

SENCORE NEWS

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HOW TO WITH INSTRUMENTS THRU *PIX FACTS*

World's Largest Technical Publication — 250,000 Per Month

WRITTEN BY
SENCORE FIELD ENGINEERS
AUGUST, 1971



CR161 CRT Auto-Tracker

\$140.00

TC162 Mighty Mite Tube Tester

READ ABOUT THE NEW AUTO-TRACKER

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READ ABOUT THE NEW MIGHTY MITE

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THE MOST OFTEN ASKED QUESTIONS ABOUT TESTING RECEIVING TUBES AND CRT'S

Introduction

We, in Field Engineering, are well aware of the importance of fast, accurate tube testing to those involved in electronic maintenance. We have all been involved in the repair and servicing of electronic equipment and feel that this first-hand experience is helpful in guiding the engineering department in the development of practical service equipment of the highest quality.

This issue of the News covers receiving tube and picture tube testers. We have helped the engineering department make some important and time saving changes in the tube testers now being introduced. They have been fully tested and found to be fast, easy and accurate by those of us in field engineering and by other service technicians such as you. We will try to answer questions on why they are needed and how they can be used to make electronic servicing and maintenance easier and faster. We hope that this issue will prove to be informative for you and that you will find a place for these excellent tube testers in your shop or lab.

Jim Smith

Chief Field Engineer and narrator of this report.

CRT's — Their Future and Yours

We are sure you will all agree that the number of CRT'S in use is increasing. New television receivers are being placed in homes, hospitals, schools, and other institutions every day. Industrial applications for the CRT are also increasing. Closed circuit television, computer terminal readout devices and other display devices such as airport flight schedule monitors are a few examples.

In just one area, the television industry, picture tube replacements are at an all time high and expected to go even higher. According to an article in a recent issue of Radio and Television Weekly, "color CRT replacement is expected to increase from 1.0 million to over 1.6 million by 1975."



What does this mean to you? First, the increasing number of CRT's used in industrial applications means that the electronics maintenance technicians will probably be adding a CRT tester to their list of maintenance equipment. The ability to quickly determine the condition of the CRT will decrease the down time of many industrial electronic systems.

Second, the service technician must face daily a problem as old as television itself — is the problem in the chassis or the picture tube? How many chassis have been removed from the cabinet and taken to the shop for repair only to find that the actual problem, the picture tube, is still in the customer's home?

This costs time and money as well as placing the service technician in an uncomfortable situation. A fast, accurate CRT test can eliminate errors such as this and increase the customer's acceptance of your abilities.

Certainly CRT testers are necessary but what must they do to be functional and practical for you? Let's look at the CRT and its associated problems to see why it is so important that they be checked accurately and according to the manufacturer's recommendations.

COLOR TRACKING TEST — THE WAY TO SPEED YOUR TROUBLESHOOTING.

Ever had a tube which was sent in as warranty defective returned to you without receiving credit for it? It can happen and if it does, it represents a sizeable sum out of your pocket. Why does this happen? Usually one of two reasons. The technician is guessing about the condition of the CRT or his tester has not given him an accurate test. When the tube is received by the manufacturer, it is thoroughly tested. If it tests good, it is returned without credit.

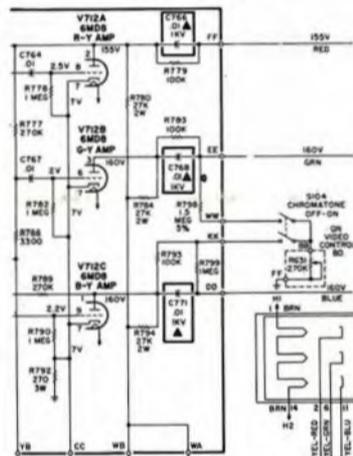
The extended warranty periods now offered on picture tubes can become costly to manufacturers unless they make certain they replace only the defective tubes. You can well afford a few minutes to find out if your tester can make the tests as the CRT manufacturers specify.

The tests which are recommended for black and white tubes are shorts, leakage, and emission. Color tubes require an additional test to determine color tracking capabilities.

All three guns of a color picture tube must be within a certain ratio or balance if you are to obtain a proper black and white picture. The black and white background information is important if you are to achieve the best possible performance from the receiver.

Many of the CRT testers on the market today cannot make these tests properly and can give misleading test results. In addition to the above tests, another important specification is that the filament voltage be at the level indicated in the manufacturer's data sheet. Too high or too low voltage applied to the tube filament will not give an accurate test.

Let us look first at the importance of a color tracking test.



Courtesy of the Magnavox Co.

A good example is a receiver which produces a predominate magenta (violet) color on a black and white picture. The schematic for the Magnavox color chassis T-940 shown here has at least three different components that could be causing the problem. The plate load resistor R784, the difference amplifier tube, or the green gun of the picture tube. The problem must be isolated in order to repair the receiver. Usually the easiest tests and those components most obvious to the trouble are checked first. The difference amplifier tube is tested for shorts, emission and grid leakage with the Mighty Mite and checks good. The next step is to test the CRT. If the tube is checked for shorts and emission, and found to be good, the chassis would most likely be pulled and taken to the shop for additional tests to locate the defective component.

After connecting the chassis to a test jig, the picture is found to be normal.

Now what's wrong? Is the problem intermittent in nature or is the CRT that tested good actually bad? Before we waste too much valuable time on this set, let's go back to the picture tube for a moment.

Picture tube manufacturers generally agree that in order to obtain proper black and white tracking with brightness changes, the emission of the guns of the color CRT must be within a 1.5 to 1 ratio. The 1.5 to 1 ratio means that the gun with the highest emission cannot be over 1.5 times that of the lowest gun. The background color cannot be correctly adjusted or will change with brightness information if the tube is not within these specifications. The emission of all guns could be sufficient to provide a picture but if one gun is considerably lower than the others, the green gun in this case, the tube will not track.

A complete test of the CRT, which many testers cannot easily provide, would have indicated that the tracking of the tube was beyond the 1.5 to 1 ratio.

The tracking test, provided on Sencore CRT testers and with greater ease and simplicity than ever before on the CR161 AutoTracker, would have pointed out the trouble immediately. This would have saved valuable time in the instance mentioned here. It is therefore very important to make a thorough test of the tube each time and this includes a complete tracking test on color CRT's. This assures both you and your customer of the right analysis the first time.

How Do I Check the Color Picture Tube for Tracking?

Just a few years ago, the CRT testers were designed for black and white CRT testing with color sockets added. A tracking test with most of these testers is almost impossible. On those testers that had a system where each color gun is tested individually with a variable G2 voltage, a tracking test can be made. It takes a great deal of time and involved calculation to see if the tube is within manufacturers specifications. Let's look at that procedure to see just what had to be done to check the tracking of the color CRT.

After the correct socket, and filament voltage have been selected, we set up a bias of around 40 volts negative on the G1 control or the control grids of the tube. Next the G2 or screen voltage control is adjusted so that the cathode current of each gun is only 20 microamps. This is considered a cut-off condition or dark raster. The bias on the control grid is now reduced to zero and the cathode current measured without bias is recorded. The zero-bias represents maximum brightness on the CRT. This gives us an indication of the condition of one of the guns. The procedure must be repeated for the other two guns and the results recorded. After all tests are made, the lowest current recorded is multiplied by 1.5 to determine if the ratio is within tolerance. This figure is now compared to the highest current recorded.

	SCREEN VOLTAGE To Set Cutoff	BEAM CURRENT At Zero Bias	EMISSION TEST
RED GUN	220V	375 μA	Good
BLUE GUN	170V	480 μA	Good
GREEN GUN	190V	440 μA	Good

170	SCREEN VOLTAGE	375	BEAM CURRENT
X 1.5	VOLTAGE TRACKING	X 1.5	CURRENT TRACKING
850	OK	1875	OK
170		375	
255.0		562.5	

If the figure obtained by multiplying the lowest current is equal to or higher than the highest current level, the CRT is good. Should the recorded current for the higher gun be greater than 1.5 times the lowest current, the tube is out of tolerance and will not perform properly in the receiver. A procedure of this type leaves room for error in multiplication, meter reading and is very time consuming.



This procedure, as you can see, is not something a service technician will want to make on each color tube he tests, whether to do so is in his best interest or not. The test will have to be made by much simpler means if it is to be practical to use.

Picture tube manufacturers demanded a color picture tube tester that would provide a simple procedure to check tracking. To answer this need Sencore brought out the first true color picture tube tester in the CR143 Champion. It has been widely accepted by both manufacturers and service technicians. The important features that were to make the CR143 an outstanding CRT tester were the 3 separate G2 or screen controls and the color tracking test. The combination of these

features allowed the user to make a complete color CRT test for the first time with relative ease and simplicity. The CR143 used a semi-automatic tracking test that cut the testing time in half without the need for multiplication or recording of cathode currents of the picture tube. The three individual G2 controls, just like those found on the television receiver, made the tracking test fast and easy. The color tracking scale on the meter allowed the technician to actually compare the three guns of the CRT to see if they were within the manufacturers tolerance.



CR143 TRACKING TEST

The procedure used on the CR143, and since copied by other CRT testers, is to set each screen control for cut-off current for the respective gun, and determine if the emission is adequate to produce a picture. Providing the emission levels are ok, the highest gun is noted. The color tracking button is depressed and the color cal control is adjusted for the highest gun until the meter reads at the color cal line. The gun selector switch is rotated, with the color tracking button depressed, and the current level of each gun is observed on the color tracking scale. The scale automatically makes the 1.5 to 1 tracking ratio test.

Since we like to do everything with the least expenditure of energy as fast as possible, the CR143 did not completely satisfy some of the individuals in the field engineering department. You had to use both hands, of all things, and the test took 3 or 4 minutes. As a result, we kept looking for an easier and faster way of making the tracking test.

The new technology, engineering ingenuity and the dogged determination of the field engineering depart-

ment to develop a faster and easier CRT tester paid off. The new CR161 Auto-Tracker is the answer you have been looking for. It provides a fully automatic, pushbutton test of color CRT tracking. This allows you to compare the three guns of a color CRT by simply depressing a button and reading a good-bad scale on the meter. No more logging information, comparing guns on a meter or lost time as the Auto-Tracking feature of the CR161 does away with it all. The time required for testing a color CRT with the CR161 is about one half that required with any other tester, including our CR143. In addition, the same test procedure is now used for all tubes, whether they are black and white or color. To top it all, the test can be made by following the function control call-outs, in a couple of minutes, with just ONE hand.



Fully Automatic Tracking Test — Cuts Your Testing Time In Half!

Auto-Tracking is something completely new, so new in fact, that Sencore has applied for a patent on the system that is used. A computer-type memory circuit is used to store the current level information of each gun as its emission is tested. This simplified diagram shows the system used in the CR161. During the emission

Step 3. Set the function switch to the Check Emission position and check the emission of each gun by rotating the gun selector switch. This will automatically charge each memory capacitor. (Note: The Emission check is explained in detail later in this article.)

Step 4. Depress the Automatic Tracking pushbutton and read the tracking condition of the CRT right on the meter.

Simple? You bet it is! And it performs the tracking test as recommended by the picture tube industry with the push of a button! Compare this procedure to that of other CRT testers to see how much time it will save you. This is something entirely new in testing color CRT's and only Sencore has it!

get a complete CRT tester with simplicity and ease of operation for a very modest price. The new CR161 with Automatic tracking test has no equal!

Why Check Emission When The Tracking Test Will Compare The Guns?

The emission must be checked as a separate test to assure you and your customer that each gun of the color CRT will provide adequate current to illuminate the screen. In addition, the tracking test is not applicable to black and white CRT's. Therefore, an emission test definitely has to be made on these tubes to determine their quality.

A good example is a color tube with only 200 microamps of beam current from each gun. This tube will indicate good tracking and this can be substantiated by calculation. The balance between guns is well within the 1.5 to 1 tracking ratio. The tracking test has no bearing on the level of emission from each gun, only the ratio existing between them. To determine whether this tube is capable of acceptable set performance, the emission must be tested. This holds true for all color tubes.

The emission test of the CR161 is very simple and fast. After the preliminary set-up steps have been performed, that is, set the correct filament voltage and bias level, and the shorts test made, the emission test begins.

Set the Gun Selector switch to the B&W/RED position. Rotate the Function switch to the Set Gun Balance position and adjust the B&W/RED Gun Balance control until the meter needle rests over the Gun Balance line on the meter. This adjustment is the

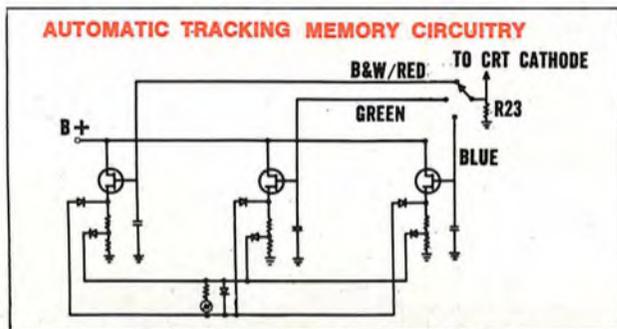
same for black and white tubes, tri-gun color tubes and import tubes. The only difference is that a single balance control is used for black and white tubes and all three are used, along with the Gun Selector switch, for color tubes. The Gun Balance adjustment sets the G2 or screen voltage of the tube to provide 20 microamps of cathode current from the gun or guns. This is considered the cutoff point of the CRT.

The next step is to place the Function switch in the Check Emission position. The emission of the tube is now determined by the upscale reading of the meter.

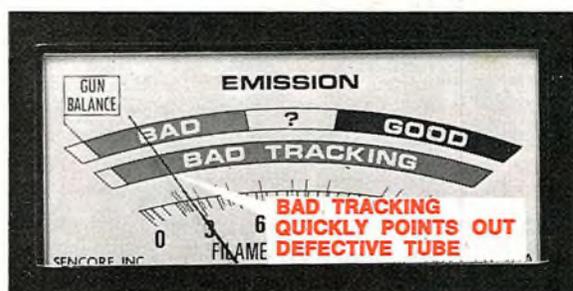
The condition of the cathode is indicated by the BAD — ? — GOOD scale of the meter.

This would complete the test of a black and white tube. For a color tube, the Gun Selector switch would be rotated to observe

the condition of each gun. After the emission test is performed, the Automatic Tracking pushbutton would be depressed to find out if the tube is within tolerance to provide correct adjustment of the gray scale and proper tracking.



test, the cathode current of each gun is passed through resistor R23. The voltage produced by this current charges the memory capacitor in the gate of an FET. After each gun has been checked for emission, the information necessary for the tracking test is stored in the memory capacitors. When the tracking pushbutton is depressed, the diode switching automatically applies the voltage from the capacitor with the greatest charge (representing the gun with the highest current) to the positive side of the meter. The capacitor with the lowest charge is connected to the negative side of the meter. If the ratio of voltages is less than 1.5 to 1, no current will flow in the meter circuit and the meter will indicate good tracking. Should the ratio be greater than 1.5 to 1, current will flow, causing the meter to read upscale in the bad tracking area.



With this new system, everything is done for you automatically eliminating the need for any computation, metered current measurements, or other systems that take valuable time and leave room for mistakes.

How Is the Automatic Tracking Test Performed?

The Auto-Tracking test is extremely simple and easy to accomplish. All you have to do is follow the call-outs around the function control and the test is made without any difficulty. Here's how the test is performed:

Step 1. After selecting the proper numbered socket and setting the filament voltage, the bias switch is set to the correct bias range as indicated in the set-up book.

Step 2. Set the function switch to the gun balance position and adjust each gun, as it is selected by the gun selector switch, to the gun balance line on the top meter scale. This is the cut-off level or black level of the tube.

What Tubes Can I Check With the CR161?

The new CR161 Auto-Tracker is designed to enable you to test all tubes, the standard tri-gun color CRT, the "single gun" Sony Trinitron, and black and white



tubes. The unique switching system and socket assemblies used now make this possible in a CRT tester. The test procedure, including the color tracking test, is the same for all tubes; the American tri-gun tube as well as imported tubes such as the Sony Trinitron. This makes color CRT testing faster and easier for you than ever before.

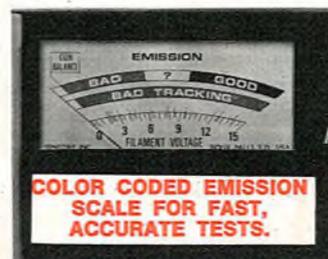
Other tubes, such as the new GE inline series of color CRT's, are also included. Examples of these are the 11SP22, 15MP22, 17EXP22 and others in this series. The sockets necessary for testing the various CRT's are included and numbered for fast, easy identification.

IMPROVED DESIGN MAKES SOCKETS STRONGER, NUMBERED FOR FAST IDENTIFICATION.



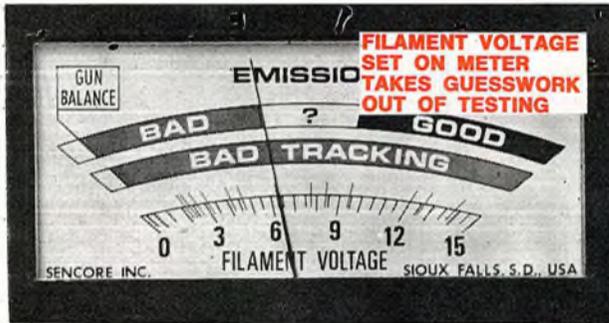
The socket harness has been redesigned and improved, compared to the CR143 to provide the greatest reliability. Each tube is listed with its proper bias level and socket number in the new and expanded set-up book that is provided with the CR161. The new socket system and switching arrangement used with the CR161 makes it a simple matter to add additional adapters if the need should arise.

All that is needed to add new sockets is an eleven pin plug to mate with the CR161 harness and the socket for the new tube. Now, for the first time, you

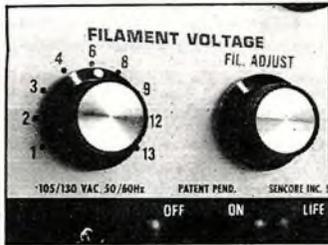


Is it Necessary to Have the Filament Voltage Set Accurately?

The tube manufacturers today specify that an accurate test be made on the picture tubes so the number of inwarranty rejections may be lowered. A substantial number of tubes are being returned as unacceptable for warranty replacement because they are still within acceptable performance limits. Either these tubes were not tested prior to replacement by the technician or were tested inaccurately. One of the important items called out by picture tube manufacturers is the filament voltage. It must be at the level specified on the design sheets for that particular tube. A 6.3 volt tube, for example, must be tested at 6.3 volts, plus or minus 5%. The previous line adjust systems used by Sencore provided a filament voltage that was well within these specifications. Many engineers felt that it would be far better to be able to monitor the exact filament voltage being applied to the tube. A meter reading would give the technician greater confidence that the tests being made would be accurate and conform to manufacturers standards. This additional feature has been incorporated on the new CR161.



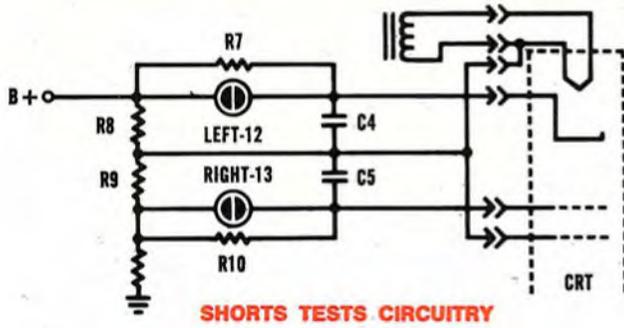
A special scale has been added to the meter allowing the filament voltage to be set to the exact level called for. Placing the function switch in the Set Filament position connects the meter across the filament leads to the CRT in the same manner that you would use an external VOM. The Filament Adjust control is then rotated until the voltage indicated on the meter is at the correct level. The red marks provided on the meter scale make exacting filament adjustments easy and fast. The calibrated filament voltage indicated on the meter scale has one additional benefit besides the accuracy obtained in setting the filament voltage. You are able to test a weak tube to determine if a CRT tube brightener would restore acceptable operation by adjusting the filament approximately 15% higher than specified in the set up information. For a 6.3 volt tube, the voltage would be adjusted until you reach a level of about 7.3 volts.



This is the nominal output of a brightener. The shorts and emission tests would be repeated to see if the tube would provide adequate emission. If it checks good with the raised filament voltage, a brightener should enable the picture tube to produce a useable picture.

How Do I Test For Shorts In a CRT?

The CR161 Auto-Tracker uses a fast, simple and accurate shorts test for all CRT's. A voltage is applied between elements of the CRT by the power supply of the tester. If a short exists, or the leakage caused by gas in the tube exceeds the tube manufacturers recommended limits, the resistance of the shorts circuit is shunted causing the neon shorts indicator bulbs to light.



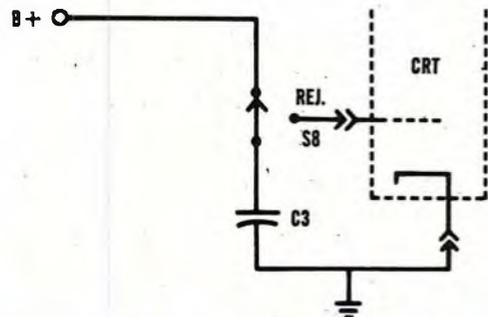
The brighter the glow of the bulb or bulbs, the lower the resistance of the short in the tube. The chart shown here, reproduced from the CR161 service manual, allows you to determine where the short exists in the tube.

LEFT LIGHT	RIGHT LIGHT	CONDITION
Does not glow	Does not glow	No short
Glow	Does not glow	Heater to cathode short from 0 to 10 megohms.
Glow	Glow	Cathode to control grid short or leakage up to 20 megohms
Glow	Does not glow	Cathode to G2 short up to 10 megohms
Does not glow	Glow	G1 to G2 short or leakage up to 6 megohms

You will note that two shorts are listed on the chart with the same indication; heater to cathode short and cathode to G2 short. It may seem at first that it would be difficult to determine which short is present. The probability of a short existing between the cathode and the screen grid, without shorting to another element, is extremely remote and can be ignored. The heater to cathode short is the most common and the short which is most likely to occur within the CRT. The very close spacing which is present between the heater and cathode does not allow much room for warping or shifting of the filament. This accounts for the heater-cathode short being the most frequent. This type of short requires the use of an isolation type brightener if the tube is to be continued in use. The heater-cathode short cannot be removed successfully in most cases. Another common short, cathode to G1, can be removed successfully in most cases as it is usually caused by internal contamination such as dust or lint.

How Does the CR161 Auto-Tracker Remove Shorts?

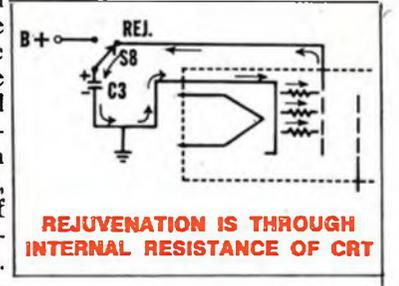
The CR161 Auto-tracker uses the same capacitive discharge system to remove shorts that Sencore has been famous for since its first CRT tester. This system employs a safe, RC timed discharge circuit rather than a direct, power supply connected system which can cause permanent and irreparable damage to the tube. The schematic shown here illustrates the RC discharge system used in the CR161.



The large capacitor is charged from the main power supply. The capacitor is disconnected from the power supply and applied to the CRT when the rejuvenate pushbutton is depressed. The discharge of the capacitor is through the short, causing it to burn out on the first try in most cases. In stubborn cases, tapping the neck of the CRT while depressing the pushbutton will help. The filament of the tube is not operated during the Remove Shorts operation to prevent possible filament damage while removing the short.

Does the CR161 Auto-Tracker Rejuvenate CRT's?

The same safe, capacitive discharge system used to remove shorts is employed to rejuvenate the CRT. This system has many advantages over the "brute force" system used by some testers. If a CRT requires only a small amount of rejuvenation, the capacitor will discharge rapidly because the internal resistance of the CRT is low. The internal resistance of the tube is the resistance to current flow from grid to cathode, as shown in this illustration. A tube which is very weak will have high internal resistance causing the capacitor to discharge more slowly. The slower discharge will maintain the rejuvenation voltage for a longer period of time, providing the level of rejuvenation necessary for the tube.



Let's look at an example. A CRT which is out of warranty has been tested and the red gun is weak. This places the tube out of normal tracking tolerance but not necessarily weak enough to replace. The customer cannot see any need to replace the tube as a picture is still visible on the screen. In this case, a minor rejuvenation of the red gun will probably bring it back to an emission level which will allow the tracking to be adjusted normally. You can charge for the restoration of this CRT as part of your service on the set. Many service organizations will later apply the amount paid for rejuvenation against the purchase price of a new CRT, thus making a satisfied customer.

Can The CR161 Tell Me If I Should Use a Brightner or Rejuvenate the CRT?

As we mentioned earlier, it is quite easy to determine if a brightner will restore the picture. If the tube tests quite weak, adjust the filament voltage about 15% higher than the normal voltage. Check the level of emission of the gun or guns in the tube. If the emission appears near normal and the guns will track, a brightner should provide a good picture. If the emission does not improve with a higher filament



SHOULD I USE A BRIGHTNER OR REJUVENATE?

setting, rejuvenation is the recommended procedure. Be certain that this is discussed with the customer before you attempt rejuvenation. Some tubes you may encounter will be too far gone to bring back and this should be brought to the customer's attention. A satisfied customer is far more important than whether or not you are able to restore CRT operation by rejuvenation.

What About Set-Up Information On New Tubes?

The Sencore field engineering department is constantly working with the various set and tube manufacturers to keep current with the latest developments in receiving tubes and CRT's. As new tubes are announced, the setup information is obtained and recorded in our complete tube file. All the information gathered is compiled and put into a new set up book about every 6 to 9 months. The actual time of up-dating depends on the number of new tubes introduced. Individual set-up information is available at any time from the field engineering department at the Sencore factory in Sioux Falls.



NEW SET-UP INFORMATION MAILED AUTOMATICALLY

Each new book is automatically sent to the owners of the CR161 as they are printed, providing they have signed and returned their warranty card to Sencore. The only cost for this service is a small fee to cover printing and mailing.



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SENCORE COLOR GENERATORS

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- **12 RESISTORS** from 10 to 5.6k, 1 watt.
- **12 RESISTORS** from 10K to 5.6M, 1/2 watt.

- **10 CAPACITORS:** 100pf to .5mfd, 600V.

- **10 ELECTROLYTICS** form 25 values.

- **POWER RESISTORS** at 20 watts, 2.5 to 15K.

- **UNIVERSAL .5 amp** selenium and silicon rectifiers.

**CHOOSE FROM
SENCORE'S
20 MOST
POPULAR
INSTRUMENTS**

SENCORE FE METERS

Sencore pioneered the idea of using Field Effect Transistors to provide a high impedance, stable and reliable replacement for the troublesome and easily damaged VOM's and VTVM's. Many changes and improvements have been added since the first Sencore FE Multimeter was introduced. The newest FE meters are shown here. Each of these instruments has the same, high, 15 megohm input impedance on DC which provides minimum circuit loading. The stability and accuracy of these instruments makes trouble shooting a pleasure rather than a task.



FE14

\$69.95

Standard Accuracy
2½% DC
4½% AC



FE16

\$84.50

Lab Accuracy
1.5% DC 3% AC

**ACCURATE
RUGGED**

**INDUSTRY'S BEST VALUE
IN MULTIMETERS**

4½ Inch Field Effect Multimeters

LESS CIRCUIT LOADING THAN VTVM. 15 megohms on DC, 10 megohms on AC.

INSTANT STABILITY. Zero warmup time . . . ready with the flip of a switch.

FULL METER PROTECTION to 100 times AC overload. No more damaged meters.

SPECIAL SHIELDED INPUT LEADS prevent stray pick-up and erroneous readings.

SPECIFICATIONS

14 DC Voltage ranges from 1 volt to 1000 volts full scale, 7 negative and 7 positive.

7 Zero Center ranges from .5 to 500 volts.

7 AC Voltage ranges from 1 to 1000 volts full scale.

5 DC current ranges from 100 microamps to 1 ampere full scale.

4 Resistance ranges from 1000 ohms to 100 megohms. 10 ohms center scale.

TUBE TESTERS



new TC162 \$99.50

MIGHTY MITE — THE WORLD'S MOST POPULAR TUBE TESTER.

NEW PIN ELIMINATION SWITCHES eliminate normal shorts caused by internal connections.

CHECKS MORE TUBES THAN EVER BEFORE. Pin elimination allows tubes to be tested which could not be checked before.

FULL RATED CATHODE EMISSION TEST.

100 MEGOHM GRID LEAKAGE TEST.

SENSITIVE STETHOSCOPIC SHORTS TEST.



MU150 \$269.50

WORLD'S ONLY TUBE ANALYZER

TRUE MUTUAL CONDUCTANCE TEST using a 5000 Hertz square wave for true tube test.

TWO TESTERS IN ONE. The MU150 can be used to make the Mighty Mite tests as well as mutual conductance.

FULL RATED CATHODE EMISSION TEST.

100 MEGOHM GRID LEAKAGE TEST.

SENSITIVE STETHOSCOPIC SHORTS TEST.



new CR161 \$140.00

NEW CRT AUTO-TRACKER WITH COMPUTER MEMORY CIRCUITS.

PUSHBUTTON AUTOMATIC TRACKING TEST. Simply push a button to make the previously complicated tracking test.

COMPUTER MEMORY CIRCUITS store CRT information for the tracking test.

CHECKS BLACK AND WHITE TUBES using the same procedure as color.

TESTS TRINITRON TUBES the same as domestic tri-gun tubes. Only one procedure for all tubes, all made possible through computer memory.

FILAMENT VOLTAGE now precisely set on meter.

ELECT MULTIMETERS



FE21
\$99.50

4½ INCH
METER
LAB OR
BENCH



FE20 \$129.50

with 30KV hi voltage probe

A
SERVICEMAN'S
DREAM



new

FE160
\$190.00

PUSHBUTTON
OPERATION
with 7 inch meter

112 RANGES
AT YOUR
FINGERTIPS

39A30-30KV HI-VOLT PROBE- \$12.00

HI-LO FIELD EFFECT MULTIMETERS—A New Concept in FE Meters

NOW . . . MEASURE RESISTANCES IN CIRCUIT IN SOLID STATE DEVICES WITH THESE HI-LO FIELD EFFECT MULTIMETERS.

FEATURES

LOW POWER OHMS using .08 volts to make in-circuit resistance measurements accurately. Allows you to use latest Howard Sams service information. Sams specifies it, only Sencore has it.

HIGH POWER OHMS for routine resistance measurements and to check front-to-back ratios of diodes. Meters would not be complete with low power ohms only.

ONE-TENTH VOLT FULL SCALE sensitivity on both AC and DC voltage. A must when servicing in solid state circuits with critical low voltage biases.

PROTECTED TO 1000 TIMES OVERLOAD. A truly burnout proof multimeter. Tested in production with 1,000 volts on .1 volt range. Multimeter resistors protected by .6 amp fuse to save these valuable and expensive components. No more trips to factory when you accidentally measure volts on ohms range.

SPECIFICATIONS

FE20 and FE21

- 9 DC Voltage ranges from .1 to 1000 volts full scale
- 3 High Voltage ranges of 3, 10, and 30KV
- 9 DC Zero Center ranges from .05 to 500 volts
- 9 AC Voltage ranges from .1 to 1000 volts full scale
- 9 AC Peak-to-Peak ranges from .28 to 2800 volts
- 9 DC Current ranges from 100 microamps to 1 amp full scale
- 7 Hi Power ohms ranges from 1000 ohms to 1000 megohms
- 6 Lo Power ohms ranges from 1000 ohms to 100 megohms

FE160

- 10 DC Voltage ranges from .1 to 3000 volts full scale
- 10 Zero Center ranges from .05 to 1500 volts
- 9 AC Voltage ranges from .1 to 1000 volts
- 9 AC Peak-to-Peak ranges from .28 to 2800 volts
- 10 DC current ranges from 30 microamps to 3 amps full scale
- 10 AC current ranges from 30 microamps to 3 amps full scale
- 8 Hi Power ohms ranges from 600 ohms to 6000 megohms
- 7 Lo Power ohms ranges from 600 ohms to 600 megohms

IN-CIRCUIT TRANSISTOR & FET TESTERS

Full Tests In Or Out Of Circuit



TF17
\$109.50

Here are two testers that can simplify every solid state repair or troubleshooting job. They will test all transistors for beta gain right in the circuit. Flip the function switch to the right and they will test Field Effect transistors for actual transconductance . . . right in the circuit. Here are some of their features:



TF151
\$129.50

IN-CIRCUIT TESTS eliminate the need for time consuming component removal and the possibility of circuit damage which can result.

TESTS BOTH TRANSISTORS AND FET's, in-circuit or out. Transistor tests can now be made fast and easy.

TRANSISTORS TESTED FOR AC BETA which duplicates their circuit performance. This is a dynamic test, not a DC test as used by some other testers.

FIELD EFFECT TRANSISTORS TESTED for actual transconductance by a dynamic test. The same type of test used to test vacuum tubes for Gm.

LEAKAGE TESTS ON TRANSISTORS for I_{cbo} leakage performed out-of-circuit. You can be sure you have a defective transistor after it has been removed from circuit and time spent ordering a replacement.

ZERO BIAS TEST for field effect transistors. Quickly determine the I_{dss} characteristics of the FET when matching or industrial sorting is necessary.

SIMPLE OPERATION with a single function control for all tests. No complicated set-up as used by other types of testers.

LARGE, EASY TO READ, COLOR KEYED METER for fast error-free tests. Color keyed to front panel for easy correlation.

SWEEP-MARKER GENERATORS

Speed Aligner

SM158

\$275.00



If it is speed and simplicity that you want, the all crystal controlled SM158 is your answer and at \$120.00 savings over competition.

- **PUSHBUTTON MARKERS** for the eight most often used IF frequencies: 39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, and 47.25. Trap and carrier markers listed right on front panel for fast identification.
- **HORIZONTAL MARKERS** available at the flip of a switch.
- **2 EXTRA RF CHANNELS** to assure interference-free response curves on RF-4 RF channels in all.

Sencore all solid-state sweep marker generators are constructed to provide the necessary signals for sweep alignment and troubleshooting. The SM158 and SM152 have these common specifications:

- **CRYSTAL CONTROLLED MARKERS** for alignment accuracy.
- **15 MEGAHERTZ SWEEP WIDTH** to cover the entire IF band.
- **SIMPLE HOOKUP** with just four cables, 2 to TV, 2 to scope.
- **ZERO BASE LINE** for reference when adjusting traps and positioning carrier markers.
- **POST INJECTION MARKERS** for distortion free response curves.

Deluxe Generator

SM152

\$450.00



If it is completeness that you want, the SM152 is the most complete on the market.

- **RF SWEEP FOR ALL BANDS**, VHF, UHF, FM, IF, and Chroma.
- **CALIBRATED RF OUTPUT AND CALIBRATED SWEEP WIDTH.**
- **IF SPOT ALIGN BAND** for pre-alignment adjustments.
- **RF MARKERS** for channels 4, 5, 10 and 13.
- **FM SWEEP** with markers for FM Alignment.

OSCILLOSCOPES

Dual Purpose Oscilloscope Vectorscope

THE FIRST REALLY COMPLETE SERVICE SCOPE

- **WIDE BAND** 10 Hz to 5.2 MHz \pm 1DB.
- **HIGH SENSITIVITY** 17mv rms per inch.
- **HIGH INPUT IMPEDANCE** 27 megohms shunted by 11pf low cap.
- **SEVEN THOUSAND VOLT** input rating with low cap probe, not 600 volts like other scopes.
- **DIRECT VERTICAL PEAK TO PEAK VOLTAGE READING** with input controls calibrated directly in volts p-p.
- **CONVERTS TO PROFESSIONAL VECTORSCOPE** with the flip of a switch. A truly complete scope with this feature.
- **FULL RANGE HORIZONTAL SWEEP** frequencies from 5HZ to 500KHz in five overlapping ranges.
- **POSITIVE SYNC** with variable control locks complex waveforms with triggered ease.
- **EXTERNAL INPUTS** for sync, sweep, Z axis and direct connections to deflection plates.



PS148 \$269.50

All New Dual-Trace Triggered or Free Running Oscilloscope

DC OR AC COUPLED

PS163 \$495.00 Plus Probes

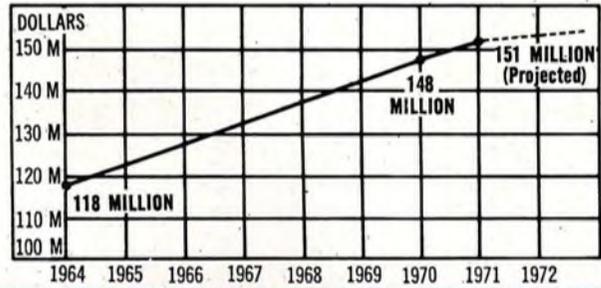


Never before has anyone presented a scope with such flexibility . . . and it's simple to operate. You simply push the button and view the screen. "What you see is what you get."

- **A SERVICE SCOPE:** AC coupled, free running, wide band scope to 8 MHz at 3 DB with direct peak to peak readout enables you to service fast with no interpretations.
- **A SERVICING WAVEFORM ANALYZER** for complex circuits. Dual trace and triggering action enables you to determine right on the nose whether or not two waveforms are appearing at the same time, and their amplitudes, in gated AGC, gated sync separators, burst amplifiers, color killers, etc.
- **A DESIGN SCOPE COSTING ONE FOURTH OF COMPETITORS!** 5 millivolt sensitivity, calibrated sweep speed, dual chopped and alternate displays, and other such specs means performance personalized for the lab.
- **A VECTORSCOPE:** Right from the front with sensitivity to spare.

WHY A NEW MIGHTY MITE? Is A Tube Tester Really Necessary Today?

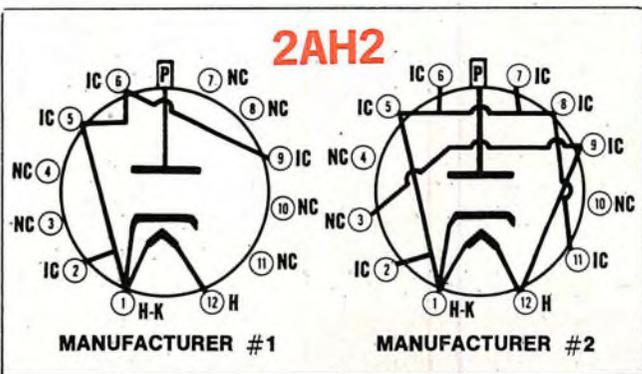
This question is the one most frequently asked of us as we talk with service technicians, instructors, industrial technicians and others across the country. The current trend toward solid state devices, including integrated circuits, would tend to indicate that tube testers and tube testing is no longer necessary. The actual facts point out more of a need for accurate tube testing today than in the past. A recent article in Radio and Television weekly, for example, states that "the replacement tube market reached its largest dollar volume last year over any other year and is expected to increase this year."



TUBE SALES FROM 1964 TO 1970 WITH PROJECTED SALES TO 1973 (BASED ON AVAILABLE INDUSTRY INFORMATION)

The greatest percentage of electronic equipment in operation today is tube type equipment. Television receivers are a good example. Approximately 90% of the sets in use are tube type or contain several tubes. Many new tubes are being introduced each year by the manufacturers adding to the already long list of tubes which must be tested. Another important reason for the new Mighty Mite is the changes which have been made recently in some of the more familiar type tubes. Many tubes, such as 2AS2, 2BU2, and 3BH2, for example, have many internal connections between elements or have the same element connected to several base pins.

The 2AH2, for example, is a compactron based tube with 12 pins. Pins 1 and 12 are the filament with the cathode tied to pin 1. The anode is brought out to a plate cap connector. This leaves the other ten pins unused for regular connections. These pins are used, however, as support points for the filament structure in the tube making electrical connection to the filament. To make matters worse, all manufacturers do not connect the filament supports to the same base pins. The drawing shows just two examples of how this tube can be connected from just two manufacturers. This



arrangement necessitates a testing procedure which will make connection to a single pin to pick up each element of the tube being tested.

The Mighty Mites of the past allowed one base pin on the tube to be eliminated or isolated from test by the "C" setup switch. This procedure allows the Mighty Mite to test over 99% of the tubes in use today. The problems begin with tubes such as the 2AH2. The number of internal connections and the differences between tubes of different manufacture will not always permit a single test setup to make an accurate test. In some cases, the arrangement of internal connections would make any meaningful test virtually impossible. The problems of testing tubes are basically the following: (1) New tube types added by manufacturers, (2) Changes in basing connections by different manufacturers, (3) Numerous internal connections making a test difficult or meaningless. Any tube tester to be introduced at this time had to have some means of overcoming these problems.

What Makes the New MIGHTY MITE Different Than Previous Models?

The major change in the new Mighty Mite is the addition of 10 pin elimination switches. This change was brought about by the increasing number of tubes with multiple internal connections. The pin elimination switches allow up to 10 pins to be isolated from test by simply setting the switches for the pin or pins to be



isolated. The switches are simple slide switches ganged together. They may be set and reset individually or all switches may be reset by pressing the reset slide. This feature makes it easy to reset a single switch if an error has been made without the necessity of clearing the entire switch bank and starting over. The pin elimination switches make it possible to check many more tubes than before with the same speed, simplicity and accuracy the Mighty Mite is famous for.

The Mighty Mite retains the full load cathode emission test, the 100 megohm grid leakage test, and the stethoscopic shorts test which has made it so popular in the past. A check of the warranty cards show that over 60,000 Mighty Mites have been purchased by technicians, schools and industrial maintenance personnel. This attests the reliability and accuracy of the instrument.

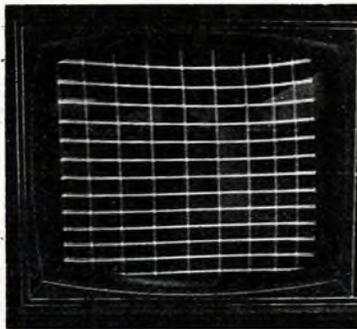
Three important tests are made on vacuum tubes with the Mighty Mite. First, the cathode emission of the tubes is tested under the full rated current level of the tube. This exclusive test assures that the tube will deliver the required current to the circuit it is used in.

Second, a stethoscopic short test is made on each and every element in the tube. This test will point out any shorts which may exist between elements.

Third, the all important grid leakage test is made at a sensitivity of 100 megohms. This test picks out the troublesome tubes that are encountered in television, radio, and industrial control circuits.

How Important Is the Full Load Cathode Emission Test On a Tube?

The ability of the cathode to supply adequate current is very important, especially in power stages. If the tube cathode is weak and will not deliver the proper level of current, the circuit will not function properly. If the tube is in the horizontal output stage of a color television receiver for example, the boost voltage will be low, the anode voltage is low, and the raster is pulled in on the sides producing a narrow, dark picture.



The tubes used in industrial control circuits can also create problems if the emission is low. One example would be an amplifier stage responsible for activating a relay or other control device. If the current capabilities of the tube are not adequate, the function or operation of the machine being controlled will not be correct. We are sure you will agree that the tube must be able to deliver the correct current to the circuit in order for proper operation to be maintained. A tube tester not having this important check will not satisfy the need

of the technician and give misleading or incorrect results. This then causes wasted time and effort which can prove very costly.

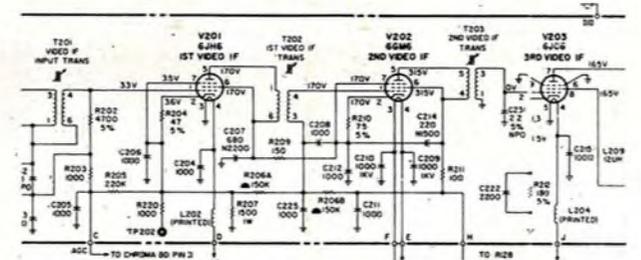
What Is Grid Leakage and Why Is It So Important?

Grid leakage or grid contamination can upset many circuits in electronics. It is caused by a coating of cathode emitting material, usually barium oxide, that flakes off the cathode and lodges on the control grid of the tube. This barium oxide on the grid is very troublesome as it requires about 15 to 30 minutes of operation in the television receiver before it begins to act. As the tube is heated over this period of time, the material on the control grid begins emitting electrons. The flow of electrons

from the grid to the plate causes an external current flow from ground through the impedance of the control grid circuit causing a positive voltage to appear at the grid. This positive voltage drop opposes normal grid bias, reducing the overall bias on the stage, causing an increase in stage gain.

If your present tube tester has a very low sensitivity on grid leakage, then it will require the same 15 to 30 minutes of operation in the tube tester before the problem shows up. These troublesome tubes can then be missed on the normal house call, making a call back a great possibility. The Sencore Mighty Mite has a grid leakage sensitivity of 100 megohms. This means that as soon as the tube is warm enough to show cathode emission on the meter scale, the grid leakage will show up. This high sensitivity makes your tube testing easier as it eliminates the possibility of a call back because you did not test the tube long enough to detect the grid leakage.

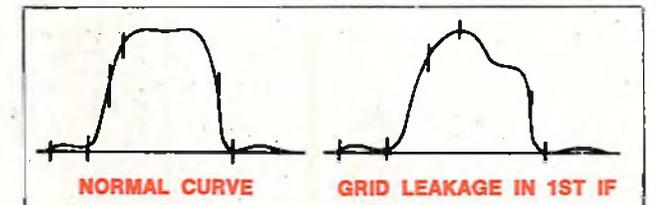
The IF amplifier stage shown here is an example of a circuit in which a tube with grid leakage will cause



Courtesy of the Magnavox Co.

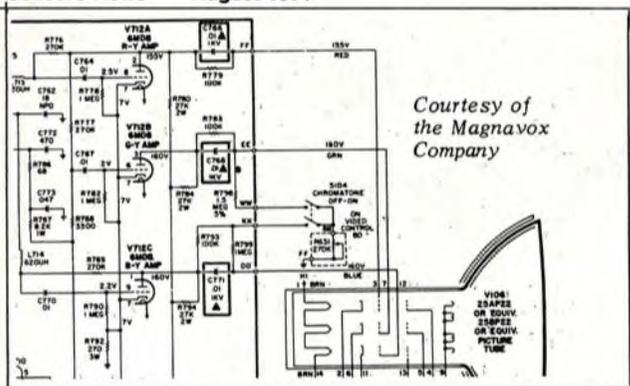
many problems. The set may operate normally when first turned on but develop problems after a few minutes. The culprit can be a tube with grid leakage causing the gain to increase in the IF's. As the gain increases, the IF stages will start saturating, clipping a portion of the signal. The sync pulses are usually the first to be distorted or clipped in this case. The results can be negative picture, pulling, loss of sync or any combination of these. Some of these symptoms usually point out troubles in other areas of the receiver. It is very important, therefore, to carefully test the IF tubes for grid leakage before hunting for problems elsewhere in the receiver.

The IF tubes should always be checked for grid leakage prior to IF alignment.



Tubes with grid leakage in the IF strip may make the alignment much more difficult or even impossible. If you are fortunate enough to obtain an alignment curve that appears to be correct, the alignment will probably change in a short time because of the defective tube. The replacement of this tube at a later date with a good tube will make it necessary to realign the receiver to obtain proper performance.

Let's look at another area where many problems can develop. The three difference amplifiers in the output of the chroma section of a receiver are each triodes and have a common cathode resistor for color matrixing.

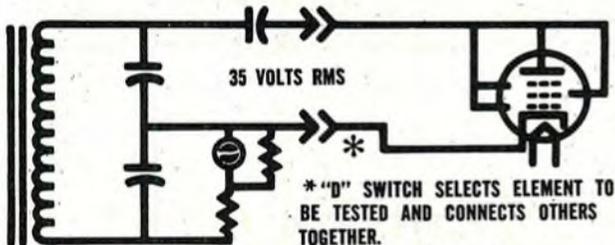


The R-Y signal is fed into V712A grid, the B-Y signal is applied to the grid of V712C. V712B operates as a grounded grid amplifier to provide amplification of the G-Y signal developed across the common cathode resistor. If the R-Y amplifier has only one half microamp of grid current across its 1 megohm grid resistor, it will develop 1/2 volt (.5 volts) drop in opposition to the normal bias of the stage. This causes the tube to conduct harder. The voltage drop across the common cathode resistor will increase. The other tubes will then experience a reduction of output causing incorrect color signal levels to be applied to the CRT. Not only are the colors wrong on the screen, but because of the D-C coupling employed between the difference amplifiers and the CRT grids, the gray scale will also change. Here is a problem which may cause an individual to change the picture tube unnecessarily if it is not tested with an accurate CRT tester such as the new CR161. In addition, the technician may look for some time to find a component defect if the difference amplifiers are not accurately checked for grid leakage.

Grid leakage will upset and change many different circuits. The reasons, as we have pointed out, are the bias changes resulting in a change of tube conduction and gain. If the tube tester is not sensitive enough to pick out tubes with even minute levels of grid leakage, much time can be spent looking for other problems when the problem actually exists in the tube. The TC162 Mighty Mite VII provides the necessary sensitivity to locate the tubes with grid leakage, many times before they have an opportunity to cause a great deal of trouble. The 100 megohm grid leakage sensitivity is a must if you are to check critical tubes thoroughly.

Stethoscopic Shorts Test—What Are They?

Sencore uses a unique shorts test procedure that tests each element against all other tube elements for shorts or leakage. Each element is selected by the "D" setup switch. The rotation of this switch through all positions picks up each element of the tube individually and shorts all other elements together.



MIGHTY MITE SHORTS TEST

A test voltage is applied and if any continuity exists, either due to a direct short or leakage, a neon shorts indicator will be illuminated. The brighter the indicator, the lower the resistance of the short. If the light is very dim or blinks slowly, leakage exists between elements in the tube.

The voltage used for the shorts test is kept to a very safe level to prevent damage to delicate nuvistors and frame grid tubes. For example, less than 50 volts must be applied between control grid and other elements of these tubes. If a higher level is applied, arc-over may result damaging the tube. This possibility of arc-over is caused by the extremely close spacing of the grids of these tube types.

Sencore has worked with the tube manufacturers to determine the correct voltage level and the sensitivity that is required for an accurate shorts test. If the short sensitivity is too high, normal internal leakage found in some power tubes may show up as a short, when in reality it is a normal condition. Sencore tube testers like the new Mighty Mite VII provide an accurate, complete shorts test for all tubes with the correct sensitivity and at a voltage level which will not damage delicate tubes.

How Do I Get Information On New Tubes and New Tube Charts?

The information contained in the Service Manual will allow you to develop setup information for new tubes which may be introduced. The only information about the tube that you need is the basing diagram, which can be obtained from a schematic, and the approximate operating current level of the tube. Should this information not be readily available to you we can supply you set-up data. The new tubes which you may encounter will probably have been checked and information placed on file for the next printing of the set-up booklet. Just drop us a note and we will forward the information to you by return mail. If the tube should be from an import receiver, it would be a good idea to include the make and model number of the receiver it is used in. This will help us to give you a quick response as information on foreign tubes is not always readily available to us. The knowledge of the equipment the tube is used in will permit us to obtain the necessary information to give you the test procedure.



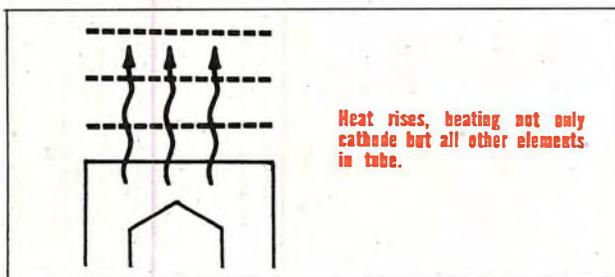
TUBE CHARTS MAILED AUTOMATICALLY

Sencore has an automatic mailing list set up to mail out new tube charts for the Mighty Mite VII as soon as they are printed. The new charts are published every 6 to 9 months, depending on the number of new tubes introduced. To be added to the automatic mailing, simply sign the warranty card packed with the Mighty Mite, and return it to Sencore. Your name will be placed on the mailing list to receive the new charts as they are available.

Completely Analyze Tubes—How To Do It Fast And Accurately.

Most of the time, in tube testing for radio, television and industrial applications, the tests of the Mighty Mite are all you need to determine if a tube is good or bad. There are times that the tubes to be tested will require the application of a good Gm or mutual conductance test such as that provided by the MU150. The Gm or mutual conductance of a tube will affect the gain of a tube and thus its circuit performance. There are some critical circuit applications for tubes in which a tube with good emission and no grid leakage or shorts will not work. The reason that the tube and its associated circuitry will not function correctly is that the mutual conductance of the tube does not meet minimum circuit specifications. Gm is critical in television tuner, IF stage, chroma and video circuits. In industrial applications, any amplifier stage is affected and its control function is lessened. In many cases a small change in Gm will not be noticed. Should the Gm drop below 75% of its original value, then trouble will begin to develop.

The filament heats not only the cathode, but all the other elements of the tube as well. The tremendous heat within a tube is best evidenced by the burned



fingers sometimes received when pulling a tube from its socket. The constant moving of elements from the heating and cooling of the tube during normal operation can cause the elements to warp or permanently change position with respect to other elements. If the control grid changes position with respect to the

A common example of the change in Gm of a tube is the RF amplifier tube in the tuner. The picture becomes snowy and the color weak as the tube changes. The tube may check good for emission and grid leakage but not perform incircuit. The changing of the position between the control grid and cathode is usually responsible. The problem is even more frequent if the tube is horizontally mounted as this allows the elements to sag and their spacing change.

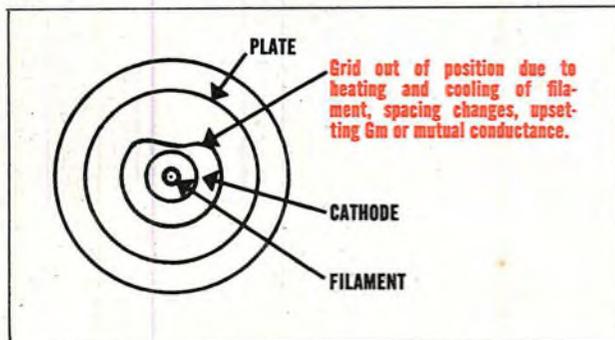
Thus, the Gm or mutual conductance of a tube can change from the regular heating and cooling of the tube during use. If the tube suffers a severe shock such as being dropped without breaking, the Gm can also be altered.

How Does the MU150 Check the Mutual Conductance of a Tube?

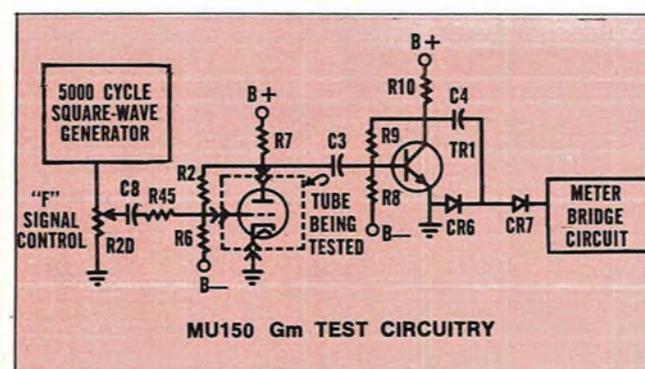
The MU150 Continental uses a 5000 Hertz square wave and the textbook formula for mutual conductance to assure a true and accurate test on tubes. Each element is operated with a DC potential comparable to that used in a receiver or amplifier circuit.

How Can the Gm or Mutual Conductance of a Tube Change, But Not the Cathode Emission or Leakage?

This is a very important point to keep in mind when you are testing tubes. Gm can and does change without affecting the emission or grid leakage. You have probably run into such cases yourself. An example would be a tube which you checked for emission and grid leakage and found to be good, but the circuit or function would not work. By replacing the tube with a new one, correct operation was restored. The Gm or gain of the tube had changed and disrupted the circuit operation. This is usually the result of the changing temperature within the tube and the resultant expansion and contraction of the elements in the tube.



cathode, the Gm of the tube changes. The gain always decreases causing a corresponding decrease in the circuit operation. If the tube is in the IF or video stages of a TV receiver, a weak or washed out picture can result. In the sync circuits, the sync can become touchy or critical. In the color circuits, the color may change, become weak, or even disappear completely.



The small 5000Hertz square wave signal is then applied to the control grid. The resultant plate current is amplified by a transistor amplifier and applied to the meter circuit.

The level of plate current is selectable at three different potentials to give a test at the plate current closest to that which the tube operates under in the actual circuit.

The MU150 is not only a true reading Gm tester, but contains the same full load cathode current check, high sensitivity grid leakage test and stethoscopic shorts test as does the Mighty Mite. You can use the MU150 on your service bench as a Mighty Mite using only three set up controls and then with a few more settings, give the tube a Gm test. This allows you to completely analyze the tube as you have never been able to do before.



How Is Bias Provided For the Tubes Being Tested On the MU150?

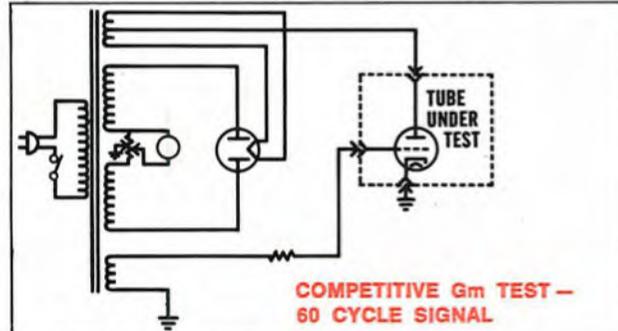
The Sencore MU150 uses an unusual and unique circuit called the ABC or Automatic Bias Control Circuit. Through careful studies of tube testers, we found that a bias control can be very critical in the set-up procedure and if not set properly, can give misleading test results. With the automatic bias control circuit, the need for a screen voltage and plate voltage control is also eliminated, making the set-up on the MU150 simpler and easier.

When a tube to be tested is placed in the socket and the desired plate current level is selected, a resistive network automatically biases the tube to a negative voltage and establishes a plate voltage of 100 volts. A

signal, placed on the control grid with the Signal control, with the tube operating at these potentials, allows the actual mutual conductance of the tube to be measured.

Why Is the 5000 Hertz Square Wave Test Better Than the Standard 60 Hertz Sine Wave Used By Other Manufacturers?

Many manufacturers use a raw 120Hertz unfiltered B plus supply for plate voltage and apply a large 60 Hertz sine wave signal to the grid of the tube. A test of this type will drive the tube between saturation and cutoff distorting the output signal making any meaningful test impossible. This condition is not like the normal



circuit the tube is operated in, does not conform to the actual formula for Gm of a tube, and can possibly destroy frame grid and nuvistor type tubes. The frame grid tubes are the most popular tubes used in the IF and chroma circuits of the modern color receivers. You certainly do not want to damage the tubes you are attempting to test.

Heater to cathode leakage and other 60 Hertz signals can add to the signal from the tube and cause a misleading indication on the tester. Grid leakage can also add to the reading with this type of test causing the tube to look better than it actually is. This misleading information can cost you time and money.

Sencore looked into this problem and began using the 5000Hertz square wave because it does away with all these problems and has several benefits as well. The

high frequency of the signal cannot be confused with or added to the heater to cathode leakage so that a true test is made. The square wave also gives a much better test on amplifier tubes than does a sine wave.

The tube being tested not only has the basic 5000Hertz square wave applied but must also amplify the very high frequency rise and fall time of the square wave.

In the MU150, a very small signal which is variable, provides the correct level of signal for each tube being tested. Thus, a true Gm reading is obtained. Grid leakage does not add to the signal in the MU150 as it does in the other systems in use today. With the Sencore MU150 circuitry, grid leakage actually subtracts from the reading making the test more accurate and meaningful than any other mutual conductance tube tester on the market today.

How Do I Check 4 and 5 Pin Based or Similar Tubes?

The older 4 and 5 pin and similar sockets have not been provided on the MU150 as these are not encountered in normal servicing. There are those technicians that may encounter tube types such as the 807 that may wish to check them in their daily service routine. The MU150 was designed with a spare socket panel providing four pre-punched socket openings. This was done to enable the user to add special sockets or new sockets as the need arises.

The procedure to add the socket is quite simple. Remove the plate covering the spare socket area and add the socket required. This procedure will require the use of a Greeley or similar punch the size of the socket you wish to install. After the socket is installed, make point to point wiring from the added socket to one of the existing sockets in the panel. The wiring follows the resistor color code for each pin number. Wire the filaments to the closest socket and you are set to check the tube.

The controls on the MU150 are numbered according to the pin numbers on the socket, making it simple to set the MU150 up from a tube manual. The MU150 Sencore Manual contains detailed instructions for socket addition and test set-up information.



CONTINENTAL II MU150

THE WORLD'S FINEST TUBE ANALYZER

Continental II MU150 combination emission and mutual conductance tube analyzer. New mechanical design and electronic improvements make the MU150 the finest yet.



REALLY PROFESSIONAL LOOKING . . . in seamless, brushed steel and vinyl-clad attache case.



A TRUE Gm TESTER

- 5000 Hertz Gm Test
- Full Cathode Emission Check
- 100 Megohm Grid Leakage Test

In a nut shell . . . here is how Sencore does it. Using only the first three controls, the MU150 becomes a speedy "Mighty Mite" cathode emission tester with grid leakage sensitivity checks up to 100 megohm . . . for fast on the spot service. Flip the last three switches into operation from the set-up data and the MU150 becomes a true mutual conductance tube analyzer using 5000 Hertz square wave to completely analyze any tube. You can't go wrong. No more need to mess around with time-consuming old fashioned tube testers with up to fourteen knobs and a rough 60 Hertz sine wave test.

The Continental tests them all including foreign tubes . . . over 3000 in all. And, it's guaranteed against obsolescence too with replaceable "new socket" panel and controls so standard that the switch numbers correspond to the pin numbers shown in any tube manual. You can actually set up the Continental without the set-up data in the cover if the need should arise. Here is everything that you could want.

The famous four way independent tests make you a master of the art of tube analyzing . . . internal shorts test; full cathode emission test; 100 megohm grid leakage test; and to back you up on critical tubes . . . a superb mutual conductance test. The beautiful Continental is housed in a vinyl-clad solid-steel attache case with lustrous all-chrome front panel.

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Sencore Sioux says:

WHY NOT MAKE A BUCK

SALESMEN "BUCK" QUESTIONS
(For Distributor Salesmen Only)

1. What is the sensitivity of the grid leakage test on the Mighty Mite? (See page 9.)
2. How many different test procedures are needed to test black and white, color and import tubes with CR161? (See page 3.)
3. What is the shape and frequency of the test signal used on the MU150? (See page 11.)
4. What are the 3 important tube tests made with the Mighty Mite? (See page 9.)
5. What is the purpose of the numbered scale on the meter of the CR161? (See page 4.)
6. What tests other than mutual conductance can the MU150 perform? (See page 11.)
7. Why is the color tracking test so easy with the CR161? (See page 3.)
8. How is up-to-date tube set-up information obtained for Sencore testers? (See page 4 and 10.)
9. What system is used for rejuvenation with the CR161? (See page 4.)
10. What feature allows the new Mighty Mite to test more tubes than ever before? (See page 9.)