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KEN-RAD
RADIO TUBES

Techni-talk on AM, FM, TV Servicing

TELEVISION RECEPTION

THE ANTENNA—2

In the previous issue antenna and transmission line selection and placement were discussed. In this issue other problems encountered while installing a television antenna will be investigated, such as standing waves, ghosts and interference.

STANDING WAVES

A standing wave is a radio frequency wave which upon reaching the end of a length of wire is reflected back to its starting point. In other words, it races back and forth along the antenna dissipating some of its energy each time until it is totally expended. Standing waves exist on all television receiving antennas but do no harm because the short over-all antenna length causes them to be dissipated so quickly that the television picture is not affected. The transmission line, however, is much longer and if standing waves are reflected back and forth on it the television picture may be affected by any number of reflections. The effect is usually one or more "ghosts" displaced in direct proportion to the length of the transmission line. Due to the transmission line not generally being longer than 100 ft the displacement of the "ghost" or "ghosts" is very small resulting in a smearing of the picture. It is, therefore, most important that the television transmission line match the input impedance of the receiver. In this way all of the energy existing on the transmission line is absorbed by the receiver and none is reflected back into the line. One check for standing waves is to reduce the contrast control until the picture is barely visible or begins to tear, then grasp the twin-lead transmission line close to the receiver and again every six or eight inches until four or five feet of line has been tested. If any change is noted in the picture there are standing waves existing on the lead in. This means that either the impedance of the transmission line has been changed by the proximity of foreign objects or the line is not being terminated into the proper impedance. If the reason for this mismatch cannot be readily located and eliminated the easiest way to correct this condition is by using a matching stub made of about forty inches of the same transmission line. The insulation should be removed for about three-fourths inches from each end of the wire and one end shorted by twisting the two conductors together. The other end should be connected to the antenna terminals parallel with the antenna lead-in. The same check for standing waves should again be made and if still present the length of the matching stub can be reduced by two or three inches until such time as there is no change in the picture. This will indicate that there is practically a perfect impedance match and all of the signal present is being transferred to the receiver. Many hours have been spent trying to eliminate "ghosts" or smearing by orienting the antenna when the trouble lay in an impedance mismatch at the antenna terminals.

GHOSTS

The main reason for installing an antenna is to provide the receiver with sufficient signal voltage to reproduce a clear television picture free of all imperfections and multiple images or ghosts." These so-called "ghosts" represent

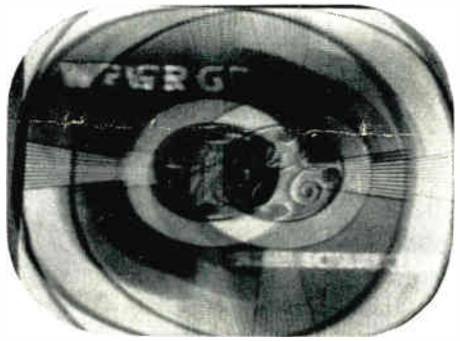

Figure 1A. Severe "Ghost"

Figure 1B. Electrical Interference

Figure 1C. FM Interference

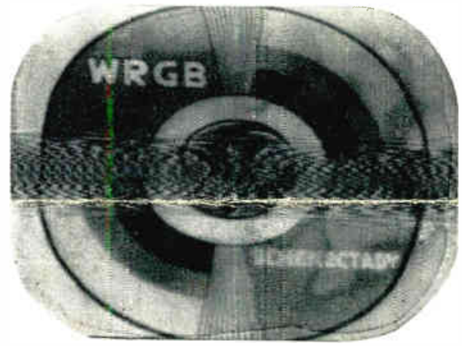

Figure 1D. Diathermy Interference

a real and serious problem for the installation engineer. In areas having only one or two television stations, the cure may be relatively easy, but in areas like metropolitan New York, where there are six separate stations, transmitting from as many different locations, the problem can be extremely difficult. The only known cure for "ghosts" not due to standing waves is the orientation or positioning of the antenna and the use of additional antenna elements.

The appearance of a "ghost" on the television screen will present a problem which can usually be solved by following a general procedure. We know that a "ghost" represents a reflected television signal which arrives at the receiver at a slightly different time than the direct television signal. Figure 2 illustrates the path of a reflected signal which would result in a pattern similar to the one shown in Figure 1A.

The reflected wave must travel the longer path from A to B to C and, therefore, will arrive just behind the direct wave travelling from A to C. This is a very simple illustration which is used to show only one path for a reflected wave. If we realize that television waves are reflected by any surface we can understand why one or more ghosts can appear on the television screen. It must be remembered however, that a reflected signal must be received with sufficient strength before it becomes visible on the picture tube screen.

For best reception, dipole type antennas must be broadside to the direction of the television station. The field pattern curves, shown in Fig. 3, illustrate approximately the changes resulting from the addition of (1) a reflector and (2) a second dipole with reflector called a stacked array. The addition of each element increases both the directivity and the signal level. The angles for a simple dipole would be slightly narrower than those shown for the folded dipole.

It can be seen from Fig. 3 that the angle indicated by peak signal strength of the direct wave as compared with peak signal strength of the reflected wave will determine the type of antenna which should be used. The narrower the angle, the more difficult the problem. The "ghost" which would appear as a result of the reflected wave in Fig. 2 would be eliminated if the antenna could be rotated so that the direction of the reflected wave was within the angle of little or no reception (Fig. 3) without reducing the signal strength of the direct wave below a usable level. The angle between the direct wave and the reflected wave can usually be determined by rotating the antenna and noting the points of best reception for the image and the "ghost." This will provide a rough indication of the type of antenna which is required. However, it may still be necessary to use the next best type before a satisfactory picture is received.

In areas having more than one station, it may be possible to rotate the antenna and eliminate the ghosts from some stations but not from others. One solution for this is the stacked array which consists of two dipoles with reflectors stacked, one above the other. Each set of elements can then be oriented for the best reception from two different directions instead of the usual one. Another solution is the addition of one or more separate antennas each one oriented for "ghost" free reception

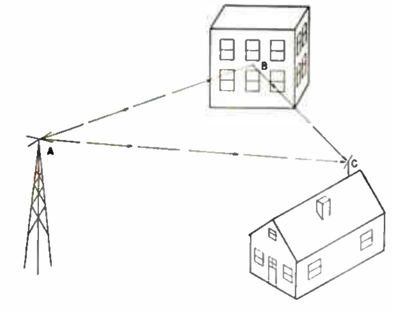

Figure 2. Receiving antenna "C" would pick up both direct signal from "A" and reflected signal from "B" resulting in "ghost."

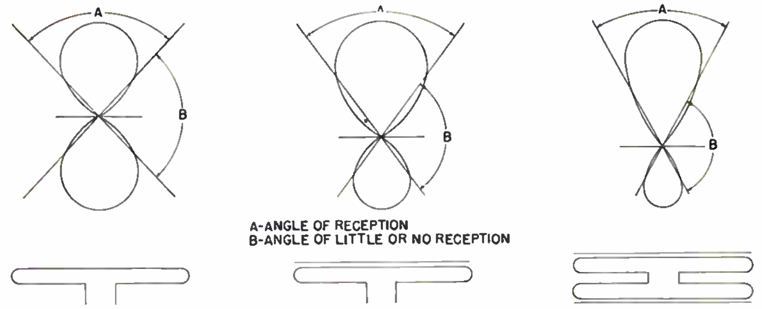

Figure 3. Average signal lobes for three different types of antennas.

from a station or stations which could not be received clearly on the original antenna. Each additional antenna should have its own lead-in separated from any other lead-in by at least one foot and connected to the receiver through a suitable switching arrangement. The inconvenience of this system is obvious and should only be resorted to when every other effort fails.

In some cases it may be necessary to use the reflected wave rather than the direct wave. This would be the case in Fig. 2 if a building were placed between points A and B. The direct signal would be effectively blocked and the only usable signal would be the one reflected from point B. The antenna would then be oriented for the best reception of the reflected signal.

Up to the present time we have only considered a ghost or ghosts displaced to the right of the stronger image. These are known as lagging "ghosts." In some cases a leading "ghost" may appear but only in high signal strength areas where a fair picture can be received without an antenna and a long transmission line is necessary if an antenna is used. The cause of this phenomenon is illustrated in Fig. 4.

The signal from A to C will be weaker but will arrive an instant sooner than the signal which travels from A to B to C. The weakest signal in this case is the direct wave and due to its arriving at the receiver terminals before the wave picked up by the antenna, it will appear as a "ghost" displaced to the left of the stronger image. This type of "ghost" can usually be eliminated by shielding the chassis thereby preventing the direct wave from being picked up within the receiver.

INTERFERENCE

Another frequent and sometimes difficult problem encountered in television antenna installation is interference. This can enter the receiver through any one or more of three paths namely (1) the antenna proper (2) the lead-in and (3) the power line. It will be necessary to recognize the usual path or paths by which a particular type of interference enters the receiver before a corrective program can be initiated. The sparking type of electrical interference similar to Fig. 1B and caused by motors and ignition systems was discussed briefly in the previous article and suggestions were made for their elimination. We shall now consider another type of interference produced by nearby FM, AM or adjacent channel TV broadcast stations.

Interference from an AM station has the appearance on the picture tube of a wire mesh and is usually confined to the area adjacent to the broadcast antenna. FM interference similar to Fig. 1C presents a constantly changing diagonal herringbone pattern and may appear any place in the area covered by the FM station.

Adjacent channel TV interference is usually indicated by the appearance of horizontal bars of varying intensity produced by the audio component riding through from the adjacent lower frequency channel.

These types of interference are picked up by the antenna and can usually be eliminated by using a $\lambda/4$ stub made of 300 ohm lead-in with one end shorted. This stub is in effect an absorbtion wave trap. It is suggested that a small capacitor be inserted in series with each side of the stub where it fastens to the antenna terminals. This will prevent any change in the R-F response curve which might result in serious impairment of the picture detail due to smearing. These capacitors should be 5 mmf for stubs in the low frequency TV spectrum and the FM band, and 2 mmf for stubs used in the high frequency channels. This gives a series parallel tuned trap which is very sharp in response and will not affect the curve of the head end unless the stub is tuned directly in the channel.

The capacitors in the tuning stubs result in a longer piece of line being required for a particular frequency. It is suggested therefore, that the stub be cut several inches longer than $\lambda/4$ and small portions cut off until maximum attenuation is obtained.

The use of a preamplifier or booster can also be used to reduce this type of interference. A television set is usually designed so that the R-F end is very broad band and may, therefore, pick up a great many unwanted signals together with the desired TV signal. The preamplifier, by increasing the selectivity of the television receiver, will reject some of the interfering signals and at the same time increase the strength of the TV signal.

Another type of interference is indicated by one or more horizontal areas having the appearance of water running through it similar to Fig. 1D. This is usually caused by diathermy interference which enters the receiver via either the antenna or the power line or both and can only be eliminated at its source. The diathermy equipment must be completely shielded and its power supply thoroughly filtered.

One case resulting in two narrow interference bands running through the picture was traced to an ultraviolet ray meat conditioner. This was a type commonly used by meat markets in their walk-in coolers. The manufacturer willingly replaced this appliance with another which had been redesigned to correct for video disturbance.

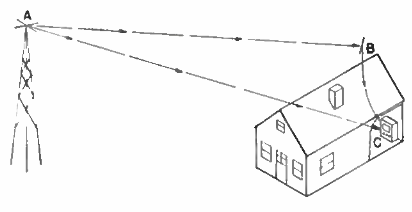

Figure 4. Leading "ghost" would result from a direct signal arriving at the receiver an instant before the signal which was picked up by the antenna.

SIGNAL BOOSTER OR PREAMPLIFIERS

As previously mentioned a booster will increase the sensitivity as well as the selectivity of a receiver. The primary use, therefore, of boosters is fringe area installations, where in addition to using the best high gain antenna, one, two and possibly three boosters are used in cascade to obtain a satisfactory signal.

When purchasing a booster there are three requirements which must be considered: (1) It should be self contained; (2) it should have a band width of approximately 6 mc. and, (3) its impedance should match the input impedance of the receiver.

In some cases a booster may be used in which the band width has been sacrificed in order to increase its gain. This will result, however, in loss of picture detail and possible loss or impairment of the audio signal.

If only one station is to be received it may be advantageous to locate the booster as close as possible to the antenna proper. In this way only the signal picked up by the antenna will be amplified and any noise picked up by the transmission line will not be increased.

ATTENUATOR PAD

In some installations too much signal may be present at the antenna terminals of the receiver. This might be true in areas adjacent to the TV transmitter or if a high gain antenna or booster was necessary in order to eliminate a "ghost" or some type of interference. The result would be a tearing of the picture due to the overloading of one or more tubes, or an extremely critical contrast control. The circuit shown in Fig. 5 can be effectively used to attenuate the signal to a usable level. The amount of attenuation can be increased by using resistors of higher value in series with the line.

We have tried to cover a number of typical problems which might be encountered during the installation of a television antenna and to offer some suggestions regarding their solution. The next article will cover the head end of a typical television receiver and typical troubles which may be encountered by the service technician.

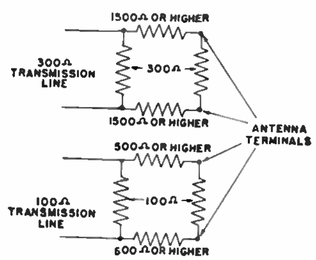

Figure 5. Attenuator Pads to be inserted between transmission line and receiver.

HOW TO GET THE MOST OUT OF YOUR TEST EQUIPMENT

In the last issue the volt-ohm-milliammeter was discussed, together with a few applications which may or may not have been new to you. In this issue the tube tester will be the subject of discussion.

THE TUBE TESTER

The primary requirement of a tube tester is to indicate whether or not a tube will operate satisfactorily. It is an accepted fact that even the most careful tests made with expensive laboratory equipment do not always tell us whether a tube will operate in every application. The service technician must, therefore, make allowances for this factor when using a commercial tube tester which represents only a fraction of the cost of a laboratory model.

As tubes have become progressively more complex so necessarily have tube testers. As a result, a considerable number of different tube testers with rather impressive names such as Dynoptimum, Mutual Conductance, Plate Conductance, Transconductance Comparison, Proportional Mutual Conductance, Dynamic Mutual Conductance, Dynamic Output, etc., have appeared. In spite of the names given these testers they are fundamentally either emission, static transconductance or dynamic transconductance or with some slight modification or combination of these basic circuits. The terms Mutual Conductance and Grid-plate Transconductance are synonymous.

EMISSION TYPE

The emission type tube tester is probably the simplest to operate and easiest to manufacture, and is, therefore, the lowest in price. In this type of tester, as the name implies, the only characteristic indicated is the total electron emission from the cathode or coated filament under static or fixed voltage conditions. All of the grids and plate are connected together as shown in Figure 1. With the proper filament voltage and a low plate voltage applied a reading is obtained from the current flow through a milliammeter in the plate circuit.

Since the emission of a tube will in most cases fall off as the tube reaches the end of its useful life, this test will usually indicate a bad tube. It may not, however, always indicate a good tube. Variations of this type of tube tester may have the grid connected to the cathode and/or the screen voltage at a lower potential than the plate voltage. However the indication even though more accurate remains one of emission under fixed conditions.

A word of caution should be inserted here regarding the length of time a tube should be subjected to an emission test. The manufacturer's instructions, particularly in regard to this operation, should be precisely followed.

When voltage is applied to the plate elements and a current reading is taken, the tube is subjected to a condition for which it was never designed and which is seldom encountered in actual operation. During an emission test practically all of the electrons emitted by the cathode or filament, not being controlled by any other tube element, flow immediately to the plate. This places a very heavy load on the cathode or filament and is quite similar to a condition familiar to practically every radio technician; i.e., when a filter condenser has short circuited and the electron flow causes the plates of a filament type rectifier tube to change rapidly in color from black to pink to red and finally to burn out the filament. All of this usually takes place in only a few seconds.

The time allowed for the actual emission test should therefore be limited to the time required for the meter to reach a peak indication. If the test condition is maintained for a longer period of time than necessary particularly on battery type tubes, it may result in the destruction of the emitting element of the tube being tested.

STATIC TRANSCONDUCTANCE TYPE

Transconductance or g_m is the quotient of the change in plate current expressed in amperes, divided by the change in control grid voltage producing it, with all other voltages remaining the same. The static transconductance type circuit is shown in Figure 2. In this circuit proper operating voltages are applied to each tube element. The grid voltage is then switched to a slightly higher voltage and the difference between the two plate current readings indicates the transconductance of the tube. Although this test indicates the tube's transconductance it is obtained under fixed conditions and may not be as accurate as an indication of transconductance under dynamic conditions.

DYNAMIC TRANSCONDUCTANCE TYPE

In the dynamic transconductance tube tester an a-c voltage is applied to the grid and the a-c current indicated on the plate circuit milliammeter is calibrated in transconductance. The advantage of this type of circuit is that the conditions under which the tube is tested is similar to actual operating conditions in that an a-c voltage is applied to the grid and the amplified a-c current is measured in the plate circuit. A typical circuit is shown in Figure 3.

SHORT CIRCUIT TESTS

Another test incorporated in practically all tube testers is the very important short circuit test. A neon lamp is usually switched into the circuit in such a way that any two elements having a relatively low leakage path between them will allow current to flow through the lamp thereby causing it to glow. The tube tester should also incorporate a provision for removing the filament voltage so that either a "hot" or "cold" test for shorts is possible. It is also important that the leakage be checked between each element with respect to every other element and not only with respect to the cathode or filament. The reason for this type of short test is obvious and this feature should be checked in the descriptive literature before purchasing a tube tester.

GAS TEST

The gas test is another test which is desirable and important to have when testing amplifier tubes. The presence of gas within a tube permits grid current to flow resulting in a number of different symptoms including distortion, defective AVC action, etc.

If the tube tester does not have provision for this type of test, much time can be wasted if it becomes necessary to try tube substitution or make current or voltage tests within the receiver.

NOISE TEST

The provision for a noise test is not considered quite as important in a tube tester as the other tests since noisy tubes can usually be found by tapping each tube while in operation in the receiver. However, some tubes may not be affected by tapping, so this is a good feature to have in any tube checker.

USING A TUBE TESTER

And now a few suggestions regarding the use of your tube tester.

1. Study the operating instructions thoroughly and make *all* possible tests on every tube.
2. Know the limitations of your tube tester, particularly in regard to rectifier tubes. A tester may indicate a "good" tube due to its not being tested under proper load conditions. Check the B + voltage in the receiver using a new tube for comparison. A variation of about 10% is normal. If more than 10% a "questionable" or "bad" reading should be indicated.
3. Do not expect to check the oscillating qualities of a tube either when used as a separate oscillator or as part of a multi-purpose tube. The tester just isn't available that will accurately check this function. A tube which tests "good" may not oscillate in one receiver but operate perfectly in some other receiver.
4. Due to tube types 6AK5, GL-2C51 and GL-5670 having extremely close spacing of the elements, it is advisable not to check these types for "shorts" since there is a possibility of a short occurring when "short" test voltages are applied. If a short is suspected a check can be made with an ohmmeter or by tube substitution.
5. If trouble exists in either the horizontal or vertical oscillator sections of a television receiver, always try substituting a new tube. Never rely entirely on the indication of "good" on your tube checker regardless of its quality.
6. Use your tube tester as the first step in your trouble shooting procedure. CHECK ALL TUBES IN ALL RECEIVERS. In this way, you will boost your tube sales and your service profits.

Remember that even though a tube tester does make a mistake occasionally, it would be the exception and not the rule. It has been the purpose of the above suggestions to point out the cases which occur infrequently so that you may recognize them if and when they do. In the next issue the capacitance and resistance bridge will be discussed.

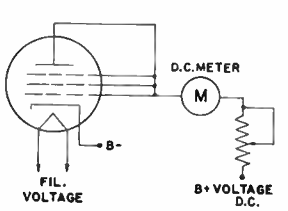

Figure 1. Emission Test

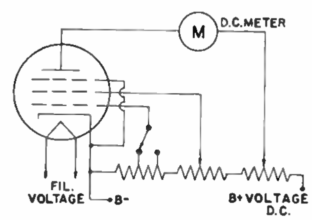

Figure 2. Grid-shift Transconductance Test

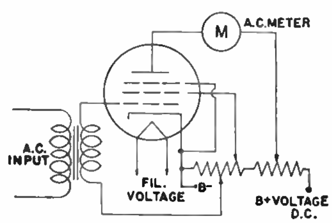

Figure 3. Dynamic Transconductance Test

BENCH NOTES

Contributions to this column are solicited. For each question, shortcut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. Send contributions to The Editor, Techni-Talk, Tube Division, General Electric Company, Schenectady 5, New York.

CONNECTION PROTECTION

The use of clear nail polish to coat the connection between the transmission line and antenna reduces the possibility of the weather creating a high resistance connection. This is especially good in salt water areas along the ocean and in smoky industrial areas. A little thing like this may prevent the over-all repair in a few months—it is much easier to do this once and be sure. To be on the safe side tape can also be applied after the coat has dried (5 minutes). This coat will not prevent taking apart at a later date. Put your antennas up to stay—it pays.

—*Joe Duffin, Washington, D. C.*

ORIENTATION CHECK TV ANTENNAS

A quick way to check for television antenna orientation is to disconnect the antenna transmission line from the receiver and touch first one side and then the other to the same antenna terminal. If there is much of a change in the picture it is probably due to incorrect positioning of the antenna. The contrast control must be set at a point where the picture is very light or begins to lose synchronization.

This test has been very helpful on installations which had been either incorrectly oriented when installed or had been changed since. The absence of any signal from one side may also indicate a break in either the transmission line or the antenna.

—*Domenic Lombardi, Schenectady, N. Y.*

NEW LOW NOISE AUDIO AMPLIFIER TUBE

A new audio input tube having an excellent signal-to-noise ratio and low microphonics, has been developed by General Electric Company and is now available at your local tube distributor.

The 12AY7 dual triode is a 9-pin miniature having design and construction features which reduce electronic and mechanical noise with a minimum of hum modulation. It has an amplification factor of 40, which is high enough to provide a suitable voltage gain and low enough to provide a moderately large output voltage with low distortion.

The original intention during the development of this tube was to provide a type which would be suitable for broadcast preamplifier work where a high degree of excellence, especially in the field of FM, is required. In addition, due to the attractive price and performance the tube should be particularly suitable in a great many other applications such as PA systems, wire or tape recorders and any other equipment where low noise and low-microphonic features are important.

The 12AY7, although not intentionally designed for such service has been used very successfully as a variable transconductance phase modulator tube for mobile radio equipment employing narrow band FM. In this application other tubes were quite unsuitable because of noise modulation caused by mechanical shock and vibration. This tube may also find considerable application in high quality receivers where the newer low level magnetic phonograph pickups are used. Also it should provide a solution to the generally difficult problem of low-level stages for electrocardiographs (heart), electroencephalographs (brain) and other special instruments of a similar type.

The service technician can, therefore, expect to find this tube in a number of electronic instruments which he may be called upon to service. Incidentally, for you fellows who are building your own PA systems, the 12AY7 will make a perfect partner for a pair of 6A5G's in a high quality audio amplifier system.

The characteristics of this tube are as follows:

	Series	Parallel
Heater Voltage (A-C or D-C)	12.6	6.3 volts
Heater Current	0.15	0.3 ampere
CLASS A AMPLIFIER: EACH TRIODE SECTION		
Plate Voltage	250	volts
Grid Bias Voltage	—4.0	volts
Plate Current	3.0	milliamperes
Amplification Factor	40	
Transconductance	1750	micromhos

DUST REMOVAL

A very simple but effective way to remove surface dust from the chassis of a receiver without damage to the set or much effort:

Obtain one large pump type insect sprayer (or a bicycle pump), remove the spray container, aim at the surface to be dusted and pump as if spraying insects. We have used it for about three years and it has never failed to get reasonable results.

P. E. Given—One Way Radio Service Memphis, Tenn.

QUICK CHECK FOR PM SPEAKERS

To check a PM speaker for voice coil or other rattles set a TUBE CHECKER filament control to 2.5 volts and run a pair of test leads from the speaker to the filament pin sockets of the tester. The 60-cycle hum will give you a good idea of the speaker's condition.

—*M. H. Wheeler, Starkey, N. Y.*

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