for radio books and tools of equal value: Books on airplane sheet metal shop practice, also How to do aircraft sheet metal work, also steel tool box with layout tools. Clarence W. Hull, Mineral Springs, Pa.

WANTED — Will buy Rider's Manuals, Vol. 11, 12 and 13; also Hickok model 202 electronic volt-ohm-milliammeter or Triplett model 1200-F automatic volt-ohm-milliammeter. R. L. Thomas, Box 583, Homer, La.

WANTED — Meissner signal shifter. State model, sets of coils available, condition and price. Nelson K. Stover, 751 Tioga St., York, Pa.

WANTED — All Rider's Manuals complete in good condition; dynamic condenser checker like Solor, Quick Check, etc.; new radio tubes, parts, tools, etc.; V.O.M. of recent manufacture. Radio Clinic, 115 W. 13th St., Sioux Falls, S. Dak.

WANTED — Cheap all wave signal generator, Superior, Readrite, C-B or the like. Will pay cash $5 to $10. Would prefer Superior 1230-1130 if possible but will buy any make. Oscar's Radio Service, Merrill, Iowa.

SELL OR SWAP — Rider's Perpetual Manuals No. 1 to and including No. 5. Will trade for short wave communication receiver or pay cash plus manuals for better or larger set. Also have Supreme and Precision tube testers. Oliver F. Klein, 2235 N. 39th St., Milwaukee, Wis.

SELL OR SWAP — One Jewell 3 inch bakelite cased A.C. voltmeter; scale reads 0-4-8-16-160-800 v. Only 4 and 160 v. have multipliers built in. A1 condition. One model 24E Audak Microdyne pickup, Hi-impedance, brown and gold finish. A1 condition. Best offer takes them or what have you in high fidelity audio transformers. Thomas Slack, 517 E. Wildey St., Phila., Pa.

WANTED — Instructograph, either A.C. or spring wound, without oscillator, but with at least 3 or 4 tapes. Must be in good condition. Please state price and condition. Martin Radio Service, 806 S. Cedar St., Marshfield, Wis.

TRADE OR SELL — Weston 590 battery operated R.F. and 400 cycle A.F. oscillator. Nat'l SW3, tubes, 8 coils continuous from 1.7 mc to 23 mc, has HRO dials, excellent condition. With or less pack—2.5 or 6.3 volt tubes. May be used on batteries. Make offer or trade list. Bob Eubank, 1227 Windsor Ave., Richmond, Va.

WANTED — A marine receiver or a long wave tuner. State full details and price. Howard G. Wacker, 2615 Spring Garden Ave., N.S., Pittsburgh, Pa.

WANTED — Volt-ohmmeter Precision 830 or equal in working or easily repairable condition. State cash price and condition, type. Globe Radio, 106-10 New York Blvd., Jamaica, N. Y.

WANTED — Riders Manuals 11 and 12 with index. Also 1,000 or 1,500 watt A.C. light plant. State best cash offer accepted. John W. Reigel, R. 2, Annville, Pa.

WANTED — Hanoria Ultra Short Wave generator, Model U.S.D. 2711. Must be very reasonable. Supreme Model De Luxe Tester, No. 585, in good condition. Voltmeter, 300 volts, millimeter 0-100. Have—Majestic 90's. What am I offered. Goldstone Radio, 1279 Sheridan Ave. Bronx, N. Y.

WANTED — Clough-Brengle; Graphoscope No. 127 C-B No. 130 A-C Bridge; C-B No. 131 Universal Speaker; C-B No. OMA C-B No. 88-A V.T. Voltmeter; C-B No. 185 Unimeter Will pay cash. Must be in good condition. Hall's Radio Service, Cor. Eighth and Pine St., Camden, N. J.

SALE OR SWAP — 1 volume (6) records of telegraph records for code instruction made via RCA. 1 Tork automatic clock 1 Crosley Facsimile machine with paper complete with amplifier. Transformers, condensers, tubes, QST's all issues HY75 and many other tubes and parts. Write for list. Nelson K. Stover, 751 Tioga St., York, Pa.

FOR SALE — New RK-28A and RCA 852, and 814; 25 watt P.A. system with four A.C. speakers and horns; 78 R.P.M. turntable; Amperex mike with plenty of shielded rubber cable. Part or all. Harry Pilafian, 77 Hampden St., Indian Orchard, Mass.

SELL OR TRADE — Bogen Model WR Wireless Remote Control, Controller, tubes, brand new. Interested in high fidelity transformers (audio) like Thordarson T15A74, 90A04 or equivalent. Best offer takes remote control or what have you. Kensington Sound Service, 517 E Wildey St., Philadelphia, Pa.

WANTED — Radio test equipment of all kinds. Please state age, condition and your net cash price in first letter. I have sound movies for sale or trade. Chas. Crank, 626 Barnard Ave., Hamilton, Ohio.

SELL OR SWAP — Supreme 89 series counter type tube checker; Precision 500 series tube tester. Both recently factory rewired to tubes. Double-barrel shotgun. Will sell or trade for National NC 100X, HRO senior, Super-Pro SX28, or Hallicrafter set. Oliver F. Klein, 2235 N. 39th St., Milwaukee, Wis.

WANTED — Cheap all wave signal generator for $5 or $6. Superior 1130-S or the like. Also want data, diagram, and directions, etc., on Superior Allmeter AMR. Will pay cash for signal generator. Oscar's Radio Service, Merrill, Ia.

WANTED — One or all volumes of Riders Manuals. Must be complete and in good condition. C.O.D. subject to examination. W. T. Ellard, Sr., 411 Ashby St., S.W., Atlanta, Ga.

TRADE OR SWAP — ½ KW R.F. transmitter and power supply, with tubes and coils for 80, 40, 20, 10, 5 Mtr. with C-D xmitting capacitors — for speed Graphic camera. I will supply photos of rig to those interested. Rig consists of 6V6 xtal/osc. RCA 815 Buffer, Eimac 35T's Final. Irving A. Gross, 3602 East 146th St., Cleveland, Ohio.

SWAP — New Abbott MRT-3-2½ meter transceiver, no power supply or tubes for Meissner late De Luxe Signal Shifter. Also want crystal microphones, amplifier, good communications, FM or television receiver. Karl H. Stello, Beltsville, Md.

FOR SALE — 1 Jackson 660 Signal Analyzer practically new; 1 E200 Precision Oscillator practically new; 1 860 Precision multi range volt-ohm-millimeter; 1 cutting and welding outfit; 1 Briggs and Stratton engine, and many other articles. If interested write for list. R. A. Bookman, Rt. 2, Casey, Ill.

(Continued on page 14)

THEORY OF THE CATHODE-RAY OSCILLOSCOPE*

PART 1

OF ALL the apparatus at our disposal there is none so versatile as the cathode-ray oscilloscope. By its use we may observe, compare or record any instantaneous changes or conditions taking place in any of our radio, sound or other electrical circuits.

The oscilloscope is to the radio engineer what the X-ray or fluoroscope is to the medical profession. By its use we can look at its fluorescent screen and see just what electrical effects are occurring in any part of the circuit to which it is connected. (Figs. 1 and 2.)

FIGURE 1
THE X-RAY SHOWS PICTURE LIKE THIS

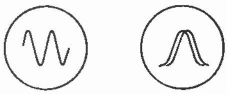

FIGURE 2
THE CATHODE-RAY OSCILLOSCOPE PRODUCES GRAPHS OF ELECTRICAL PHENOMENA

What Is the Oscilloscope?

The heart of the instrument is the cathode-ray tube. This is a special type of high-vacuum tube, shaped like a funnel, containing an electron gun, usually two pairs of deflecting plates, and a coated screen at the front of the tube where the image or pattern is viewed.

In operation, the heated cathode releases a cloud of free electrons. These are drawn through the electron gun which accelerates their velocity and focuses them into a tiny stream. As these electrons strike the coated surface of the viewing screen, a fluorescent glow is produced, lasting for a fraction of a second.

It is a property of emitted electrons that they will be attracted or repelled by any positively or negatively charged bodies in their proximity. Located between the electron gun and viewing screen will be found two sets of flat deflecting plates, arranged so the electron stream must pass between them.

Placing an electrical charge on these plates will cause the beam to move up or down, or to either side, making visible a graph of whatever action is taking place within the circuit under inspection.

In addition to the cathode-ray tube there is a special type of "saw-tooth" timing oscillator for providing the horizontal deflection, as required by the majority of applications. But this is quite simple! In most commercial oscilloscopes we will find two amplifiers, labeled "vertical" and "horizontal," along with their respective gain controls, and switches for cutting them in or out of the circuit as desired. And then there is a power supply—usually a dual sort of affair. And that's about all there is to the instrument.

Put these five units—cathode-ray tube, saw-tooth oscillator, horizontal and vertical amplifiers and power supply into a suitable cabinet and there you have a complete, self-contained cathode-ray oscilloscope. A block diagram of this assembly will be found in Fig. 3.

Applications Are Many

It would be impossible to list all the applications for which the cathode-ray oscilloscope may be used to advantage. Its users are always finding new roles for it to play.

But before telling some of its more popular uses, let's consider its workings

* *By Jay Boyd in "Radio."*

in a little more detail. We mentioned that the "movable element" is the electron stream. The mass of these electrons is so infinitesimally small that, for all our practical purposes, their weight and mass may be entirely ignored. The diversion of this stream, or beam, from its normal course may be effected at the highest radio frequencies without the sluggishness which would be the case if a mechanical vibrating element were used, however small it might be. Therefore, the

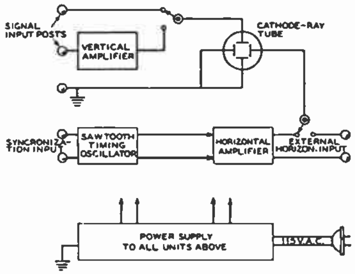

Fig. 3. Block diagram of a typical cathode-ray oscilloscope.

beam will faithfully follow excitation of any frequency and produce a true graph upon the viewing screen.

Now let's consider some of the cathode-ray oscilloscope's more popular uses.

Audio amplifier checking—We may observe and correct waveforms, tube overloads and consequent distortion, feedback, unwanted oscillations of audio or radio frequencies, power supply hum, inductive pickup, check and measure gain per stage, frequency response, match phase-inversion circuits or load impedances.

The effect of any changes may be observed when "cleaning up" or "flattening out" a newly-built amplifier which, to the critical ear, will sound only as good as it looks on the oscilloscope.

Transmitter checking—The oscilloscope is the most satisfactory instrument known for checking the performance of radiophone transmitters. Besides checking the entire audio system from microphone to modulation transformer, we can also adjust the transmitter for the much desired hundred per cent modulation, check neutralization, lack or excess of grid drive, over- or under-biasing of amplifier, linearity of modulation, overloaded speech or modulator tubes. Modulation transformers may be properly matched to r.f. load. The source of hum modulation or r.f. feedback may be more easily found and corrected.

Or, in short, if the phone transmitter is "ailing," the 'scope will certainly show up its faults. These checks are made by observing either the modulation envelope, audio waveform, or trapezoidal patterns, and sometimes by the eliptic or cat's eye pattern.

Receiver checking and alignment—Besides being useful for stage by stage checking of receiver circuits, the cathode-ray oscilloscope offers the most accurate means known for correctly aligning tuned circuits, and particularly the intermediate frequency channels of superheterodynes. Performance of de-modulator and audio systems of the receiver may also be easily checked.

Study of power circuits—Alternating current waveforms are shown as a "graph" upon the screen and their various relations may be studied, measured and analyzed. Transients and surges may be inspected, as well as operation of relays, circuit breakers, fuses, etc.

Large-screen oscilloscopes are ideal for classroom demonstrations of all sorts of electrical and radio phenomena.

The automotive and aviation industries have made frequent use of oscilloscopes in their studies of vibration, noise, combustion pressures, ignition systems, etc.

One special type of cathode-ray oscilloscope, the cardiograph (or 'scope) is used by doctors and hospitals for the study of heart conditions.

Another special type of instrument is used by orchestra directors for the exact tuning of musical instruments.

The Story of Cathode Rays

Now that we have covered a rough outline of the instrument and its many uses, let's turn back the pages of history for a brief look at its forbears. Not that it is necessary in order to understand the 'scope. But because its history is so interesting, and because we will more greatly appreciate the instrument when we remember the earlier apparatus.

The production of electron streams, which he named "cathode rays," was first discovered by Sir William Crookes about 1874, while experimenting with Geissler tubes (Fig. 4). These are simply vacuum tubes having electrodes in either end and containing small amounts of rarefied gases, which glow, something like our present-day neon tubes, when high voltages are applied to the electrodes.

He noticed that if these were pumped to a very high vacuum, the gaseous glow would disappear and then the inside walls of the glass tube would show brilliant fluorescent effects.

It was also found that these free electrons always left the cathode at right angles to its flat surface, and that if this cathode were made concave they could be focused into a highly concentrated beam, having enough energy to fuse platinum foil inserted at this focal point within the tube. There was much controversy over the question of whether the cathode ray was an ether wave, an invisible light, or a stream of material particles flowing between the cathode and anode.

Sir J. J. Thomson, about 1892, determined that these cathode rays were, in reality, a stream of free electrons and proved that they might be deflected by a magnetic or electrostatic field (Fig. 5). In his experiment he placed a strip of mica, coated with zinc sulphide, within the tube, parallel to the electron stream. Placing a magnet near the tube deflected the beam. As the electrons ricocheted along the screen, their path was made visible by the fluorescent glow thus produced. This experiment laid the foundation for our modern cathode-ray tubes.

Here we may diverge a moment to be reminded of another important discovery, for which the cathode ray was directly responsible. A German physicist, Wilhelm Konrad Röntgen, in 1895, made the discovery that whenever cathode rays fell upon the walls of the tube or any obstacle within, and especially the platinum anode, a form of invisible radiation, capable of passing through many opaque objects, was produced. He had discovered the X-ray!

It should be noted here that the cathode ray differs from the X-ray in that the former is simply a stream of

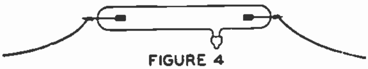

FIGURE 4
GEISSLER TUBE

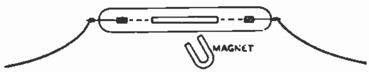

FIGURE 5
CROOKES' EXPERIMENT, PROVING DEFLECTION OF CATHODE-RAYS

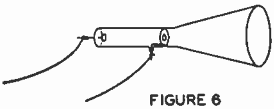

FIGURE 6
A SIMPLE BRAUN TUBE

free electrons, while the latter is similar to our radio and light waves, only much, much shorter.

And now back to our story. About 1894 a Frenchman, Hess, suggested using the cathode ray as the writing stylus for tracing curves of electrical phenomena. Then K. F. Braun of Germany designed and applied a cathode-ray oscillograph for this purpose as early as 1897 (Fig. 6).

This and all former tubes used a cold cathode, electron emission being effected by means of high vacuum and potentials of anywhere up to 100,000 volts. With such high potentials, the electrons attained velocities of about one-half the speed of light.

A few years later, Dufour in France and Sir J. J. Thomson and A. B. Wood in England built oscillographs of this pattern. They stood several feet in height, being made of iron and shaped like an upturned funnel, with the cathode at the top. They were equipped with a door for insertion of the six photographic plates and two fluorescent screens which were carried on a revolving drum. A glass window permitted viewing as well as photographing the phenomena under study.

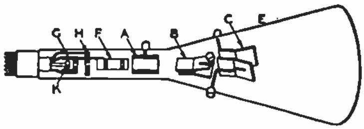

Fig. 7. A typical cathode-ray tube.

After loading the plate-holders and pumping the vacuum for awhile, these pioneer physicists were ready to photograph a few patterns, which usually consisted of a single trace across the screen. But in spite of this laborious method, some very fine oscillograms were produced, particularly of radio wave trains.

So just remember that, the next time you think it is a little trouble to hook up your modern and highly developed oscilloscope!

Modern Cathode-Ray Tubes

In 1905 Wehnelt found that by using a hot cathode operation at very low voltages was practical but the filament life of the tube was a short one. Western Electric brought out their type 224, hot-cathode tube about 1921. This tube contained a small amount of argon gas, which, along with a critical adjustment of filament temperature, caused the electrons to gather into a concentrated stream. An improved cathode structure increased the filament life to several hundred hours.

In the earlier 1930's, Manfred von Ardenne in Europe and R.C.A., Dumont, Farnsworth and others in America began experimenting with cathode-ray tubes for television. This resulted in development of the excellent series of hot-cathode, high-vacuum tubes now available for either oscilloscopic or television use.

These tubes all focus by adjustment of voltages on certain elements of the electron gun, and, containing no gas, have a very long life.

Theory of the Tube

Having covered a rough outline of cathode-ray tubes and oscilloscopes, let us now examine the individual components in greater detail.

The "innards" of a typical cathode-ray tube are shown in Fig. 7. These comprise the cathode K which releases free electrons when heated by the filament within the cathode sleeve. This cathode is surrounded by a cylinder G, which has a small hole in its front for the passage of the electron stream. Although this element is not a wire screen as our usual grid, it is known by that name because its action is similar; that is, the purpose of controlling the cathode stream by a variation of its negative potential.

Next in line is found the first accelerating anode, H, being simply a disk having another small hole in its center. In some tubes this element is connected within the tube to a second cylindrical accelerating anode, A, both these elements operating at the full potential of the tube. In the tube sketched the first accelerating electrode connects to a base pin and operates at reduced voltage.

Between these elements is found a sleeve, F, containing two more small disks, these also having small holes in their centers. This is known as the focusing electrode.

The electrodes just described comprise the electron gun, which produces free electrons and focuses them into a slender, concentrated stream, for projection onto the viewing screen.

A comprehensive explanation of the electron action in this process of focusing involves a study of what is known as "electron optics," so called because the electron stream obeys many common optical laws.[1]

We will simply state here that when the focusing electrode voltage is adjusted to approximately one-fifth that of the accelerating electrodes, a very fine beam of electrons will find a focal point on the viewing screen.

Since the tube manufacturers have designed their tubes so as to focus properly, all we have to worry about is the inclusion of a potentiometer in our circuit for making this adjustment, and another potentiometer for adjusting the grid voltage to the value necessary for producing the desired brilliance of pattern.

Deflecting the Beam

Up to this point we have covered only the production and focusing of the beam. This, of course, must be deflected from its normal course so as to strike any part of the viewing screen if a pattern is to be produced. As previously stated, either a magnetic or electrostatic field will attract or repel the beam from its normal course.

Some tubes, particularly a few of the larger ones meant for television use, are designed for magnetic deflection and do not contain the electrostatic deflection plates found in all the smaller tubes used in cathode-ray oscilloscopes. Beam deflection in tubes of the former type is accomplished by means of electromagnets, usually made in the form of a yoke, which slip over the neck of the tube.

The only point in mentioning electromagnetic deflection here is to impress upon the reader that the beam is easily deflected by magnetic fields, since this may be the source of much annoyance if the tube is not kept clear of all power transformer and filter choke fields.

Electrostatic Deflection

Referring back to Fig. 7, we will find, between the electron gun and viewing screen, two pairs of flat electrodes which we know as deflector plates. An outside connection, similar to a grid cap on receiving tubes, is brought out from each plate in the tube sketched. However, in the case of smaller tubes for oscilloscopic use, these terminals are connected to pins in the tube's base. Also, it should be mentioned, one plate of each pair is tied together inside the tubes and then connected to the accelerating electrodes, A and H, making actually four electrodes tied to this common pin. These electrodes are operated at ground potential, which is the positive terminal of the high-voltage power supply in oscilloscope practice. The two remaining free plates, then, are used for application of the voltages under test.

It will be noted that each pair of plates is mounted at right angles to the other set. Placing a positive voltage on either free plate will divert the beam toward that plate and a negative charge will likewise repel the beam, as shown in Fig. 8.

If the top plate of the set nearest the electron gun is made alternately positive and negative, as by connection to an alternating current potential, the beam will move up and down. As the electrons strike the screen a momentary fluorescent glow is produced.

Cathode-Ray Tube Characteristics

As with other types of vacuum tubes, cathode-ray tubes are designed to operate with certain specified voltages, although they are quite tolerant in this respect. The 902, for instance, is rated for 400- to 600-volt anode potential,

[1] "Electron Optics in Television," by I. G. Maloff and D. W. Epstein.

but will focus with good brilliance at considerably less voltage.

In changing the anode voltage, however, the deflection sensitivity, spot diameter or line width, and maximum brilliance will be affected.

The higher the anode voltage, the smaller is the spot diameter or line width, the greater is the brilliance of trace, and the lower is the tube sensitivity.

Deflection Sensitivity

The user of an oscilloscope should know the deflection sensitivity of his instrument, whether with or without use of any amplifiers. The potential required to move the beam from its center position to outer edge of the screen varies from about 100 to 150 volts, depending on the particular tube used and its anode potential.

In order to make the oscilloscope useful for testing voltages of such magnitude as encountered in receivers and amplifiers, a vertical amplifier is provided to boost the voltage under test to the value needed for beam deflection.

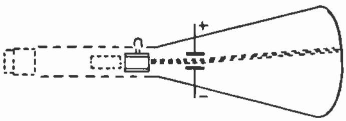

Fig. 8. A positive charge attracts the electron beam, deflecting it toward the charge.

Changing the anode potential affects the sensitivity, this change being inversely proportional to the change in anode voltage. Or in other words, reduce the anode voltage to one-half and the tube is twice as sensitive. This is due to the simple fact that the velocity of electrons in their journey from the gun to the screen is in proportion to the anode voltage, and, therefore, a greater voltage charge is required on the deflector plates to divert a faster-moving stream.

The Fluorescent Screen

Cathode-ray tubes are made with several types of screen material, depending upon the purpose for which the particular type of tube is intended.

Their chief characteristic is known as "persistence," which refers to the period of time the screen will glow after being bombarded by an electron shower.

Tubes intended for visual observation use screens of medium or long persistence; that is, the pattern remains on the screen for a fraction of a second, which eliminates any flickering at all but the very lowest frequencies. Screens of this type are well suited for "still" photography, whenever the pattern is of such character that it will remain stationary upon the screen.

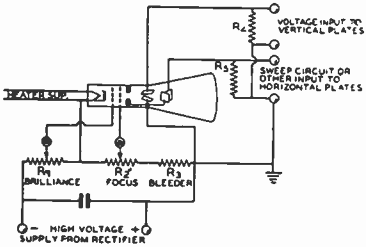

Fig. 9. Typical cathode-ray tube circuit.

There is also a short-persistence type of screen, which retains its glow for less than thirty microseconds, making it useful for oscillographic recording by means of moving-film photography. In this type of work the signal being recorded is connected to only one set of deflecting plates, the movement of the film furnishing the element of "time."

Medium or long-persistence screens glow with a greenish hue which is quite pleasant to the eye, especially when watching the screen for long periods of time. Short-persistence screens produce a blue line which is highly actinic, photographically.

In answer to the demands of television a screen giving a white line can be had in certain tube types. These make possible black-and-white pictures for the television audience.

Cathode-Ray Tube Circuits

Having covered the various elements inside the tube, as well as their functions, let us now consider a typical circuit in which they are used, as shown in Fig. 9.

The tube is shown schematically, with both the control grid and focusing electrodes shown by the usual grid symbols, as is customary in cathode-ray tube circuits. The potentiometers, R1 and R2, control the intensity (brilliance) and focusing of the beam, R3 simply completes the bleeder circuit.

Mention has been made of the two "free" deflector plates where test voltages are connected. Actually, they are connected to ground through resistors of from one to ten megohms. These resistors would not be needed if all circuits under test provided a ground return path. But with such high values, the input signals will not be affected. If allowed to "float" entirely free, these plates would soon accumulate enough electrons to give them a negative charge and shift the beam completely off the screen.

The heater supply is connected to a transformer which furnishes 2.5 or 6.3 volts to the filament, depending on tube type. In the smaller tubes the cathode is connected to one side of the filament, within the tube.

The high-voltage leads are connected to the rectifier output of the power supply. It should be noted, though, that the positive lead is grounded, which is contrary to receiver practice.

Sweep Circuits

What is the "sweep circuit" and how does it function? This is one of the first puzzling questions of those to whom the oscilloscope is new. We are all familiar with those graphs which engineers use to show the relation of one function to another. Take the old familiar sine wave, for example, a graph of which appears in Fig. 10.

To the left we find a vertical line representing instantaneous voltage values. At the bottom is found a notation of the time in which these changes take place, being 1/60 of a second in this case.

Now we will see how this same curve would be plotted on the cathode-ray screen. Facing the front of the tube would be seen the four de-

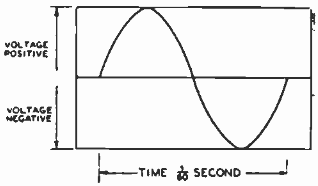

Fig. 10. Graph of a single sinusoidal wave.

flecting plates if the screen were removed, and we would see the electron stream as a tiny dot if it were visible. (Fig. 11.)

The secondary of a transformer is here connected to the vertical plates so the beam will be moved up and down in accordance with the voltage. The voltmeter will read the r.m.s. voltage across the secondary, but the beam will follow the instantaneous potential. With no voltage on the horizontal plates, a fine vertical line will appear on the screen. Since this line represents the voltage changes from minimum to maximum, it is possible to measure the peak voltage directly with a ruler placed on the screen, provided the oscilloscope's sensitivity has been previously determined.

Examining the remaining apparatus we find a battery with its center cell grounded and its positive and negative terminals connected across a potentiometer P, the slider arm A of which goes to the free horizontal plate. It is plain, then, that the beam will be moved to the right or left, depending upon the arm position.

This latter member is connected to a lever which follows the contour of a cam, C, being turned by a synchronous motor operating from the line under test.

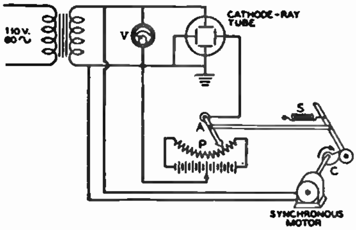

Fig. 11. Mechanical sweep circuit.

As the cam revolves, the slider arm will be drawn from left to right at a uniform rate and the electron beam will follow simultaneously. As the maximum lobe on the cam turns by its follower, the lever L and slider A are instantly snapped back to the left position by the spring S, and the sweep cycle starts all over again.

It will be apparent that during this cycle the beam has been deflected vertically by the voltage under inspection, and horizontally by the sweep circuit mechanism. If the cam is geared to the synchronous motor so as to revolve 60 times per second the beam will trace a pattern upon the screen similar to Fig. 10.

In one second's time the beam will traverse the screen 60 times, making a trace each time. But since the sweep mechanism moves in perfect synchonism, each trace will cover the exact position on the screen as did all preceding traces. Instead of seeing a moving pattern, then, the electrical wave appears to be "stopped in its tracks," permitting study as long as desired.

The above applies, of course, only if the phenomena is recurrent (and the sweep synchronized) but this condition holds true for most electrical phenomena in which we are interested.

Any transient surges occurring during this study will register as a deviation from the normal waveform, and appear as a fine line, diverting from the true waveform. They will glow for an instant, and then disappear.

While such a mechanism as above described might work at very low frequencies, it is quite evident that a better means must be found for sweeping the beam at frequencies varying from 15 to 10,000 cycles per second, or more.

(Continued in next issue)

THE RADIO TRADING POST

(Continued from page 6)

FOR SALE — 3-inch oscilloscope built by service engineer to RCA circuit. Neat appearance, tube not burned, no hum. $65. Model 150 RCA Oscillator excellent condition, $60. One new 913 Cathode Ray tube $3. Paul Wilson, 323 S. Phillips Ave., Sioux Falls, S. D.

WANTED — A 3-inch Cathode Ray Oscillograph for cash. Please state make, model, condition and price. Donald B. Berry, 196 Adams St., Waltham, Mass.

FOR SALE — Radio laboratory apparatus such as General Radio, panel type and portable meters of all types. Send stamp for list. L. Tulauskas, 104 N. Eaton Ave., Indianapolis, Ind.

FOR SALE OR TRADE — Transformer 110 v. primary; secondary 6,000 v, 20 ma. Was used for luminous gas sign. Best offer takes it. J. W. Shortell, 2333 Washington Ave., Bronx, New York.

WANTED — Position as a radio serviceman for young man. Ineligible for draft. Recent graduate of the Y.M.C.A. School, but with no experience. Willing to learn. Will accept nominal salary. Charles J. Neff, 67 Highview Ter., Yonkers, N. Y.

WILL PAY about $5 for a 1220 Superior pocket laboratory. Also want diagram, instruction, and full data on Superior All meter AMR. Oscar's Radio Service, Merrill, Iowa.

FOR SALE OR TRADE — Hundreds of used radio parts, tubes, speakers, magazines, electrical books, tube checkers, meters, tools, etc. Describe your goods, list for stamp. Roby's Swapmart, 3569 Cottage Grove, Chicago, Ill.

WANTED — Will pay cash for any good service equipment such as Supreme 560A Vedolyzer, 561 audolyzer, 562 signal generator, 571 oscillator, 504, 592 or Precision 920, 954, 844, 854P E-200, Ev10, 856 or Averox 75 condenser checker. Kennedy's Radio, 3407 14th St., N.W., Washington, D. C.

FOR SALE — Magazines, Radio Craft, Feb., 1932 to 1941, Service 1932 to 34, some Radio News 1930 to 34. Make an offer. John Staron, 2909 Julian St., Youngstown, Ohio.

WANTED — Rider's Manuals 1 through 12 in good condition complete with supplements and indexes. Quick cash sale if price is right. If you haven't all 12, what have you. Carl E. Mead, 833 Chicopee St., Willimansett, Mass.

BUY, SELL and EXCHANGE — All makes of foreign radio tubes. Want foreign radio tube tester. Aladdin Camera & Radio Exchange, 4 East 32nd St., New York.

WANTED — Dynamic Mutual Conductance Tube Tester. Full details in first letter. Will pay cash. Leo Kolehmainen, 1426½ Midvale Ave., West Los Angeles, Calif.

WANTED — Rider's Manuals volumes 4 through 13, good condition, cash. Advise what you have. Karl Wagner, C. C. Bk. Bldg., Des Moines, Iowa.

WANTED — A handicapped person is looking for a big hearted radio service man who has no more use for the extra signal generator, parts and radio diagrams which are lying around the shop. Peter J. Jarvis, 4817 S. Elizabeth St., Chicago, Ill.

FOR SALE — Breting 12 Recr. $50. Set Rider's Manuals new includes 1 to 5 abridged, 6 through 13, $85. Used Manual set 1 through 12, $85, C.O.D., F.O.B., Los Angeles. Fine condition guaranteed. Send check for prepaid shipment. Your check returned if mdse. previously sold. Also Precision E 200 OSC $40, Triplett 1601, $35. Earl K. Moore, 11537 Pope Ave., Lynwood, Calif.

WILL SWAP — A-1, 22 cal. bolt action, 7 shot clip, Western Field rifle for short wave receiver, transmitter, test equipment, books, or what have you. Also have a 210 lb. set of Bar-bells with 3 courses on weight lifting. Trade for any of above items. Fred C. Schiebler, 909 Adams St., Neenah, Wis.

WANTED — Small 2 or 3 tube AC-DC radio (headphones or speaker). Give full description. L. LeClere, 312 W. Wabash, Carthage, Ill.

TRADE OR SALE — K&E polyphase duplex Trig slide rule, like new, perfect condition. Also have a Bell 16mm. movie camera. Want 12-inch P.M. speakers of 15 watt continuous rating. What have you. Melvin Cohen, 1025 East 2nd St., Duluth, Minn.

WANTED — Automatic Record Changing Player Unit, Garrard or Webster, with record cutting head. Please state type and model. Will pay cash. Aladdin Camera & Radio Exchange, 4 East 32nd St., New York.

FOR SALE — Portable "Presto" Recorder, Type E, Ser. No. 1324. Also one Bogen Playback. Will sell one or both. Earl W. Hall, 1427½ Quarrier St., Charleston, W. Va.

WANTED — A complete set of Rider's Manuals. Will pay cash for books in good condition with indexes and supplements. Please state condition and lowest price asked for the set. Max Person, 4316 Corliss Ave., Seattle, Wash.