

SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device that he is working on and observe the following precautions.

1. The CR31 should be connected to the CRT under test only after the receiver has been turned off, and all high voltage circuits discharged.
2. Care should be taken when working with the fragile glass neck of a CRT, because of the possible danger of an exploding CRT.
3. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.
4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.
5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.
6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

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DESCRIPTION INTRODUCTION

Today's serviceman requires a CRT tester that can effectively test the many different types of picture tubes used in today's TV market. It must also be capable of providing easy-to-use functions and give easy-to-explain test results that can convince the untrained customer that their picture tube should be replaced or possibly be restored to extend its life.

Sencore Engineers recognize that because of the cost involved in replacing a picture tube, many customers might rather spend a nominal amount in an effort to gain some additional life from the old CRT. With this thought in mind they have designed the instrument with the safest method on the market today, for restoring additional life to a weak CRT.

The answer to these two needs is the CR31 Super Mack CRT Tester and Beam Builder. The CR31 is the first instrument to provide all of the functions necessary to completely test a picture tube, plus all of the necessary repair and restore functions that will reactivate a weak or damaged gun structure for additional picture tube life. The CR31 provides additional tests of line voltage, focus and high voltage to determine if the CRT really needs testing. Individual, numbered CRT adaptors provide instant adaptability to any CRT base and all tubes are tested with the same simple test procedure. All test results are read on the big, easy-to-read, Super Mack Meter.

The CR31 incorporates the patented (3688184) Automatic Tracking test for the fastest, most accurate test possible on color CRT's. In addition, the Super Mack has a Beam Builder section for removing G1 shorts, rejuvenating and restoring gun emission in the safest possible manner. Super Mack is a "one stop" instrument that can be used safely and effectively by even the least trained TV technician. Super Mack does the whole job. Check the features and specifications, then compare.

FEATURES

- * Patented Automatic Tracking Test.
- * All test results shown on large 6" meter.
- * Complete set of individual, number socket adaptors to test all CRT's.
- * Complete CRT circuit tests include line voltage, focus and high voltage.
- * Five steps of rejuvenation includes automatic restoring function.
- * Simple, easy-to-use setups for all CRT's.

SPECIFICATIONS

FILAMENT VOLTAGE:

Continuously variable from 1 - 14 volts
Meter accuracy $\pm 5\%$

SHORTS TEST

H-K shorts - 2 Meg sensitivity $\pm 20\%$
G1 shorts - 20 Meg sensitivity $\pm 20\%$

EMISSION

Measures zero bias beam current for CRT under test

Meter Sensitivity

Low end of GOOD: 300uA, $\pm 5\%$
High end of BAD: 200uA, $\pm 5\%$

TRACKING

Ratio of 1.55 to 1 $\pm 10\%$, or greater will indicate BAD tracking.

LINE VOLTAGE

$\pm 2\%$ of meter reading
Factory set at 115VAC

10KV AND 50KV

$\pm 3\%$ of Full Scale

RESTORE AUTO CYCLE

0 - 100mA restore current
Nominal 4 seconds ON and 2 seconds OFF for 3 cycles.
ON time adjustable from front panel.

RESTORE MANUAL 1

0 - 100mA restore current

RESTORE MANUAL 2

0 - 150mA restore current

GENERAL

Meter: 6", 100uA, 2%, 1900 ohms
Size: H = 12 $\frac{1}{4}$ " (30.6 cm)
W = 11" (27.5 cm)
D = 7" (17.5 cm)

Weight: 13 $\frac{1}{4}$ lbs. (5.9Kg)

Power Requirements: 105 - 130VAC, 50/60Hz.

CONTROLS

POWER ON-OFF: This rocker switch controls the AC power to the CR31. The "ON" condition is indicated by one of the section indicator lights being lit.

FILAMENT VOLTAGE: This rotary switch is used to select the filament voltage range needed.

FIL SET: This is a wire wound control used in conjunction with the FIL SET scale on the meter to precisely set the filament voltage for the CRT under test, according to the set-up book.

BIAS: This rotary switch selects the negative G1 bias voltage applied to the tube. The A setting corresponds to 20 volts; B-35; C-50; and D-70 volts. The correct setting for this switch is found in the CR31 set-up book.

AUTO CYCLE TIME: This is a screw driver control which allows adjustment of the Restore Auto Cycle time. The center setting of this control provides an auto cycle "ON" time of approximately 4 seconds. This control may be adjusted for an "ON" time of from 2 to 6 seconds approximately.

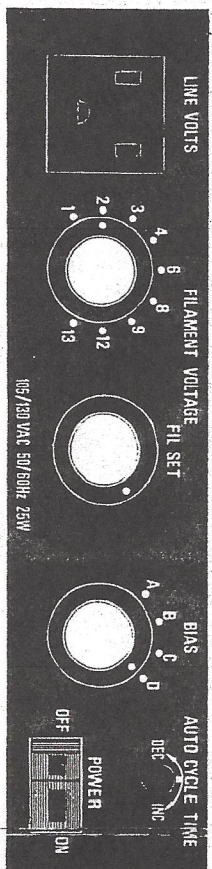


Fig. 1 CR31 Filament Voltage, Fil. Set., Bias and Auto Cycle Time

GUN SELECTOR: The three push button switches in the center of the panel select the gun to be tested. The first button (R/B&W) is to be used to test black and white CRT's or the red gun of color CRT's. The second (G) button selects the green color gun and the third (B) button selects the blue color gun.

GUN BALANCE: The three GUN BAL controls located above the Gun Selector push buttons control the G2 voltage applied to the CRT during the GUN BALANCE test function.

LIFE TEST: This push button switch provides a lowered filament voltage to check the emission properties of the cathodes at lower temperature. This test is very important in determining the life expectancy of a CRT.

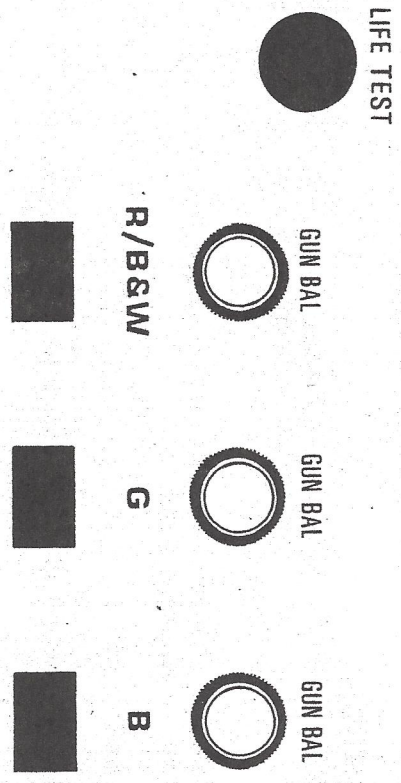


Fig. 2 CR31 Gun Selector, Gun Balance and Life Test

CRT TEST function switch gives a selection of test functions in the sequence in which they should be performed.

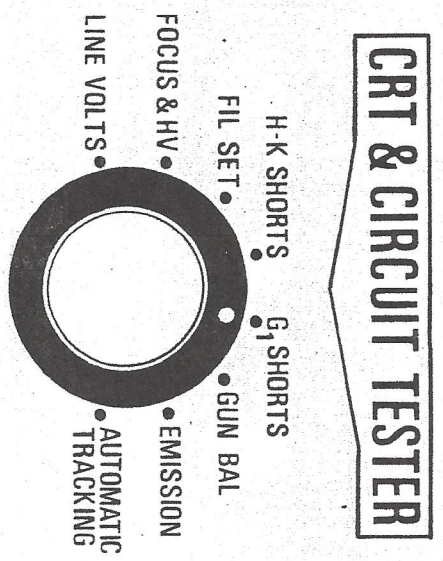


Fig. 3 CR31 CRT and Circuit Tester

BEAM BUILDER function switch is used in conjunction with the REJUVENATE OR RESTORE push switch for removing G1 shorts, Rejuvenation and Restoring of the CRT.

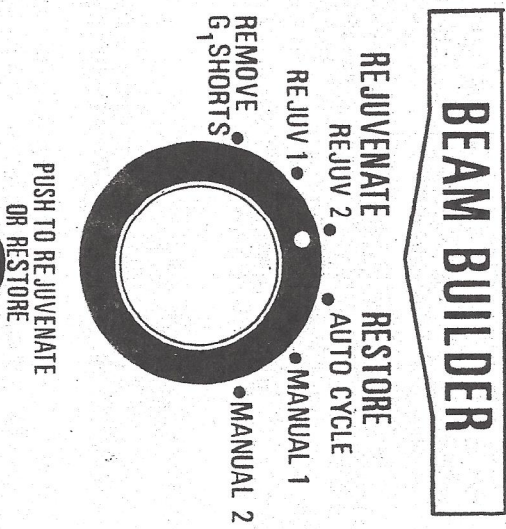


Fig. 4 CR31 Beam Builder and Restore

CRT TEST or BEAM BUILDER section is selected by a rocker switch located at the top center of the panel. A light behind each section indicator will show which section is active.

CRT ADAPTORS

The CR31 uses individual numbered socket adaptors arranged in the cover in numerical order. The CR31 set-up book lists the correct socket for the tube to be tested. To remove a socket adaptor, simply pull it from its plastic holder. To replace the adaptor after use, push it into the holder, taking care to line up the pins with the holes in the holder.

HV PROBES: Two probes are supplied with the CR31 for measuring high voltages within the TV set prior to the CRT test. The 10Kv probe is designed for measuring the focus voltage. With the 50Kv extender probe attached to the 10Kv probe, high anode voltage can be measured up to 50 kilovolts.

OPERATION

First, let us look at Super Mack's big meter and see what it has to offer. Note that the meter scale is divided into three groups to

make the meter more functional and simple to interpret. These groups are: CRT TEST, RESTORE and VOLTAGE. The CRT TEST group consists of three scales which indicate qualities of emission, tracking and shorts during the CRT test. The RESTORE scale indicates a range of gun cathode current up to 100mA maximum for AUTO CYCLE and MANUAL 1 positions and up to 150mA for MANUAL 2 position. The VOLTAGE scale group consists of four scales. The upper, FIL SET scale, is used for setting the exact filament voltage required for a particular tube being tested. The LINE CHECK scale is used to measure the line voltage being applied to the TV set. The lower two scales are 10Kv and 50Kv used for measuring the focus and high voltages in the TV set. As you can see, all necessary voltages, currents and tube conditions are displayed right on the big, easy to read, Super Mack Meter.

TV VOLTAGE MEASUREMENTS

When you encounter a TV set with poor picture quality the first step should be to measure the line voltage that the set is operating on.

1. Plug the TV set into the LINE VOLTS outlet on the CR31 panel.
2. Apply power to the CR31 and select the CRT and CIRCUI TEST section with the rocker switch.
3. Set the function switch to the LINE VOLTS position and read the line voltage applied to TV set on the CR31 meter.

If the line voltage is very low this could be the cause of the loss of picture quality. Further checks should then be made by using a variable transformer to raise the line voltage to the TV to normal value. If the picture quality returns to normal, testing of the CRT may be unnecessary and the low line voltage problem should be corrected.

If the line voltage is within normal limits as specified by the TV manufacturer, then proceed with the focus and high voltage tests as follows:

FOCUS VOLTAGE

1. Set the function switch to FOCUS and HV position.
2. Attach the black ground lead from the CR31 to the TV set chassis.
3. Using the 10Kv probe, measure the focus voltage, preferably at the CRT socket.
4. Attach the 50Kv extender probe to the 10Kv probe.
5. Measure the high voltage at the CRT second anode connection.

If either or both focus and high voltage is not close to the specified reading or within the range shown in the CR31 set-up book for that tube, troubleshooting of the high voltage circuitry is recommended

before further CRT tests are made. These voltage tests should always be made prior to CRT tests because they may save you time in the long run. Many times poor picture quality can be traced to one or both of these voltages and the CRT may still be good.

CRT TEST

SET-UP

	1	2	3	4	5	6
TUBE TYPE	FIL	BIAS	SKT	ANODE KV	FOCUS VOLTS	
2EP4	6.0	A	4	/11.0	-50/350	
5AXP4	6.3	B	1	/19.8		
5BNP16	6.3	B	1	/19.8	-50/350	
5CEP11	6.3	B	1	10/22.0	2200/4500	

1. Locate tube to be tested here.
2. Adjust FILAMENT VOLTAGE controls for this voltage.
3. Set BIAS switch to this letter.
4. Use this socket adaptor.
5. Reference voltage for high voltage measurements.
6. Reference voltage range for focus voltage measurements.

Fig. 5 CR31 Set Up Book

Locate the type number of the CRT to be tested in the CR31 set-up book. Tubes are listed first in numerical order by screen size. (ie. 12, 17, 19, 21, etc.) and second in alphabetical order of the letters following the screen size. For convenience, both black and white and color CRTs are contained in the same listing. The tabs in the set-up book list the first tube on that page. High Voltage and Focus Voltage ranges are also included for reference.

Set the coarse FILAMENT VOLTAGE switch to the value nearest that listed in the set-up book, and turn the FIL SET control fully counterclockwise. Set the BIAS switch to the correct position as indicated in the set-up book. Rotate the G2 controls fully counterclockwise, press the R/B&W Gun Selector pushbutton, and set the function switch to FIL SET position. Select the correct socket adaptor, as indicated in the set-up book, and plug it into the adapter cable socket.

CONNECTION

Remove power from the equipment containing the CRT to be tested and discharge the second anode of the CRT. CAUTION!—A severe shock hazard and possible damage to the CR31 will result if an attempt is made to test a CRT with second anode voltage applied.

Connect the socket adaptor to the base plug of the CRT. Take care to align the keyway properly, to eliminate possible damage to the pins of the CRT.

TEST

ADJUST FILAMENT VOLTAGE

Set the Function switch to the FIL SET position. Rotate the FIL SET control, observing the FIL SET scale on the meter, until the exact voltage listed in the set-up book is indicated. Wait 30 seconds to allow the filaments to warm up then readjust. The filament voltage will stabilize when the filament of the CRT has reached its normal operating temperature.

CHECKING FOR SHORTS

The shorts tests on the CR31 have been designed to test for all shorts and leakages that will occur in color or black and white CRTs.

The H-K SHORTS test will indicate any short or leakage existing between heater and cathode, cathode and G2, or G1 and G2. The dividing line between the GOOD and SHORTED portions of the SHORTS scale represents a leakage value of 2 megohms for this test.

The G1 SHORTS test will indicate any short or leakage existing between cathode and G1, or G1 and G2. The dividing line between GOOD and SHORTED portions of the meter SHORTS scale represents a leakage value of 20 megohms for this test.

The sensitive shorts tests, coupled with a meter indication rather than other indicating devices, allows a complete and accurate shorts testing of any CRT. Minute leakages of 50 to 100 megohms or greater will be indicated, but will cause a reading in the GOOD portion of the scale. If the meter indication is in the upper portion of the GOOD scale it is suggested that the filament voltage be raised approximately 10% to determine if the leakage becomes pronounced. An increased up scale reading, or an indication in the SHORTED portion of the scale, will indicate a leakage condition which will become increasingly worse as the tube ages. A SHORTED indication when testing the tube with normal filament voltage should be cause to replace the tube or attempt shorts removal as explained in the next section.

1. Depress the R/B&W Gun Selector pushbutton. Rotate the Function switch to H-K SHORTS position and observe the meter SHORTS scale. Repeat with G and B pushbuttons for full test on a color CRT.
2. Rotate Function switch to G1 SHORTS and observe the meter SHORTS scale. Depress G and B pushbutton for complete color tube shorts test.

3. Exact location of the short, and possible corrective action, can be determined as follows:

- A. If a short is indicated in both H-K and G1 SHORTS position, the short exists between G1 and G2. In most cases it will be possible to remove a G1 to G2 short with the CR31 REMOVE G1 SHORTS function. Refer to the REMOVE G1 SHORTS section.
- B. If a short is indicated in H-K only, the short may exist between heater and cathode, or cathode and G2. To determine if a short exists between cathode and G2, turn the GUN BAL control for the gun showing short fully counter-clockwise. Set the Function switch to GUN BAL position and observe the meter SHORTS scale. If the meter indicates into the SHORTED area of the SHORTS scale, the short exists between cathode and G2 and cannot be removed or corrected. If the meter indicates in the GOOD area of the SHORTS scale, the short exists between heater and cathode and may be corrected through the use of an "isolation" type of brightener.
- C. If a short is indicated in G1 SHORTS only, the short exists between cathode and G1. In most cases it will be possible to remove a cathode to G1 short with the CR31 REMOVE G1 SHORTS function. Refer to the REMOVE G1 SHORTS section.

GUN BALANCE

1. Depress the R/B&W pushbutton and rotate the Function switch to the GUN BAL position.
2. Adjust the R/B&W GUN BAL control to position the meter needle to the GUN BAL line on the meter. Repeat GUN Balance for each gun of a color CRT by adjusting Green GUN BAL control with the G pushbutton depressed, and adjusting Blue GUN BAL with the B pushbutton depressed. Recheck the settings of the GUN BAL controls to be sure that all three guns are accurately adjusted to the GUN BAL line on the meter. (If the guns of a color CRT are not balanced properly the results of the emission and color tracking tests will not be valid.)

NOTE: A tube that fails to adjust to the GUN BAL line should be considered questionable, regardless of the results of EMISSION and TRACKING tests. Tubes that fail the GUN BALANCE test do not meet the manufacturers specifications for grid cut off range, and will usually show poor contrast (reduced dynamic range). Color CRT's that fail the gun balance test may also exhibit gray scale set-up problems in some receivers.

CHECK EMISSION

Depress the R&B&W Gun Selector pushbutton and rotate the Function switch to the EMISSION position. Observe the tube condition on BAD — ? — GOOD meter scale. Repeat the EMISSION test with the G and B pushbuttons depressed for a complete test for color CRT's.

NOTES ON EMISSION TEST

1. Many CRT's will develop a large space charge around the cathode during preliminary SHORTS and GUN BALANCE tests due to the heating of the cathode. This space charge will cause a higher than normal initial emission reading. The emission level will decrease to actual emission of the gun after depletion of the space charge, approximately 60 seconds after switching to emission test for that gun. To assure accurate test results, especially on color CRT's, allow the emission to reach its final value before testing another gun.
2. Any color CRT containing a gun that indicates in the ? or BAD area of the meter scale on emission test, should be considered defective and replaced or corrective action taken to restore weak guns. (See RESTORATION section of this manual.) The results of the TRACKING test, if performed, would be invalid. The TRACKING test is designed to determine tracking ability of color tubes passing emission test.

LIFE TEST

The life test is a measurement of the reserve emission, or life remaining in a CRT. As a tube ages the reserve emission decreases, so that an older tube capable of a maximum emission of 400mA would have a much smaller reserve and a shorter life expectancy than a new tube. The curve in Fig. A shows the emission vs. filament voltage characteristics of a good tube as tested on the CR31. Note that the emission of 1.16mA at 6.3 volts filament is relatively constant from 5.8 to 7.4 volts, and drops only to 1.1mA at the life test voltage of 5.4 volts.

The curve in Fig. B shows the emission characteristics of a tube that would fail the life test. The emission of 400uA at 6.3 volts is still well inside the GOOD area of the meter scale, but at the life test filament voltage of 5.4 volts, the emission has dropped 50% to 200uA or into the BAD area of the meter scale. Note that at the brighter filament of 7.2 volts the emission has increased to 510uA

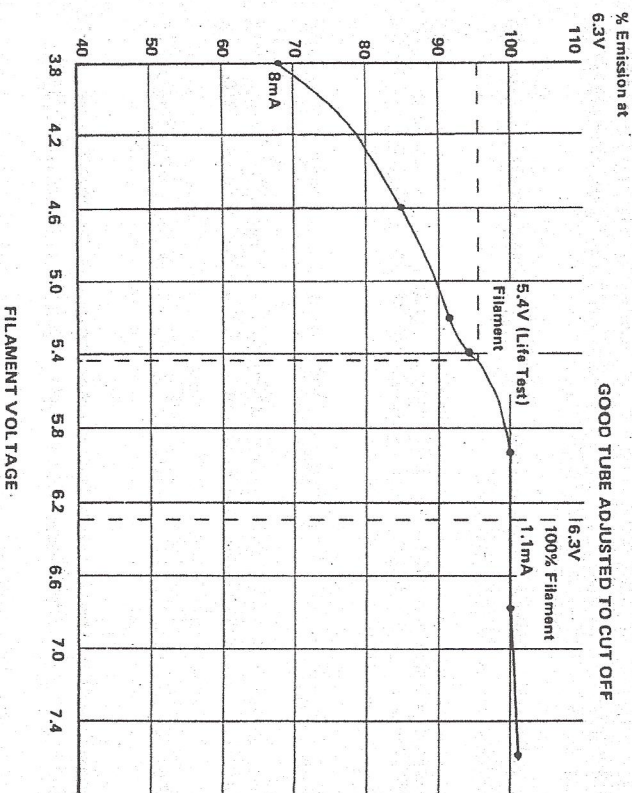


Fig. 6A

Fig. 6 Emission vs Filament Voltage for A - good CRT, B - Bad CRT

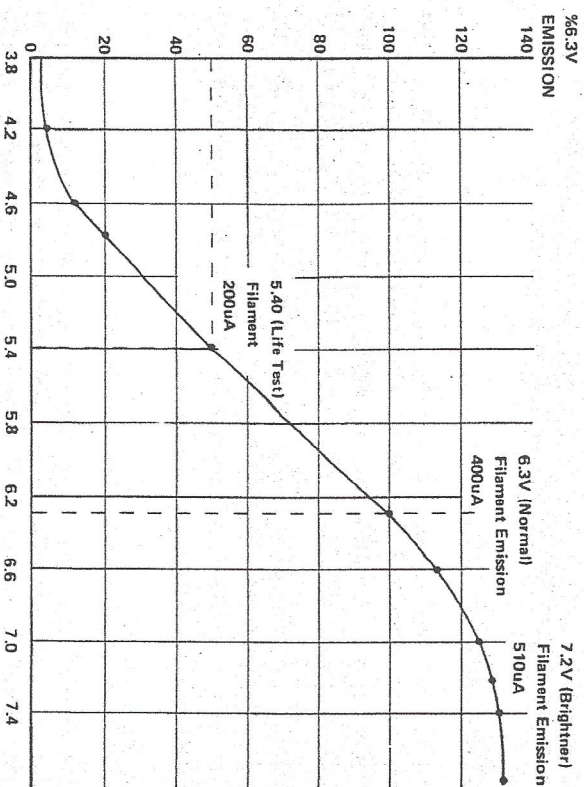


Fig. 6B

and has stabilized at that level. This would indicate that the addition of a brightener would prolong the useful life of this tube. To perform the normal life test, proceed as follows:

1. Perform the standard test on the CRT using the filament voltage listed in the CR31 set-up book.
2. Set the Function switch to EMISSION position, press the LIFE TEST button and observe the meter EMISSION scale while allowing time for the filament to cool.

A tube with good life expectancy will indicate nearly the same emission with the life test button pushed as with normal filament voltage applied. A tube whose emission falls off rapidly or one that reads in the ? or BAD area of the EMISSION scale, after the life test button has been depressed for 60 seconds, has failed the life test. Even though a tube has failed the life test it may still be possible to extend its life expectancy. You may try the following method:

- A. Increase the filament voltage in switch steps slowly (15 seconds per step) until the filament voltage is twice the normal voltage.
- B. Allow the filament to operate at increased voltage for 5 minutes. Then reduce the filament voltage in steps slowly until the proper voltage is applied.
- C. Repeat the life test to determine if the emission at lower filament voltage has been improved. If not, you may try a RESTORE function application, or install a brightener on the CRT. (Refer to RESTORATION section in this manual).

EXPANDED LIFE TEST

The purpose of the expanded life test is to determine if a CRT operating at a constantly low filament voltage will produce an acceptable picture. To make the expanded life test, adjust the CR31 FILAMENT VOLTAGE controls for a voltage 15% less than listed in the CR31 set-up book. Repeat the SHORTS, GUN BALANCE, EMISSION and TRACKING tests. If the CRT fails the expanded life test, an auto-transformer should be used to raise the line voltage to a normal value or a brightener installed on the CRT to raise its filament voltage closer to normal.

TRACKING TEST

The Tri-gun CRT requires an additional test not necessary on single gun black and white CRT's. If the color CRT is to produce a good gray scale from low to high brightness, the ratio of emission of any

two guns cannot exceed 1.5 to 1. The exclusive patented (No. 3688184) Sencore Automatic tracking test automatically compares the emissions of all three guns for the 1.5 to 1 ratio. The Sencore automatic tracking system uses a memory circuit which allows automatic comparison of gun emissions and displays either a good or bad tracking condition, in one easy step, on one meter. Other testers require an interpretation of readings from three separate meters, by the technician, which leaves room for error and is much more time consuming.

NOTE: The accuracy of the TRACKING test will depend on how carefully the GUN BALANCE and EMISSION tests were performed. Be sure to read notes 1 and 2 on testing emission before performing the tracking test. If anything is done to change the CRT, such as rejuvenation or increasing the filament voltage to determine the effect of a brightener, the GUN BALANCE and EMISSION tests must be repeated before rechecking the tracking.

1. Complete the EMISSION test on all three guns. Without touching the GUN Selector switches, turn the Function Switch to the AUTOMATIC TRACKING position.
2. Observe the TRACKING scale on the meter. The meter will indicate zero for a good CRT. A CRT with questionable tracking will indicate in the white area of the scale, and a CRT with bad tracking will indicate in the red, BAD area of the scale.

CRT RESTORATION FUNCTIONS

CORRECTING BAD TRACKING WITH REJUVENATION

1. Set the Function switch back to the EMISSION position and observe the EMISSION reading for all three guns.
2. Push the GUN selector switch corresponding to the gun with the lowest emission reading, then select the BEAM-BUILDER section and set the Function switch to one of the rejuvenation functions. (SEE REJUVENATION).
3. After attempting rejuvenation, be sure to go back to the SHORTS test and completely recheck the CRT.

WITH A BRIGHTENER

1. Set the Function switch to the FIL SET position and increase the filament voltage by approximately 10%.

2. Recheck the CRT at elevated filament voltage. If it checks good on all tests, the addition of a brightener should restore acceptable performance.

REMOVE G1 SHORTS

If a G1 short is indicated it is generally possible to remove it with the CR31. The CR31 REMOVE G1 SHORTS function applies a charge stored on a 100uF, 450 volt electrolytic capacitor between the control grid and G2/Cathode, with the filament voltage removed to prevent possible damage to the cathode or filament. The power stored in the capacitor will burn away most common G1 shorts caused by foreign material within the CRT. The discharge of the capacitor is determined by the degree of the short, and once discharged, the capacitor will not apply additional power that could damage the CRT. To remove a G1 short proceed as follows:

1. Select the BEAM BUILDER section of the CR31. Set the Function switch to the REMOVE G1 SHORTS position and depress the GUN Selector pushbutton corresponding to the shorted gun. IMPORTANT: Allow the filament to cool at least 30 seconds.
2. Press the PUSH TO REJUVENATE OR RESTORE button and observe the neck of the tube. If a flash occurs switch to the CRT TEST section and with the Function switch in G1 SHORT test position check to see if the short has been removed. If no flash occurred, press the REJUVENATE OR RESTORE button again. If no flash occurs after several attempts to remove the short, and if the short is still present, the short is mechanical in nature and cannot be removed by the CR31.

REJUVENATION

Rejuvenation is a process of accelerating the beam current and/or increasing the filament voltage temporarily to bring to the cathode surface new emitting material and enlarge the opening or aperture in the G1 control grid. The Sencore CR31 uses a capacitive discharge system of rejuvenation, so no timing is necessary. The CRT and the capacitor automatically determine the rejuvenation time. If the REJUVENATE OR RESTORE button is held down, the capacitor will discharge and no further voltage is applied to the CRT unless the button is released and pressed again. This system prevents excessive rejuvenation and CRT damage which can result from powered, brute force rejuvenation methods. NOTE: Each gun of a color CRT is rejuvenated independently.

Simply press the GUN SELECTOR switch corresponding to the gun you wish to restore and proceed with the rejuvenation operation. Normally the REJUVENATE function would be used if only one gun shows low emission and the others normal, which would be indicated as bad tracking or weak on life test. The RESTORE function would be used if all guns were weak on emission or life test. Under this condition tracking may or may not be good. (Refer to RESTORATION section.)

It is good practice to inform the customer of the slight danger involved in rejuvenating any CRT, and have his consent before rejuvenation is attempted. Many technicians use rejuvenation and restoration as a way to generate future business by offering to deduct the charge for rejuvenation or restoration from the cost of a new CRT installation at some future date.

For rejuvenation proceed as follows:

1. Select the BEAM BUILDER section of the CR31 and press the Gun Selector button corresponding to the gun showing low emission or weak on life test.
2. Set the Function switch to REJUV 1 position and depress the REJUVENATE OR RESTORE button.
3. Switch back to the CRT TEST section and repeat the EMISSION and/or LIFE test to see if any improvement has been made. The REJUV 1 operation may be repeated as often as required with no danger to the CRT. If emission level or life tests results are still unsatisfactory proceed with step 4.
4. Set the BEAM BUILDER function switch to REJUV 2 position and allow the filament to warm up for 30 seconds, then press the REJUVENATE OR RESTORE button.
5. Recheck the EMISSION and/or LIFE TEST to see if any improvement has been made. It will be necessary to allow the filament to cool down and the emission reading to stabilize after REJUV 2 operation has been used. For most CRTs, REJUV 2 operation can be repeated as often as necessary, however, care should be taken on small neck tubes and those with a bias setting of A or B. If the results of the rejuvenation operation are unsatisfactory because the emission level has not increased sufficiently, the RESTORE functions may be used in an attempt to revive the weak CRT cathode. (Refer to RESTORATION section.)

CATHODE WELDING

If a CRT indicates absolutely no emission, and the filament is still working, an open cathode is indicated. When this occurs the automatic controlled REMOVE G1 SHORTS circuit of the CR31 can be used in an attempt to weld the cathode. If the tube is an older type with solder pins on the base, these should be soldered first, as this may be the cause of the open cathode. It must be stressed that cathode welding may be accomplished only in a few instances and should not be considered a completely effective repair procedure.

1. Set the BEAM BUILDER function switch to the REJUV 2 position and allow the filament to warm up for 60 seconds. Press the Gun Selector button corresponding to the gun having the open cathode.
2. Set the Function switch to the REMOVE G1 SHORTS position and IMMEDIATELY press the REJUVENATE OR RESTORE button before the filament has time to cool. At the same time, tap the neck of the CRT.
3. If a flash occurs in the CRT neck, release the REJUVENATE OR RESTORE button. Return to the CRT TEST section and check the CRT for emission. If no flash occurs and/or no emission can be read on the meter, the cathode cannot be welded to restore performance.

RESTORATION

Restoring of a picture tube is actually a reactivation of the electron emitting properties of the CRT cathode. A cathode in good condition will emit electrons in large quantities, which form a cloud around the surface of the cathode. Only a small percentage of these electrons are used to form an electron beam in a picture tube. Because small quantities of gas are liberated in the tube, there is a constant bombardment of the cathode by positive ions. The electron cloud around the cathode affords some protection from the positive ion bombardment but enough ions get through to the cathode to start contamination of the oxide coating on the cathode. This reduces the emitting properties of the cathode and consequently reduces the size of the protective cloud around the cathode. Thus, because of this "snow-balling" effect, when a tube starts to become weak it weakens very rapidly. The restoration process removes the contaminants from the surface of the cathode oxide coating, restoring it's ability to emit electrons in large quantities.

The CR31 Super Mack employs the safest method of restoring a CRT on the market today. The RESTORE function, on AUTO CYCLE

position, applies a constant DC voltage between G1 Control grid and cathode for a normal time of 4 seconds then removes the voltage for 2 seconds and repeats this cycle 3 times while the REJUVENATE OR RESTORE button is held depressed. The current is limited to a maximum of 100mA which protects G1 from overheating and consequent damage. During the RESTORE operation the filament voltage is increased by 50%, since reactivation of the cathode requires a 50% increase in temperature (degrees Kelvin). Cathode temperature increase is nearly linear with an increase in filament voltage in the normal filament voltage range. MANUAL positions of restore provide the operator with the option of applying voltage to G1 while observing the meter indication of cathode current, and thus, having full control over the restore operation. In MANUAL positions of RESTORE, voltage will be applied to the control grid while the REJUVENATE OR RESTORE button is held depressed; therefore, CAUTION must be used when MANUAL positions are employed, not to apply voltage for too long a time as damage to G1 from overheating will result. In MANUAL 1 position maximum current is limited to 100mA and in MANUAL 2 position maximum current is limited to 150mA.

RESTORE AUTO CYCLE

For RESTORE AUTO CYCLE operation proceed as follows:

1. Select the BEAM BUILDER section of the CR31 and set the Function switch to AUTO CYCLE position. Allow the CRT filament to warm up for 30 seconds.
2. Select a gun that is weak on emission test by depressing the Gun Selector switch for that gun.
3. Set the AUTO CYCLE TIME screw driver adjustment to its center position. This provides an Auto Cycle "ON" time of approximately 4 seconds. As you become familiar with the RESTORE operation you may wish to decrease or increase the "ON" time with this adjustment, which is variable from 2 to 6 seconds approximately.
4. Press and hold the REJUVENATE OR RESTORE button and observe the meter Auto Cycle - Man I scale. The cathode current should rise during each successive "ON" period for the three cycles while the button is held depressed.
5. After one three-cycle RESTORE operation for each weak gun, repeat the GUN BAL, EMISSION and TRACKING tests using the CRT TEST section.

If the LIFE test indicated the need to restore the CRT then repeat the life test. Failure to pass these tests would require that the RESTORE operation be repeated.

CAUTION: RESTORE operation should only be continued as long as the meter indicates increasing cathode current during the "ON" period of restoration. As soon as the current levels off or fails to increase, IMMEDIATELY release the REJUVENATE OR RESTORE button. Continuing the RESTORE operation beyond this point can damage the cathode and render the CRT useless. In some tubes this point may be reached at a current level below the 100mA limit of the AUTO CYCLE function.

RESTORE MANUAL

For the serviceman desiring to use the RESTORE MANUAL functions, always use MANUAL 1 position first, since it has the lower current limit, and proceed as follows:

1. Select the BEAM BUILDER section of the CR31 and set the Function switch to MANUAL 1 position. Allow the CRT filament to warm up for 30 seconds.
2. Press the Gun Selector corresponding to the gun that indicated weak on emission test.
3. Press and hold the REJUVENATE OR RESTORE button and observe the Auto Cycle - Man 1 scale on the meter for an increasing cathode current. When the cathode current levels off or fails to increase further, IMMEDIATELY release the button.

Under no circumstances should the button be held down for more than 15 seconds continuously even though the current is still increasing. Allow 10 seconds for the G1 element to cool before continuing the RESTORE operation. Restore time and maximum current will vary from tube to tube depending upon the type of the tube and the condition of the cathode prior to using the Restore function. Generally, a tube that is very weak will require a longer restore time, and thus, must be watched closer for overheating of G1. MANUAL 2 position may be used in the same manner as MANUAL 1 except that MANUAL 2 has a current limit of 150mA and should only be used on tubes capable of delivering higher cathode current and then ONLY as a last resort for tubes that will not respond to AUTO CYCLE or MANUAL 1 restore operation.

4. After the MANUAL RESTORE operation is performed on all weak guns, return to the CRT TEST section and repeat the SHORTS, GUN BALANCE, EMISSION and TRACKING tests.

Generally, it is advisable to repeat the LIFE TEST on EMISSION position to determine if the restore operation has increased the life expectancy of the CRT.

NEW CRT SET UP BOOKS

New CRT set-up books are printed at regular intervals for the CR31 Super Mack tester. To receive this up-to-date information, sign and return the enclosed warranty card to the Sencore West Sales and Service Office, 3200 Sencore Drive, Sioux Falls, South Dakota 57107. Your name will then be placed on an automatic mailing list to receive each new chart as it is printed. You will be billed a small charge for printing and handling for each chart received. If you encounter a new CRT that is not listed in the set-up book, contact the Sencore West Sales and Service office in Sioux Falls. A card file of up-to-date information is maintained at this office to assist you.

NEW CRT ADAPTORS

Space has been provided in the CR31 cover for new tube adaptors should the need arise. If a new tube is announced, an adaptor and information on this tube is available from the Sencore office nearest you. You may also wire an adaptor yourself by obtaining a socket and wiring it according to the schematic diagram. The plug used on the CR31 socket adaptor is an Amphenol 86 - CP11 or equivalent.

CR31 CIRCUIT DESCRIPTION

1. Filament Circuits
2. Power Supply
3. Line Volts, Focus and High Voltage
4. Shorts Test Circuits
5. Gun Balance, Emission and Tracking Circuits
6. Remove G1 Shorts and Rejuvenation Circuits
7. Restore Functions

FILAMENT CIRCUITS

The CR31 Filament transformer (T2) is multitapped on both primary and secondary sides. The taps on the secondary winding are connect-

ed to SW5 the coarse FILAMENT VOLTAGE switch. SW5 selects the proper secondary tap and couples it to pin 11 of the Adaptor Cable socket. When the secondary common lead is negative current flows through CR213, SW201F, R223, SW1E, M1, SW1F, SW201E, R221 and back to SW5 wiper. When SW5 wiper is negative, current flows through R220, SW201F, R223, SW1E, M1, SW1F, SW201E and CR214 to secondary common lead. Thus on each half cycle of AC voltage current flows through meter, M1, in the normal negative to positive direction providing a reading of the filament voltage. C210 provides filtering of the AC ripple and R222 is a calibrating resistor in parallel with the meter movement.

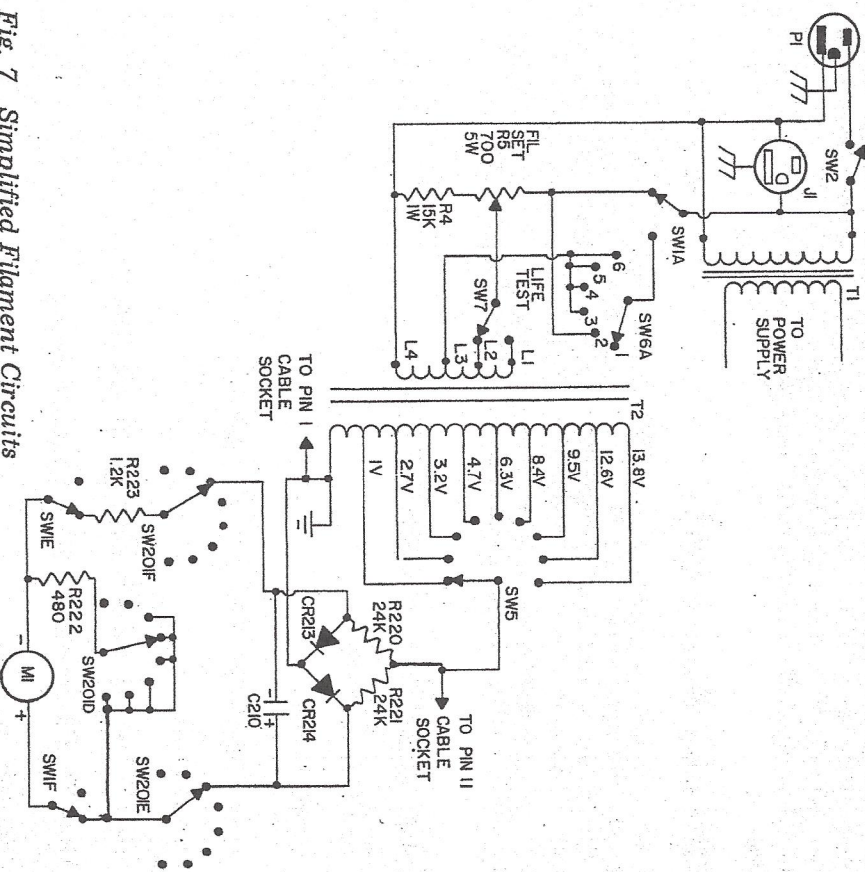
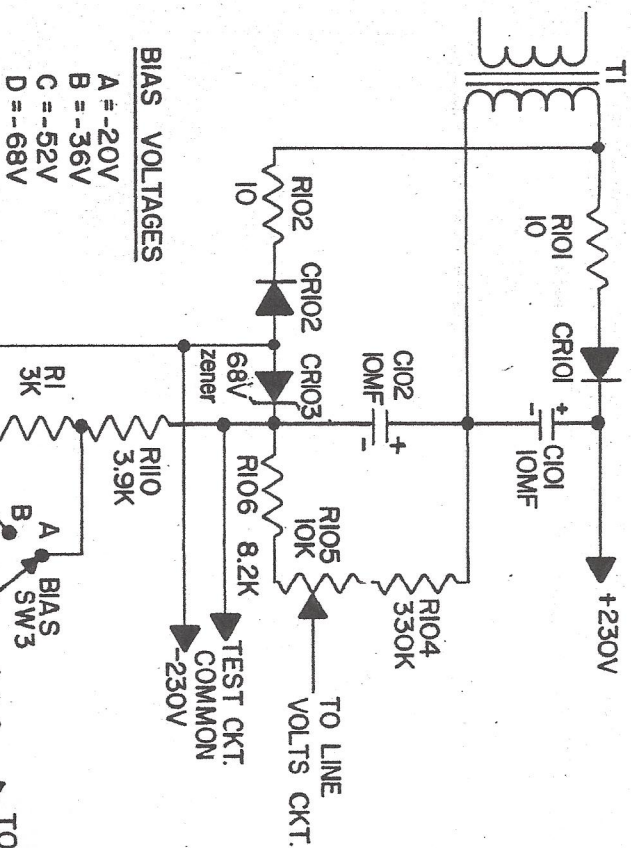


Fig. 7 Simplified Filament Circuits

SW1 selects either the CRT TEST or BEAM BUILDER sections of the CR31. With SW1A in the position shown (CRT TEST) the hot side of the AC line is connected through ON - OFF switch, SW2, to R5, the FIL SET control. With SW7 (LIFE TEST button) out, voltage from R5 wiper is coupled to L2 for normal filament operation. With the

LIFE TEST button pushed, the AC voltage is coupled to L1 to provide reduced filament voltage. With SW1 selecting the BEAM BUILDER section, SW6A provides, through position 2, AC voltage to L2 for normal filament voltage during REJUV 1 operation. In REJUV 2 and RESTORE functions, SW6A supplies AC voltage to L3 for increased filament voltage (SW6A positions 3 - 6). Filament voltage is increased by 50% for REJUV 2 and RESTORE functions. During REMOVE G1 SHORTS operation, (SW6A position 1) no filament voltage is applied to the CRT.

POWER SUPPLY



BIAS VOLTAGES

- A = -20V
- B = -36V
- C = -52V
- D = -68V

Fig. 8 Simplified Power Supply Circuits

The output of T1 secondary (180V RMS) is rectified by CR101 and filtered by C101 to provide a positive 230VDC output. The output of T1 is also rectified by CR102 and filtered by C102 to provide a negative 230VDC output.

The sum of the two outputs (460VDC) is connected to the rejuvenate capacitor C1 and to a voltage divider to produce various voltages required by the CR31. Starting from the anode of CR102, current flows through CR103, (68 volt zener) in parallel with the bias voltage divider (R1 - R3 and R110.) The positive side of CR103 (cathode) is the zero voltage reference point for the CR31. From the zero reference end of CR202 provides 20 volts to power the FET circuits. From the 20 volt point current flows through the shorts voltage divider R109 and R108 back to the cathode of CR101. The G2 GUN BAL controls are in parallel with R108 and R109, shorts voltage divider. The output of the shorts voltage divider (junction of R108 and R109) is +100VDC used for Shorts Test functions.

LINE VOLTS, FOCUS AND HIGH VOLTAGE

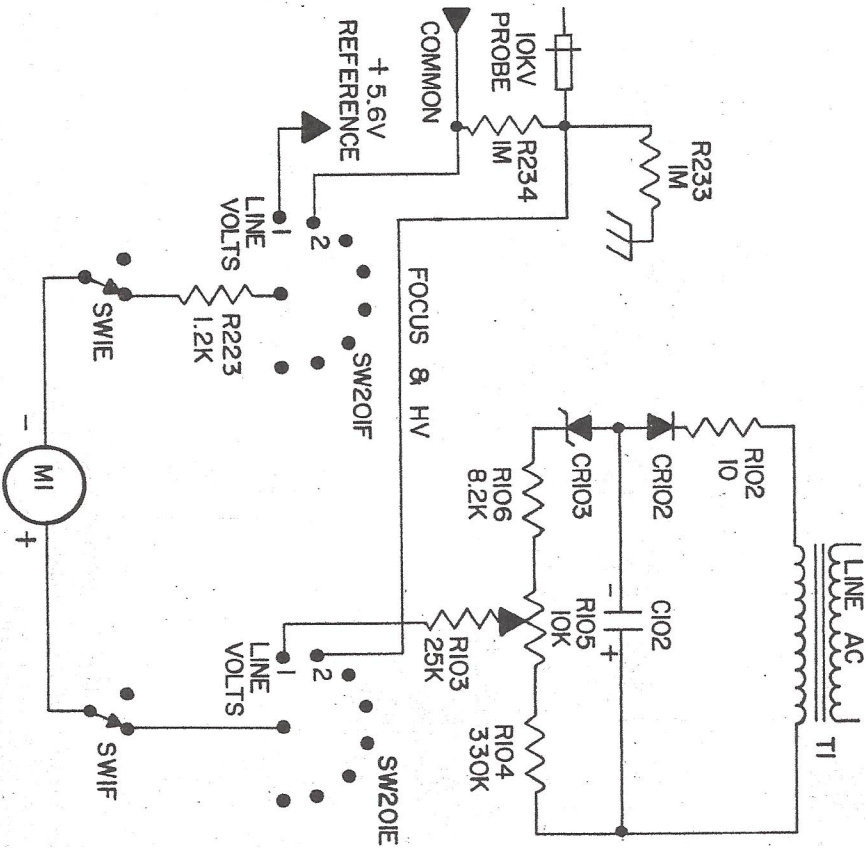


Fig. 9 Simplified Line Volts and Focus and HV Circuits

Meter reference voltage for measuring line voltage is taken from CR201 (5.6 volt zener) which is in parallel with the 20 volt source, CR202. The +5.6VDC is coupled through SW201F, R223 and SW1E to the negative side of the meter, M1. The positive side of M1 is coupled through SW1F, SW201E and R103 to the wiper of R105, the line voltage calibration control. R104, R105 and R106 comprise a voltage divider supplying a varying DC voltage corresponding to a change in AC line voltage. Any change in line voltage then is felt across the meter with a corresponding change in the meter reading. R105 is factory adjusted, at 115VAC line voltage, for a meter reading of 115 volts on the LINE VOLTS scale.

When measuring focus and high voltage the black, common lead is connected through SW201F, R223, SW1E to the negative side of meter, M1. The output of the 10Kv probe is connected through SW201E and SW1F to the positive side of the meter. R234 limit the maximum possible voltage inside the chassis to 100 volts, should the meter circuit happen to open up during the measurement of focus or high voltage.

SHORTS TEST

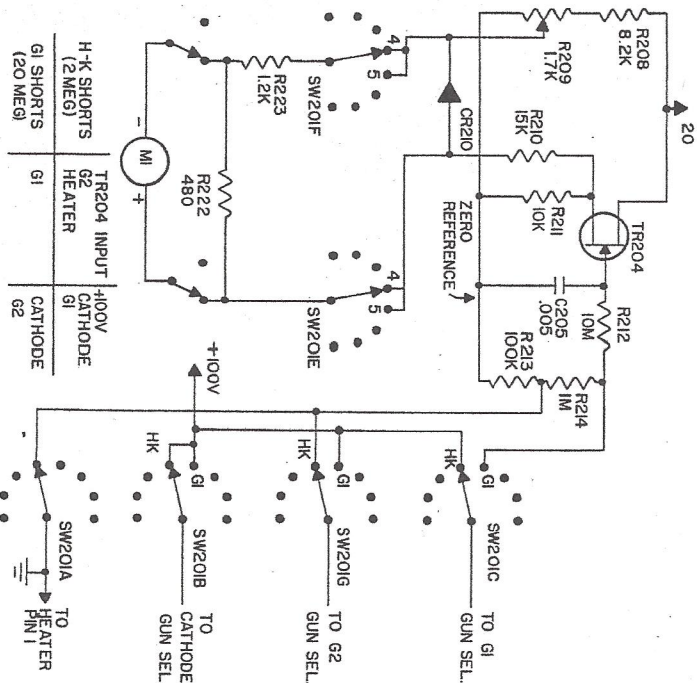


Fig. 10 Simplified Shorts Test Circuit

With no CRT connected to the CR31 the gate of TR204 is at the same potential as the zero reference, and the source at some positive value as determined by the Idss characteristics of the FET. R209 is an internal meter zero control that is factory adjusted for zero current through the meter (voltage equal to source of TR204.)

The CR31 shorts test applies +100VDC from the shorts voltage divider in the power supply between the elements of the CRT gun being tested. Any current that flows as a result of shorts or leakage flows through one or both of the sensing resistors in the gate of TR204. This shorts or leakage current produces a positive voltage at the gate of TR204. TR204 couples this positive voltage to the meter, M1, causing an upscale reading. In the H-K shorts test the leakage current flows through R213 (100K) only, and a leakage of 2 Megohms will cause a mid-scale reading on M1.

In the G1 shorts test the leakage current flows through both R213 and R214 and a leakage of 20 Megohms will cause a mid-scale reading on M1. The table in Fig. 10 lists which CRT elements are connected to the inputs of TR204.

GUN BALANCE AND EMISSION CIRCUITS

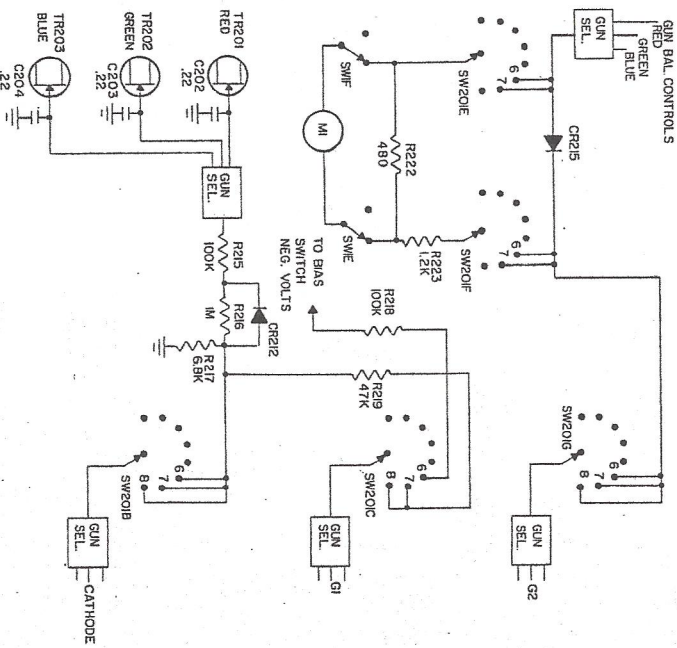


Fig. 11 Simplified Gun Balance and Emission Test Circuits

The GUN BALANCE, EMISSION and TRACKING tests are all related and use much of the same circuitry. Fig. 11 is a simplified drawing of the applied voltage and metering circuits during the GUN BALANCE test. Current flows through R217, SW201B and the gun selector switch to the cathode of the gun under test. Current then flows through the gun being tested, to G2, and back to the CR31 through the gun selector switch, SW201G, SW201F, R223, SW1E, M1, SW1F, SW201E and the gun selector switch to the wiper of one of the GUN BAL controls. A negative voltage, as selected by the BIAS switch, is applied to G1 of the gun under test through R218, SW201C and the gun selector switch. During the GUN BALANCE test, the GUN BAL control is adjusted for a small (20uA) current through M1. This test is used to determine cut-off characteristics of the CRT and to establish a reference current for testing the three guns of a color CRT.

The only change for the emission test is that the negative bias is removed from G1 and G1 is connected to the cathode through R219 (47K). Removing the bias increases the current flow through the gun under test and this zero bias emission current is read on M1. The zero bias emission current also flows through R217 (6.8K). As each of the three color guns is tested for emission, the voltage produced by the current flow through R217 is used to charge the memory capacitors (C202, C203, C204) selected by the gun selector switch.

TRACKING CIRCUITS

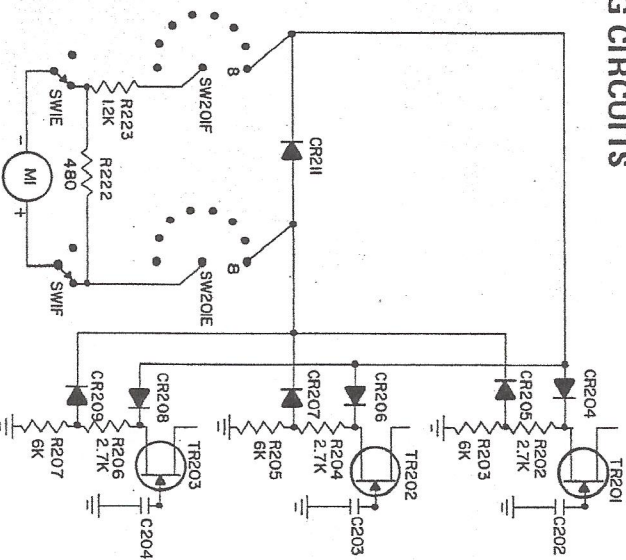


Fig. 12 Simplified Tracking Circuits

During the emission test the memory capacitors in the gate circuits of TR201, TR202 and TR203 are charged to a voltage proportional to the emission of each gun. During the tracking test, the FETs function as very high impedance source followers, transferring the gate voltage to the source without changing the gate voltage. If the voltage at the junction of the two source resistors in any one of the three FET source followers exceeds the voltage at the source of any other FET, two of the steering diodes (CR204 - 209) will be forward biased allowing current to flow through M1.

EXAMPLE: During the emission test of a certain CRT the gate of TR201 is charged to 10 volts, the gate of TR202 is charged to 8 volts and the gate of TR203 is charged to 6 volts. The source followers transfer the gate voltage to the source. The voltages at the junction of the source resistors would be 6.9 volts for TR201, 5.5 volts for TR202 and 4.1 volts for TR203. In this example the voltage at the source of TR203 was 6 volts and the voltage at the junction of the source resistors of TR201 was 6.9 volts. This forward biases CR205 and CR208, allowing current to flow through M1, indicating that the color CRT in this example has bad tracking.

REMOVE G1 SHORTS AND REJUVENATE CIRCUITS

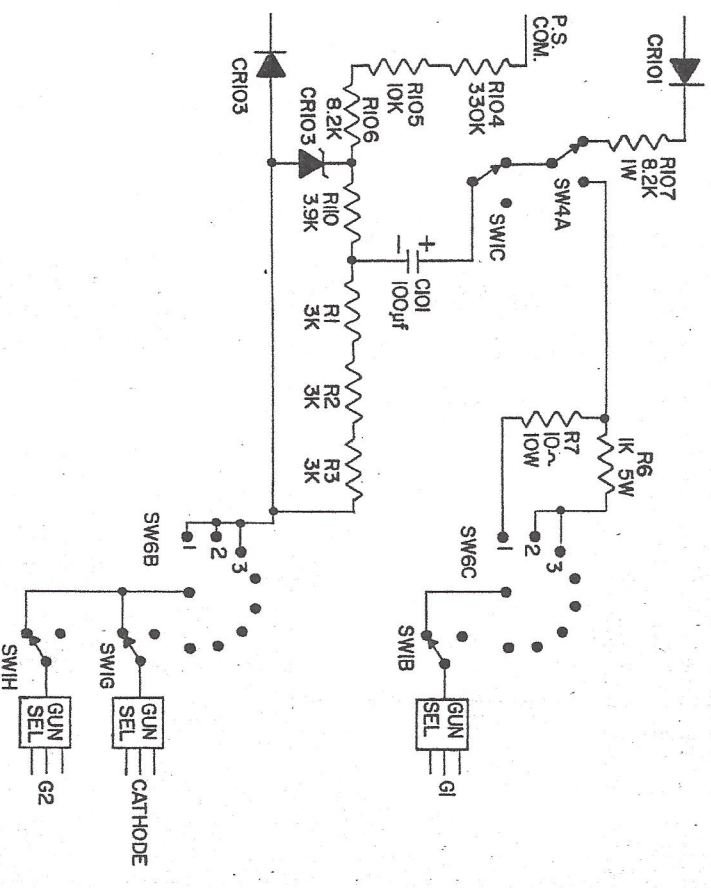


Fig. 13 Simplified Remove Shorts and Rejuvenation Circuits

The remove shorts and rejuvenation functions all depend on the discharge of C1, a large 100mF capacitor. In the Remove G1 Shorts function (SW6 position 1) the filament voltage is removed from the CRT and the capacitor is discharged between G1 and cathode or G1 and G2 depending upon which pair of elements is shorted. The heavy discharge current of C1, limited somewhat by R7 (10 ohm), will burn away most G1 shorts and because the cathode is cool there will be no danger of giving the gun unwanted rejuvenation.

In the REJUV 1 and REJUV 2 positions the capacitor, C1, is discharged to G1 through R6 (1K) which limits the peak current to a value that is safe for all CRTs. In REJUV 1 position the filament voltage is normal as set by the FILAMENT VOLTAGE controls, while in REJUV 2 position the filament voltage is increased by approximately 50%.

RESTORE FUNCTION CIRCUITS

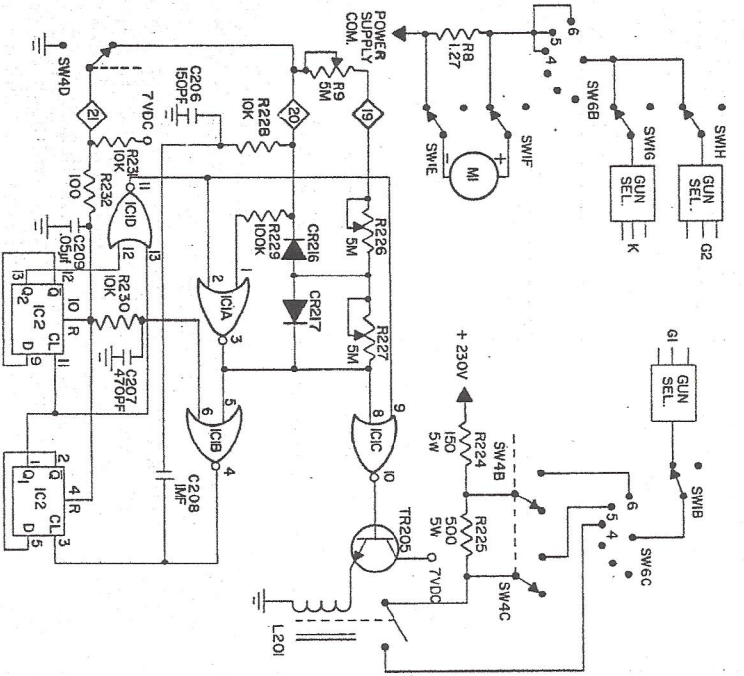


Fig. 14 Simplified Auto Cycle Restore Circuitry

Auto cycle restore function utilizes a quad NOR gate chip, IC1, and a two section clock IC2. IC1 uses two of the NOR gates (IC1A, IC1B) connected as a flip-flop with IC1C output used as control of

the transistor switch, TR205. IC1D controls the flip-flop operation and stops its operation at the end of three cycles as determined by the clock, IC2. Quiescent state of IC1B pin 4 is "O". When the RESTORE button is depressed ground or "O" is placed on the IC2 reset pins 4 and 10 and also on IC1B pin 6. IC1B pin 4 then switches to a "1", IC2 "Q" outputs switch to "1"s and, thus, IC1D output is "O". With a "O" on IC1C pin 9 and a "O" from IC1A pin 3 on IC1C pin 8 the output of IC1C pin 10 is a "1" which turns on TR205, closing relay L201.

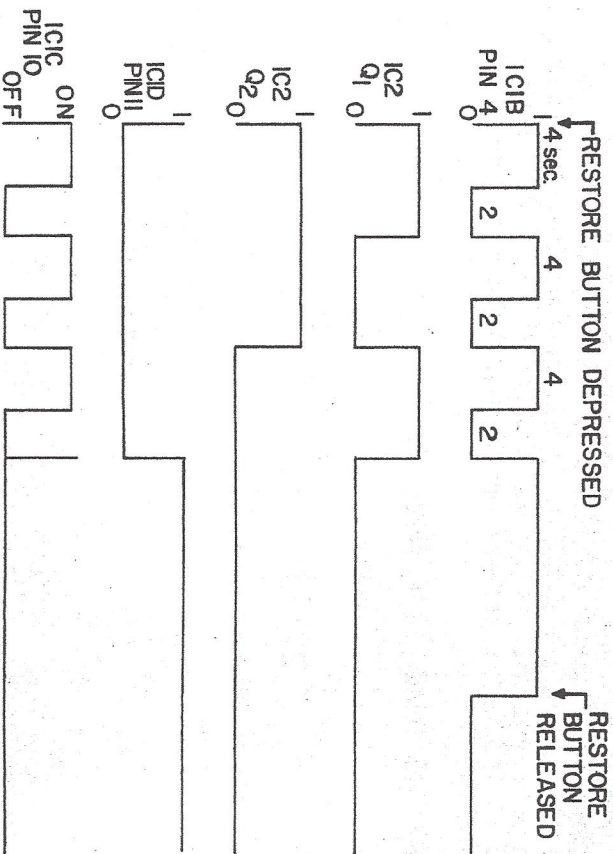


Fig. 15 Auto Restore Digital Timing

Voltage is now applied through SW6C and SW1B to G1 of the CRT gun being restored. The "ON" time of the G1 voltage is determined by the charging time of C208 through CR217, R226 (internal ON time adjustment), R9 (front panel AUTO CYCLE TIME adjustment), and R228. The "OFF" time of the G1 voltage is determined by the discharge of C228 through R228, CR216 and R227 (internal "OFF" time adjustment). Following the digital timing displayed in Fig. 15, will show that IC1C pin 10 follows IC1B pin 4 until the IC2 outputs Q1 and Q2 both reach "O" after the third cycle. At this time IC1D pin 11 goes to a "1" which drops IC1C pin 10 to "O" and holds IC1B pin 4 at a "1". These states will remain until the RESTORE button is released, at which time a "1" is placed on IC1B pin 6 which drops IC1B pin 4 to a "O" preparing the entire circuit for another Auto cycle operation, which may be initiated by once again depressing the

RESTORE button. C206 (150pf) acts as a bypass for transients that could cause false timing. R232 and C209 act as a filter to prevent spikes from SW4D from triggering IC2. R230 and C207 provide a delay to hold off IC1B until the clock, IC2, is ready to react to the positive excursion which will come from IC1B pin 4.

In MANUAL 1 function voltage is applied to G1 of the gun being restored through R224, R225, SW4C, SW6C and SW1B. Resistors R224 and R225 provide a current limit of 100mA maximum to protect the CRT gun. In MANUAL 2 function G1 voltage is applied through R224, SW4B, SW6C and SW1B. R224 provides current limiting of 150mA maximum.

During the restore operation, with voltage applied to G1, current flows through R8 (1.27 ohm), SW6B, SW1G, and gun selector switch to the cathode. The current through R8 develops a voltage which is applied to the meter, M1, through switches SW1E and SW1F. M1 provides an indication proportional to the current flowing through R8.

SERVICING YOUR CR31

REMOVING THE CR31 FROM ITS CASE

Remove the CR31 cover, containing the socket adaptors, from the case. Remove two screws from the lower end of the case, just below the aluminum trim wrap, and two screws from the top end of the case, below the trim wrap. Lift the panel assembly up and out of the case. To install the CR31 into its case, reverse the above procedure.

CALIBRATION INSTRUCTIONS

STATIC METER ZERO

Switch the CR31 off and using a thin blade screwdriver, adjust the meter mechanical zero adjustment screw to position the meter pointer to the left edge of the meter scale.

LINE VOLTS CALIBRATION

Line voltage adjustment should be made with 115VAC line voltage applied, but if an accurate 115V source is not available use a voltage that will be near the mid-scale region of the meter.

1. Connect the voltage source to the CR31 line cord plug and measure the AC voltage at the AC socket on the front panel with a known accurate AC voltmeter. Set the Function switch to LINE VOLTS position.

2. Adjust R105 until the CR31 meter reads exactly the same voltage.

NOTE: Accuracy of the CR31 line volts function will depend upon the accuracy with which the applied voltage is measured when calibration is made.

SHORTS TEST ZERO ADJUST

1. Set the Function switch to H-K SHORTS position.
2. Adjust R209 (shorts zero adjust) to position the meter pointer to the left edge of the meter scale.

AUTO CYCLE TIME ADJUST

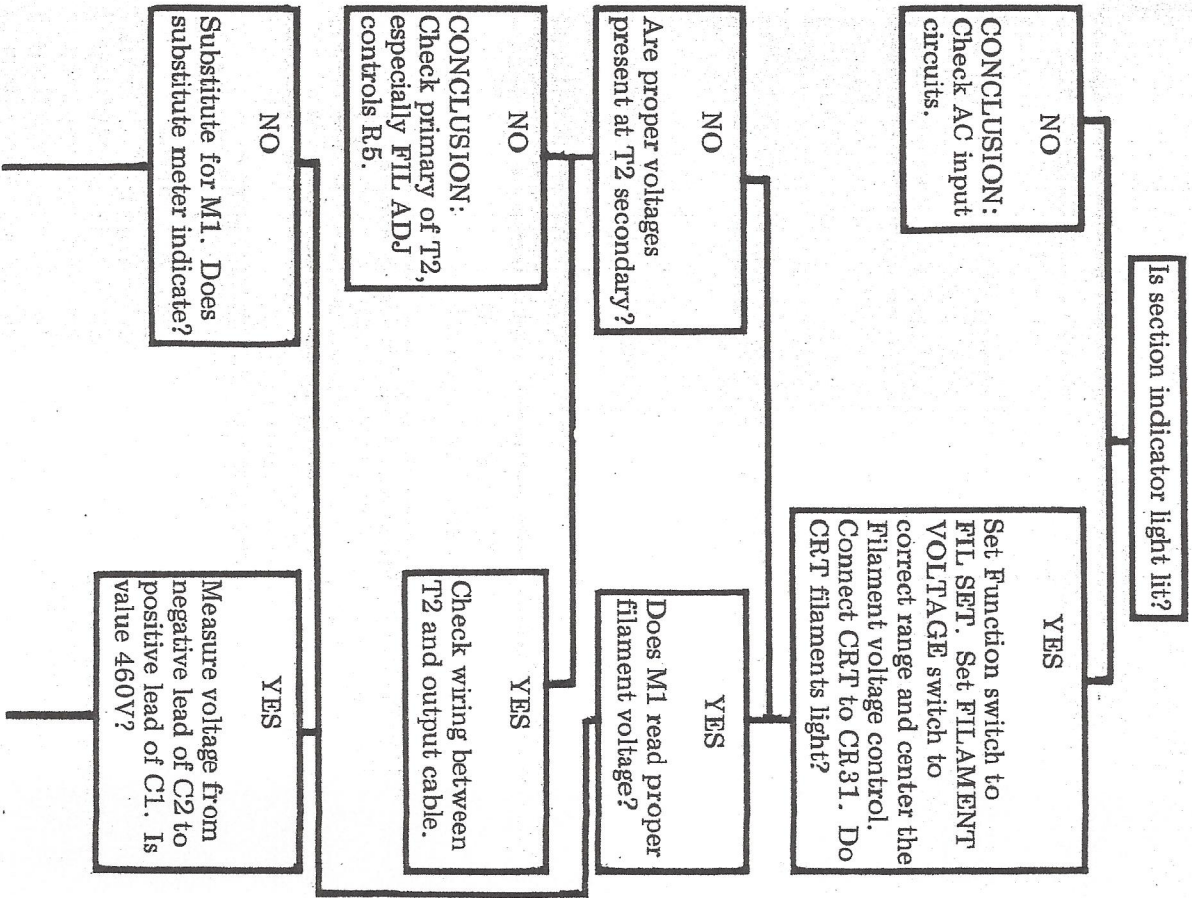
1. Switch to BEAM BUILDER section and set the Function Switch to AUTO CYCLE position. Adjust the AUTO CYCLE TIME (Front panel adjustment) to center range.
2. Connect a DC voltmeter, adjusted to measure at least 250 volts, with common lead to adaptor cable socket pin 2 and positive meter input lead to adaptor socket pin 8. Push the R/B&W gun selector switch.
3. Press and hold the RESTORE button and measure the time that voltage is present on the DC voltmeter, using a timer or watch.
4. Adjust R226 (ON time adjustment) until the voltage is present on the voltmeter for 4 seconds during each cycle.
5. Adjust R227 (OFF time adjustment) until the voltage is NOT present on the voltmeter for 2 seconds during each cycle.

NOTE: The AUTO CYCLE restore function will operate for a period of 3 cycles then stop. To repeat the sequence merely release the RESTORE button and push it again. R226 and R227 are independent of each other and adjustment of one will not affect the other.

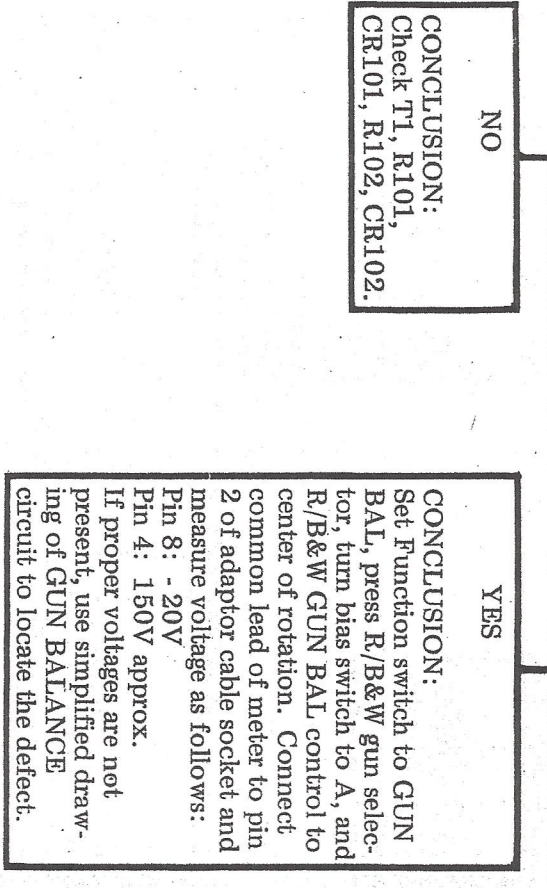
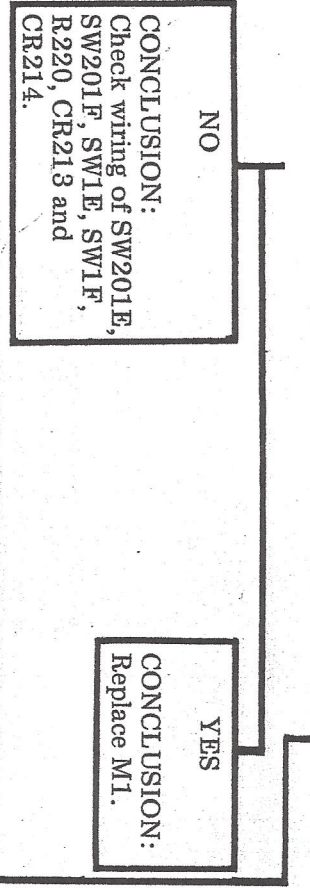
TROUBLE CHARTS

NOTE: Be sure to check several tubes using different sockets to be sure that a defective adaptor is not causing the problem.

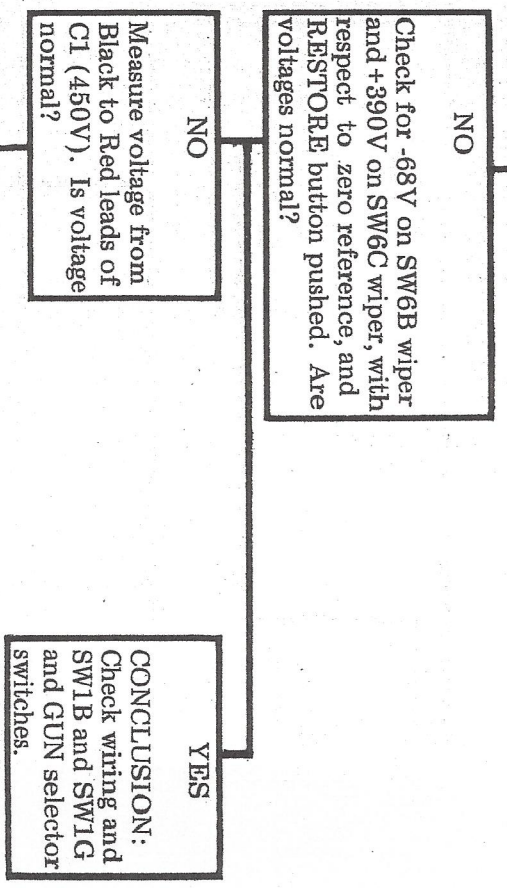
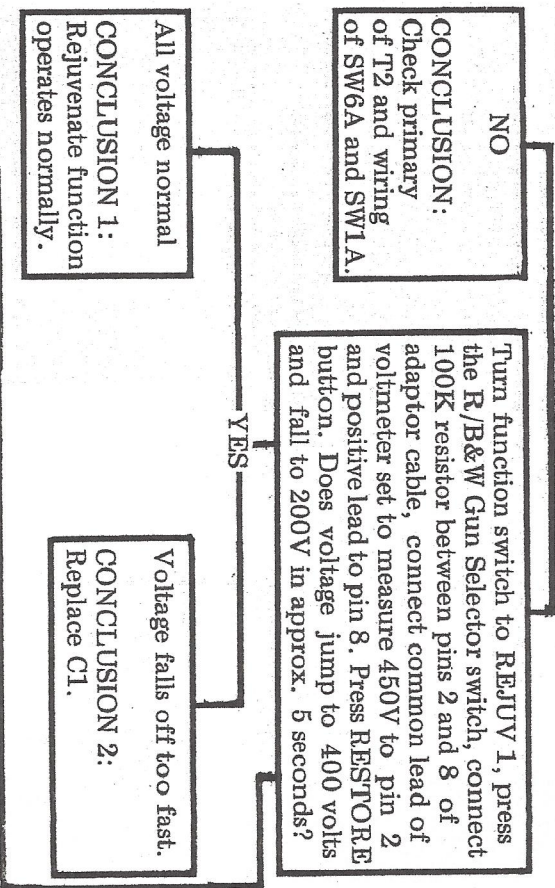
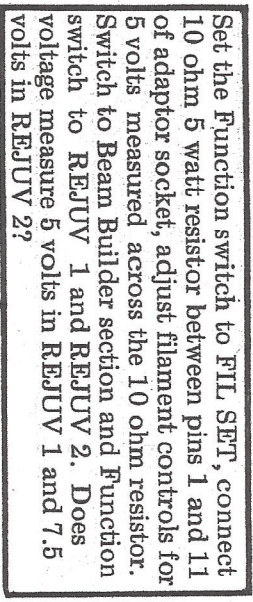
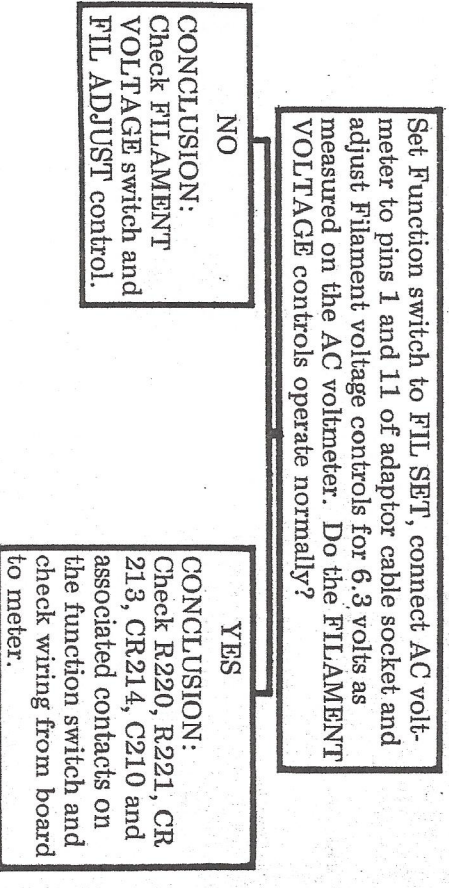
CR31 INOPERATIVE — ALL TESTS

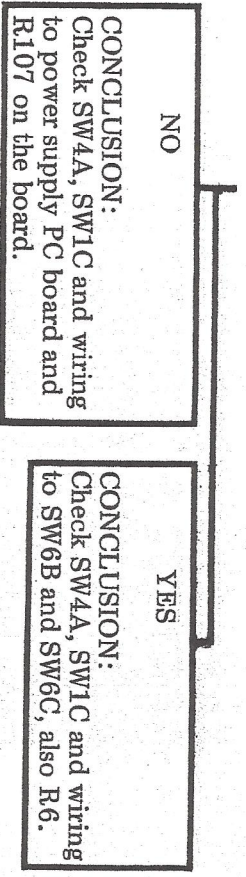


REJUVENATION FUNCTIONS INOPERATIVE



FILAMENT VOLTAGE
Does not read correctly on meter.





GUN BALANCE ERRATIC OR INOPERATIVE

Turn function switch to GUN BAL, connect voltmeter set to measure negative DC volts between pins 2 and 8 of adaptor cable socket and press R/B&W GUN Selector. Check for -20 volts in BIAS switch A position, -35 volts in B, -50 volts in C and -68 volts in D. Repeat using pins 3 and 9 for green gun and 7 and 10 for blue gun. Are all voltages normal?

NO
Are all voltages normal on bias voltage divider R110, R1, R2, R3?

YES
Turn GUN BAL controls to maximum, connect 1.2 Meg resistors between pins 2 and 4, 3 and 5 and 7 and 6 of adaptor cable socket. Do all 3 guns indicate near the lower edge of the GOOD scale on the CR31 meter?

NO
CONCLUSION:
Check CR103 and bias divider resistors

YES
CONCLUSION:
Check wiring between voltage divider and cable socket.

NO
CONCLUSION:
Use simplified schematic of gun balance test to locate the cause of problem.

YES
CONCLUSION:
If CRT filaments are operating normally the GUN BAL test is operating normally. Refer to operating instructions to find possible CRT related causes for erratic operation of the GUN BAL test.

ALL CRT'S TEST SHORTED

Remove socket adaptor from cable. Is short still indicated?

NO
CONCLUSION:
Replace adaptor.

YES
Unplug the Molex connector carrying adaptor cable wires to PC board. Are shorts still indicated?

NO
CONCLUSION:
Repair or replace adaptor cable as necessary.

YES
Turn Function switch to H-K shorts and measure voltage from zero reference to Molex pin 11 on main PC board (R/W wire). Is voltage 100 volts approximately?

NO
CONCLUSION:
Locate the cause of incorrect voltage.

YES
Switch the CR31 off, leave the Function switch in H-K Shorts, measure resistance between zero reference and Molex pin 16 on main PC Board. (100K). Switch to G1 shorts and measure resistance between zero reference and Molex pin 11 (1.1 Meg). Are resistances normal?

NO
CONCLUSION:
 Locate cause of incorrect resistance.

YES
CONCLUSION:
 Measure voltages in circuit of TR204 and check TR204 to locate problem.

ALL COLOR TUBES TEST BAD TRACKING
 (Emission and Gun Balance Tests Normal)

Connect 150K resistors between pins 2 and 4, 3 and 5, and 7 and 6 of adaptor cable socket. Turn the GUN BAL controls to maximum and set the function switch to EMISSION. Press each of the Gun Selector buttons and observe the meter. Do all 3 guns test near full scale on the meter?

NO
CONCLUSION:
 Follow procedure for defective emission.

YES
 Measure the voltage at the source of TR201, 202, 203. Are all voltages within 10% of each other? (11V)

NO
CONCLUSION:
 Check FET where source voltage is different, also FET drain voltage and Gun Selector switch going to gate of FET.

YES
 Measure the voltage at the junction of the two source resistors for TR201, 202, 203. Are voltages all within 10% of each other?

NO
CONCLUSION:
 Check R202 - R207, CR204 - CR209 and associated wiring.

YES
CONCLUSION:
 Check wiring for abnormal source of voltage to M1 while in tracking position of Function switch.

EMISSION TEST READS TOO HIGH OR TOO LOW

NO
CONCLUSION:
 If one gun only reads incorrectly check G2 voltage and connections for that gun. If all three guns read incorrectly, check CR215, R222, M1 and associated wiring.

YES
CONCLUSION:
 If filament voltage is correct, emission test is correctly calibrated. Refer to operation section of manual for probable CRT related causes.

AUTO RESTORE FUNCTION INOPERATIVE

Select the BEAM BUILDER section, set Function switch to MAN 1 position. Connect a voltmeter set to measure 250 volts between pins 2 and 8 of adaptor cable socket. Press the R/B&W button. Is 230 volts present on the meter?

NO
 Connect voltmeter common lead to power supply common (junction of C101, 102). Press RESTORE button. Is voltage present on voltmeter?

YES
 Turn Function switch to AUTO CYCLE position, press RESTORE button. Does 230 volts appear on voltmeter for 4 seconds, OFF 2 seconds, for 3 cycles then disappear?

NO
CONCLUSION:
 Using simplified Auto Cycle schematic check for voltage at SW1B, SW6C, SW4, R225, R224.

YES
CONCLUSION:
 Check R8, SW6B, SW1G and Gun Selector switches and associated wiring.

BOARD LAYOUTS

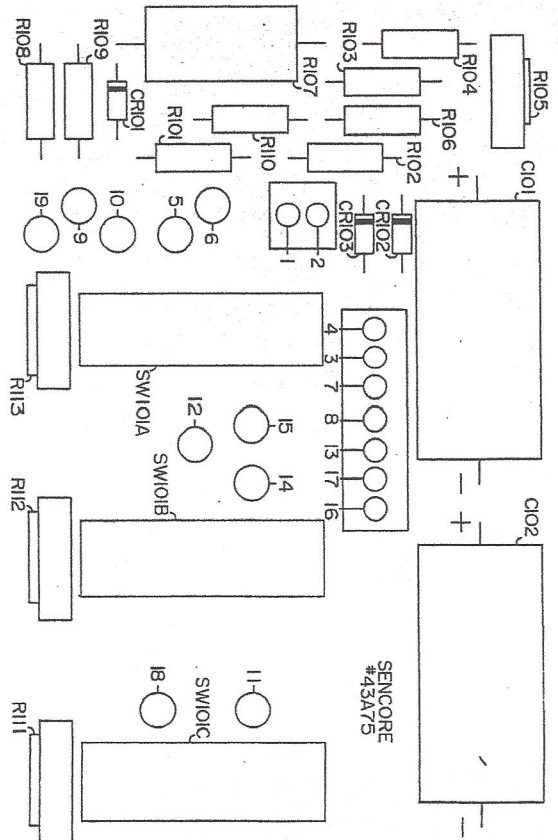


Fig. 16 Component Side View

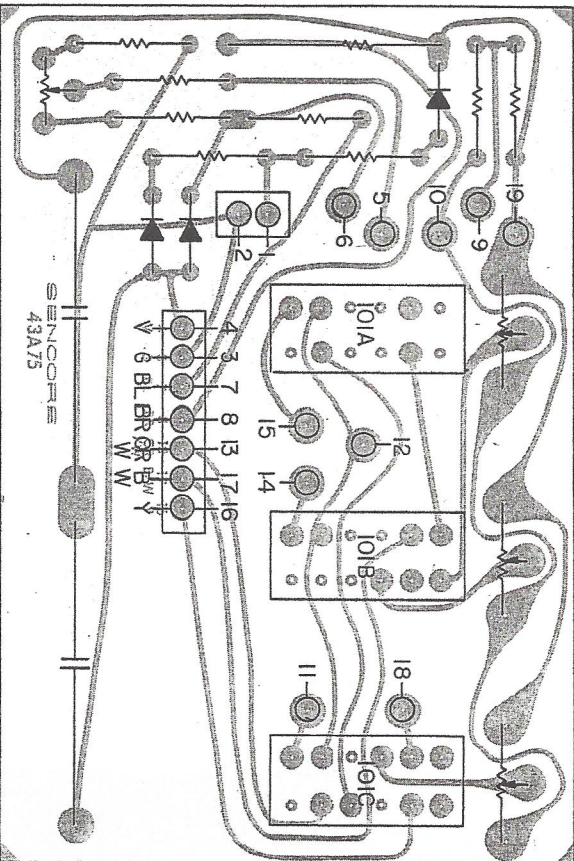


Fig. 17 Foil Side View

NO
Connect common lead of voltmeter, set to measure 10 volts, to C201 negative lead. Touch probe to IC1 pin 10, press RESTORE button. Does 7 volts appear for 4 seconds, zero volts for 2 seconds, for a duration of 3 cycles?

YES
CONCLUSION:
AUTO CYCLE function is normal. If M1 did not indicate during CRT restoration, check R8, SW1E, SW1F and M1.

NO
Touch voltmeter probe to IC1 pin 11 and press RESTORE button. Does voltmeter read zero volts with RESTORE button depressed?

YES
CONCLUSION:
Check TR205 and L201 and associated connections.

NO
CONCLUSION:
Check CR216 and CR217. If they check good the cause could be either IC1 or IC2. Replace as necessary.

YES
CONCLUSION:
Check CR216 and CR217. If they are good replace IC1.

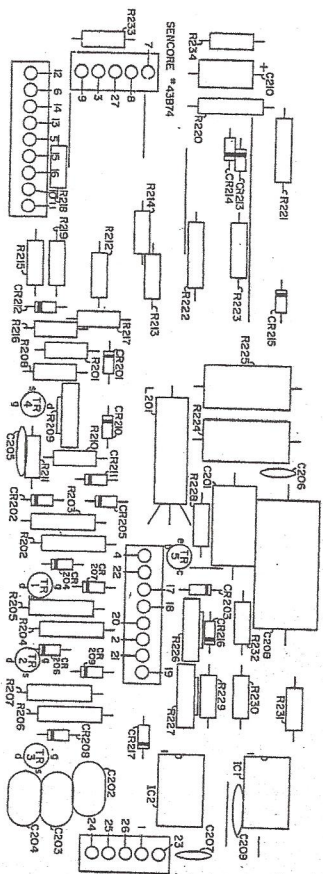


Fig. 18 Component Side View

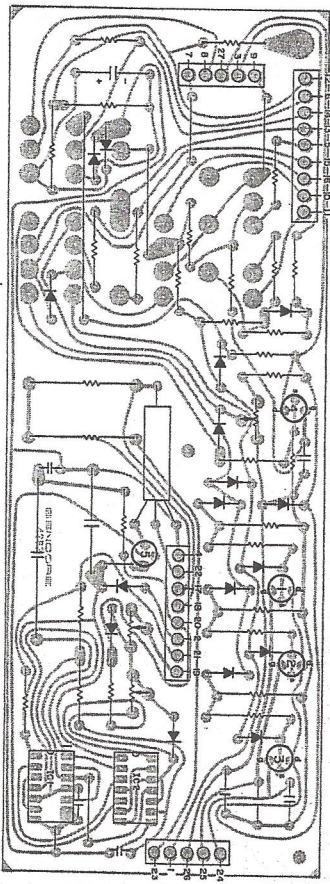


Fig. 19 Foil Side View

SERVICE AND WARRANTY

You have just purchased the finest CRT tester on the market today. The Sencore CR31 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the CR31 is covered by a warranty as explained on the warranty policy enclosed with your instrument.

Sencore has five Regional Offices to serve you. Instruments to be serviced should be returned to the nearest Regional Office by UPS if possible. Parcel Post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the Regional Office. The display carton is not an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own CR31 CRT Tester, we have included a schematic, trouble chart, and parts list. Any of these parts may be ordered directly from the Regional Office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

SENCORE REGIONAL OFFICES:

Sencore East Central
4105 Duke Street
Alexandria, VA 22304
703 751-3556

Sencore Central
2711 B Curtis Street
Downers Grove, IL 60515
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Sencore Western Coast
833 Mahler Road
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