MOTOROLA

The AC LINE REGULATOR in QUASAR™ TV

How it Works

the Story of

Optimum Performance
Extended Reliability
Simplified Service

FROM THE NATIONAL SERVICE DEPT
MOTOROLA CONSUMER PRODUCTS

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"AC" LINE REGULATION
In
Motorola Quasar TV Receivers

Table of Contents

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I N T R O D

WHY AC Line Regulation! What are the BENEFITS to YOUR CUSTOMERS?

1. OPTIMIZED PERFORMANCE

Regardless of input line voltage, the Motorola AC Line Regulator provides the proper supply voltages to all the circuits. This means each Quasar TV receiver will operate exactly as it was designed . . . . optimized performance everywhere, all the time.

2. EXTENDED LIFE

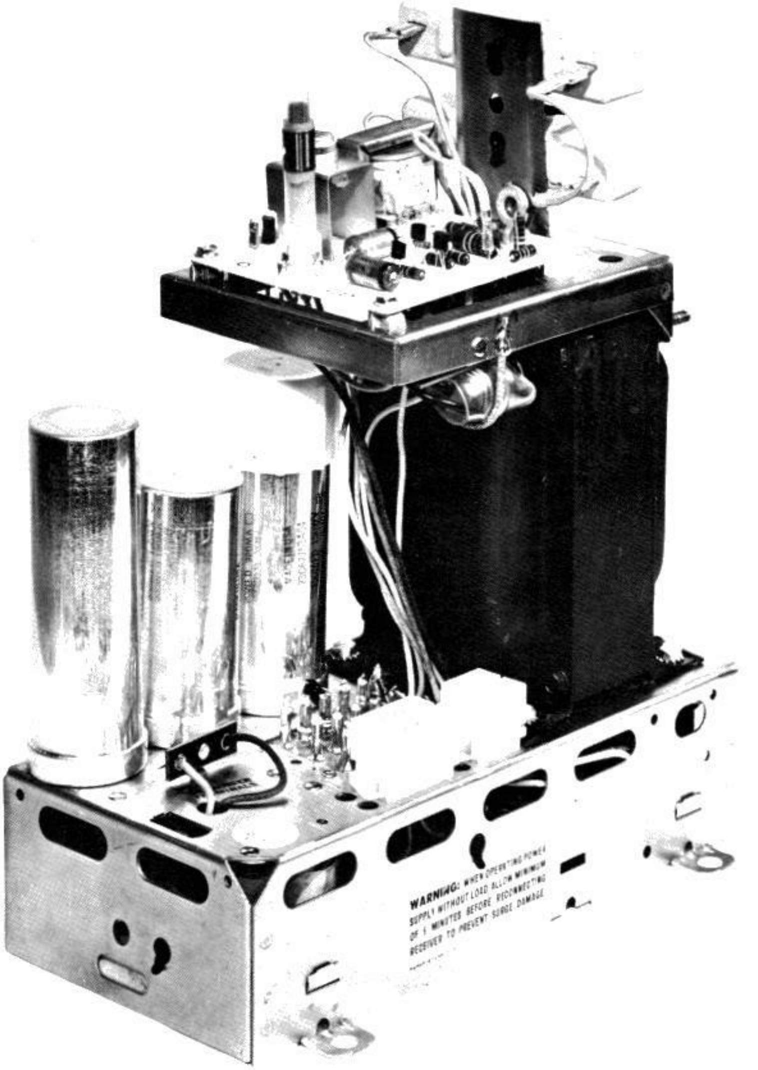
All circuits receive the right amount of voltage . . . . not too much or too little. This avoids overheating . . . . overworking . . . . voltage breakdowns and all the other causes of premature failures.

3. SIMPLIFIED SERVICE

All voltages from the power transformers and supplies are essentially constant. This makes variations easier to identify. Operating characteristics can be isolated to the offending circuits rapidly if the service technician knows the supply voltages are right.

WHAT ABOUT COMPETITIVE EQUIPMENT?

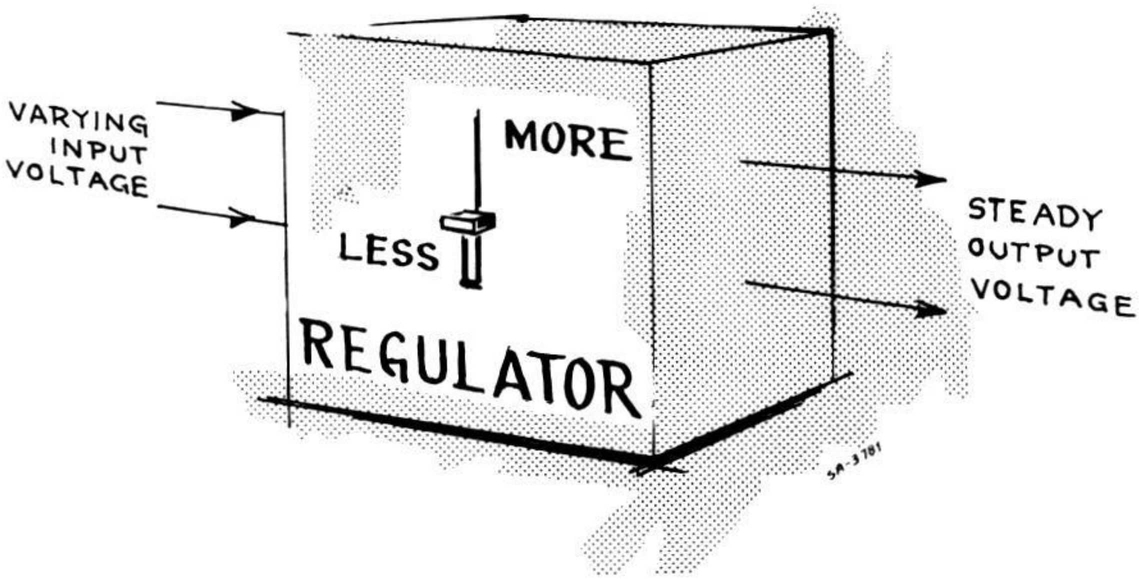
Other sets have "taps" on the primaries . . . . some even have switches to make it easier to select the desired tap. This is okay if the line voltage is always the same, but offers little customer "protection" if the line voltage changes!



The Complete Quasar TV AC Regulated Power Supply Assembly.

The Line Regulator Panel (Z) contains all the Regulator components except the two 50-watt Resistors.

HOW THE REGULATOR WORKS



I. WHAT IS REGULATION?

A. Regulation provides a constant output voltage, even though the input voltage changes.

B. Voltage regulation is possible for AC sources as well as for DC.

C. The Motorola AC Line Regulator provides a constant 105 Volts AC to the Quasar TV over a wide range of AC line voltages.

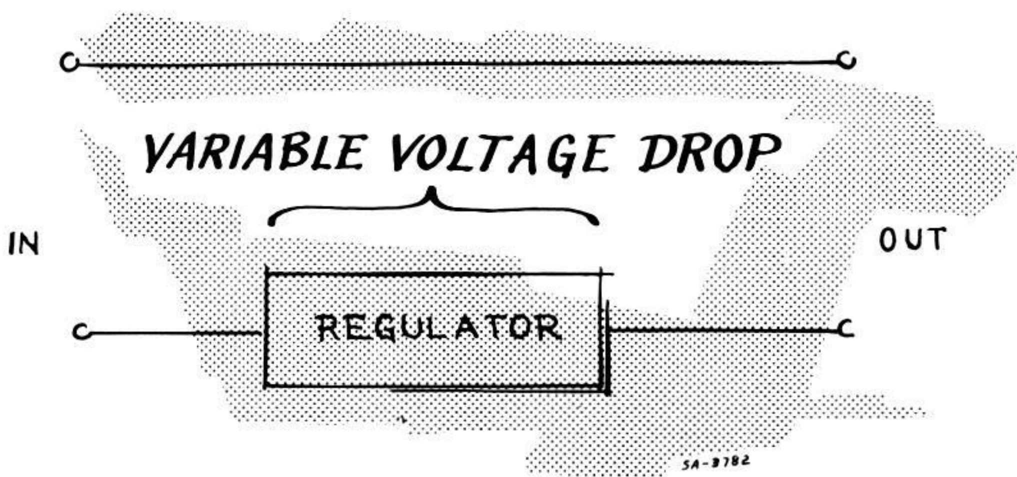
2. WHAT'S THE BASIC IDEA!

A. The regulator is actually in SERIES and provides a "voltage drop" between the input and the regulated output.

B. Makes use of "Kirchoff's Law" . . . . in a series circuit, the sum of the circuit voltage drops is equal to the applied voltage.

C. The input voltage must be equal to or greater than the desired output voltage.

D. If the input is higher than the desired output, the "extra" voltage must appear across the regulator.



3. HOW ABOUT SOME EXAMPLES? Suppose The AC Line Varies Between 105 And 125 Volts!

A. In the chart, we see that for an input of 105 volts, the regulator must look like a short and produce no drop.

INPUT	REGULATOR	OUTPUT
105 V	?	105 V
125 V	?	105 V
115 V	?	105 V

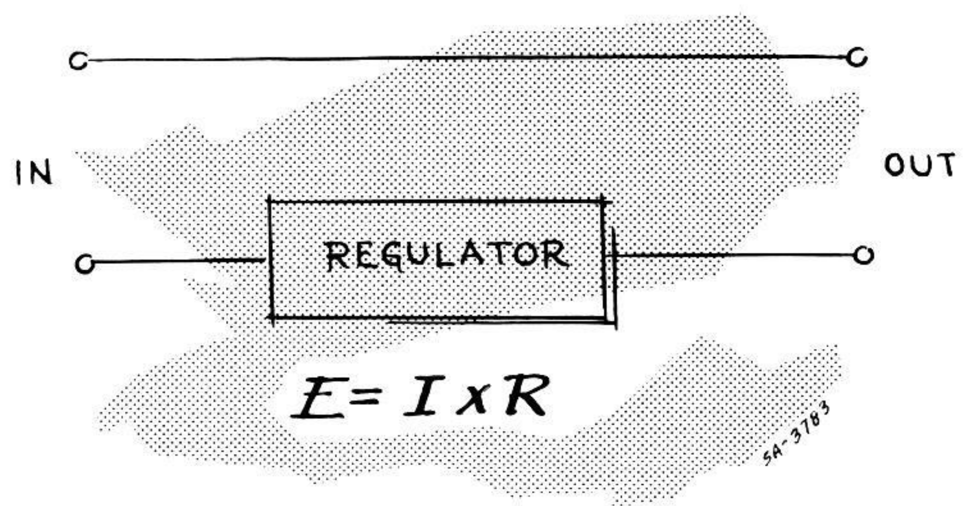
SA-3794

B. For a maximum input of 125 volts, the regulator causes a 20-volt drop. (115 - 105 = 20).

C. With an input of 115 volts, the regulator should cause a 10-volt drop. (115 - 105 = 10).

D. From this we see how we maintain a constant 105-volt output by controlling the drop at the regulator.

4. HOW DO WE GET A VOLTAGE DROP? How Can We Control How Much Drop Is Produced?



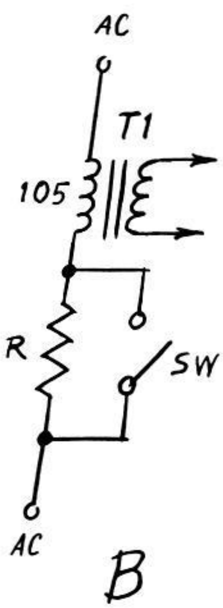
A. To answer this question we go back to another basic concept: OHM'S LAW, which says that voltage loss or drop is caused by forcing current through resistance. You'll recognize . . . . E = I x R.

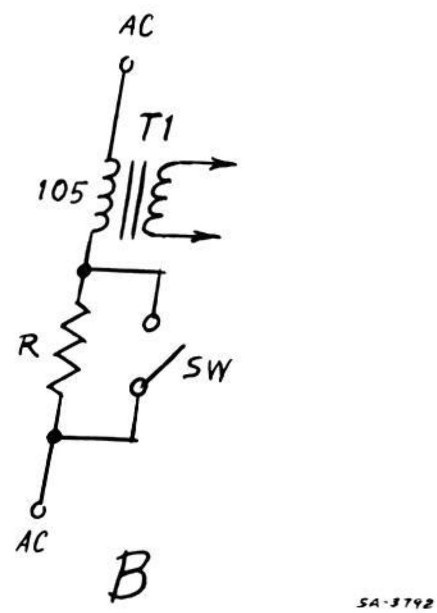
B. Thus, if we want to change this voltage, all we need to do is (1) use a variable resistor or (2) change the amount of current through a fixed resistor.

5. HOW DOES MOTOROLA CONTROL THE REGULATOR VOLTAGE?

A. Lets look first at A, the basic circuit.

B. Resistor R is placed in series with the primary of T1. Thus, we have a fixed resistor and will control the current through it.





C. In B, a switch is placed across the resistor. When the switch is open the current must go through the resistor. When the switch is closed, there is neither current through R nor voltage drop across the resistor.

6. LETS LOOK AT THAT CHART AGAIN! When Do We Close The Switch?

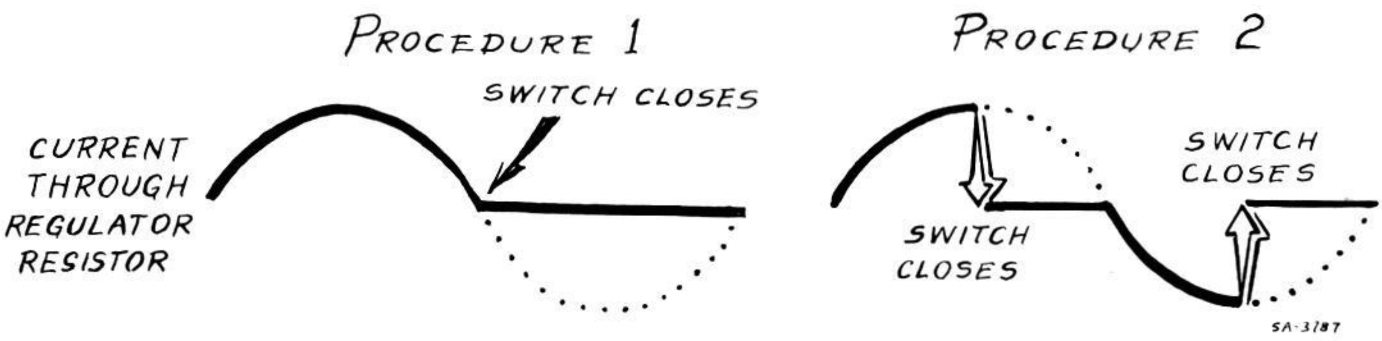
INPUT	OUTPUT	VOLTAGE DROP	SWITCH
105 V	105 V	0 V	?
125 V	105 V	20 V	?
115 V	105 V	10 V	?

SA-3195

A. The first is easy to see. When the input is 105 volts, we can close the switch, there will be no drop across the regulator resistor, and the output is 105 volts.

B. The 125-volt input is just as easy. Leave the switch open and the current will produce the 20-volt loss.

C. 115 volts is something else. Looks like the switch will have to be open half the time and closed the other half. This will reduce the current through the resistor to one-half and cause one-half the voltage drop.



7. LET'S LOOK AT THAT OPEN-CLOSED SWITCH A LITTLE CLOSER. There Are Several Possibilities.

A. In procedure 1 the switch would be open for one-half cycle (one alternation) and closed for the next.

B. While this would reduce the total current through R to one-half, this is NOT a good procedure.

C. In number 1 the current in the transformer is greater in one direction than in the other. This is the same as putting some DC through the primary .... it will overheat ... or open the circuit breaker.

D. Procedure 2 is a better solution .... this is the system we want. Each alternation must be treated the same way.

8. NOW LET'S EXPAND THAT CHART.

INPUT	OUTPUT	VOLTAGE DROP	SWITCH	CURRENT
105 V	105 V	0 V	CLOSED	
125 V	105 V	20 V	OPEN	
115 V	105 V	10 V	OPEN / CLOSED	

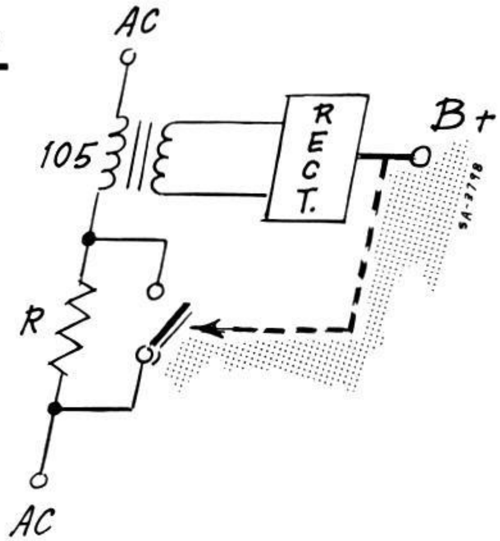
A. To control the amount of voltage drop across the regulator we merely leave the switch open, or close it.

B. For a high input voltage, we need a large drop, so the switch will be left open longer.

C. If the line voltage is low, we don't want much current through the resistor, so the switch will be closed early during each alternation.

D. The switch must close at the same point in each alternation.

9. WHAT TELLS THE SWITCH TO STAY OPEN OR TO CLOSE?



A. The receiver "B+" point is a real good "sensor".

B. If the AC wants to increase or decrease, the first place it will effect is B+.

C. If the line (and B+) starts to increase, we want to increase the voltage drop across R, so the switch will have to stay open longer.

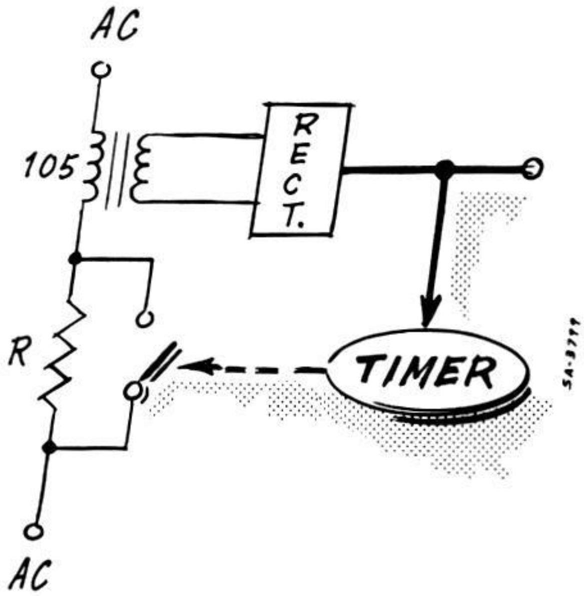
D. The opposite action is needed for a decreasing line voltage. Less B+ will have to close that switch near the beginning of each alternation.

10. LOOKS LIKE B+ WILL HAVE TO CONTROL A TIMER!

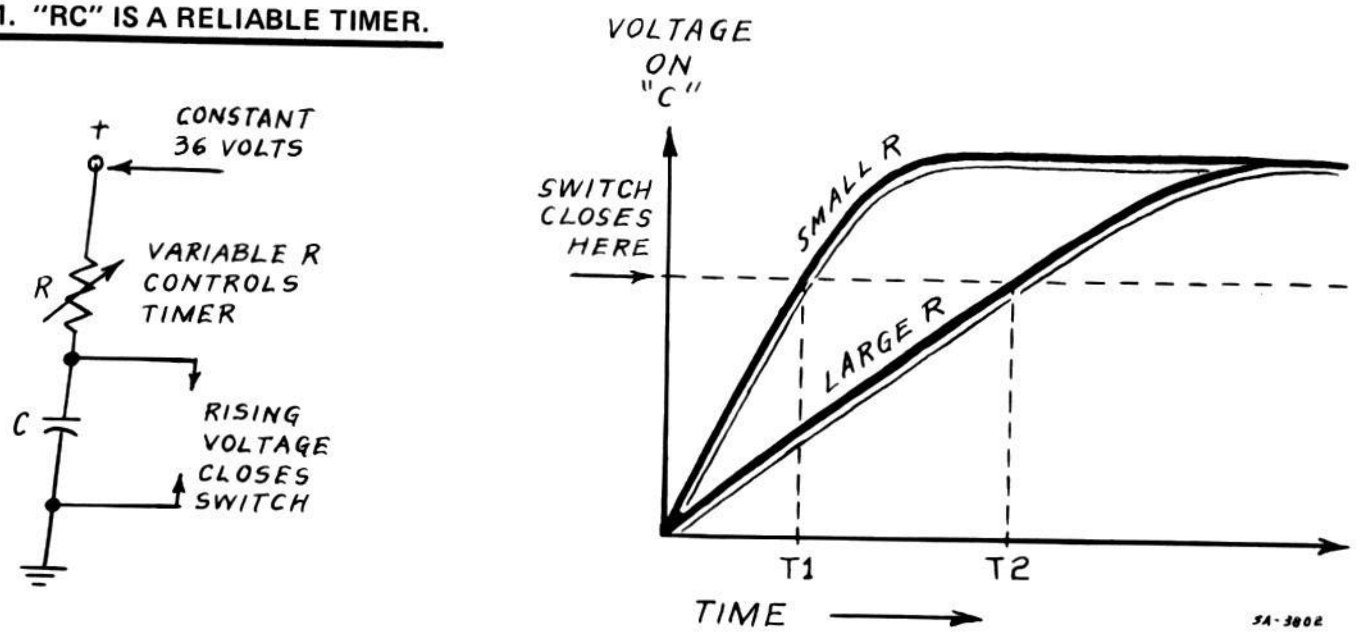
A. Any change in B+ alters the timer to OPPOSE the original change.

B. A higher B+ slows down the timer so the switch stays open longer.

C. A lower B+ speeds up the timer and reduces the drop across the regulator.



11. "RC" IS A RELIABLE TIMER.



A. The "RC time constant" makes a good timing device . . . . simple and reliable.

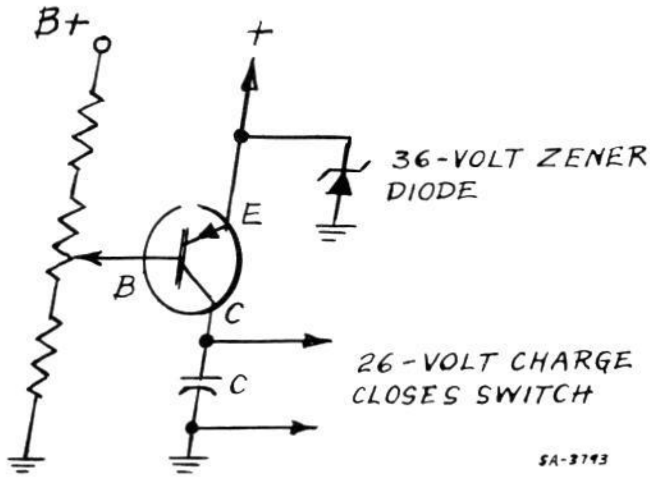
B. The voltage (charge) on C is used to close the regulator switch.

C. A small R allows a high charging current and C charges rapidly.

D. A larger R reduces the charging current into the capacitor; it takes longer for C to charge up and close the switch.

12. A TRANSISTOR MAKES A GOOD VARIABLE RESISTOR IN OUR RC TIMER.

A. The conductivity (resistance) of transistor Q1 determines how long it takes for C to charge to 26 volts and close the switch.



B. The changing current through the transistor is determined by the E-B forward bias.

C. The emitter is always the same . . . . +36 volts. The base varies with changes in B+.

D. If B+ goes up, the base (N-material) swings positive. This REDUCES the forward bias and there is less charging current.

E. Less B+ makes the base less positive and increases the forward bias . . . . .more current.

13. HOW ABOUT A CHART ON THIS ACTION?

A. Our chart is self-instructive but we'll summarize:

If the line voltage increases, we'll need a larger voltage drop, so the timer must slow up and keep the switch open. This is caused by the reduced forward bias on the transistor.

A lower line voltage must cause the switch to close early, in order to produce less voltage loss at the regulator. The increased forward bias on Q1 speeds up the timer as required.

B. By connecting the Base of Q1 into the B+ circuit we have accomplished our goal. This "B+" point is the unfiltered or "raw B+" directly at the rectifier output.

LINE	B+	Q1 BIAS (FORWARD)	CURRENT (IN Q1)	TIMER	SWITCH	VOLTAGE DROP
GOES UP	RISES	LESS	LESS	SLOWS DOWN	DELAYED CLOSING	INCREASES
GOES DOWN	DOWN	MORE	MORE	SPEEDS UP	EARLY CLOSING	DECREASES

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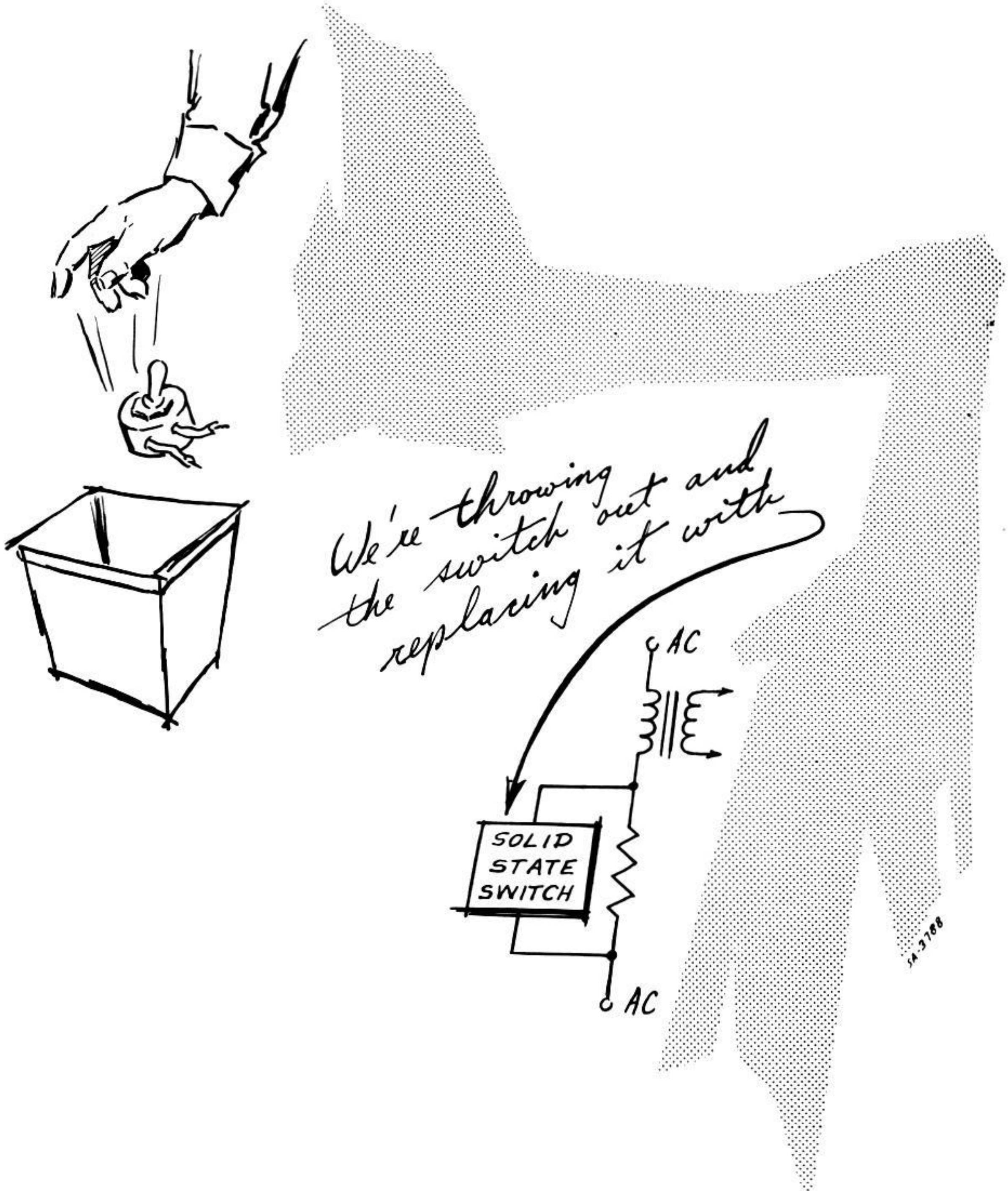
14. DO WE REALLY USE A "SWITCH" TO BYPASS THE REGULATOR RESISTOR?



A. Of course we wouldn't use a MECHANICAL switch, but we can substitute a highly-reliable and efficient solid-state switch.

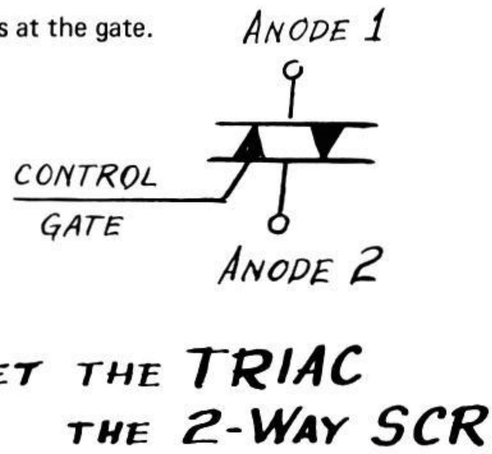
15. WHAT KIND OF SOLID-STATE SWITCH IS USED? Review Of SCR (And Triac) Action.

A. Acts just like a power rectifier, only you have to turn them on (fire them) with a gate voltage.

B. Once they "FIRE" they STAY ON regardless of what happens at the gate.

C. Once fired, TRIACS conduct as long as the A1 - A2 circuit maintains current. (There is a minimum current called the Holding Current.)

D. The TRIAC can be turned on or fired by a pulse of either polarity.



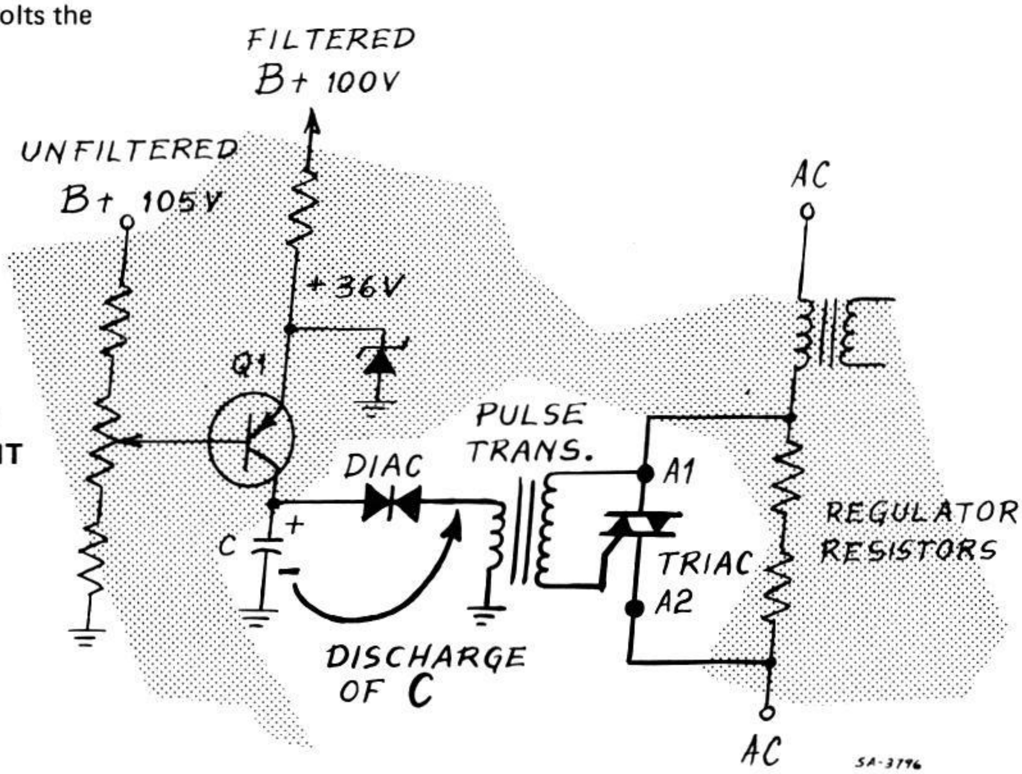
16. LET'S SEE THE SWITCH CIRCUIT

A. The capacitor is essentially in parallel with the primary of a pulse transformer. But if connected DIRECTLY, the primary would short C and prevent any charge.

B. A DIAC (a back-to-back pair of diodes that act like the emitter-collector of a transistor) allows the capacitor to charge in the normal manner.

C. When C charges to 26 volts the DIAC "breaks down" and is conductive.

THE SWITCH (TRIAC) CONTROL CIRCUIT



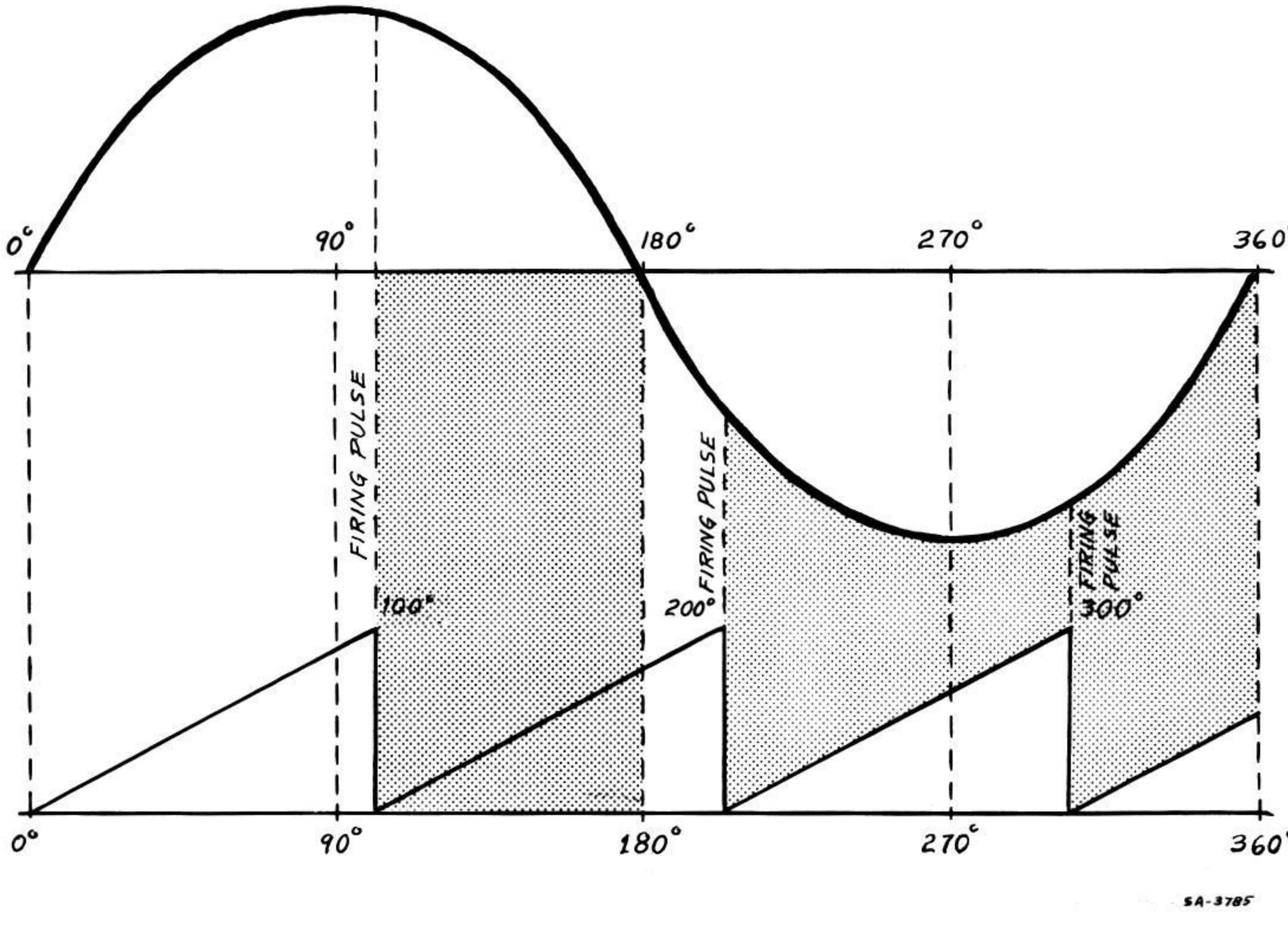
D. The capacitor now discharges rapidly through the pulse transformer.

E. This current produces a secondary pulse and fires (turns on) the TRIAC.

17. ONE MORE "PROBLEM" TO SOLVE!

SITUATION:

Assume that line conditions call for the timer to require 100 degrees to reach 26 volts and fire the TRIAC. Assume that the timer starts again and reaches a second firing point at 200 degrees, etc.



A. During the first alternation of applied AC the TRIAC fires at the 100 degrees point.

B. During the second alternation, the TRIAC is fired at 200 degrees, or just 20 degrees into the second alternation.

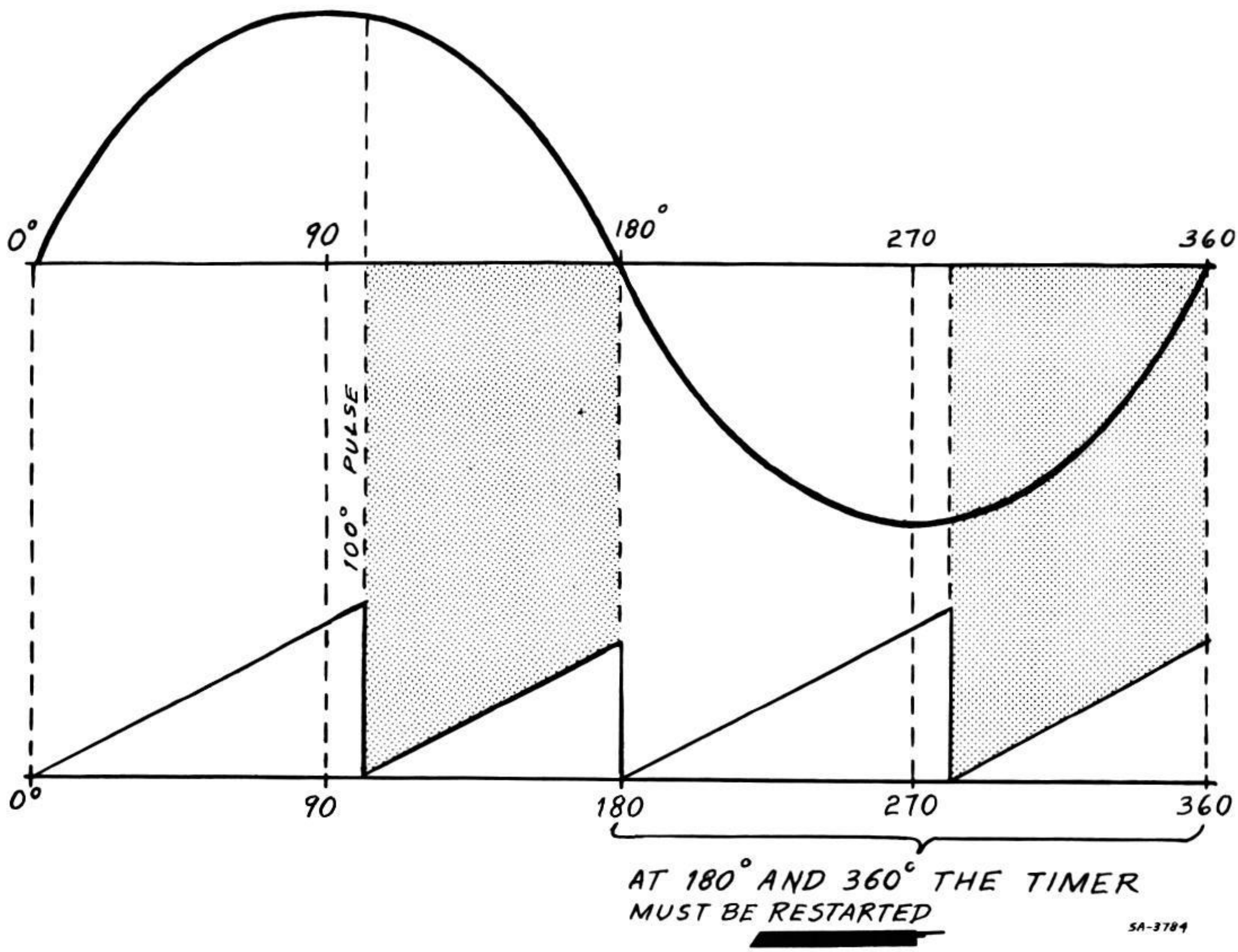
C. The following "firings" are somewhat haphazard and produce unbalanced primary currents (DC) and open the circuit breaker.

18. SOME "SYNCHRONIZING" IS NEEDED.

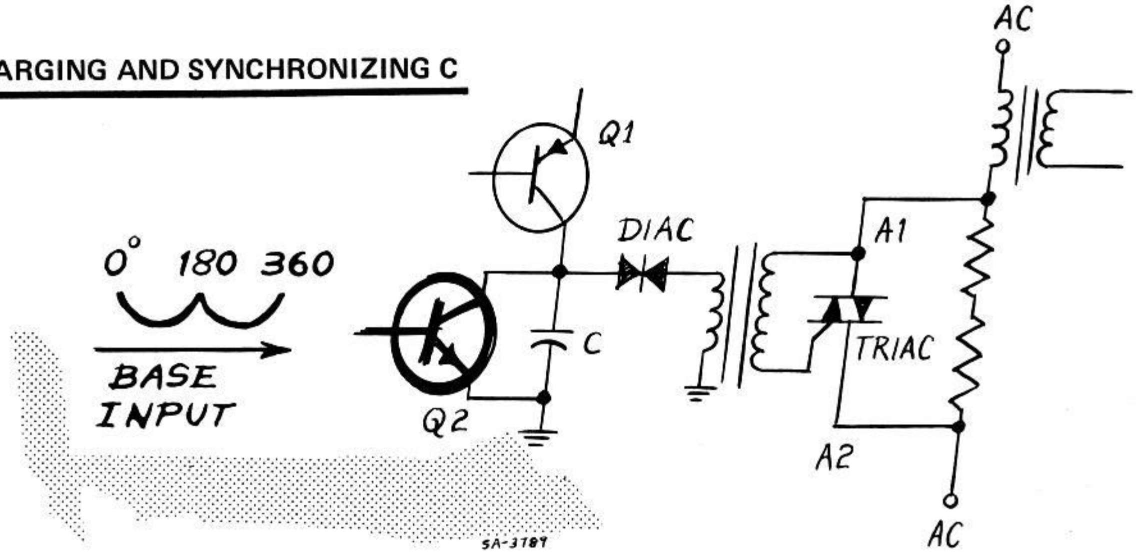
SOLUTION: At the BEGINNING of each alternation the timer must be restarted so that it turns on the TRIAC at the same point in every alternation.

A. The timer can be restarted by DISCHARGING the capacitor.

B. Thus, at 0 degrees, 180 degrees, 360 degrees etc., the capacitor must be discharged.



19. DISCHARGING AND SYNCHRONIZING C



A. With a NPN transistor across C, the base should go POSITIVE at 0 degrees, 180 degrees, 360 degrees, etc., to drive the transistor into conduction and discharge C at these points.

B. At all other times Q2 should be non-conductive: the base must be negative.

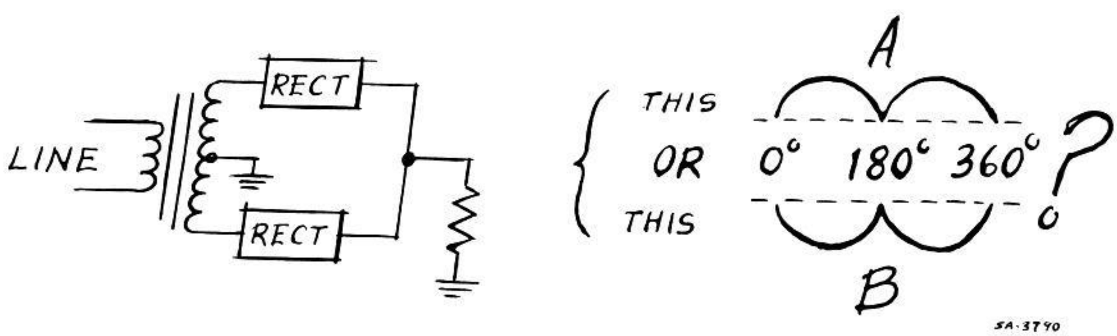
20. SYNC PULSE DEVELOPMENT PROBLEM: HOW TO CONNECT THE RECTIFIERS.

A. First, to provide pulses at 0 degrees, 180 degrees, 360 degrees, etc., full-wave rectification is needed.

B. Rectifiers can be connected to provide a "+" or a "-" output.

C. However, we are concerned with the DIRECTION of the waveform at 0 degrees, etc.

D. Waveform A is a POSITIVE output voltage, BUT, look at the direction for synchronization!

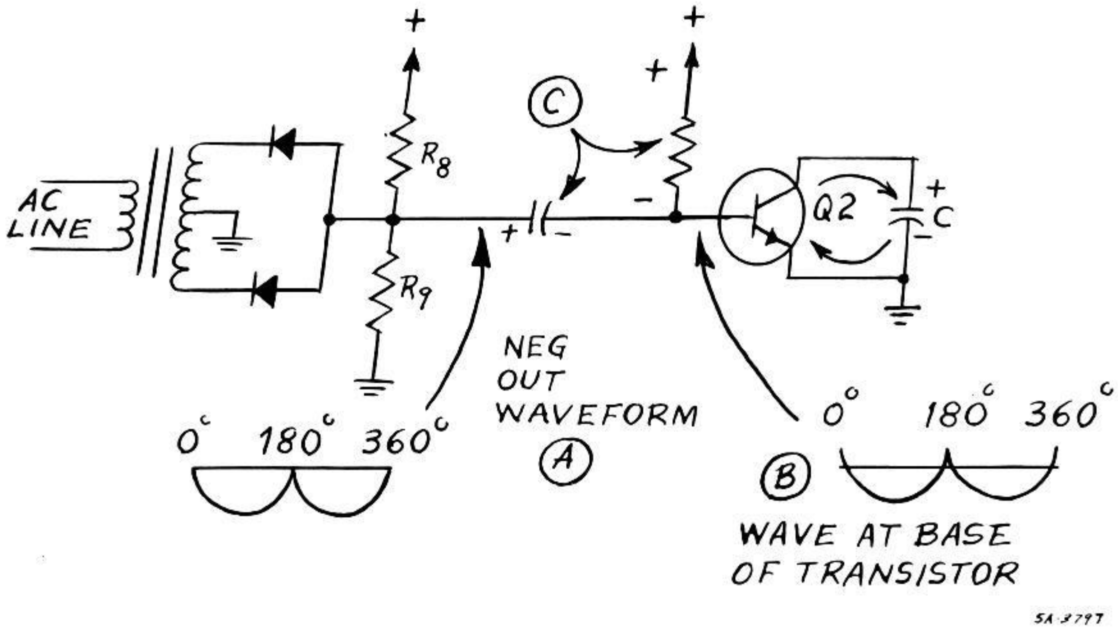


E. Obviously, B is the desired wave. The rectifiers must be connected for a NEGATIVE output waveform.

21. POSITIVE-GOING SYNC PULSES

At (A) we find the negative output from the full-wave rectifier.

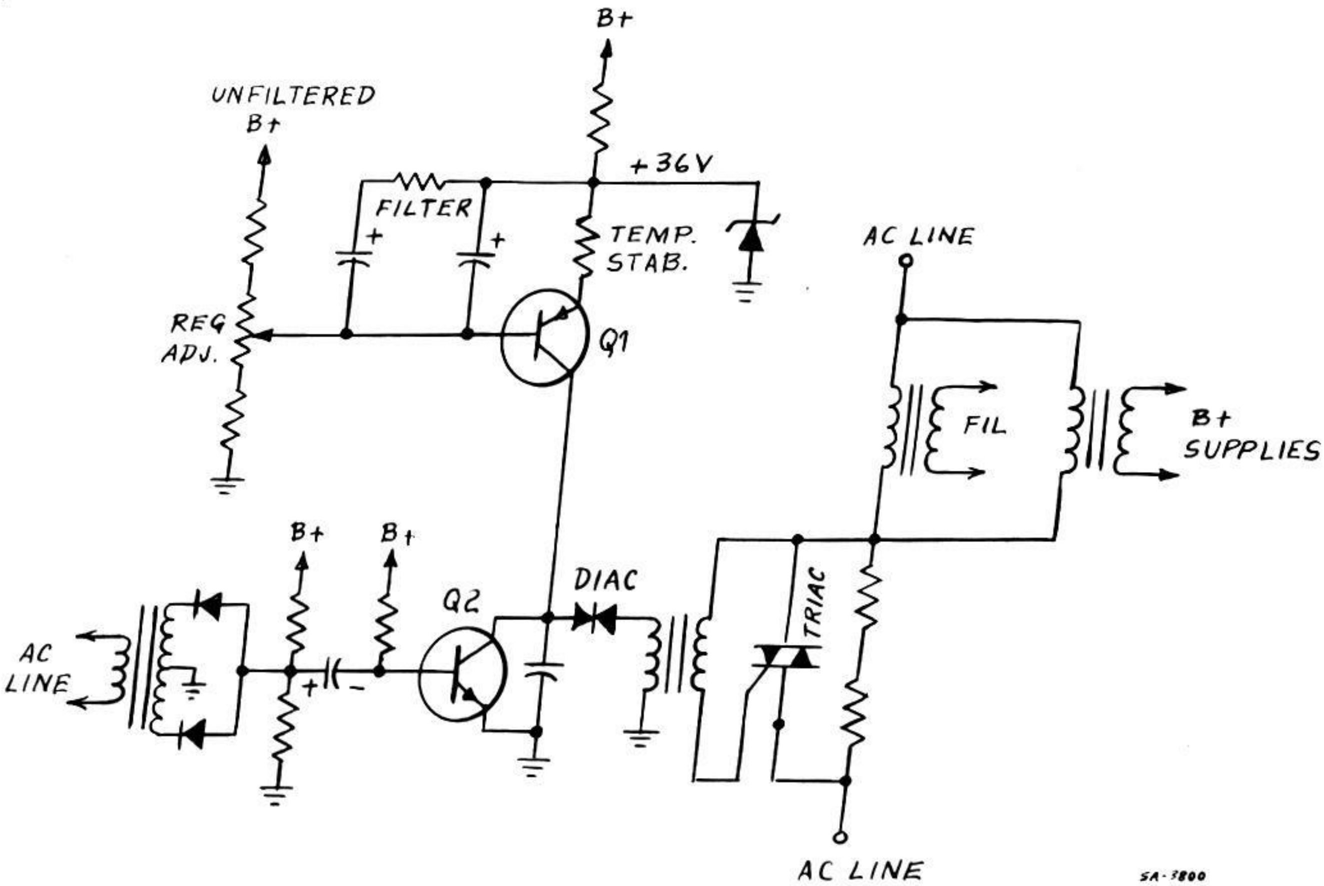
At (B) the peaks are now positive due to the blocking-coupling action of the capacitor. (Action same as in RC coupled amplifiers.)



At (C) we find an RC combination which makes Q2 operate in "Class C" . . . . beyond cutoff except during positive pulses. (Action same as grid-leak bias for tubes. We'll call it base-leak bias.)

A small positive voltage from the divider (R8 and R9) gives optimum conduction and waveform at the rectifiers.

22. THE COMPLETE REGULATOR



NEWLY ADDED

A. An emitter resistor in Q1 provides for timer stability with temperature variation.

B. A filter between E-B of Q1 makes timer immune to 120-cycle variations of the unfiltered B+ supply line.

C. A potentiometer in the Q1 Base provides adjustment to designed mode of operation.

D. The picture tube filament supply and B+ supplies are all regulated by maintaining a constant primary voltage.

CHARACTERISTICS

1. RANGE OF VOLTAGE

Nominally, the regulator provides an essentially constant voltage for AC input voltage variations between 105 and 130 volts.

These values are typical for average brightness viewing. At higher brightness settings, the regulation range increases to higher input voltages.

2. POWER CONSUMPTION

Quasar receivers with regulated power supplies consume approximately 25 watts of additional power. Nearly all this power is dissipated in two 50-watt resistors mounted on the power supply chassis.

3. RESPONSE

The Motorola regulator has a minimum time response of 166 milliseconds. This corresponds to 6cps (Hz). Thus, having a relatively fast response time, sudden changes are quickly followed by regulator action and little if any variation reaches the power supply output.

ADJUSTMENTS

1. PRECAUTIONS

Both AC and DC voltages of high current capacity are present on the regulator panel. Extra care should be exercised when measuring voltages anywhere on or near the panel. An unintentional slip of the meter, scope or other probes, may cause panel damage.

2. ADJUSTING THE REGULATOR

There is only one adjustment on the regulator panel. All panels including replacements are preadjusted at the factory, and adjustment is not usually required as part of "set-up" procedures.

Should adjustment become necessary as evidenced by "under" or "over" picture scan, it is very important to readjust the High Voltage (width) after making the regulator adjustment.

A. REGULATOR ADJUSTMENT

a. Set brightness and contrast controls to minimum (zero beam current).

b. Connect VTVM or VOM (set to 150V DC scale) to terminal 6Z on panel. See accompanying photos.

c. With an insulated tool, adjust regulator control (R5Z) for 105 Volts DC (approximate voltage range is 90 to 120V DC).

B. HV ADJUSTMENT (for regulated power supplies only)

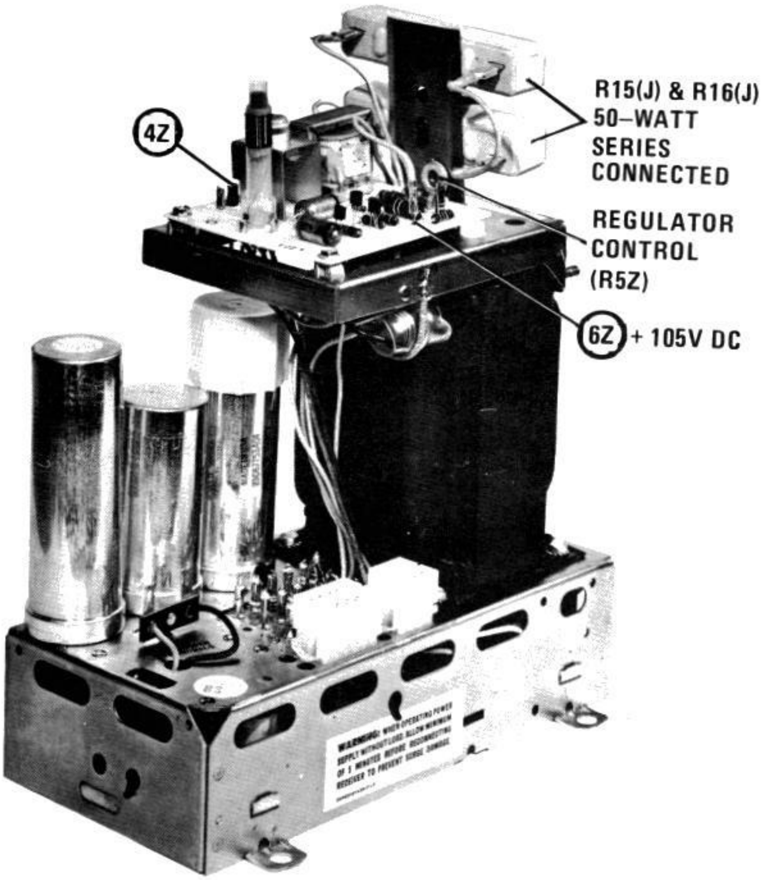
a. Adjust regulator as indicated.

b. Set brightness and contrast for normal picture.

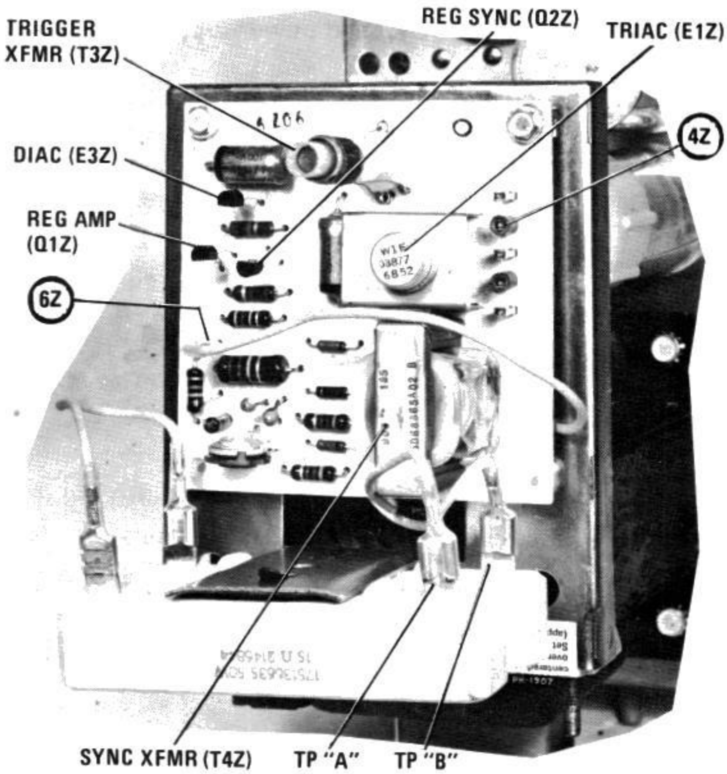
c. Adjust HV control (located on pincushion panel "G") for slight horizontal picture "over-scan".

3. CAUTION

It is unadvisable to adjust the regulator control by monitoring the 105V AC transformer primary voltage with the average VOM or VTVM. Service-type meters are designed and calibrated to measure pure sinewave voltages. The regulator primary voltage is seldom a pure sinewave, due to TRIAC switching. Thus, inaccurate and misleading voltages will be measured on most meters.

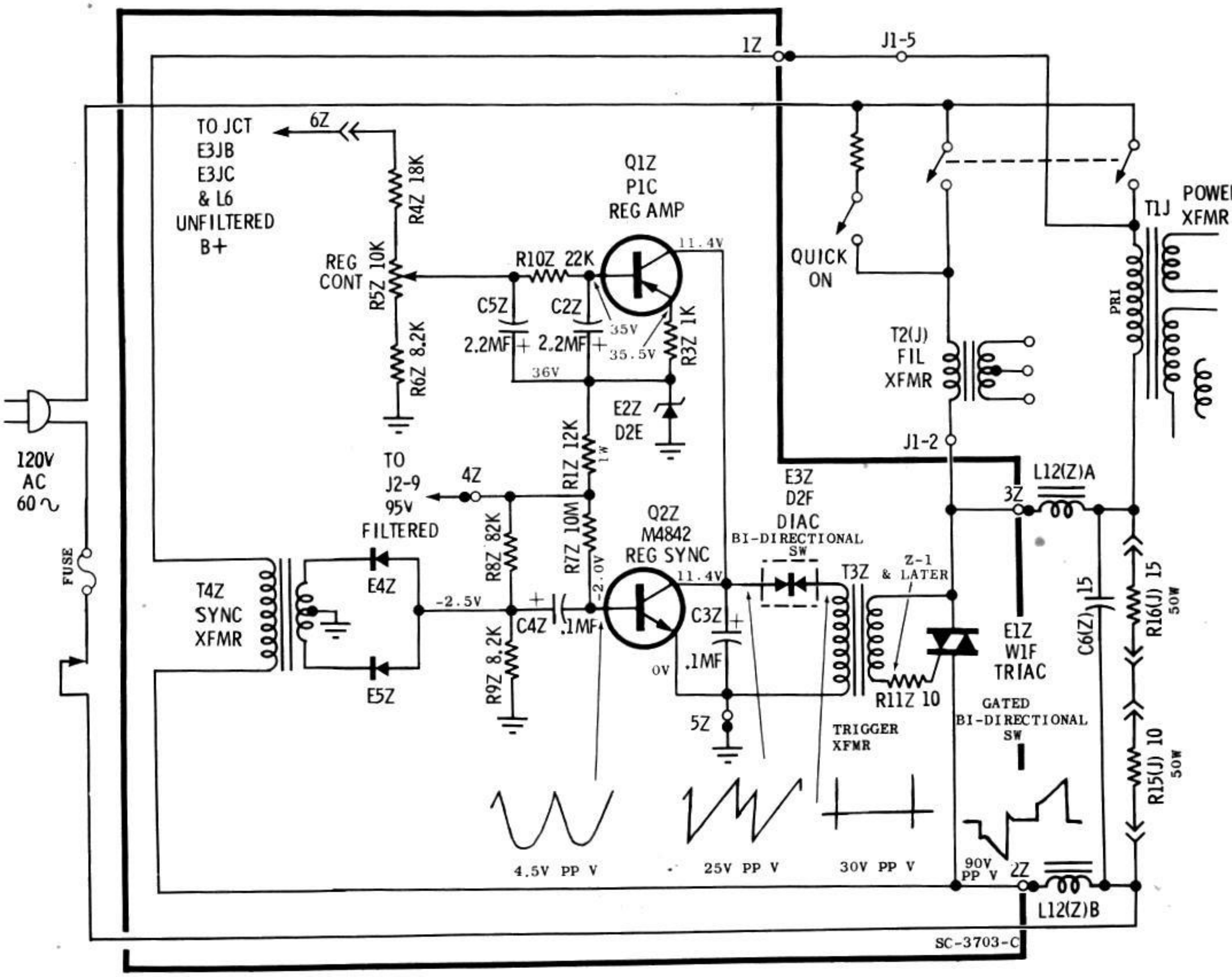


Side View



Top View

AC LINE REGULATOR SCHEMATIC



POWER SUPPLY INTERCHANGEABILITY

The regulated power supply is basically similar to unregulated models, but there are limiting differences in both the power and filament transformers. The primaries are designed for 105V AC operation instead of the usual 120V AC.

Further, the filament transformer is located on the main chassis and is not a part of the power supply assembly. Thus, power supply interchange may produce undesirable results and degradation. For example, replacing a regulated supply with an unregulated one produces excessive CRT filament voltage. The filament transformer primary now operates with full line voltage (120V AC) across its primary instead of the required 105V AC.

A third difference is in the High Voltage transformer. Operation of unregulated supply sets from a regulated supply may produce a narrow picture when the primary voltage is low.

SERVICE PROCEDURES

I. PRELIMINARY

The first step of any logical service procedure is an accurate isolation or identification of thc defective section. One recommended "first step" is the adjustment of related controls . . . . to check for normal action. A control which has little or no effect, or a wrong action, is usually related to the troubled section.

For example, assume a "problem" of small horizontal size. You might first try the power supply adjustment (regulator control). If it can be adjusted properly, next try the sweep adjustment (Horizontal size - HV). Inability to set HV, indicates possible horizontal sweep trouble (Horizontal size - HV).

Once the defective section has been identified, give it a good visual check for loose plug connections, loose or broken wires, overheated or burnt components, etc. . . . . these preliminary checks could save considerable time.

Thus, we have an established procedure. In the following sections we will first attempt to isolate problems either to the regulator or to some other section. A following section gives details on isolation of problems to specific components on the regulator assembly (panel). To assist us in those procedures we have included several trouble isolation charts.

I. A FEW GENERAL SUGGESTIONS

a. Give the receiver a visual check.

b. Make certain all panels are secured to the chassis mounting studs.

c. Be sure that all connecting plugs are tight.

d. Check controls for proper adjustment that may be associated with the trouble. Inability to adjust a control may help isolate the troubled section.

TOOLS REQUIRED

a. Insulated screwdriver.

b. Jumper leads.

c. VTVM or VOM.

2. ISOLATE THE PANEL

All the regulator components and circuitry except for the two series-connected, 50-watt resistors (R15J and R16J) are located on plug-in panel "Z". Thus, regulator troubles can be isolated to either panel "Z" or the two 50-watt resistors.

See the complete regulator circuit . The area outlined in dark border represents the panel. When the panel is removed, there is still AC voltage applied to the power and filament transformers through the two series-connected, 50-watt resistors.

There will be some possible reduction in raster size if the receiver is operated without the panel . . . . this is normal because the B+ voltage is less.

Before a panel is condemned, be certain B+ source voltages are present. There are two source voltages for this panel, +105V DC at 6Z and +100V DC at 4Z. Be extremely careful with your test prods if you measure the voltage at 4Z.

3. USING THE TROUBLESHOOTING CHARTS

PANEL REPLACEMENT

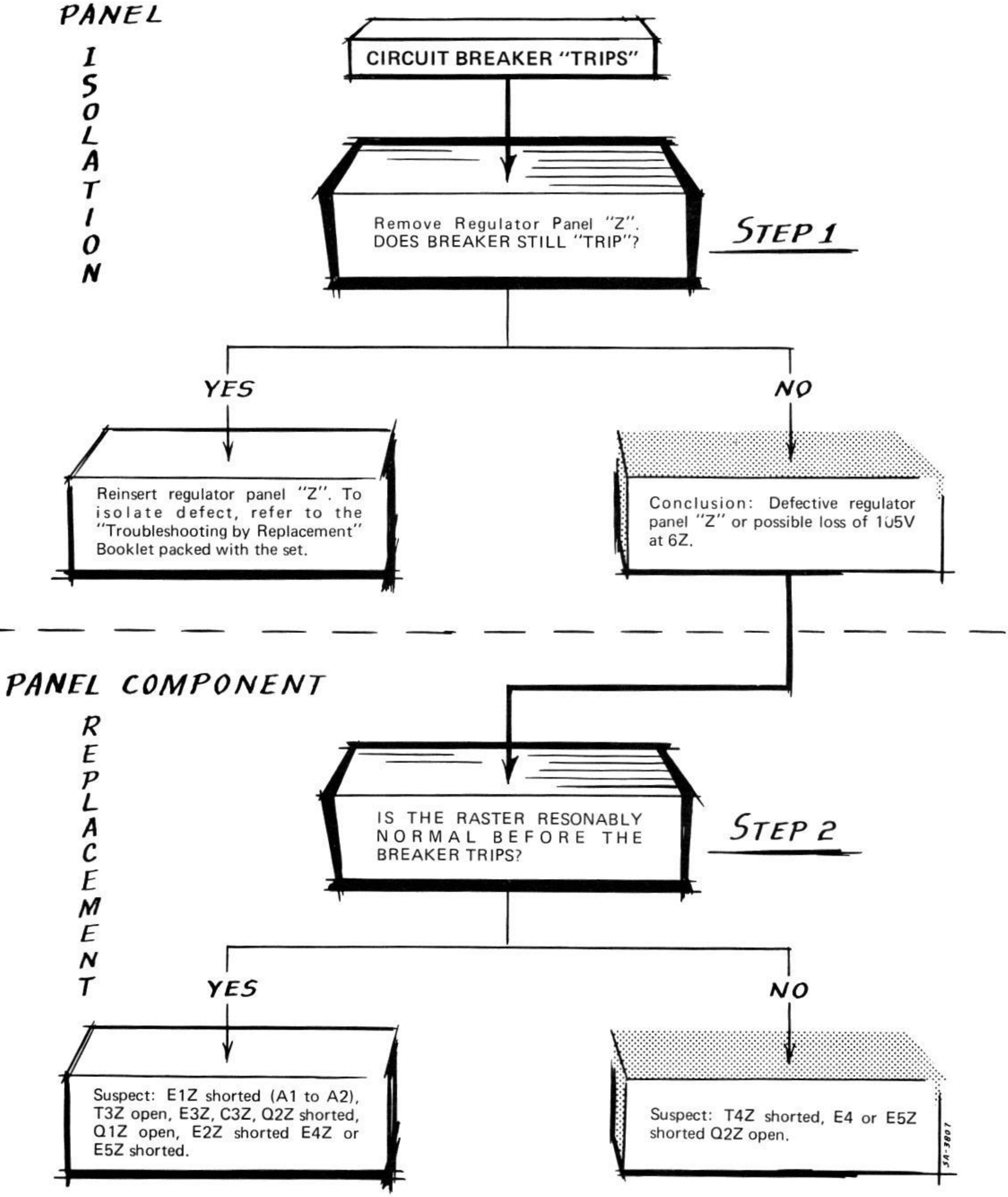
The step-by-step charts are intended to supplement the "Troubleshooting By Panel Replacement" booklet packed with each set. These charts follow the same general format. Refer to the chart corresponding to the symptom and follow the suggested action in each block. The results found for each block leads you to the next block. The last block on the chain gives the conclusion.

ON-PANEL TROUBLES

Panel repair is best accomplished by locating the defective part "in operation". Only in a few instances is it necessary to use static tests, as is the case when a defective panel opens the circuit breaker, etc.

The second half of the troubleshooting charts gives procedures, measurements and components to check for the various problems/symptoms found in the regulator. Analysis of the problems suggests full use of your understanding of how the regulator works.

CHART 21 *



**Charts 1 Through 20 Are In The "Troubleshooting By Panel Replacement" Booklet.*

CHART 22

PANEL ISOLATION

SMALL RASTER SIZE

STEP 1

Connect a jumper lead across the 50-watt resistors (TP "A" & "B" see top view photo.) DOES THE RASTER FILL OUT SUBSTANTIALLY?

YES

Conclusion: Defective regulator panel "Z" or possible loss of 100V at "4Z".

NO

Suspect power supply (not regulator) diodes and related components.

Suspect: E1Z open, E1Z 10 ohm ¼W gate fuse open (also check for shorted E1Z), t3Z open, E3Z leaky or open, C3Z open or shorted, Q2Z shorted, Q1Z open, C2 or C5Z shorted, E2Z shorted.

SA-3808

SPECIFIC COMPONENTS DEFECTS

CHART 23

PANEL ISOLATION

UNSTABLE RASTER SIZE & BRIGHTNESS

STEP 1

Set brightness until raster is just visible. Momentarily connect jumper across both 50W resistors (TP "A" & "B" see top view photo). (If brightness is set too high, circuit breaker may trip.) DOES RASTER AND BRIGHTNESS STABILIZE?

YES

Conclusion: Defective regulator panel "Z" or possible loss of AC line voltage (120V AC) between 1Z & 2Z).

NO

Suspect: Trouble either in low voltage or hi voltage supply sections.

DEFECTIVE PANEL COMPONENTS

Suspect: Q2Z open, C4Z open, E4Z or E5Z, open, T4Z open.

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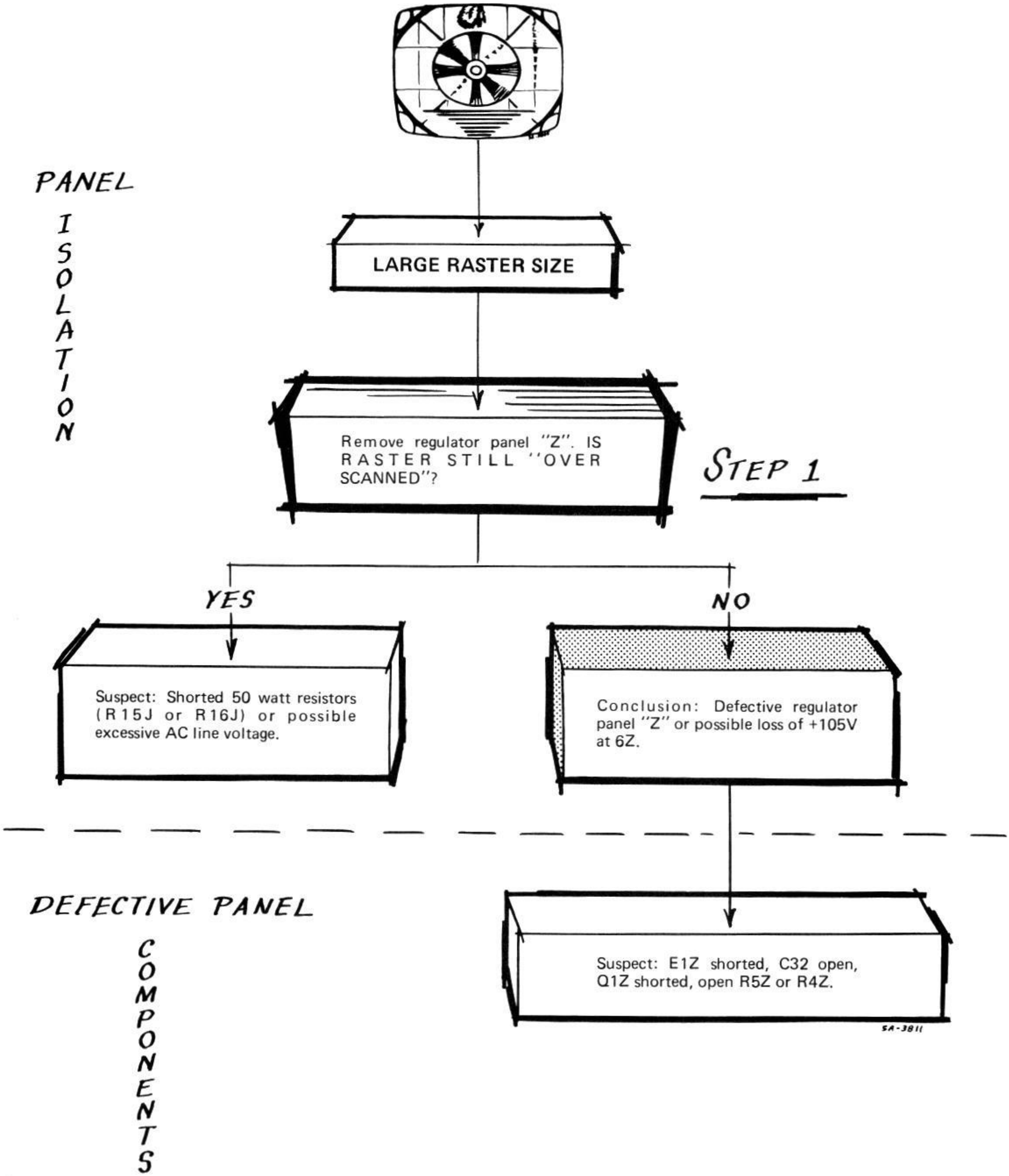
CHART 24


PANEL ISOLATION
LARGE RASTER SIZE
Remove regulator panel "Z". IS RASTER STILL "OVER SCANNED"?
STEP 1
YES
NO
Suspect: Shorted 50 watt resistors (R15J or R16J) or possible excessive AC line voltage.
Conclusion: Defective regulator panel "Z" or possible loss of +105V at 6Z.
DEFECTIVE PANEL COMPONENTS
Suspect: E1Z shorted, C32 open, Q1Z shorted, open R5Z or R4Z.
SA-3811

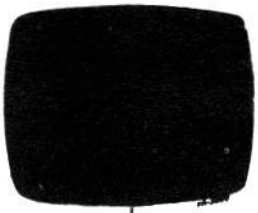


CHART 25

COMPLETELY DEAD RECEIVER

DOES THIS RECEIVER HAVE A REGULATED POWER SUPPLY?

STEP 1

YES

1. Turn set on.
2. Depress circuit breaker momentarily.
3. DOES THE CRT FILAMENT TURN ON AND REMAIN ON?

NO

Refer to the "Troubleshooting By Panel Replacement" booklet, Chart No. 4.

YES

If there is still no raster or sound, see the "Troubleshooting By Panel Replacement" booklet, Chart No. 9.

NO

STEP 2

1. Remove regulator panel "Z".
2. Depress circuit breaker momentarily.
3. DOES THE CRT FILAMENT TURN ON AND REMAIN ON?

YES

Conclusion: Defective regulator panel "Z".

NO

STEP 3

1. Reinsert "Z" panel.
2. Locate the two 50-watt resistors (R15J and R16J) on top of the power supply.
3. Connect a jumper across each resitor, one at a time and depress breaker.
4. DOES THE CRT FILAMENT TURN ON AND REMAIN ON?

YES

Conclusion: Open 50-watt resistor, R15J or R16J. The resistor with the jumper across it is open.

NO

Refer to the "Troubleshooting By Panel Replacement" booklet, Chart No. 4.

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LAB STUDY GUIDE

EQUIPMENT REQUIRED

Schematic . . . Part No. 68P65129A39E
VTVM or VOM.
Quasar TV with Regulated Supply.

PROCEDURES

1. On the regulator panel "Z", there are seven solid-state components (diodes, diacs, triacs, and transistors). List each one below.

NAME	REFERENCE NO.
1. ______	______
2. ______	______
3. ______	______
4. ______	______
5. ______	______
6. ______	______
7. ______	______

2. Are there any other additional components for the regulated power supply besides the "Z" panel and two 50-watt resistors (R15J and R16J).

   a. ______

3. The CRT filament and B+ voltages are maintained relatively constant over what range of AC line voltage?

   a. From ______ VAC to ______ VAC

4. An additional 25 watts of power is required for the regulated supply. Specifically where is the majority of this power dissipated?

a. ______________________________

5. Should extra care be taken when checking voltages on the regulator panel? Why?

a. ______________________________

b. ______________________________

____

ADJUSTING THE REGULATOR

6. How many adjustable controls are located on the "Z" panel?

a ______________________________

7. If the regulator control is misadjusted, what picture symptoms may result?

a. ______________________________

b ______________________________

8. Because of the TRIAC switching, the filament and power transformer primaries seldom contain pure sinewave voltages. (a) Can these non-sinewave primary voltages be accurately measured with the average VOM or VTVM. (b) Why?

a. ______________________________

b ______________________________

Adjust the regulator per procedure. Record the DC voltage readings at the two extreme settings of the regulator control.

MINIMUM :__________V DC MAXIMUM:__________V DC.

REGULATOR ADJUSTMENT PROCEDURE

9. Is the regulator adjustment made with or without a raster?

a. ______________________________

10. Where is the DC voltmeter connected to adjust the regulator control? What should this voltage measure with proper adjustment?

a. ______________________________

b. ______________________________ volts DC.

11. Does adjusting the regulator control affect the HV?

a. YES____________________NO________________

12. To set the HV, simply adjust the HV control (horizontal size) for slight horizontal overscan. Is this the same procedure for non-regulated power supplies?

a. YES____________________NO________________

POWER SUPPLY INTERCHANGEABILITY

13. The power and filament transformers in the regulated supply are different than those in the unregulated supply. What is the difference?

a. ____

14. Where is the filament transformer located (physically)?

a. ____

15. Regulated and unregulated supplies are not interchangeable. (a) Why? (b) What may result if the supplies are interchanged?

a. ____

b. ____

PRELIMINARY TROUBLESHOOTING

16. If turning the regulator control has little or no effect on the raster size, but adjusting the HV control has normal effect on raster size, which stage or stages would you suspect?

a. ____

17. Will the receiver operate without the "Z" panel? Why?

a. YES________________________NO____________________

____

18. There are two B+ source voltages from the power supply that feed the regulator circuit. What is the value of each of these voltages and where are they located on the "Z" panel?

	VOLTAGE	LOCATION (T.P.)
a.	________________	________________
b.	________________	________________

19. Give a list of preliminary checks to make before using the troubleshooting charts.

a. ____

b. ____

c. ____

d. ____

TROUBLESHOOTING

20. What are five common picture symptoms that can result from a defect in the AC line regulator.

a. ____

b. ____

c. ____

d. ____

e. ____

21. Looking at the complete receiver scehmatic including the AC line regulator, list all the possible defects (components) that could cause a complete loss of AC voltage across the power and filament transformer primaries.

a. ____

b. ____

c. ____

d. ____

e. ____

22. The customer complains about a "washed out" picture at high brightness settings. While the set is operating you set the Quick-On switch in the off position. After a short time the raster gradually fades away. What is the first thing you'd do to isolate the problem? You don't have a voltmeter.

a. ______________________________

23. If the AC line voltage drops below 105V AC, what happens to the CRT filament voltage and B+ voltage?

a. ______________________________

24. Will the receiver operate with one of the 50-watt resistors, R15J or R16J, open? . . . . try it.

a. ______________________________

b. ______________________________

25. Remove the regulator panel. (a) Is the raster normal? (b) Under these circumstances what would the raster look like, if the AC line voltage were very high . . . say 135V AC?

a. ______________________________

b. ______________________________

26. Reinsert the panel. Leave the red B+ lead at 6Z disconnected. (a) Does the receiver operate? (b) Can you adjust the regulator per procedure?

a. ______________________________

b. ______________________________

27. Reconnect the red lead at 6Z. Set brightness and contrast to maximum. Short the base of Q2Z to ground. IMPORTANT: MAKE SURE YOU DON'T GROUND THE WRONG POINT. Describe what happened.

a. ______________________________

28. Put the set back in operation. Turn brightness and contrast to minimum. Again, ground base of Q2Z (regulator sync.)

(a) Are the receiver symptoms the same? (b) Why?

a. ______________________________

b. ______________________________