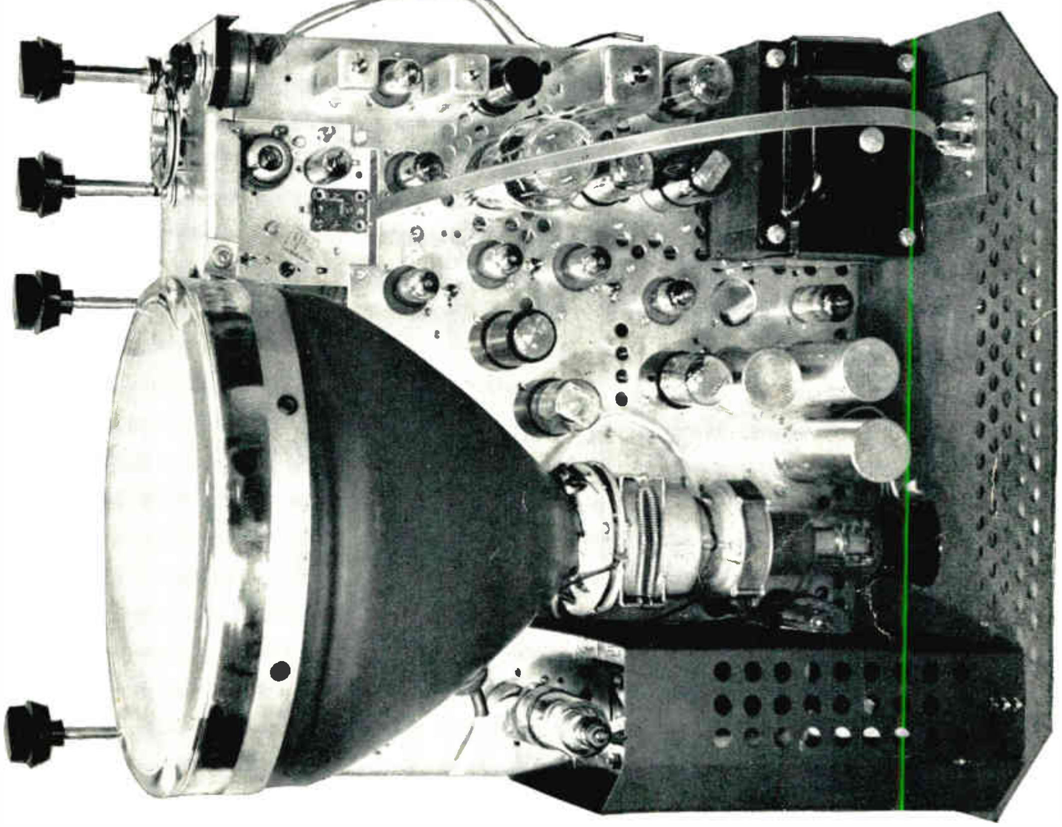
FEBRUARY-MARCH 1949
VOL. 1—No. 1

Techni-talk on AM, FM, TV Servicing

KEN-RAD RADIO TUBES

TELEVISION RECEPTION

THE ANTENNA—1



A typical television receiver chassis using a 10" direct view picture tube.

The above chassis, from a General Electric Model 810, was chosen as a typical television receiver and is representative of the type of receiver which the service technician will be called upon to install and repair. All twelve commercial television channels can be received on this type of receiver.

We shall endeavor to explain the installation and operation of this type of receiver in the service technician's language with a minimum amount of theory. A thorough understanding of theory is important and essential in order to install and service television receivers efficiently. We feel, however, that theory is presented and covered more thoroughly in any good textbook on the subject than would be possible in a publication of this type.

The finest television receiver is not capable of improving upon the signal presented to it by its antenna. It is, therefore, important that we select the proper antenna and install it in such a way that the signal present at the receiver's antenna terminals be sufficiently strong to provide a satisfactory picture. The average amount of signal voltage required to do this is approximately 150 to 200 microvolts depending upon both the receiver's sensitivity and the amount of electrical interference present. The average amount of signal voltage required at the antenna terminals of the ordinary AM or FM receiver in order to provide satisfactory sound reproduction is only about 10 microvolts. The television antenna system, therefore, must supply from 15 to 20 times more signal voltage to its terminals than is necessary on AM and FM receivers. The importance of the television antenna cannot be overemphasized and every effort should be made to make its installation as efficient and permanent as possible.

ANTENNA SELECTION

A number of manufacturers either recommend an antenna or supply one with the receiver. In such cases the manufacturers recommendations should be followed. If, however, the choice of an antenna is left with the service technician, his first consideration should be the input impedance of the receiver. This information is usually included in the installation instructions, and if it is omitted can be obtained from the Rider Television Manual or by writing to the manufacturer.

Probably the best known and most popular types of television antennas are the folded dipole and the simple dipole. If the receiver's input impedance is 300 ohms which is today the most widely used and generally accepted by the television industry, the probable choice will be the folded dipole. This type of antenna, when made of uniform diameter tubing, has a characteristic terminal impedance of 300 ohms and when used with 300 ohm twin-lead transmission line, presents an efficient low loss antenna system. The folded dipole is also receptive to a broader band of frequencies than the simple dipole if the same diameter tubing is used on both antennas.

Most pre-war and some post-war receivers have an input impedance of from 75 to 100 ohms. The type of antenna which presents the closest impedance match, in this case, is the simple dipole which has a characteristic terminal impedance of about 73 ohms. If 75 ohm twin-lead transmission line is used with this type of antenna we again have a very efficient matched system.

ANTENNA FREQUENCY

All antennas have resonant frequencies depending upon their length which is usually one half wavelength (λ/2) from end to end. Manufacturers usually design their folded dipole antennas for broadband, high gain response over the 54-88 mc band. In general this means that the resonant frequency is approximately at the midpoint of the 54-88 mc band. A folded dipole cut for this frequency will also provide very satisfactory reception on the 174-216 mc band providing, of course, that the orientation of the antenna is receptive to both signals.

Due to the shape of the folded dipole its length and, therefore, its frequency cannot be changed. However, one manufacturer uses approximately the midpoint of channel 2 for the resonant frequency and supplies shorting bars which may be used to increase the frequency. This is accomplished by sliding these bars toward the center, thus reducing the electrical length and increasing the resonant frequency. This feature would be particularly useful in low signal strength areas where the antenna could be adjusted for maximum signal strength at other than the midpoint of the 54-88 mc frequency band. Complete instructions are supplied with each antenna.

Simple dipole antennas are also designed for maximum response at about the midpoint of the 54-88 mc band. The resonant frequency can be decreased by increasing the rod length, which usually isn't practical, or increased by reducing the rod length which permanently changes the antennas frequency. Due consideration must, therefore, be given to the possibility that the antennas characteristics be so changed that future television stations operating on the lower frequency channels 2-6 might not be received. Only in cases of insufficient signal strength where every fraction of a microvolt is important should any alteration be made to the length of each dipole. If it is desirable to change the frequency, the following table lists the (λ/4) rod length for each channel:

Channel	Frequency	Length in Inches
2	54–60	48.4
3	60–66	43.8
4	66–72	40.0
5	76–82	34.9
6	82–88	32.5

If more than one station is to be received on the low frequency band, the average length should be used and if a reflector is used its length should also be reduced proportionately. The length of the reflector should be about 5% longer than the over-all antenna length.

IMPEDANCE MATCHING

Almost any type of antenna can be matched to any type of transmission line and this to any receiver as long as all impedances are known. We shall first consider matching the 300 ohm dipole to 75 ohm coaxial cable, the use of which may be necessary in some installations where the transmission line must run near a source of electrical interference. The coaxial cable in this case is to be used with a receiver having an unbalanced 75 ohm input. In this case the only mismatch occurs at the point where the 300 ohm antenna feeds the 75 ohm transmission line. The Technical Appliance Corporation, manufacturer of TACO Antennas recommends the use of a half-wave matching transformer for this purpose. This is merely a length of the same 75 ohm coaxial cable cut approximately 75% of a half wavelength (λ/2) long and connected as shown in Fig. 1.

If the same antenna and transmission line is connected to a receiver having an input impedance of 300 ohms it also becomes necessary to change the impedance of the transmission line at the receiver to 300 ohms. In this case the addition of a second half-wave matching transformer cut the same length as the first is connected as shown in Fig. 2.

The length of the matching transformer will depend upon the frequency or frequencies to be received. The following is a list of the approximate lengths of the half-wave transformer to be used on each television channel.

Channel	Frequency	Transformer Length in Inches
2	54–60	77.5
3	60–66	70
4	66–72	64
5	76–82	56
6	82–88	52
7	174–180	25
8	180–186	24
9	186–192	23.5
10	192–198	23
11	198–204	22
12	204–210	21.5
13	210–216	21

On installations where only one station is to be received, the half-wave transformer is considered the ideal method of matching as practically no loss is introduced into the system. If reception is required on several stations within the low frequency band it is suggested that the dimensions for channel 4 be used. If both high and low frequency stations are wanted channel 4 dimensions should also be used except when 7 and 8 are desired. Should channels 7 and 8 plus a low channel station be required use the length for channel 3. The Technical Appliance Corporation states that these lengths when used will not produce a loss through a mismatch of more than 3 db.

General Electric recommends the use of a resistor network to match either coaxial cable or 100 ohm shielded twin-lead to a 300 ohm receiver. An illustration of this network appears in Fig. 3. This method has the advantage of being both compact and easy to install and most important it has little or no frequency discrimination. There is, however, a considerable loss in signal strength which limits the application of this type of system to high signal strength areas.

RECEIVER PLACEMENT

After the proper antenna and transmission line has been selected, probably the first consideration before attempting the installation is the permanent location of the receiver. This should be placed in a position which will accommodate as many viewers as possible. It is also not advisable to allow direct daylight to fall upon the face of the picture tube as the picture may appear "washed out."

ANTENNA LOCATION

The next consideration is a tentative antenna site. The height of an antenna will depend on two factors: (a) signal strength and (b) electrical interference. The amount of signal present in an area usually depends upon the distance from the broadcast antenna and the presence of intervening hills or buildings which either absorb or deflect the television signal. Electrical interference may come from practically any source which interferes with broadcast or short-wave reception such as car ignition systems, sparking in a-c operated machinery, starting and stopping of street cars, lightning flashes and numerous other forms of natural or man-made disturbances. In some installations height may not be too important. However, in most cases it is advisable to locate the antenna at the highest practical point as far away from any source of electrical interference as possible.

In order to reduce the possibility of ignition noise, the antenna should be placed in such position that some part of the building will be in the line of sight path between the street and the antenna. The building will shield and absorb some of this type of interference. In some cases ignition noises have been considerably reduced by rotating a dipole antenna with reflector so that instead of the reflector being in back of the antenna, it is between the dipole and the transmitter.

TRANSMISSION LINE

The transmission line should be kept as short as possible in order to reduce the line loss which is in direct proportion to its length. Twin-lead transmission line must not be permitted to rest against objects such as the side of building (wood or otherwise) and should be so suspended that it clears such objects by at least an inch. Paint should never be applied to the transmission line either indoors or out as this will definitely change its impedance. In order to minimize both the possibility of noise pickup and any change in the impedance, the transmission line should be kept clear of metal objects and in no case be permitted to run against metal surfaces or inside of pipes. There are several types of stand-off insulators which have been designed for twin-lead transmission line and distributed by General Electric, Amphenol, Workshop Associates, etc. Any one of these types can be effectively used to keep the transmission line from touching foreign objects. It is recommended that the line be twisted about one turn per foot from the antenna terminals to the receiver terminals in order to help balance out man-made interference.

If coaxial cable is used the grounded shield prevents any noise interference pickup by the transmission line, therefore, the precautions concerning the lead-in can be disregarded.

LIGHTNING ARRESTER

The installation of an antenna system should conform with local building and fire regulations. If a lightning arrester is required by local ordnance or requested by customer, use a Double Lightning Arrester such as Taco No. 409 or GE Cat. No. REM-001 or any other make specifically designed for television transmission line. The instructions included with the arrester should be followed very carefully so as not to change the lead-in impedance at the point of connection.

In order to protect both the customer and the installation technician a No. 8 wire should always be connected from the antenna mast to a good ground. This wire should be kept at least one foot from the twin lead and should be installed regardless of whether a lightning arrester is used or not.

(To be continued next issue)

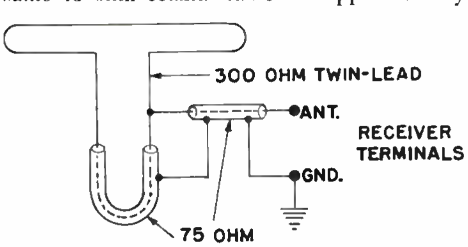


Fig. 1. Using a half-wave transformer to match 300 ohm twin-lead to 75 ohm coaxial cable.

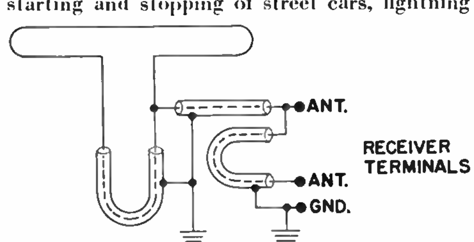


Fig. 2. Using a half-wave transformer to match 75 ohm coaxial cable to a 300 ohm input television receiver.

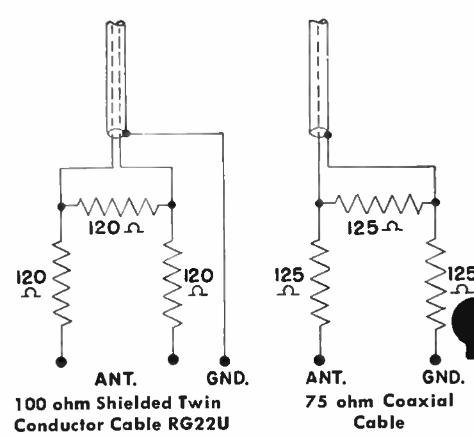


Fig. 3. Using resistors to match shielded transmission line to 300 ohm input television receiver.

HOW TO GET THE MOST OUT OF YOUR TEST EQUIPMENT

The purpose of this series of articles is to suggest possible uses for test equipment which will enable the technician to get the most out of the equipment which he has purchased, or will purchase in the very near future.

THE VOLT-OHM-MILLIAMMETER

The first instrument which will be discussed is the volt-ohm-milliammeter. This is probably the most used piece of equipment, with the possible exception of the tube checker, on the service bench. A considerable number of sets can be completely repaired without using any other piece of test equipment.

As a voltmeter, the usefulness of this instrument is somewhat dependent upon the sensitivity of the basic meter. This is represented by the reciprocal of the amount of current which must flow through the basic meter, exclusive of all resistors and shunts, in order to obtain a full scale deflection. The following table illustrates the sensitivity ratings on several basic meters.

Basic Meter	Expressed in Amperes	Reciprocal	Sensitivity in ohms per volt
1.0 ma	.001	$\frac{1}{.001}$	1000
500 μa	.0005	$\frac{1}{.0005}$	2000
200 μa	.0002	$\frac{1}{.0002}$	5000
50 μa	.00005	$\frac{1}{.00005}$	20000

The sensitivity indicates the amount of resistance which is placed across a circuit whenever a voltage reading is obtained. This is particularly important when attempting to read voltage after it has passed through a high resistance such as at the plate of a resistance coupled amplifier. The effect is similar to placing a resistor between plate and ground. The resistance is equivalent to the voltage which is present at the plate, times the sensitivity of the basic meter. By using a more sensitive meter, this resistance is higher and the reading more accurate due to less current flowing through this path to ground.

AS HIGH VOLTAGE MULTIPLIER

The sensitivity of the meter is also very important when reading high voltage in television power supplies where the current delivered by the rectifier is in the order of only a few milliamperes. In this application the only instrument which will give a reasonably accurate indication is the 20,000 ohm per volt voltmeter. A number of voltmeters having a sensitivity of 20,000 ohms per volt have a maximum range of 1000 or 5000 volts. This is inadequate for checking most television voltage supplies. The 1000 volt range can be extended to 10,000 volts by using either a 200 megohm series resistance or a 200 meg voltage divider. Ten 20 megohm one watt resistors, soldered together, can be used for either method.

Figures 1 and 2 indicate the connection used to measure up to 10,000 volts. The resistors can be mounted zig-zag on a piece of high resistance material such as lucite or, if the series resistance method is used, the resistors can be soldered end to end and inserted into a tube made of high resistance material. Well insulated lead wires should be soldered to each end and both ends can then be sealed with any insulating material so that all bare wires are completely covered. For convenience, Alligator clips should also be attached to each end. The voltage divider method is somewhat less accurate due to the shunting effect of the meter across part of the voltage divider. This offers a parallel voltage path which may cause a considerable reduction in voltage depending upon the instrument used.

Every precaution must be taken when measuring high voltage. The power supply should always be turned off before making any connections and the B+ should be shorted to ground using an insulated screw driver held firmly against the chassis and then touched to B+. Never change or touch any connections while the power is on.

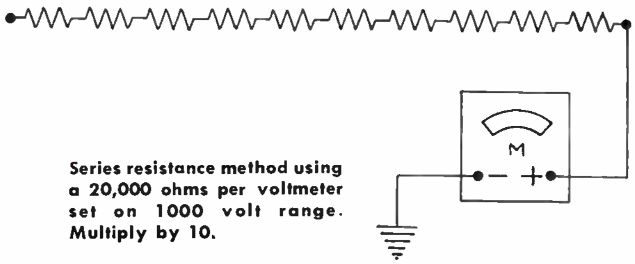


Fig. 1.

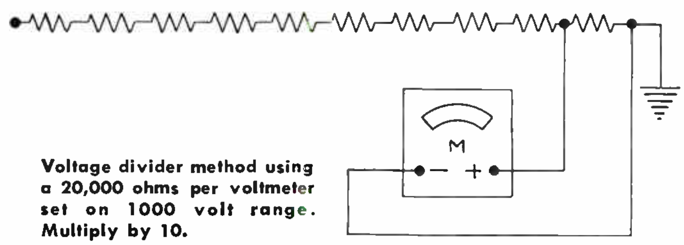


Fig. 2.

OTHER USES FOR VOLT-OHM-MILLIAMMETER

Innumerable tests and checks can be made with the VOM and most every service technician has his own particular applications. The following is a list of a few applications which may or may not be new to you:

(1) A considerable amount of time can be saved by using the ohmmeter instead of the tube checker to locate tubes with either open filaments or intermittently open filaments. Some tubes with intermittently open filaments will form a temporary weld when placed in a tube checker. This weld, however, will not be permanent and the same complaint can be anticipated in the near future.

(2) An ohmmeter can also be used to check for a break or a bad connection in a folded dipole antenna system. The resistance of 300 ohm line is about 2 ohms per hundred feet when connected to a folded dipole.

(3) Hard to find "cracking" noises may originate in resistors which have changed value by more than 10%.

(4) "B" Batteries which discharge too rapidly may be due to current being drawn while a receiver is turned off. This can be checked by connecting a milliammeter in series with the B+ lead. The highest ampere or milliampere range should always be used first when measuring current and if little or no current is drawn, the range can be reduced step by step to the lowest range. No current should be indicated even on the lowest range. If any current is drawn, check for a filter condenser which may be connected so that it is between the battery B+ and ground even with the switch in the "off" position.

(5) Noise due to shorted plates on variable condensers can be located by connecting an ohmmeter across each section and noting any change in the resistance while rotating the condenser. The receiver's power switch should be turned "off" and the ohmmeter should be on its lowest range. The movement of the ohmmeter will usually indicate whether the noise is due to shorted plates or an accumulation of dirt and dust between the plates. If the plates are shorted the meter will usually indicate a steady short, whereas, if it is due to dirt it will usually jump back and forth erratically. If the plates are shorted it is usually a simple matter to locate the point or points where the plates are touching and eliminate the trouble by slightly bending that particular plate. The results can be checked by watching the ohmmeter while rocking the condenser back and forth.

If the ohmmeter has indicated that the trouble is dirt accumulation, there are two methods by which this can be eliminated. The first is by using a pipe cleaner to clean the air space between each plate. The second is by the application of several hundred volts AC across the condenser. Before applying any voltage, all leads going to the stator should be unsoldered so that this side of the condenser is not connected to any circuit. A pair of leads can then be connected from each side of the condenser to the high voltage terminals of a power transformer. This can be either a spare transformer or the rectifier plate connections on any set that may be available. If the set being repaired has a power transformer, this supply can be used. When the power is turned "on" the voltage will arc across at any point where dirt is present. The condenser should be rotated back and forth until this arcing stops. This indicates that all of the dirt and dust has been burned off.

All of the usual precautions regarding the use of high voltage should be followed. This method obviously cannot be used if the plates are touching as this would short the power supply and probably burn out the transformer.

In this article an effort has been made to point out some practical applications which will enable the technician to get the most out of his test equipment. If you have found some particular application for any piece of equipment which is especially useful or time saving, won't you share it with other service technicians by sending it to: The Editor, Techni-Talk, Tube Division, General Electric Company, Schenectady 5, New York. A certificate good for the purchase of $10.00 worth of Electronic tubes will be awarded for each suggestion published. Conditions stated under "Bench Notes" on page 4 also apply to items included in this series of articles. Next month the Tube Tester will be discussed.

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.

FASTER TV ANTENNA INSTALLATION

A two-way sound-powered Telephone Handset will save considerable time in antenna installation. These phones are easily connected by clipping one wire to one side of the lead-in ribbon and the other to ground. With the use of these phones, the antenna is quickly and easily oriented. The man at the receiver is in constant contact with the man at the antenna and can more accurately report the best position for the antenna. This is a very important operation, as the quality of reception depends upon the exact position and orientation of the antenna.

As the name indicates, the handsets are sound-powered and no batteries are required, making them compact and easy to carry. One side of the lead-in ribbon itself is used to transmit the voice, thus eliminating the use of additional wires for this communication. Reception is not affected by this procedure.

No doubt there are a number of manufacturers of sound-powered phones; however, the set used was made by the Wheeler Insulated Wire Company of Waterbury, Connecticut.

It can easily be seen that this equipment will more than pay for itself by saving time. However, the largest and most important factor is that the customer will have a good installation, and it's well-known that a satisfied customer is the best advertisement. Efficiency always pays.

—H. E. Doutt, Scotia, New York.

ALUMINIZED TUBE SUBSTITUTION

Question: Can the G.E. Daylight Picture Tube type 10FP4 be used as a replacement for the 10BP4 in any make of television receiver? *—Joseph Zukauskas, Philadelphia, Pennsylvania.*

Answer: Yes, the replacement of a 10BP4 by the new 10FP4 in modern television receivers is even more simple than replacing the original type. Mechanical size and shape of the two tube types are identical. No changes need be made in the position of the face mask, tube shield, deflection yoke, focus coil, tube socket or anode connector; that is, no changes other than would be encountered by variation between individual tubes of the same type.

Since the 10FP4 with its aluminum-backed screen requires no special electron gun and external magnet to eliminate ion-spot blemish, the external ion-trap magnet used with the 10BP4 must not be used on the 10FP4 tube neck. When the ion-trap magnet is of the permanent-magnet type it simply is removed from the television receiver.

The electro-magnet type presents a different problem. Since the winding of this magnet is an integral part of the receiver power supply, it must remain connected but be kept physically out of the vicinity of the 10FP4. The magnet should be securely taped, wired, or clamped to some part of the chassis or cabinet in a position as far from the picture tube as its lead wires will allow. It should not be placed close to a receiving tube.

If no convenient position can be found for the magnet, it can be removed from the circuit and a resistor of equal resistance be substituted.

In all respects, a change-over is so simple for the serviceman to execute, that no television-set owner who values picture brightness, definition, and clarity need be without the advantages of the new aluminum-backed picture tube.

HERE'S A TUBE SAVER

An RCA model 66BX was brought into my shop the other day for repairs. The set was turned "on" and after allowing sufficient time for "warm up" it was still dead. The switch was turned to the "off" position and I started to check the tubes. The first tube checked, a 3V4, was dead. A new 3V4 was inserted into the tube socket and a slight flash was noticed inside the tube. The filament between pins 7 and 5 on the new tube was now open. All other tubes and the circuit were carefully checked and everything was found to be OK.

A voltage check was then made by connecting a Simpson VTVM between pin 7 and ground with the 3V4 removed from its socket. The voltage rose to 45 volts as soon as the 117Z3 warmed up. This voltage came down very slowly to about 18 volts after the set had been turned "off" for one minute. There was still about 12 volts remaining on pin 7 after the set had been "off" for five minutes due to the charge remaining on the 160 microfarad condenser C31.

In order to prevent any future tube loss the 1800 ohm resistor (R-15 in Rider's Manual XV) connected from pin 5 to ground was changed from pin 5 to pin 7. A voltage check indicated an immediate voltage drop to almost zero within 5 seconds after the set was turned off. No difference in the operation of the set was noticeable.—*Elmer H. Wirsing, Albany, New York.*

ETR-16C RECEIVING TUBE CHARACTERISTICS BOOKLET EXTENSIVELY REVISED

In a new and completely revised version of the highly popular characteristics booklet, every effort has been made to make it of even greater use to the service technician. Included in the over 600 listings are all tube types, which have been released by RMA and classified as receiving tubes, from old timers such as the 01A, 12A and X99 to the newest types for FM and Television. Data on some Television Picture types are also listed.

One feature which will make this publication particularly useful is the location of the basing diagrams on the same page as the characteristics. These diagrams together with typical operating voltages for as many as forty different tubes are available on each double page.

You'll have constant use for this booklet when making voltage or resistance measurements at the tube socket terminals in AM, FM and Television receivers, and you'll find that one feature of the book will really save time—it opens flat on the bench and stays that way.

Be sure to ask your distributor to reserve a copy for you. They'll go fast.

POSTMASTER: If addressee has moved and new address is known, notify sender on Form 3547, postage for which is guaranteed. When Form 3547 is sent abandon this mailing. Return only if no correct address is available.