Vol. 8 JAN.-FEB., 1943 Nos. 1 & 2

CORNELL-DUBILIER ELECTRIC CORP.
HAMILTON BOULEVARD
SOUTH PLAINFIELD, N. J.

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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 Unpublished items will not be returned.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.

Volume Control Repairs

During this period of scarcity of radio parts when old parts have to be replaced or repaired it is well that we servicemen make every effort to repair those parts of a set where it is at all possible.

We at our shop have solved the problem of repairing most of the defective volume controls by means of a few simple operations.

In cases of controls having developed a defective or open section of the carbon resistance element the open part is first located by probing with an ohmmeter and then rubbed with the point of a soft carbon lead pencil. Controls repaired in this manner have been in service for years and show no signs of wear.

In cases of opens in wire wound controls the break in the windings is spot welded with a pointed carbon rod electric welding device made by simply connecting two heavy wire leads across a 6-volt storage battery as described in a previous issue of the "C-D Capacitor."

Repairs made in this way do of course alter the resistance values of the controls but the difference is so small that no effect can be noticed in the operation of a set.—*Robert Javelin, Brooklyn, N. Y.*

Zenith Model 11S474

If sets of this type fail to pick up reception of stations yet seem to be in operation, check the sections of the voltage divider R18 for a defective section. The 40-ohm section of this divider, Zenith Part No. 63-1048, will cause this condition.

It is suggested that a 50-ohm 10-watt resistor be substituted as a replacement in this case which will in no way affect the efficient operation of the set.—*G. D. Griffin, Ithaca, N. Y.*

G. E. Models LF115-116 and LFC28

When there is no signal or a very weak signal on both A.M. and F.M. in this set, check for a shorted .02 mfd. by-pass capacitor. These units may be found shorted as the result of a high voltage surge as the tubes heat up.

The writer suggests when new capacitors are replaced in this set that higher voltage, 600 volt, capacitors be used instead of the same 400 volt units. — *John N. Boojamra, Brooklyn, N. Y.*

Battery Supply for Farm Radios

Since the compact combination A and B battery packs are so difficult to obtain in many localities, the writer suggests that the socket be removed from an old A-B pack and long leads be soldered to it in order to employ external A and B batteries of any variety.

Where the ordinary B batteries can be obtained, the A battery supply can be made up of the regular No. 6 or 1½ volt dry cells connected in parallel. A storage battery may also be employed for those who prefer it for its rechargeable features.

When the A and B battery packs are again available all there is to do is to pull out the plug of the old battery socket and replace with the new battery pack.—*Edgar D. Cameron, Ash Grove, Mo.*

Arvin Model Six

In various sets, serial Nos. 85,001 to 86,001 the writer observed oscillation takes place between 1100 and 1500 kc. This condition may be remedied by placing a 20,000 ohm, one-quarter watt resistor in the "B" plus lead to the oscillator. Also try connecting a .002 mfd. capacitor from the "B" plus lug of the oscillator coil to the ground.

This should completely eliminate the condition as it has on those sets in which the writer made repairs.—*Milton Bobring, St. Louis, Mo.*

Preliminary Checking for Set Repairs

The writer has an old switchboard-type AC ammeter which reads two amperes full-scale on the panel of the service bench. This he connected to the terminals of a separate receptacle on the panel. A toggle switch turns the power on and off at this receptacle.

Invariably this is used the first thing to check the power consumption of a receiver brought in for repair, and it often promptly shows up shorts that would otherwise consume considerably more time to discover. The toggle switch can immediately be flipped to the "off" position if the meter hand goes full-scale. Though of course not as accurate as a good wattmeter, it is a handy, practical, and inexpensive substitute. — *D. J. Foard, Kalamazoo, Mich.*

Centering Speaker Cones

Here is a quick method employed at our shop for centering speaker cones without using shims.

Loosen the centering screw in the cone and connect 2.5 volts a.c. across the voice coil with set in operation. Then while the cone is vibrating it will find its center position. After centering, tighten the centering screw. The lower a.c. voltage, taken from the set or your tube checker, is employed so as not to overload the voice coil. —*Lewis J. Long, Indianapolis, Ind.*

Substitute 35Z4 for 35Z5

If 35Z5 GT tubes are difficult to obtain in your locality, try using a 35Z4 GT type tube. However in some sets it will be necessary to replace the dial lamp with a No. 44 as the B voltage is applied through the lamp.—*J. W. White, Jr., Galax, Tex.*

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 — Weston Model 772 Type 2 super-sensitive analyzer with Model 666-1B socket selector. This equipment is in A-1 condition. National Sound Equipment Co., 625 Main Street, Worcester, Mass.

WANTED—Tube tester, 1938 make, or later model A. T. Marr Radio Service, E. Ayer St., Ironwood, Mich.

WANTED—Good VOM, any good brand. Will pay cash up to $20. Eldred Sherrill, General Delivery, Sapulpa, Okla.

WANTED — Thordarson high fidelity and power transformers No. 15R05 No. 90A04, No. 90S13

SELL—250 M.A. 1000 V. Westinghouse M.G. set with ½ h.p. 3600 r.p.m. motor and field rheostat. Back issues Popular Photography 4 pr. Western Electric earphones. National AC5 receiver, coils to 600 meters and power supply. Make offer Murray J. Douglas, Concord, Calif.

WANTED — Photo spotlights, state type, make and whether fresnel lens, also other photo equipment. Stanley Galaski, 223—54th St., Brooklyn, N. Y.

WANTED — Riders Manuals 10, 11, 12. Please state price of each volume or complete. A Woodcroft, 19165 Albion Ave., Detroit, Mich.

WANTED — Riders Vols. 11, 12 and 13. Also, all wave oscillator. Budin's Radio and Auto Supply, 11203 Superior Ave., Cleveland, Ohio.

WANTED — A 310 lb. barbell set with courses in weight-lifting. State price. George A. Gould, 1540 E. 24th Street, Brooklyn, N. Y.

WANTED — Will purchase analyzers: Supreme 592, Weston 772; or any other standard type 20 or 25,000 ohms per volt For war use on AA-1 priority contract Radio Navigational Instrument Corporation, 500 Fifth Ave., New York City.

WANTED — Signal generator, condenser analyser, and recording playback combination—at least 15 watts with crystal mike. Joseph F. Simoncic, 8956 Sussex, Detroit, Mich.

WANTED — Signal analyzer, chanalist, Jackson, Supreme, or Superior, also Rider Manuals 7 to 13 inclusive, will pay top prices Universal Radio, 1818 W. Cermak Road, Chicago, Ill.

WILL TRADE new General hand operated slicing machine and nearly complete frequency modulation receiver for television receiver, communications receiver, or what have you? Also want A.C. 110 volt gasoline motor driven generator at once. Karl H. Stello, Beltsville, Md.

WANTED — Typewriter, sextant, K & E drawing instruments, 3 in. cathode-ray oscilloscope and a transit. Michael Karabinchak, New Street, Fords, New Jersey.

WANTED—Precision signal generator and models 920, 954, 915, 922 meters. Please state price in first letter. Charles Birmingham, 2757 Mosher St., Baltimore, Md.

WANTED—Two five inch K & E polyphase duplex slide rules, one eight inch K & E polyphase duplex rule. Quote prices in reply Ray Gaulding, 4804 Government Road, Richmond, Virginia.

FOR SALE OR TRADE—L. N. Mallory vibro-pack 300v.-100m.a. Lear 3105 k.c. at crystal, Universal aircraft hand mike with push to talk switch. Two RCA 955 Acorns. Want pocket volt-ohm meter or 8 mm. movie equipment. Ross J. Sedita, Donelson, Tenn.

FOR SALE OR SWAP—One Shure crystal microphone model 708S, it is new has only been used once. One set of crystal headphones in good condition. Dyer Matlock, Jr., Box 423, Mt. Pleasant, Tenn.

WANTED—8 mm. movie equipment, especially a good projector, 500 watt size, Revere, Eastman, etc. Also camera, 2.5 lens. Have radio parts or cash. W1LZY. J. A. McGregor, 31 Westglow St., Dorchester, Mass.

FOR SALE—12 issues "Electronics," Jan. to Dec. 1942, $3.50 postpaid Books are clean and complete. Paul Wunsch, Jr., 387 Clifton Ave., Clifton, N. J.

FOR SALE—Seven Tube communication receiver, RCA 13C, $35. Superior Signal Generator $8.00. 954 Acorn 955 $3.00 each. Want adapter for 771 tube checker, or what have you. Arnold T. Halpen, 119 Tudor Place, Bronx, N. Y.

WANTED—Volume 5, and Volume 7 of the Gernsback Official Radio Service Manuals. Also want a telegraph sending key. Oscar's Radio Service, Merrill, Iowa.

WANTED—A K & E Log, Log Duplex, Vector Slide Rule. A-1 condition. State price. George A. Gould, 1540 E. 24th St., Brooklyn, N. Y.

WANTED—Rider Manuals, Vols. 10, 11, 12. State price and condition. Stanley Galaski, 223—54th St., Brooklyn, N. Y.

FOR SALE—Riders Manuals Nos. 6, 7, 8, 9, 11. These manuals are like new, what am I offered. Write, James Radio Service, 2909 Buena Vista, Alton, Ill.

FOR SALE—Riders Manuals from one to ten, with index, in excellent condition. Make offer. Presto Recorder with following equipment. Presto 1B cutting head, 16" turntable, 65 lbs., Speed 78 and 33 1-3 r.p.m., playback electromagnetic pickup, 200 ohms. microscope, etc. first class condition, in cabinet 4 ft. x 3 ft. x 2½ ft. Value $500. A reasonable offer will take it. Walter Bickmeyer, 31 Azalia Court, Hempstead, N. Y.

WANTED—General Electric 1937 E line radio, 9 or 10 tubes, or other good chassis measuring no more than 13½ inches across chassis front. 6L6 output preferred. Cash on test equipment. Samuel Wiwegnad, 937 W. Huntingdon St., Philadelphia, Pa.

FOR SALE—New G. E. portable home recorder complete with microphone, $34.50. Zenith inverter, 32 volts d.c. to 110 a.c output, cap. 100 watts, $12.50. DeWitt Radio Service, Cottonwood Falls, Kansas.

WANTED—Main cable for Supreme Standard analyzer, model 339 and want plugs for same. State condition and price. Also interested in stock of new tubes. James A. Dalrymple, 116 S. Magnolia Ave., Lansing, Michigan.

WANTED—Rider's Manual No. 13. Will pay cash, but must be in first class condition and the price reasonable. Index and any supplements included. Reed's Electric Co., 621 High St., Palo Alto, Calif.

FOR SALE—RCA No. 150 test oscillator and No. 151 cathode ray oscillograph, both $60, RCA No. 156 tube tester $20, Weston D.C. voltmeter model No. 1, range 0-50 $25; Bristol recording thermometer, range 50-90 on 3 day charts $20. R. F. Bronson, 142-18—230 Place Rosedale, N. Y.

WANTED—Complete set of Riders Manuals 1 to 13 inclusive. Must be reasonable. Roy B. Donovan, Lovington, Illinois.

WANTED — Solar Model CE capacitor exam-eter. Will pay cash for same in good condition. Theo. L. Seybold, 610 Eye Street, N.W., Washington, D. C.

WANTED—A portable radio tube and set tester combination; preferably with an associated plug-in set analyzer unit. Must be in good operating condition. State price and make. Alex Levenson, 250 Ocean Parkway, Brooklyn, N. Y.

FOR SALE — Latest edition listing all makes and models of radios. M. Y., 4th edition Radio Encyclopedia. 75c each postpaid. Regular net 90c. Have three 6½ inch magnetic speakers, like new, $1.10 each postpaid. Max Shively, 3115 Ingham, Lansing, Mich.

FOR SALE—One late 1941 complete N. R. I. radio servicing course in first class condition, bound looseleaf in beautiful binders and indexed for quick reference complete with questions and answers also experimental parts of the course. State your highest bid in your first letter. Quality Radio Service, 1615 Brown Ave., Norfolk, Va.

WANTED—NRI service course with kits if possible; Ghirardi's radio physics course; small hand grinder with accessories; used record changer in good condition priced reasonably; used FM converter or kit. Will pay cash for above items. Judson Ferentz, 3603 Bainbridge Ave., Bronx, New York.

(Continued on page 15)

THE CATHODE-RAY OSCILLOSCOPE*

PART 5 - SEEING PATTERNS ON THE SCREEN

Having covered the theory and design of cathode-ray oscilloscopes in preceding issues, we can hook up that instrument to some of our pet apparatus, and watch it work. But first, let's make a few checks on the oscilloscope itself.

Checking 'Scope Operation

Turn on the heaters, but allow them to warm up a minute with the brilliance control turned low. Then set the focus control near its middle position and turn up the brilliance control until a spot appears on the screen. Turn the focus control to the right or left until this spot becomes as small and sharp as possible, and at the same time keeping the brilliance fairly low. Place the spot in the center of the screen by adjustment of the beam centering controls.

The spot should never be allowed to remain in one position any longer than necessary, as this may soon burn a dead spot in the fluorescent material coating the screen. So be careful to always keep the beam in motion or reduce the brilliance below that required for visibility.

Having learned the operation of the four knobs controlling the beam; that is, brilliance, focus, vertical and horizontal centering, we are now ready to try the saw-tooth oscillator.

Switch the free horizontal deflection plate to the horizontal amplifier and its grid to the saw-tooth oscillator—its normal position. Advance the horizontal gain control and the spot should become a horizontal line as the beam is swept back and forth across the screen. The synchronization control should be turned to the left.

Since the electron stream must now cover a much greater screen area than when not deflected, it will be necessary to advance the brilliance control to maintain a visible line. The rough and fine frequency controls may be manipulated, but won't show much effect on the horizontal line until the frequency is reduced to 15 cycles per second or less, or until a signal is applied to the vertical plates.

Before placing an a.c. signal on the vertical plates, we may check vertical deflection of the beam by application of any convenient d.c. voltage of 20 to 70 volts. Connect the positive to the unamplified vertical binding post and negative to ground. Switch the free vertical plate to this binding post and the beam should shift upward. If the d.c. voltage is known, we can ascertain the deflection sensitivity of the instrument, which will be useful in future testing.

And while about it, we might also test the vertical amplifier. Switch the free vertical plate to this amplifier and apply a small signal to the vertical amplifier binding post. A positive d.c. signal will cause the beam to flick downward momentarily, after which it returns to the center of the screen. An a.c. voltage shifts the beam both upwards and downwards.

The reason a positive voltage causes a downward flick when using the amplifier is that the amplifier's output voltage is always opposite in sign (or 180° out of phase) to the signal applied on its grid. Also, a d.c. signal displaces the beam only momentarily because the amplifier is capacity coupled, being intended for amplification of d.c. signals. If it were intended to amplify a d.c. signal, or a.c. of very low frequencies, a direct-coupled amplifier would be necessary, and that's another headache.

Formation of Patterns

After having ascertained that the oscilloscope is functioning properly, we are ready to put it to work. When

* *By Jay Boyd in "Radio."*

the instrument is properly connected to any type of electrical apparatus various types of patterns will be formed on the fluorescent screen. The shapes of these patterns show just how the apparatus is functioning.

The great variety of patterns produced are without number. We can show and explain only a limited number of the more frequent ones in this limited space. Every user will discover patterns that are "not in the book." So if he is to benefit most he must carefully study the way in which these patterns are formed, so the interpretation of unfamiliar patterns will be easy.

Tracing a Sine Wave

Let's begin by playing around with a common 60-cycle sine wave. Connect the vertical deflection plates to any convenient 60-cycle supply, either direct or through the vertical amplifier. If the particular 'scope is equipped with a "60-cycle test" binding post, wire this over to the vertical amplifier post and work through that amplifier.

With this signal on the vertical plates, and with the horizontal amplifier gain turned to zero, a thin, vertical line will be formed, extending an equal distance above and below the center of the screen.

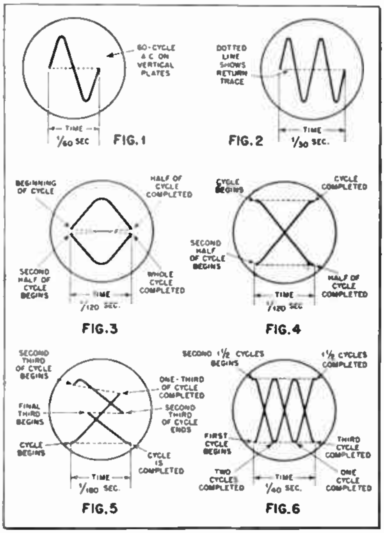
With the horizontal plates connected to the saw-tooth oscillator (through the horizontal amplifier, of course) we may get any number of patterns, depending upon the frequency of the saw-tooth oscillator. But to make it easy, first adjust this oscillator to a frequency of nearly 60 cycles per second.

A pattern like that in Fig. 1 will appear, but it will wriggle like a worm as it changes its shape upon the screen. With the synchronous selector switch turned to the "internal" position, advance the synchronization potentiometer slowly until this wriggling suddenly stops.

Now the saw-tooth oscillator frequency is locked to the 60-cycle signal being observed. And if the frequency of the test signal should vary several cycles per second, the saw-tooth oscillator will follow it and remain locked to the frequency under test.

But let's study this simple pattern more closely and see how it is formed. Remember, the beam is being acted upon by two voltages; that from the signal and that of the saw-tooth oscillator.

The latter is frequently called the "timing" oscillator because it furnishes the "time" bases of the "graphs" we make on the c.r. screen. In the



Six sketches, explained in text, showing how various patterns are developed on the 'scope screen. Fig. 1 is a 60-cycle sine wave.

case given, its frequency is 60 cycles per second. Therefore, the time required for one cycle is 1-60th of a second.

Being saw-tooth in form, the voltage increases at a uniform time rate in one direction, drawing the electron beam across the screen. Then this voltage collapses instantly, returning the beam to the opposite side of screen and the cycle begins anew.

The beam, then, will move uniformly from one side of the screen to the other, this direction being from left to right in most oscilloscopes.

But at the same time, the beam is also shifted up and down by the signal voltage applied to the vertical plates. It is the combination of these two forces upon the beam, and their timing relationship, which causes the formation of patterns upon the screen.

At this point the reader may wonder why we see only one sine curve, knowing that 60 of these cycles occur each second. Yes, 60 traces really are made on the screen each second but the saw-tooth oscillator begins its cycle in synchronism with the signal on the vertical plates, so each trace lies exactly on top of the preceding one. Due to the persistence time of the screen and also our own eyes (the latter retaining an image for about a twelfth of a second), we see the pattern as a single trace.

Other Patterns From Same Signal

Now change the sweep frequency to 30 c.p.s. and you will find two cycles on the screen, as shown in Fig. 2. The sweep time is slower and the signal goes through two complete cycles for every one of the saw-tooth oscillator.

Set the s.t.o. at 120 c.p.s. and the pattern may look like Fig. 3 or Fig. 4, depending on just what part of the signal cycle the trace begins. Since the time is just one-half that required for a complete cycle, two horizontal sweeps are necessary to record a single cycle.

Next, set the s.t.o. for 180 c.p.s. and make the "pattern" shown in Fig. 5. If the foregoing pattern formation is not quite clear, repeat all the experiments until they are understood thoroughly, before going to more complex patterns.

As the s.t.o. frequency is varied, a number of other patterns are produced, many of these being pretty but having little practical value.

One of these, where the s.t.o. frequency is neither an exact multiple nor sub-multiple of the signal frequency, is shown in Fig. 6. Here the sweep time is one-and-a-half times that of the signal (or two-thirds signal frequency—40 c.p.s. in this case), so we get three cycles on the screen for every two horizontal sweeps.

Patterns Not Requiring S.T.O.

In all foregoing examples, the graphs were drawn by plotting the test signal against a linear time base, the latter furnished by the saw-tooth oscillator. While the s.t.o. is necessary for about ninety per cent of the work you will do, there are a number of applications which make its use unnecessary.

Trapezoidal patterns, so useful in transmitter checking, and Lissajous figures, from which frequency comparisons may be made, are produced by applying a.c. signals to both vertical and horizontal plates simultaneously.

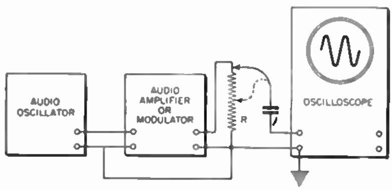


FIG. 7

Simple set-up, with audio oscillator, for checking the frequency response of audio amplifiers.

Receiver alignment is another special case, wherein the horizontal deflection is controlled by a frequency wobbulator. But since we have just shown how a.c. wave forms are plotted against a linear time base, it is perhaps most logical to next consider audio amplifier checking by this method.

Checking Audio Amplifiers

Audio amplifiers may be checked on the oscilloscope by several methods but the set-up sketched in Fig. 7 allows us to see most easily what we wish to know. The audio oscillator may be simple or elaborate, so long as it will produce sine waves of good form. Its output does not have to be "flat" in respect to frequency.

The amplifier feeds into a load having an impedance similar to that for which it was designed. The output may be fed either to the vertical plates or through the vertical amplifier. A coupling condenser of .25 μfd. should be used when not working through the vertical amplifier. If a modulator is being checked it will be necessary to reduce the voltage to 50 or 75 volts by tapping the 'scope down on the load resistor R.

Horizontal deflection is obtained by using the s.t.o. for the "time" base, its frequency being adjusted to that of the audio amplifier. Using "internal" synchronization, the pattern produced should be a perfect sine wave similar to that shown in Fig. 1. Halving the s.t.o. frequency will place two waves upon the screen. It is somewhat optional whether we see one, two, or three cycles, although the former is better when really going after "bugs."

Overloading an amplifier stage can be expected to produce flattened peaks, which may look like Fig. 8. But this overloading usually produces harmonics in the amplifier's output which may alter its waveform to appear something like Fig. 9.

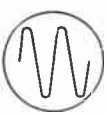


FIG. 8

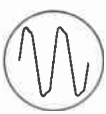


FIG. 9

FIG. 10

Fig. 8—Flattened peaks due to overloading. Fig. 9—Distortion due to presence of harmonics. Fig. 10—Distortion caused by harmonics and phase shift.

The exact appearance depends on several factors such as degree of overloading, percentage and relative amplitudes of all major harmonics, presence of regeneration, amplifier phase shift, adjustment of grid operating point, grid drawing current, saturation of audio transformers or other undesirables.

If the waveform is composed of fairly straight lines bending at well-defined angles like that of Fig. 10, use larger coupling condensers and check up plate and grid resistor networks; phase shift is occurring somewhere.

Correct analysis of distorted waves unquestionably requires a great deal of skill. But this does not detract from the oscilloscope's usefulness. If any distortion is found, the observer should next check the amplifier stage by stage until the fault is localized. It should then be easy to remedy the fault by

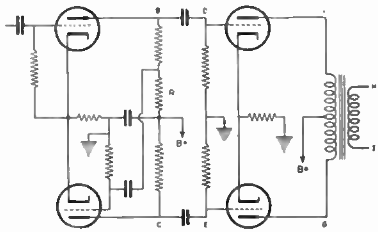


FIG. 11

Typical phase-inverter circuit easily balanced by means of the oscilloscope. See text.

substitution of any parts suspected, rechecking each change for improvement of pattern.

Balancing Phase Inverters

Whenever phase-inverter circuits are used it is essential that both sides of the circuit be perfectly balanced. To check circuits similar to Fig. 11, connect oscilloscope ground post at A and run B or C into the vertical amplifier. If resistor R is of correct value the signals taken from B and C will be of equal amplitude. Swinging the vertical amplifier to D and E should also show equal signals.

Similar signals will be found at F and G but this is misleading, since the voltage at one end of the transformer primary will be found at the opposite end of the winding, whether the tubes feeding this winding balance or not. Therefore, the overall output should be checked between H and I.

Single-ended Stages

Single-ended Class A stages produce very little distortion if operated with correct bias and are not over-driven. If correctly biased but overloaded, both peaks will be flattened as in Fig. 8. If improperly biased, flattening will occur on either the top or bottom peak, depending on whether the bias is too little or too much, and will produce patterns similar to Fig. 13.

Another excellent test of linearity may be obtained from the set-up sketched in Fig. 12. A signal from the audio oscillator feeds the vertical plates through the oscilloscope's vertical amplifier, while the same signal deflects the beam horizontally, working through the audio amplifier under test, and not using the 'scopes horizontal amplifier.

If the amplifier being tested is operating linearly the pattern will appear as a straight diagonal line like Fig. 14. A pattern such as Fig. 15 indicates slight overloading at the bottom, while the upper bend shows very bad overloading on the upper peak.

This test presupposes, of course, that the oscilloscope's amplifier is linear.

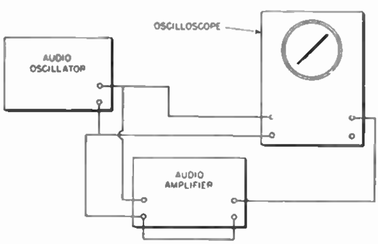


FIG. 12

Test set-up for checking linearity of audio amplifier

Incidentally, the two amplifiers within the oscilloscope may be checked in a similar manner, which should be done before making the above test.

Checking for Hum Pickup

The oscilloscope is also useful for checking hum in amplifiers or other apparatus, where it is frequently difficult to distinguish between a.c. field pickup and power-supply ripple. With the equipment set up as in Fig. 7, but with the oscillator output turned down, an a.c. ripple may appear on the screen.

Remember that inductive field pickup will show up as a 60-cycle wave, while power-supply ripple will have a frequency twice that of the power line, or 120 c.p.s. So with the s.t.o. set for 60 c.p.s., if this ripple shows up as a single cycle the trouble is

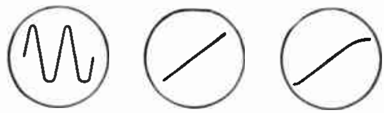


FIG. 13 FIG. 14 FIG. 15

First pattern indicates improper biasing; second, perfect linearity; third, overloading at both ends.

hum pickup in an input transformer or wiring pickup in one of the first stages. But if two cycles are found, a need for more power supply filtering is indicated.

Another method is to run a 60-cycle a.c. signal on the horizontal plates with the audio amplifier running into the vertical amplifier. Sixty-cycle hum pickup produces a narrow oval, while power supply ripple shows a "figure 8" lying on its side.

Transmitter Testing

For checking the performance of radiophone transmitters the cathode-ray oscilloscope has no equal. Besides checking the speech and modulator stages as described, the overall output can be conveniently observed. Fig. 16 shows a typical set-up which allows observation of either the r.f. envelope or formation of trapezoidal patterns, simply by flipping the usual horizontal selector switch, SW1, to either position.

Unless the transmitter is a broadcast job running after hours, a suitable dummy antenna should be substituted for the usual sky-wire. A two- or three-turn pickup loop placed near the final amplifier tank feeds the r.f. signal directly to the vertical plates without the amplifier.

A non-inductive voltage divider[1] from the modulation transformer to ground and a tenth- or quarter-mike coupling condenser taps off the audio signal, furnishing horizontal deflection for trapezoidal patterns.

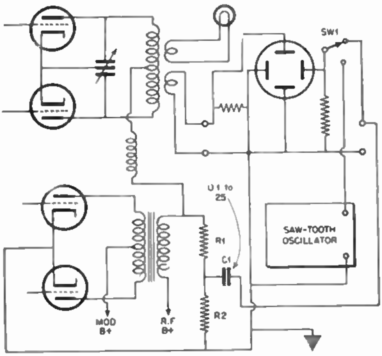


FIG. 16

Set-up for observing r.f. envelope at output of transmitter.

Throw the horizontal selector switch to the s.t.o. and turn on the transmitter. With no audio signal adjust the pickup loop until a ribbon of color shows across the screen. This pattern should look like Fig. 17, except in practice the individual r.f. cycles are so close together as to be indistinguishable. These individual cycles are shown in all sketches to make pattern formation more easily understood.

If the ribbon is bulged in spots like Fig. 18, there is hum on the carrier. This may be in either the speech or r.f., but if the former it should have been removed before testing the whole rig.

Now turn on the audio oscillator and watch the pattern change to the shape of Fig. 19, which shows a good, 100% modulated envelope. Use internal synchronization to make the "bumps" stand still.

Crank up the gain and notice narrowing of these individual "bumps," (Fig. 20) which seem tied together like link sausage. Those bright horizontal lines have no vertical deflection, telling us quite definitely that no carrier is being transmitted at these points. If the modulator is working beyond its capacity, the peaks will also be found flattened.

Fig. 21 shows flattening of the peaks only, although the carrier is not overmodulated. This may indicate lack of sufficient grid excitation or incorrect grid bias on the final amplifier. Or it may mean that the modulator or one of the speech stages is being overtaxed.

Trapezoids and Triangles

The r.f. performance of 'phone rigs should also be checked by trapezoidal patterns which, generally speaking, indicate their performance more clearly than the envelope method. Their formation is brought about by deflecting the beam vertically by the r.f. and horizontally by the audio signal. This latter must be taken from the modulation transformer; if taken from a low-level stage, phase shift will be present and the patterns meaningless.

The way in which these patterns are formed should be apparent from a study of Fig. 22. A minute fraction of the audio power which modulates the carrier is used to swing the beam horizontally. Positive audio peaks increase the carrier amplitude to twice

---

[1]A total resistance of around one megohm seems best in practice. Larger values produce phase shift, making meaningless patterns. If the voltage on the final amplifier runs around 1,000 volts, R1 may be made up of two half-megohm, one-watt resistors, with about 50,000 ohms for R2. R1 should consist of eight or ten 100,000-ohm, one-watt resistors for 2,000-volt rigs. And keep those resistors off the operating table; they carry dangerous voltages!

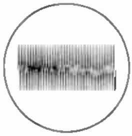


FIG. 17

FIG. 18

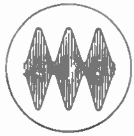


FIG. 19

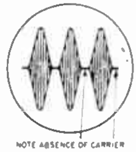


FIG. 20

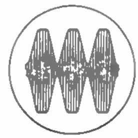


FIG. 21

From left to right: Pattern of carrier; hum on r-f. carrier; carrier 100% modulated; overmodulated carrier. In Fig. 21, the carrier is not overmodulated, but the flattened peaks indicate insufficient excitation.

its unmodulated value, while negative audio peaks reduce the carrier to zero.

Positive audio peaks swing the beam to the left, negative to the right in most 'scopes. The opposite occurs in certain makes, reversing the pattern, but this is of no importance. If modulation is 100% the left side of the pattern will be twice the unmodulated value, while the vertical deflection is reduced to zero at the right. The increased brightness on this side of the triangle is due to the beam covering less area and does not indicate faulty adjustment.

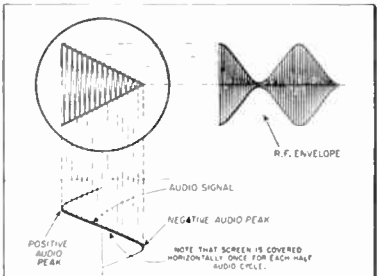


FIG. 22

Illustrating the manner in which a trapezoidal pattern is formed on the screen of an oscilloscope. See text

When modulation is linear the sides of this triangle will be perfectly straight, although the height of the left (perpendicular) side does not have to be equal to the length of the other two.

Fig. 23 shows linear modulation of less than 100%, the pattern being a trapezoid rather than a triangle. This pattern is very useful for measuring modulation percentage. Carefully measure the maximum and minimum height of the trapezoid and apply the following formula:

Percentage modulation equals

$$\frac{E\ max. - E\ min.}{E\ max. + E\ min.} \times 100$$

Fig. 24 shows a familiar pattern. The modulation is very good—but there's entirely too much of it! The bright "handle" shows the beam being dragged along by the audio signal but no vertical deflection, the carrier being completely cut off. Turning the audio gain knob to the left cures this sort of trouble.

Patterns such as Fig. 25 show improper phase relations between the audio and r.f. signals on the deflection plates; not a transmitter fault. If such occurs, increase C1 and reduce R1 and R2 in Fig. 16 and check ground connections.

Incorrect R.F. Amplifier Adjustment

In all foregoing examples there was no fault with the final r.f. amplifier; the trouble was over-modulation, overloaded speech or modulator stage, or faulty oscilloscope connection. But now let's take a look at some r.f. amplifiers that are ailing.

One common fault, lack of final grid driving power, shows up as Fig. 26. Note that modulation is linear up to about 60%, after which the r.f. peaks do not continue to rise in proportion to the audio voltage increase.

Sometimes we find a pattern like Fig. 27, in which the r.f. voltage rises in greater proportion than the audio, causing the outward curvature of the

FIG. 23

NOTE LACK OF CARRIER

FIG. 24

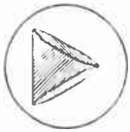


FIG 25

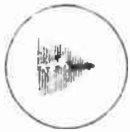


FIG 26

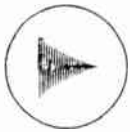


FIG. 27

Trapezoidal patterns provide an easy means of checking the r-f. performance of phone rigs.

triangle's sides. This comes from regeneration when the final amplifier is not properly neutralized.

Checking Other Modulation Methods

Grid, screen, suppressor or cathode-modulated rigs are checked by the same apparatus set-up, the only difference being the requirement of less resistance in R1 (Fig. 16). Adjustment of all these methods of modulation is less tolerant than plate modulation and their frequent checking is especially recommended.

Space does not permit a detailed description of all patterns, so a number of sketches are grouped together and briefly explained in Fig. 28, most of these being shown in the new Radio Handbook. Other patterns may be found in various articles. A very unusual case was described in the June, 1939, issue of Radio[2] but is too long to repeat here.

Bear in mind that the oscilloscope may be connected to any stage suspected of faulty operation, so don't be afraid to experiment. And when new patterns are found think out the cause before trying haphazard cures. The results will be very much worth while.

Visual alignment of receivers, frequency comparisons by Lissajous figures, and numerous other oscilloscope applications will be discussed in the next installment.

[2]The Pursuit and Capture of Parasitic "X."

(To be continued in next issue)

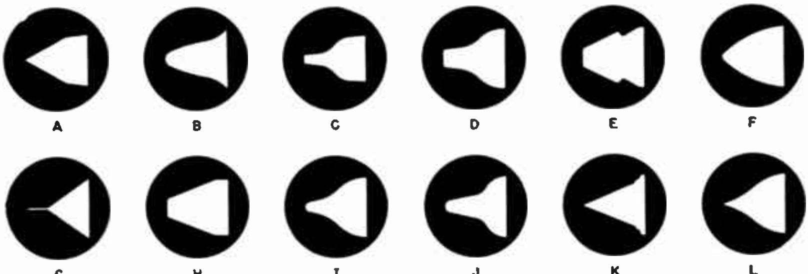


FIG. 28

Trapezoidal patterns. A: Insufficient Class C excitation. B: Improper neutralization. C: Distortion of negative peaks. D: Mismatched modulator. E: Regeneration in modulated stage. F: Insufficient excitation and bias. G: Overmodulation, with clipping of negative peaks. H: Plate modulation of s-g tube. I: Approximately 100% suppressor modulated. J: Suppressor modulated, with xtal in grid circuit. K: Whiskers (parasitics) on positive peaks. L: Well-adjusted grid or cathode modulation.

THE RADIO TRADING POST

(Continued from page 6)

FOR SALE—One drafting set of instruments, transmitting tubes, condensers, chokes, and parts. Write for list. Nelson K. Stover, 751 Tioga St., York, Pa.

WANTED—Late model dynamic type tube tester, cash by wire if suitable. Advise model and price AIR MAIL. Needed for defense project. Norwest Radio Laboratories, Shelby, Montana.

WANTED—Cornell-Dubilier, Solar, Aerovox Condenser analyzer; volt ohm meter of good quality. H. A. Carlson, 620 E. Sixth, Jamestown, N. Y.

FOR SALE — 3 Brunswick Chassis and speakers, G. E. K-32 chassis and speaker, 4 Kolsters 20 and 43. Kolster power amp. and dynamic speaker, K-5, brand new. Zeniths, Atwater Kents, Fada, RCA and Philcos. All in fair condition and playing. Low prices. Goldstone Radio, 1279 Sheridan Ave., Bronx, New York.

FOR SALE—Large assortments of transformers for Kolster, Fada, Sparton, Majestic power packs, dynamic speakers, magnetic speakers. Low prices. Goldstone Radio, 1279 Sheridan Ave., Bronx, New York.

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FOR SALE—20,000 ohms per volt voltmeter, price $10. For particulars write Philip Stomberg, Wheatland, N. Dak.

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WANTED—A Model 561 Supreme Oscillator and a Supreme Model 560 Vedolyzer. Either new or used. Will pay cash. Please give condition of instruments and lowest price in first letter. B & B Radio shop, Box 22, Gaston, Ind.

WANTED — Record changer, vac. tube volt meter, all kinds of sound equipment. Swap tube checker, oscillator. Will pay cash for mobile amplifier that has phono on top. Shines Radio Shack, 69 West 23rd St., Chattanooga, Tenn.

FOR SALE—Riders Manuals, Nos. 1 to 5 (1 volume), also Nos. 6, 7, 8, 9, 10, 11. $9 for each volume. All like new. Carl L. Chase, 110 W. Mahoning St., Hibbing, Minnesota.

FOR SALE—Weston Mod. 676 tube tester $17. 1 RCA 861 tube with socket A-1 shape, Abbott MRT-3 transceiver, 2 National type N dials, 5 Triplett meters, National SW-3 with four sets of coils AC or DC, 50 watt tubes and parts from 1000 watt phone transmitter. Write for list. Enclose stamp. Nelson K. Stover, 751 Tioga St., York, Penna.

FOR SALE — 0-1000 watt Westinghouse type DY meter, 1 Westinghouse 0-5 Amp. AC meter; 600 mil. choke; 6 1 mfd. 2000 volt condensers. Nelson K. Stover, 751 Tioga St., York, Pa.

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WANTED in new condition a Precision model 912-P portable tube tester, 4½" meter 1941 or 1942 model, also a 5-inch oscilloscope Dumont or RCA or a RFO 5 Hickok. Write Paul Capito, 637 W. 21 St., Erie, Pa.

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