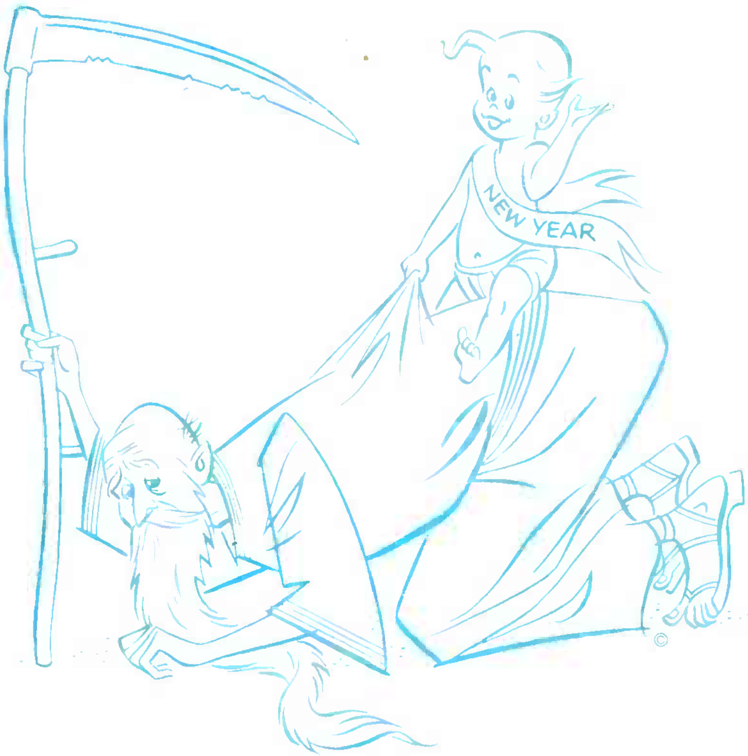
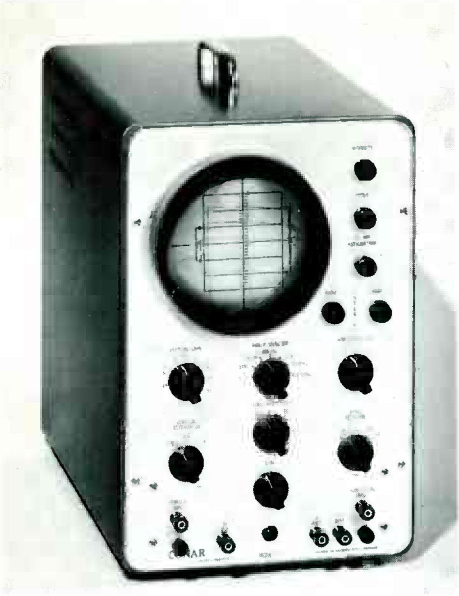
nri journal



January/February 1969

35 cents



CONAR

5" Wide Band Oscilloscope

KIT	CATALOG PRICE	NRI STUDENT AND ALUMNI PRICE
250UK	$99.90	$82.90
		$5 PER MONTH
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OPTIONAL ACCESSORY

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Stock #250PB. 2 lbs. Parcel Post $17.70

ADVANCED DESIGN · NEWEST CIRCUITRY · EXCLUSIVE FEATURES

Advanced design, newest circuitry, exclusive features—a truly professional oscilloscope for laboratory or service shop. The Model 250 is ideally suited for color and monochrome TV, AM-FM and transistor radios, hi-fi and stereo amplifiers, plus numerous industrial electronic applications.

Note these CONAR Model 250 features:

• Uses 2400 volts on the cathode ray tube—50% more than most scopes. Trace remains, clear, distinct, bright, with increase in sweep frequency or vertical-horizontal expansion. Forget about darkening room to observe traces on your Model 250 screen!

• Vertical gain control is calibrated for direct reading of peak-to-peak voltages. Simply multiply vertical gain control setting by attenuator setting by trace height for quick, accurate peak-to-peak readings. No need to remember special formulas or "feed-in" calibrating signals.

• New improved scope circuitry gives excellent linearity at low frequencies without limiting the production of frequency sweep signals.

• **Two stage** retrace blanking amplifier gives 100% retrace blanking at all frequencies produced by the scope sweep generator. Retrace lines **will not** confuse the display at high sweep frequencies.

• Accurately measures ripple output of power supplies; checks auto radio vibrators dynamically.

• Intensity and focus controls use special insulated high voltage potentiometers to eliminate leakage and shock hazards.

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• Sweep range—10 cps to 500 kc—**five times** the range of most other scopes, using special linearity circuit.

The Model 250 can be assembled in less than 15 hours—even by an inexperienced kit builder. Uses only top grade components. Most components are overrated, giving you an extra margin of dependability plus years of trouble-free service. And—there's no trouble finding replacement parts if ever needed. (Of course, we stock a complete inventory of parts, too.)

Step-by-step assembly instructions include big 17" x 22" picture diagrams plus 12 full pages of comprehensive operating instructions with more than 30 illustrations showing waveforms and connecting points.

SPECIFICATIONS

VERTICAL SENSITIVITY: .023 VRMS. **VERTICAL FREQ. RESPONSE:** Flat 13 cps to 2.5 mc, Down .05 db at 11 cps, Down 1.5 db at 3.58 mc (color burst), Down 3.5 db at 4.5 mc. **HORIZONTAL SENSITIVITY:** 1.0 VRMS. **HORIZONTAL FREQ. RESPONSE:** Flat 20 cps to 90 kc, Down .8 db at 12 cps, Down 3 db at 250 kc. **RISE TIME:** .05 ms. **SWEEP FREQUENCY:** 10 cps to 500 kc. **TUBES:** 11 (equivalent of 19 using dual types). **PUSH-PULL ON-OFF** does not upset other adjustments. **CONTROLS:** Intensity, Focus, On-Off, Astigmatism, Horiz. Centering, Vert. Centering, Horiz. Gain, Vert. Gain, Sweep Selector, Vert. Attenuator, Fine Frequency, Sync Selector, Sync. **CABINET:** Heavy gauge steel, baked-on rich blue finish, rubber feet, chrome handle. **PANEL:** Satin finish aluminum (not painted) with red lettering. **BINDING POSTS:** 5-way type to accommodate all connectors. **DIMENSIONS:** 9⅜" x 13¾" x 15½". **POWER SUPPLY:** 110-120 volts, 60 cycle AC, fused circuit. **ACTUAL WEIGHT:** 21 lbs.

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CONTENTS

2. SCR's in Horizontal Sweep Circuits

12. The Cathode Ray Oscilloscope as a Training Aid : III

19. Electronics Puzzle

24. Job Opportunities

28. Alumni News

SCR's IN HORIZONTAL SWEEP CIRCUITS

by William F. Dunn

The silicon-controlled rectifier, abbreviated SCR, is a solid-state device designed to replace the thyratron tube. The SCR has been widely used in industry, but has been of no importance to the radio-TV serviceman because it has not been used in radio and television receiving equipment. However, a new solid-state color television recently introduced by RCA contains two SCR's and two silicon diodes in the horizontal sweep circuit. Therefore the time has come when the TV serviceman must learn about silicon-controlled rectifiers.

Basically the SCR is a switch. It is able to control and rectify ac. It can also be used to control dc. The switch is a form of latching switch; that is, once it is turned to the on position, it remains in the on position until the power is removed from the circuit.

In the silicon-controlled rectifier there are four semiconductor regions arranged as shown in Fig. 1. At the N end of the rectifier is the cathode, and at the P end is the anode. Connected to the second region is an additional connection called a gate. You can see from Fig. 1 that we have three junctions in the rectifier. Both the center N and P sections act as base regions.

In operation from a dc source, a positive voltage is applied to the anode and a negative voltage to the cathode. With this polarity applied to the rectifier, we have a forward bias across the first junction, labelled J_1, and a forward bias across a third junction labelled J_3. We have a reverse bias across the second junction, J_2. If the voltage between the anode and cathode is made high enough, the second junction, J_2, will break down. Once this happens we will have a high current flow through the rectifier. Current will continue to flow until the voltage between the anode and cathode is reduced to a low value. Then the current will drop to a certain minimum value after which the flow of current stops completely.

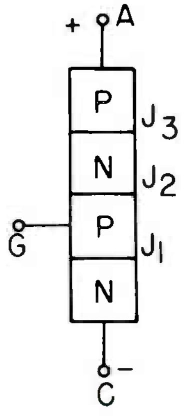


Fig. 1. The SCR has four semiconductor regions and three junctions.

The rectifier can also be made to conduct by use of the gate. With a positive voltage applied to the anode and a negative voltage to the cathode, assuming the voltage is not high enough to break down the second junction, we can cause current to flow by applying a positive voltage to the gate. This causes a current to flow from the cathode to the gate. Once it reaches a certain level, the rectifier switches to the on state, and a high current can flow through it from the cathode to the anode. The resistance of the rectifier becomes so low that the current flow through the rectifier is limited almost entirely by external resistance in the circuit.

Once we have turned the rectifier to the on state by means of a positive voltage or a positive pulse fed to the gate, the gate loses control of the rectifier. In other words, simply removing the gate voltage or pulse will not cause the rectifier to stop conducting. Current will continue to flow through the rectifier until the current reaches a certain minimum value. It may reach this minimum value because the anode-to-cathode voltage drops below a certain value or something may happen to the resistance in the external circuit to reduce the current below the holding value. Once the current flow through the rectifier stops, the gate once again gains control and can be used to turn the rectifier back on.

In some applications where the rectifier is used in an ac circuit, the portion of the cycle over which it conducts can be controlled by the phasing of the signal fed to the gate. For example, if the voltage applied between the anode and cathode is kept low enough so the breakdown does not occur, we might arrange the gate pulse so that when the anode becomes positive with respect to the cathode, a quarter of a cycle passes before a positive pulse is fed to the gate.

Once the positive pulse is fed to the gate, the rectifier will begin conducting and will conduct for the remainder of the half-cycle during which the anode is positive. When the polarity of the voltage applied to the rectifier reverses, current flow through the rectifier will stop and once again we can turn the rectifier back on at the appropriate time at the positive half-cycle.

The schematic symbol used to represent the SCR is shown in Fig. 2. Notice that the symbol is very much like the symbol used for a diode; we simply added the external gate connection to the diode symbol.

Now let's go ahead and learn how the SCR is used in a horizontal sweep system.

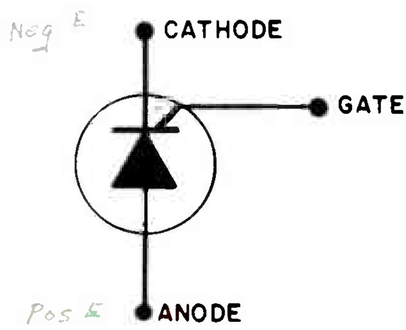


Fig. 2. Schematic symbol of silicon controlled rectifier.

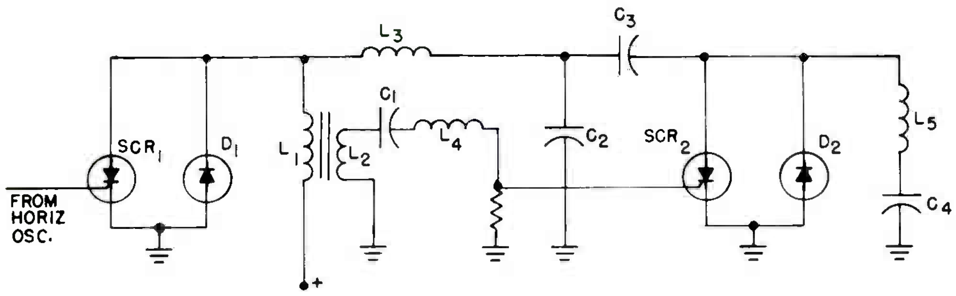


Fig. 3. Simplified schematic of horizontal sweep.

THE BASIC SYSTEM

A simplified schematic diagram of the basic circuit used in the horizontal sweep output stage of the RCA CTC40 solid-state color television is shown in Fig. 3. Notice that there are two SCR's and two diodes used. SCR_2 and D_2 control the sweep of the electron beam from the left side of the picture tube across the face of the tube to the right side of the picture tube. SCR_1 and D_1 control the retrace as the beam flies rapidly from the right side back to the left to start the next line. L_5 is the deflection yoke, L_3, C_2 and C_3 are used in the circuit to aid in the rapid retrace of the electron beam from the right side back to the left side during the horizontal blanking interval.

THE HORIZONTAL CYCLE

In Fig. 4 we have shown graphically the horizontal trace and retrace current cycle. We have labelled the current we are discussing I_1 and we will discuss I_2, also shown on the graph, later. When the electron beam is at the extreme left side of the tube, we have a maximum current flow through the deflection coil in one direction. This is indicated by T_1 in Fig. 4. As the beam moves at an even rate from the left side to the center of the tube, the current through the deflection coil decreases in a linear fashion until at point T_2, the electron beam is in the exact center of the screen and at this time the current through the deflection coil is zero.

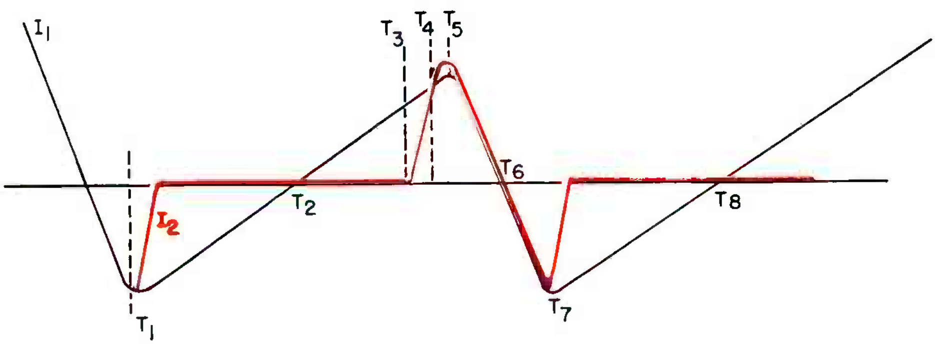


Fig. 4. The horizontal trace and retrace cycle.

Now as the beam is moved from the center of the tube to the right side, the current through the deflection coil must increase in a linear fashion from zero at point T_2 to its maximum value in the opposite direction at point T_5. At point T_5, the electron beam is at the extreme right of the tube and the retrace cycle begins. The deflection coil current must drop rapidly to zero at T_6 and build up to its maximum amplitude with the opposite polarity at point T_7. The cycle then repeats itself as the beam is swept back and forth across the face of the picture tube.

For our analysis of the operation of the circuit, let's consider that the beam is at the extreme left of the picture tube at point T_1. In other words, we have maximum current flowing through the deflection coil L_5. At this point, all of the energy in the deflection circuit is stored in the field about L_5. Capacitors C_3 and C_4 will be discharged at this time. There will be no current flow through L_1 and hence no voltage drop across it; this will place a reverse bias across D_1 so it cannot conduct. SCR_1 cannot conduct because it has been turned off, and there is no positive pulse applied to the gate to turn it on to the conduction state. Similarly, SCR_2 cannot conduct because the polarity of the voltage applied across it will be such that the anode will be negative and the cathode positive.

The current flow in the circuit will be as shown in Fig. 5. The yoke current will place the correct polarity across D_2 so it will conduct, and current will flow through the yoke as indicated by the arrows and labeled I_1. This current will begin to charge capacitor C_4, so that the grounded end will become negative and the other end positive. At the same time, part of the yoke current will flow into one side of C_3 and out of the other side. This current through L_3 and L_1 will begin to charge this capacitor. The energy needed to charge C_3 is supplied by the power supply and thus any energy lost during the sweep cycle is replaced. This action continues, as the current through L_5 drops to zero at time T_2.

The charging of C_3 causes a current to flow through L_1. L_1 is inductively coupled to L_2 and induces a voltage in it. By means of the phasing network consisting of C_1, L_4 and R_1, a positive pulse has been produced and is applied to the

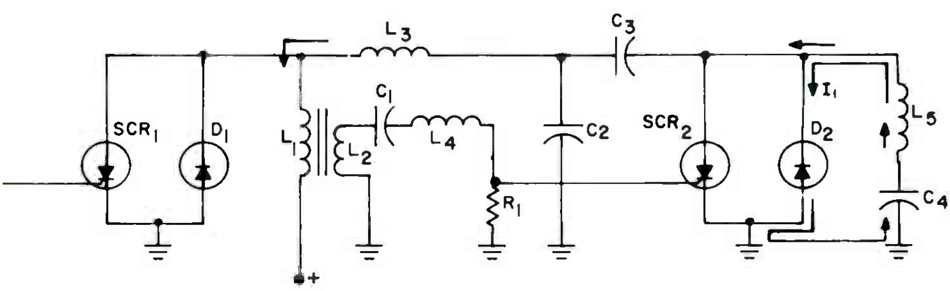


Fig. 5. Current flow through yoke and D_2 at T_1.

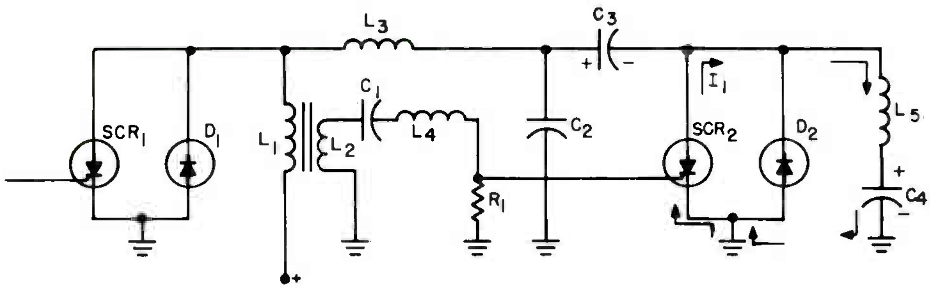


Fig. 6. Current flow at the start of the second half of the trace cycle, just after T_2.

gate of SCR_2. The rectifier does not conduct, however, while the current is flowing as shown in Fig. 5, because the polarity of the voltage applied to the anode and cathode is incorrect.

When the yoke current drops to zero at time T_2 and reverses as shown in Fig. 6, the polarity of the voltage across D_2 changes and it stops conducting. SCR_2, however, goes into conduction immediately because it has the correct polarity applied between the anode and cathode, and also we have applied a positive voltage to the gate. Meanwhile, capacitor C_4, which has charged during the interval T_1 to T_2, will have the polarity shown in Fig. 6. It is this capacitor discharging that causes the current to flow through SCR_2 and the yoke L_5 during the second half of the trace cycle. We have labelled this current I_1. If C_3 is not fully charged, it continues charging through SCR_2, L_3 and L_1.

The current through L_5 continues to build up from T_2 to T_3 as shown in Fig. 4. At this instant a positive pulse is fed from the horizontal oscillator to the gate of SCR_1. At time T_3 capacitor C_3 will be fully charged so there will be no voltage drop across L_1. This means that the full B-supply voltage will be applied to the anode of SCR_1, so that the rectifier begins conducting immediately.

The current through SCR_1 is represented by I_2 in Fig. 4 and also is labelled I_2 in Fig. 7. Notice that electrons flow from ground through SCR_1, through L_3 and into the positive plate of C_3. Electrons begin leaving the negative plate of C_3 and flow through L_5 and into the positive plate of C_4. Electrons will leave the negative plate of C_4 and flow back to ground. Meanwhile the current I_1 continues to flow through SCR_2.

The significance of the current I_2 is that it now begins to supply part of the yoke current, so that the current flow through SCR_2 begins to go down. The current I_2 builds up very rapidly during the interval T_3 to T_4 as you can see in Fig. 4. This is due to the short time constant of L_3 and C_3 in series with L_5. Thus at point T_4 the current I_2 equals the current I_1 and then almost immediately exceeds this value. Now the current through SCR_2 drops to zero and the rectifier is shut off and will

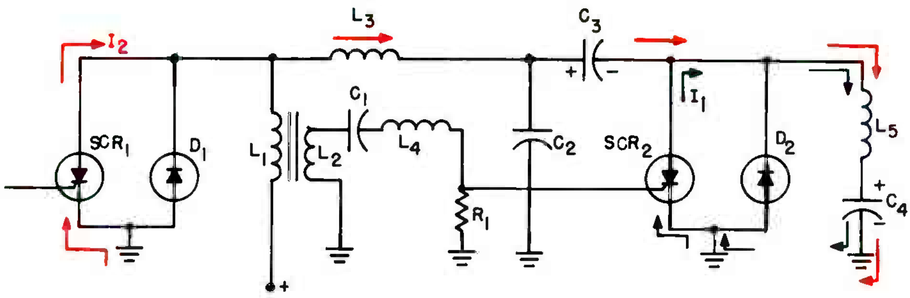


Fig. 7. Current flow during the interval T_3 to T_4 when both SCR's are conducting.

not start conducting again until time T_8, when we will once again have a positive voltage on the anode, a negative voltage on the cathode and a positive pulse on the gate.

During the interval T_4 to T_5 when the current I_2 exceeds the yoke current, the polarity of the voltage across D_2 reverses and part of I_2 flows through D_2. The remainder flows through the deflection yoke, bringing the beam over to point T_5 where retrace starts. Remember that at point T_5 we have maximum current through the deflection yoke flowing in the direction shown in Fig. 8. At the same instant D_2, which has been conducting during the interval T_4 to T_5, stops conducting. Capacitors C_4 and C_3 will be discharged and all the energy in the circuit will be stored in L_3 and L_5.

At the interval T_5, D_2 stops conducting. Now the circuit consisting of L_3, C_3 and L_5 begins ringing. C_4 is so large that it has no effect on the resonant frequency of this circuit. It is controlled primarily by the inductance of the two coils and the capacitance of C_3. The circuit goes through the next half-cycle from T_5 to T_6 rapidly with the current I_2 flowing through SCR_1 as shown in Fig. 9. At the same time, the capacitor C_3 is charged with the polarity shown, but little or no

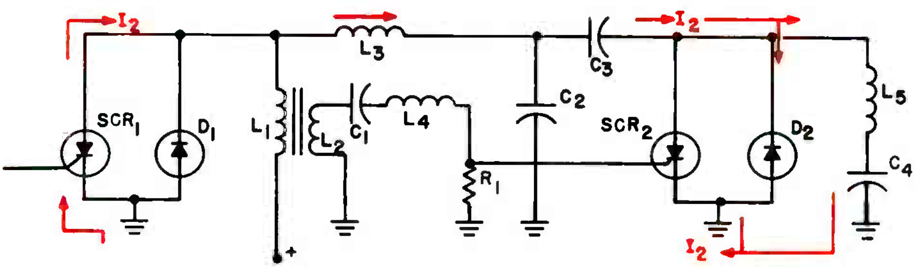


Fig. 8. Current flow during the interval T_4 to T_5 when SCR_1 and D_2 are conducting.

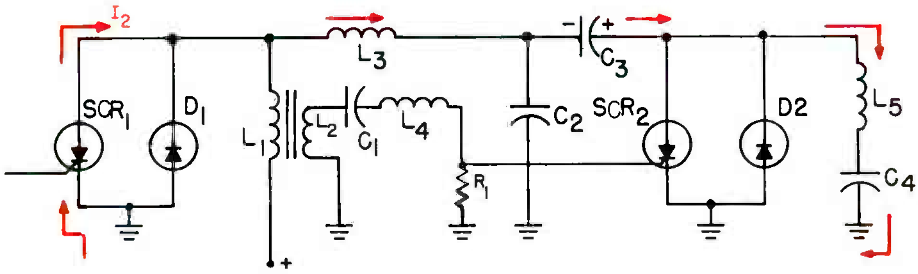


Fig. 9. Current flow during the interval T_5 to T_6. Now only SCR_1 is conducting.

charge is built up across C_4 because of its large size.

At time T_6, the current through L_5 will have dropped to zero and will begin to change direction. When the current reaches this point, the current through SCR_1 reaches such a low value that conduction through this rectifier stops, and it will remain turned off until it gets the next positive pulse from the horizontal oscillator circuit as it did at time T_3.

At the time T_6, shown in Fig. 4, the current through L_5 begins flowing in the opposite direction as shown in Fig. 10. The current begins discharging C_3. Electrons leave the negative plate of C_3 and flow through L_3 and through the diode D_1 as shown in Fig. 10. Once again, there is little or no charge built up on C_4 because of its large size. Current continues to build up during the interval from T_6 to T_7.

The value of L_3 and C_3 are selected along with the value of L_5, so that the total time required for one cycle at the resonant frequency will be twice the retrace interval. Thus we can have one half-cycle during the retrace interval which is sufficient to move the beam from T_5 to T_7.

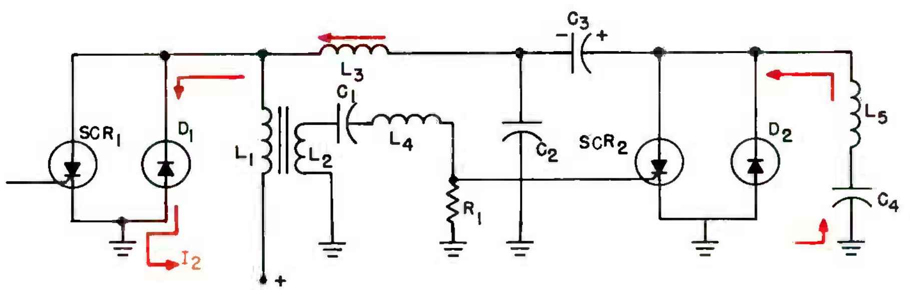


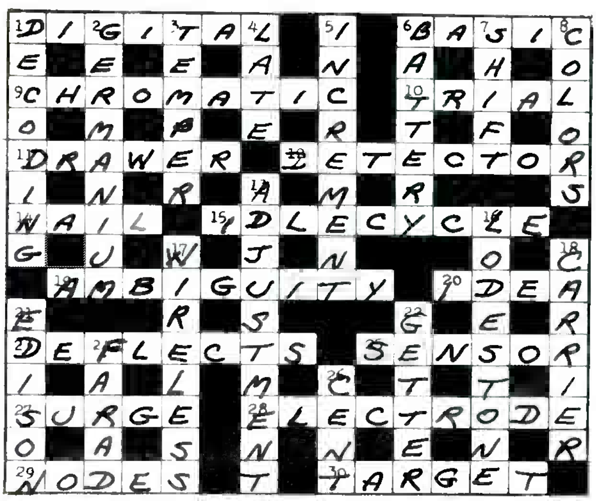
Fig. 10. Current flow during the interval T_6 to T_7 when D_1 is conducting.

When the electron beam reaches point T_7, we'll have maximum current flow through the yoke in the direction shown in Fig. 10 and current will begin to decrease. At the interval T_7, C_3 will be discharged and therefore the voltage across D_1 will disappear and this diode will stop conducting. However, D_2 begins conducting as the electron beam starts moving from point T_7 to T_8 to initiate the first half of the trace. Capacitor C_3 and C_4 begin charging and the cycle repeats itself.

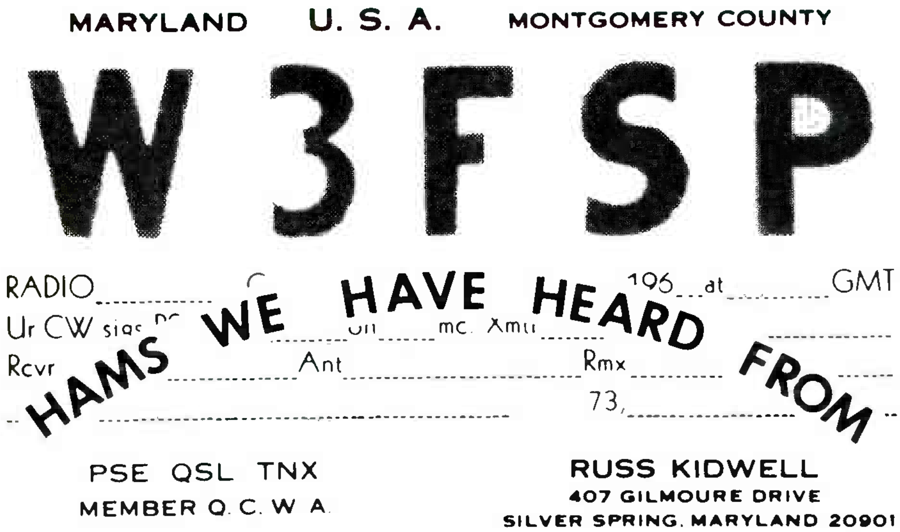
SUMMARY

The operation of the horizontal sweep using the two silicon-controlled rectifiers is not particularly simple and you have to go over it several times to get the entire sequence of events. However, to summarize briefly, here is what happens. As the electron beam starts moving from the left side of the screen to the center, current flow is through the yoke and through D_2. As the beam moves slowly from the center to the right side of the screen, current flows through the yoke and SCR_2 until the electron beam is almost to the extreme right side of the screen. Near the right side of the screen SCR_2 begins supplying the yoke current.

During the retrace interval as the beam moves rapidly from the right edge to the center of the screen, the deflection field current collapses through SCR_1 and then as the field current builds up with the opposite polarity the current builds up through the yoke and D_1. Timing pulses are generated in the transformer made up of L_1 and L_2 to have SCR_2 gated positive so that current will begin to flow through it at time T_2. A timing pulse is fed into the gate of SCR_1 from the horizontal oscillator to turn it on at the appropriate time to start the sequence of events that initiate the retrace.



Solution to Crossword Puzzle



Our CQ in the last issue of the Journal brought replies from currently licensed amateurs in 35 states. We thought you might like to know who the amateurs are among the readers of the Journal, so here are the calls heard from by the deadline for publication of this issue (November 29):

WA1DUD
WA1EYX
WA1FKE
K1GJK
WA1HXI
WA1IAU
K1IVJ
WA1JPK
WN1JTT
WN1KJM
K1QBI *
K1WIQ

W2DIA
WB2EXP
WN2FMW
W2FZG
K2JTU
WB2QJX
WB2RGS
WB2STY
WB2TPX
WB2YEE
K2YXK
WA2ZGX
K2ZZN

WA3AFI
W3AMQ
WA3HMR
WA3HTM
WN3JVK
WA3KOH
WN3LAG
W3UMY
W3ZGG

WA4CDC
K4CPQ
WB4GIO
W4HE *
W4HPG
W4HUW
WN4JDC
W4NRH
WA4RID
W4STX
W4ZZV

K5HXR
WA5JSE
W5MGD
WN5OWR
WA5RPJ
WA5WBK

WA6CBQ
K6LFR
WB6LFT
WB6LHJ
WB6NYX
WA6ROV
WB6VSO
WB6ZIP
W7DJW
WA7GQA
W7IKA
W7JGL

WN8ARJ
WA8DHG
WA8KFY
WA8NJZ
WA8PBD

*EXTRA CLASS LICENSE

WA8RZM	K9BSK	WAØAXM	WAØRJC
WA8SLK	WA9IDP	WØBGH	WAØRZU
WA8VEA	WA9KCN	WAØEBY *	WAØSYP
K8VJU	W9QXF	WØERF	WAØUUH
W8WDB	K9SNF	WØFSH	
K8ZOH	WA9TMT	WØKLG *	
WA8ZPJ	K9TXU	WAØQEU	KL7FPM

This list doesn't show the license classes, except for the Extras who have been honored with an asterisk, and the Novices, whose calls designate them. We made a breakdown of license classes, and here it is:

Extra	4	Conditional	9
Advanced	26	Technician	9
General	38	Novice	8

Some of you did not tell us your license class, so we had to resort to the "Call Book" to come up with these statistics. If you have obtained your Extra ticket since the "Call Book" we used was issued, and we should have so listed you, we're sorry -- you shouldn't have been so modest!

We also heard from a number of former amateurs who allowed their licenses to expire, and from some operators of Citizens Band stations. We hope to welcome all of you (back) to the ranks of ham radio in the near future.

You collectively indicated a rather wide variety of ham interests -- all bands from 160 meters to UHF. As to modes, cw and phone (AM and SSB) were mentioned about equally, with RTTY a surprisingly strong third.

The best DX we heard from was KL7FPM, who is also the only YL listed.

Thanks to all who took the time to write us, we now have a file of amateurs who are NRI graduates or students. When our amateur course students get to the point of needing volunteer examiners, some of you will undoubtedly be hearing from us.

An additional result is that the employees in the NRI Incoming Mail Section now know what amateur QSL cards look like! In that connection, there can be many a slip in mail handling, so if you responded to our CQ but haven't heard from us, please let us know about it, and we'll try to rectify the situation. Also, if you didn't see the item in the last issue, or meant to send in your card but forgot it, we would still like to list you in our file of amateurs.

The Cathode Ray Oscilloscope As A Training Aid : III

by J. B. Straughn

In the November/December issue the author discussed how to use the scope to show B-H curves, and various rectifier waveforms. In this concluding article of the series he investigates power supplies and filters.

To perform the experiments outlined in this article, you will need the same equipment described in the previous article: parts from Servicing Course kits through 4WW (or equivalent), a service scope (such as the CONAR Model 250), a vtvm (such as the CONAR Model 211), plus a few other parts.

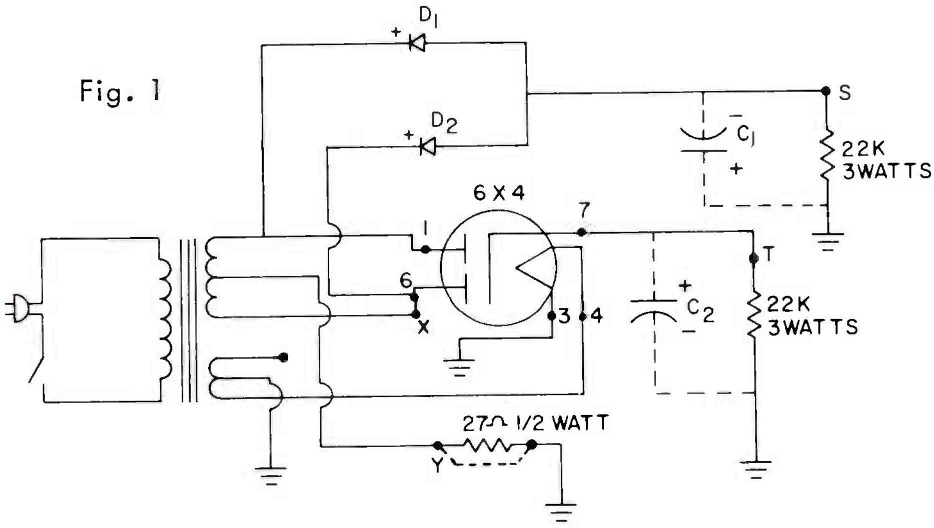
Before we investigate a complete power supply, a little review work is in order. For now you won't need your scope, but you will need your vtvm, a 20 mfd, 150-volt electrolytic capacitor, a couple of .25 mfd capacitors, and the power supply setup used in the November/December article, shown in Fig. 1. (Notice we have connected a 27-ohm, ½-watt resistor from Y to ground in Fig. 1. This will be used a little later on to observe current waveforms.)

CAPACITOR ACTION

You will charge the capacitors from the positive voltage pulses produced by the tube rectifier. Solder one lead of a .25 mfd capacitor to a ground terminal and the other lead to an unused terminal insulated from ground (chassis). Solder a lead to this terminal that will reach terminal T (do not solder to terminal T).

Set your vtvm for +dc measurements on the 120-volt range. Clip the vtvm ground

Fig. 1



lead to the chassis and the probe to the ungrounded terminal of the .25 mfd capacitor. Turn on the equipment and wait 30 seconds or so for the 6X4 to warm up. Touch T with the lead you have soldered to the capacitor terminal and hold it there while you read the meter. It should read between 60 and 70 volts.

Remove the lead and continue to observe the meter, noting how long it takes the meter reading to become negligible (a few volts). It should take about 10 seconds, which you can time by counting "one hundred and one, one hundred and two, one hundred and three, " etc.

Make and break the connection a number of times while observing the meter reading. In one instance, you may note a sudden momentary increase in voltage at the instant the connection is broken at point T. At other times you may note an abrupt drop, or you may see no instantaneous change. Just what happens depends on the time (on curve Fig. 2A) when the connection is opened.

If the charging pulse equals or is less than the capacitor voltage, there is no instantaneous change. If the charging voltage is dropping from its positive peak, there may be a sudden increase in capacitor voltage. This is because the 22K-ohm load resistor has also been disconnected, and the sudden slowdown in discharge results in a little extra "push" from the dielectric and a sudden voltage surge. The opposite effect occurs if the circuit is broken while the charging pulse is increasing, because the voltage stored in the capacitor lags the charging voltage.

Now install the 20 mfd capacitor in the same way, using different lugs and a separate connecting wire lead, and being careful to connect the negative lead of the electrolytic to a grounded terminal lug. Repeat the measurement and count off 10 seconds after breaking the connection to T. This time we find that in about 10 seconds the voltage gradually decreases from about 80 volts to 66 volts.

Thus we can conclude that a charged capacitor acts like a battery, although it will discharge more rapidly than a battery. Similarly, it can be charged more rapidly than a battery. In a power supply the output capacitor is the dc voltage source, and if we can charge this capacitor at the same rate it is discharged we will have a pure dc source.

Now let's put our .25 mfd capacitor across the tube load, by connecting the free .25 mfd capacitor lead to T, and observe the voltage wave shape by connecting the scope vertical lead to T. Compare the new signal shown in Fig. 2A with the signal obtained with the capacitor out of the circuit (Fig.2B). Notice the voltage from O to A is constant, while from + to A we have a discharge and charge action following the charging pulses of rectified voltage. The action is easier to see if you change the circuit to a half-wave rectifier by opening the lead between X and pin 6 of the 6X4 (Fig. 1). The wave shape changes from Fig. 2C (no capacitor) to Fig. 2D (with the capacitor in place).

At this time insert the 6.8K-ohm resistor at X to give an imbalance, and observe the wave shape before and after the .25 mfd capacitor is in charging position. Double the capacity by soldering another .25 mfd capacitor in parallel with the

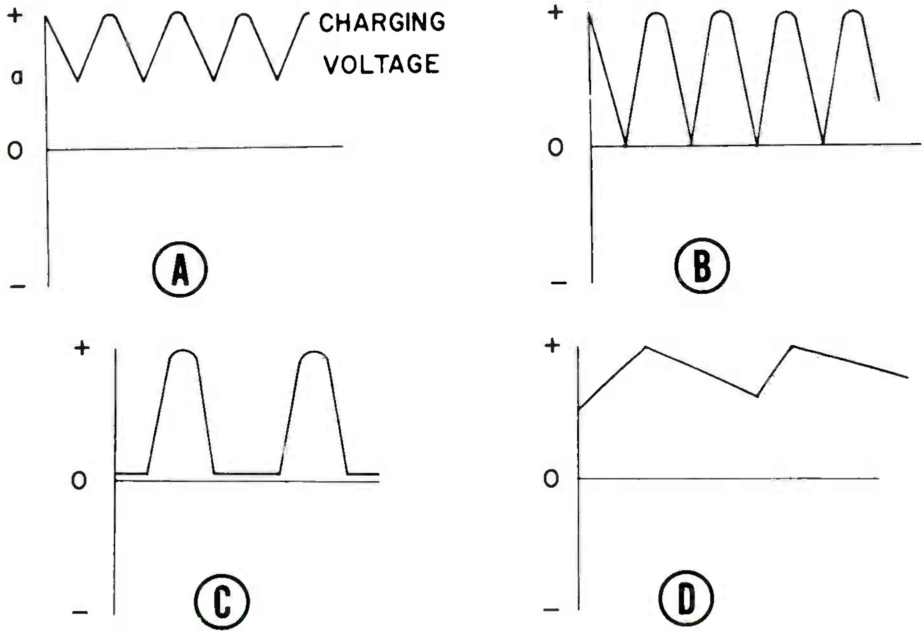


Fig. 2. Power supply waveforms. (A) Full-wave ripple with capacitor and load. (B) Full-wave ripple without capacitor and load. (C) Half-wave ripple without capacitor and load. (D) Half-wave ripple with capacitor and load.

original and note the effect on the wave shape. Remove the 6.8K-ohm resistor and the extra .25 mfd capacitor.

Restore the connection at X, remove the charging lead of the .25 mfd capacitor from T, and replace it with the charging lead of the 20 mfd capacitor. The wave shape shown in Fig. 2B is with the capacitor out, while Fig. 2A shows the capacitor in the circuit. Figs. 2C and 2D are similar to Figs. 2B and 2A, but for half-wave rectification (with X open).

With the capacitor in the circuit the vertical gain control must be advanced, because the 20 mfd capacitor does not discharge to as low a value as the .25 mfd capacitor, and hence does not have to recharge as much to reach full charge, resulting in a smaller ripple.

From the preceding it would seem that by using a very large capacitor the ripple would be reduced to a negligible value and no further filtering would be required. This is true in the case of low current, low voltage demands. For example, a 2000 mfd capacitor fed by a low voltage rectifier can operate a portable transistor receiver without noticeable hum. Such a high capacity at a low voltage is practical.

However, with tube equipment where the capacitor working voltage might range from 150 volts (ac-dc set) to 450 volts for a TV set or transformer-operated radio, the expense of a very large capacitor would be prohibitive. Filter capacitors in ac-dc sets usually range from 30 to 50 mfd. While the input capacitor ripple is not more than a few volts in amplitude, this is still too high and a further reduction for hum-free operation is a necessity.

The necessity for the series element and output filter capacitor can be understood by reference to Fig. 3, where we show the rectified voltage pulses at A, the charging effect in the input capacitor at B, and the fairly constant dc voltage across the output capacitor at C.

In Fig. 3B the capacitor voltage is about constant up to line X. Above this to Y, a ripple is present, due to the loss of capacitor voltage as it supplies current to the load and an increase in capacitor voltage as it is recharged. Most of this ripple is dissipated in the series leg of the choke and a steady dc flows into the output capacitor. If the current into this capacitor equals that delivered to the load, there will be a constant dc voltage across the output capacitor, which is the desired condition.

Thus far we have observed the voltage wave shape across the capacitor and the resistor load. In order to observe the charging current wave shape, it is necessary to insert a small resistor in series with the circuit. First reconnect X to pin 6 of the 6X4 socket. Disable the diode rectifiers by disconnecting the 22K-ohm resistor from point S. Connect the lead of the 20 mfd capacitor to T. Break the circuit at Y and insert a 27-ohm, ½-watt resistor as shown in Fig. 1.

Turn on the equipment, let the 6X4 warm up and observe the signal at point T with the scope. Again you will view a display similar to Fig. 2A. Change the vertical lead of the scope to view the charging current wave shape by attaching

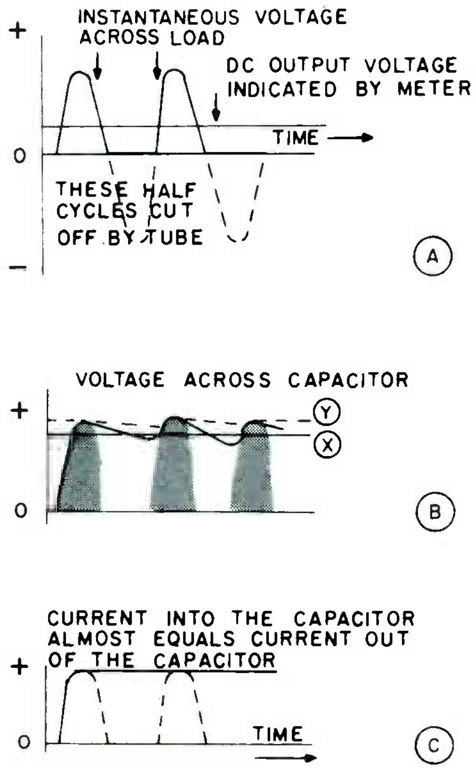


Fig. 3. Voltage waveforms at the output of a half-wave rectifier. (A) resistor alone is used; (B) load discharges the capacitor; (C) output capacitor fed through choke or resistor.

it to terminal Y, the junction of the 27-ohm resistor and the center tap of the power transformer. You should observe a narrow charging pulse, as illustrated in Fig. 4.

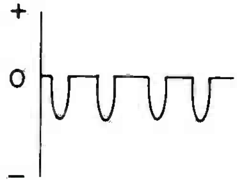


Fig. 4. Full-wave capacitor charging current.

The sawtooth in Fig. 2A results from the fact that the capacitor charges when the 6X4 conducts and starts to discharge slowly through the load resistor between conducting pulses. During the first part of the charging cycle, the capacitor acts as a short-circuit across the power supply, and hence the current pulse is comparatively large.

As the capacitor reaches full charge the charging current drops off quickly, and becomes narrow and pulse-shaped. Its amplitude is greater than in the simple rectifier circuit without a capacitor, but is considerably narrower. This can be demonstrated by leaving the scope vertical input lead connected to the 27-ohm resistor and observing the current pulse as the 20 mfd capacitor is connected and disconnected. The only real difference between the full and half-wave circuits is in the number of cycles observed per second and in the relative amplitude of the sawtooth and pulse displays.

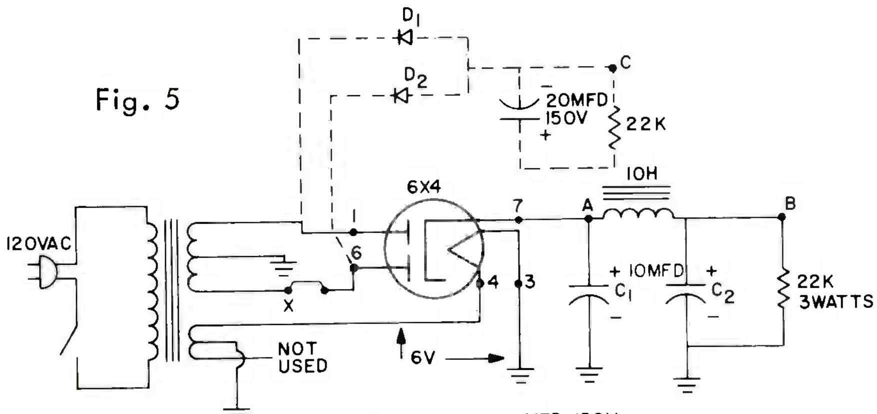
TYPICAL POWER SUPPLY CIRCUITS

Most power supply circuits are similar in form to the one shown in Fig. 5 without the diodes, shown by the dotted lines. These are left in the circuit except that their 22K-ohm load resistor is disconnected. Note that capacitors C_1 and C_2 are 10 mfd units rather than the 20 mfd units supplied with 4WW.

When you have the circuit wired up, you can make modifications for capacitor input, choke input, half-wave and full-wave rectification, unbalanced full-wave rectification, and can demonstrate the operation of an R-C filter. The various wave shapes that may be encountered with different types of operation are illustrated in Fig. 6. In all cases the scope ground connection is made to the chassis. The Vertical Input lead is connected to either point A or B, as indicated in the caption for Fig. 6. To change from full-wave to half-wave rectification, open the circuit at point X. A 6.8K-ohm resistor inserted at point X (Fig. 5) produces unbalanced full-wave rectification.

In addition to the experiments suggested in Fig. 6, you should, using the circuit in

Fig. 5



NOTE: C_1 AND C_2 ARE 10MFD 150V
THE 20MFD WITH 4WW ARE TOO LARGE FOR USE HERE

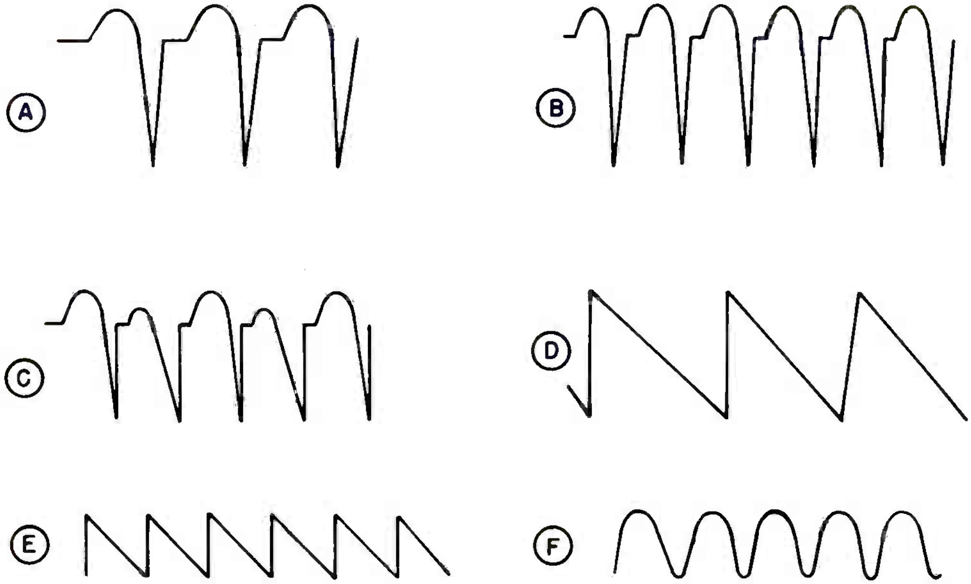


Fig. 6. (A) Half-wave rectification - choke input (C_1 disconnected) observed at point A in Fig. 5. (B) Same as (A) except full-wave rectification. (C) Same as (B) except full-wave unbalanced rectification (6.8K-ohm resistor inserted at X). (D) Half-wave rectification choke input (C_1 disconnected) observed at point B, Fig. 5. Full-wave is similar except for number of cycles. (E) Full-wave rectification capacitor input filter, observed at point A, Fig. 5. (F) Full-wave rectification - choke input, observed at B, Fig. 5.

Fig. 5, try other modifications of the filter circuit. As an example, observe the effect on wave shape and amplitude when a 500-ohm, 1-watt (two 1K-ohm, ½-watt resistors in parallel) are substituted for the 10H choke. Try both larger and smaller values of resistance here, and also try increasing the value of the 22K-ohm load resistor.

OTHER RECTIFIER CIRCUITS

You have already seen how, by reversing the diodes, a negative voltage can be obtained. Connect the 22K-ohm load of these diodes to the chassis as well as the + lead of its shunting 20 mfd capacitor (Fig. 5). Measure the dc voltage from C to chassis and from B to chassis. Figure the sum of these voltages (add them), then measure this amount with the ground clip of your vtvm to C and the probe to B. This is a full-wave bridge rectifier circuit. Notice that we do not need the center tap of the transformer at all for the circuit to operate.

Fig. 7 shows two commonly used voltage doublers. You can build them from the parts you have and observe the wave shapes between points A and the chassis. If you connect your scope ground lead to some point other than chassis potential,

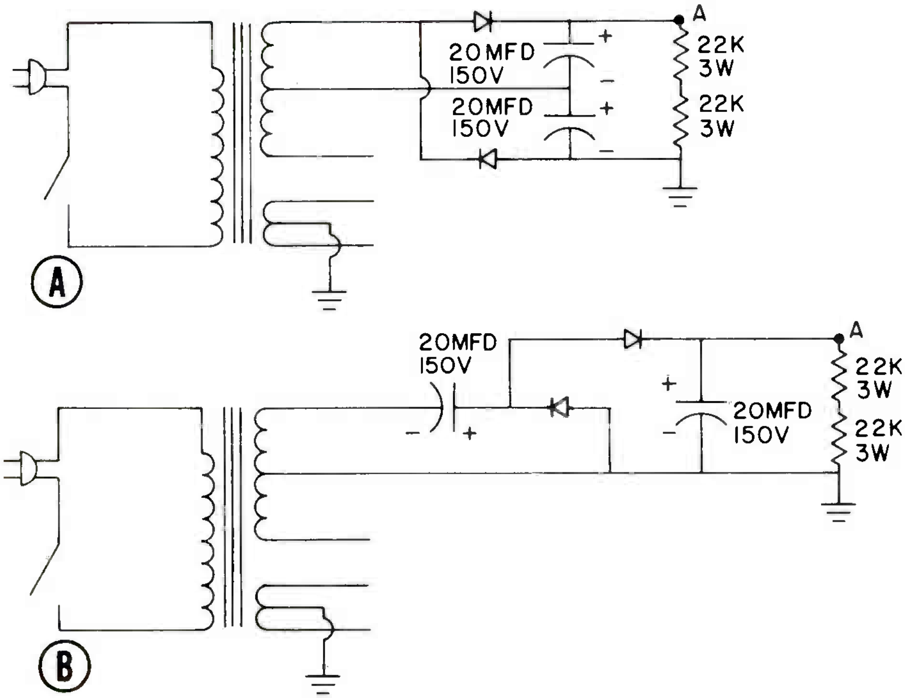
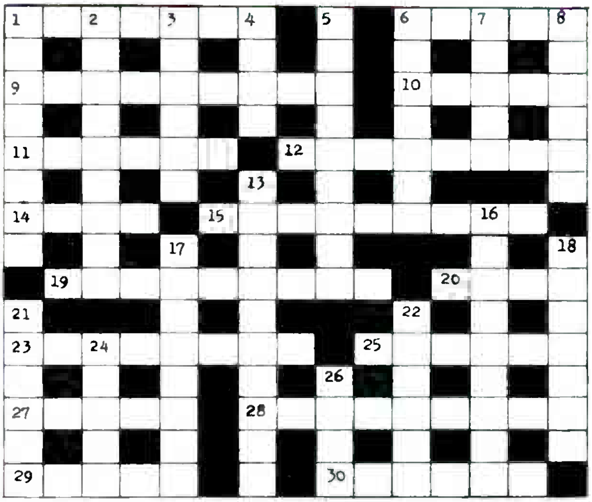


Fig. 7. (A) Full-wave voltage doubler. (B) Half-wave voltage doubler.

do not touch the chassis and scope at the same time. This precaution will avoid shocks.

If you would like to see another article along these lines dealing with kits 5W and 6W let us know.

ELECTRONICS CROSSWORD PUZZLE



By Michael Kresila

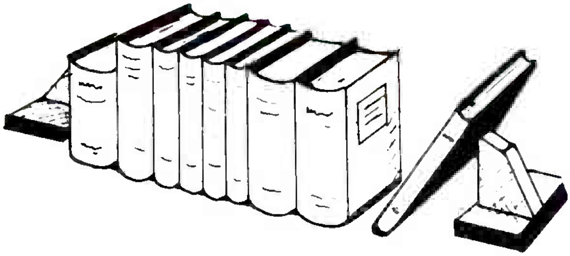
(Solution on page 9)

ACROSS

1. A type of computer.
6. Frequency of component considered to be most important.
9. Pertaining to a color or colors.
10. The act or process of testing.
11. Sliding box in a workbench.
12. Stage or circuit that demodulates the rf signal into its audio or video component.
14. Slender piece of metal.
15. Part of an electronic movement during which a machine performs no operation.
19. Condition obtained when navigational coordinates define more than one point.
20. Notion.
23. Deliberate movement of a meter pointer.
25. Portion of navigational system which perceives deviations from a reference and turns them into signals.
27. Sudden increase of current in circuit.
28. Essential component in a vacuum tube.
29. Point, line, etc., in a stationary wave system at which amplitude of variable is zero.
30. Discrete object which reflects energy back to radar.

DOWN

1. Process of obtaining intelligence from a code signal.
2. Metallic element used in semiconductor diodes and transistors.
3. To bring to the proper hardness.
4. Tardy.
5. Changes in the values of a variable.
6. Dry cells connected to serve as a dc voltage source.
7. Displacement of an ordered set of characters one or more places to left or right.
8. Visual sensations produced when light enters the eye.
13. To regulate and arrange rightly.
16. Also called magnetite.
17. Radio.
18. Wave suitable for modulation.
21. Standard screw base for light bulbs.
22. Material in a vacuum system for absorbing residual gas.
24. Basic unit of capacity.
26. Interval between two sounds whose basic frequency ratio is the 12/100th root of two.



NEW BOOKS

by Donald Smith

TV Servicing Guidebook: Problems & Solutions, By Art Margolis. Tab Books, Blue Ridge Summit, Pa. 17214. 176 pp, $3.95 paperbound, $6.95 hardbound.

One of the most difficult things for any school, and for that matter any instructor, to teach the electronics student, is how to troubleshoot television sets. Not how the set works, the specs of the system used, how parts operate, or anything like that, but how to get into the set and begin to find the trouble. Any help that the newcomer can get in this respect is very worthwhile.

The TV Servicing Guidebook is a good case in point. In it, Art Margolis has taken 62 classic examples of television service problems which he has run into himself, working on television sets in his shop. He has had many years of experience in radio-television servicing and really tells and shows how in this book.

No less than 30 separate troubleshooting approaches are given, including pictures, illustrations and diagrams. No extra theory is given, but instead, down-to-earth methods of how to find the trouble, in both color and black-and-white sets. Mr. Margolis gets to the point! In certain troubles, more then one component could be at fault, and in these cases, he tells the reader which part is most likely bad, how to find out if it is, what equipment to use, and if that part is not at fault, which part in that circuit is next most likely.

For example, in Chapter 2, Mr. Margolis has a complaint which he discusses under the head of "No Color." He first tells the reader how to be sure that there really is NO color. Then he goes on to explain that generally only one color is affected by the demodulators, difference amplifiers and color picture tube. Next he shows why the trouble is likely to be in the rf-i-f circuits and how to find out which, and then what to do about it.

Anyone interested in television servicing will find this book very helpful. The newcomer and student, as well as the average television serviceman, will find in this book good, practical television servicing techniques which can be turned into a great savings of time. In the service business, time means money!

Handbook of Electronic Tables & Formulas, Third Edition, Edited and Compiled by Donald Herrington and Stanley Meacham, Howard W. Sams & Co., Indianapolis, Indiana. 224 pp, Hardbound, $5.50.

Here is a book that everyone in electronics needs! Yes, everyone: students, teachers, servicemen, engineers, technicians, etc. It has a great quantity of useful information in it, including formulas, laws, constants, standards, symbols, codes, service and installation data, design data and mathematics.

I bought my first edition of this book in 1960 and still have it in my library, though it is pretty worn. This new Third Edition contains more information than the older ones, is more complete and easier to use. I would be lost without this book to refer to when a formula, constant or what have you has become foggy in my mind.

The book is broken down into sections, such as "Electronics Formulas", "Constants and Standards", and so on. A list of tables is given, making it easy to find the particular table for which you are looking. A full color FCC Allocation Chart is included in the book, which is a fold-out, and easy to use.

Teacher and student alike can get much use out of the formulas and tables given. Even reactance charts are included, which permit the finding of capacitor and inductive reactance, at many different frequencies. Coil winding tables will be of much interest to experimenters and those who like to "wind their own."

Servicemen will appreciate the information on coaxial cable characteristics, panel lamps, gas-filled lamps, relay rewinding data, machine screw and drill sizes, and so on. Technicians will also be interested in this information, and some of the design information given.

Though this is not a book that one sits down and reads, it is a book that electronics people should always have right at their fingertips for handy reference. I think when you see it you will feel as I do, and will not want to be without your own copy.

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A TOTAL NO. COPIES PRINTED (Net Press Run) 272,200	45,366	44,950
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I certify that the statements made by me above are correct and complete. ▶ (Signature of editor, publisher, business manager, or owner) Allene Magann

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Alumni News

Walter Adamiec	President
Franklin Lucas	Vice-Pres.
James J. Kelly	Vice-Pres.
Reynolds Nickless	Vice-Pres.
E. J. Meyer	Vice-Pres.
T. F. Nolan, Jr.	Exec. Sec.

WALTER ADAMIEC IS TAKEN ILL

In the November/December issue of the Journal we announced that Walter Adamiec was our new president. We are sorry to say that he suffered a heart attack shortly before receiving word of his election.

He is now recuperating at his home in Middleboro, Mass. We are sure that he would appreciate hearing from fellow members. His address is: 109 Taunton St., Middleboro, Mass. 02346. A card or note would surely cheer him while he is convalescing at home.

TRANSISTORIZED COLOR TV IS TOPIC FOR DETROIT

NRI Executive Secretary Tom Nolan was speaker at the Detroit Chapter meeting, with his subject transistorized color TV. Memebers learned about the newest RCA color TV chassis, the CTC40, and the solid-state set manufactured by Motorola, the Quasar.

The club raffled off a transistor radio, which was won by Raymond Berus. At the November meeting, Mr. Berus demonstrated a Model WE93A Transistor Demonstration Board. Hints on Color TV servicing were also given. L. Massman, a former member, was a visitor.

FLINT CHAPTER ATTENDS AN OLD-TIME AUCTION

Flint (Saginaw Valley) Chapter's Andy Jobaggy gave a very interesting talk on the installation and servicing of European car radios. His talk included the substitution of American-made auto radios in European cars, particularly those of German make.

Prof. Bill DeJenko gave a little refresher course on the gray scale setup in color TV. He also explained some uses of digital instruments in experimental electronics work.

The Chapter members were invited to an authentic old-time auction at Taylor Consumer Products Co. Here Larry Taylor auctioned off the very latest TV as well as some of the oldest radios and other assorted electronic merchandise. Coffee, cider and doughnuts were served.

Flint Chapter enjoys a talk given by one of their members, Andrew Jobaggy.

LOS ANGELES CHAPTER IS STILL GOING STRONG

Chairman Eugene DeCaussin held the customary meeting of the Los Angeles Chapter at his shop, with the subject the vacuum tube voltmeter. Everyone learned something and the meeting was very enjoyable. Coffee and doughnuts were served after adjournment.

At the previous meeting the topic was the color TV kit newly introduced by NRI. Two new members were welcomed by the club, as was Joe Stocker, who is just out of the hospital after a lengthy stay.

TWO NEW MEMBERS WELCOMED BY NEW YORK CHAPTER

Wiener Diamanche and Patrick Burke were welcomed by New York Chapter as new members. Happy to have you with us, fellows!

Charlie Vevo is still bringing new and interesting equipment to each meeting of the Chapter. This helps all of the members as far as Electronics education is concerned.

Willie Foggie gave an interesting demonstration of the B & K Analyst's capabilities on horizontal and vertical circuits at the November meeting. Also on the program was Frank Lucas, who did exceptionally clear blackboard diagrams of horizontal and vertical deflection circuits along with his talk. He used defective parts such as a deflection yoke to show members what happens with keystoning, its cause, and how to run down the error in the TV set. By using ringing tests, the analyzer, and several less definitive tests, the culprit was ferreted out in the electronic circuit.

NORTH JERSEY CHAPTER CHANGES MEETING PLACE

The North Jersey Chapter has changed its meeting place to the store owned by George Stohl, charter member of the chapter. The new address is Middle Hardware, 155 Middlen Ave., Kearney, N. J. It is approximately seven blocks from Washington Square toward the east and at Middlen Avenue and Devon Street.

The Players Club will continue to be used for special events where a large audience has to be accommodated. Any change of address will be noted in announcements of the meetings.

North Jersey has a new treasurer, William Whitley, who owns a radio and TV service store in Lincoln Park, N. J. At the October meeting, Mr. Whitley gave a talk and demonstration with the B & K Analyst, and Alex Reid, who sells and services TV sets at local motels, talked on Admiral TV sets, sales, and services.

Alumni member George Kitchen rounded out the evening by exhibiting a CONAR black-and-white TV set and a CONAR oscilloscope which he constructed from kits. He explained the simplicity of assembly, and the accuracy of operation upon completion. Alex Reid double-checked the scope for accuracy and found it to be right on the button.

PHILADELPHIA-CAMDEN CHAPTER TOURS AIRPORT, WESTINGHOUSE

Fourteen members of the Philadelphia-Camden Chapter toured the Westinghouse plant at Metuchen, N. J., as guests of Bill Heath, service supervisor, and Chuck Trout, technical advisor, for the tour and luncheon.

At the next meeting Russ Gimellaro, technical director of Jerrold Electronics, demonstrated the company's Tennarotor, illustrated with a movie.

A visit to the Philadelphia International Airport Communications Bureau was the group's next event. FAA director Phil Moscovitz arranged the tour for the 22 members who attended. Frank Hibbs, electronics technician, and Stan Brancyzk, maintenance technician, guided the group through the radar room, central control, power supply room and communications tower. The members then went to the city Communications Bureau, where Bill Washburn, a former member of the Chapter, served as guide. He is night troubleshooter at the Bureau.

Setting up color TV was the next project, with all the members having a hand in it. It gets easier all the time! Following this,

Jules Cohen of the Philadelphia-Camden Chapter stands in front of the plane owned by Tom Nolan, one of the NRIAA executives.

Tom Nolan spoke on the all-transistor color TV, to everyone's enjoyment. Members then held their usual end-of-the-year party, with hot dogs and sauerkraut plus trimmin's on the menu. Before flying back to Washington from Philadelphia, Tom took secretary Jules Cohen of the Chapter on a plane ride.

PITTSBURGH CHAPTER TALKS IT ALL OVER

Pittsburgh Chapter members utilized their October meeting for a general bull session, which proved to be one of the year's most interesting meetings. Everybody had a chance to compare notes on dogs, servicing problems and solutions, etc.

At the November meeting, the Chapter heard Mr. Rohleder of the Bell Telephone Lab on the history of communication from early telephones through radio waves and laser beam methods. Much was learned about communications by the members.

JOSEPH D. RENNINGER JOINS SAN FRANCISCO

Joseph D. Renninger was welcomed as a new member at the October meeting of the San Francisco Chapter.

Art Ragsdale, one of the charter members of the chapter, demonstrated the square-wave response of a signal generator, showing rise time and tilt to indicate the frequency response of the scope. Everyone praised his efforts and learned quite a bit from watching the pulses change shape as they passed through R and L networks.

SOUTHEASTERN MASSACHUSETTS HOST TO NATIONAL OFFICERS

Visitors to the Southeastern Massachusetts Chapter meeting were Ted Rose and Tom Nolan, Jr., national officers. Under the guidance of Mr. Nolan, the NRI Color kit was thoroughly explored for a very constructive meeting. The next four meetings will be used to digest the information. A large number of new members were present, and it looks like the chapter will have the busiest season yet.

Unfortunately, Walter Adamiec, Chapter secretary and incoming President of the NRIAA, is at home recuperating from a recent heart attack.

BOB MONETTE IS ELECTED SPRINGFIELD VICE-PRESIDENT

Bob Monette was elected vice-president of the Springfield (Mass.) Chapter at its October meeting. Bob Allen of Springfield was introduced as a new member. He told of his work in repairing transistor radios.

At the November meeting, the members voted to buy a secondhand Zenith color TV from one of the members. The TV is in very good operating condition. Chapter members will use it in their studies of color TV service and adjustments.

Brother Bernard Frey, the chairman, thanked the membership for their support in the past year and hoped that attendance would continue as well in the coming year.

Bob Jensen gave a very good talk on the history of tape recording, and Bob Allen discussed the repair of small transistor tape recorders. Both talks were well appreciated by the members.

DIRECTORY OF CHAPTERS

DETROIT CHAPTER meets 8 p.m., 2nd and 4th Friday each month at St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich. VI 1-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m., 2nd Wednesday of each month at Andrew Jobbaggy's shop, G-5507 S. Saginaw Rd., Flint. Chairman: Arthur Clapp, 705 Bradley Ave., Flint, Mich. 234-7923.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 p.m., 2nd Thursday of each month at George Fulk's Radio-TV Service Shop, Boonsboro, Md. Chairman: Robert McHenry, RR2, Kearneysville, W. Va.

LOS ANGELES CHAPTER meets 8 p.m., 2nd and last Saturday of each month at Chairman Eugene DeCaussin's Radio-TV Shop, 4912 Fountain Ave., L. A., Calif., NO 4-3455.

NEW ORLEANS CHAPTER meets 8 p.m., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 p.m., 1st and 3rd Thursday of each month at St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: Samuel Antman, 1669 45th St., Brooklyn, N. Y.

NORTH JERSEY CHAPTER meets 8 p.m., last Friday of each month at Middle Hardware, 155 Middlen Ave., Kearney, N. J. Chairman: William Colton, 191 Prospect Ave., North Arlington, N. J.

PHILADELPHIA-CAMDEN CHAPTER meets 8 p.m., 2nd and 4th Monday of each month at K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore Ave., Philadelphia, Pa.

PITTSBURGH CHAPTER meets 8 p.m., 1st Thursday of each month at 436 Forbes Ave., Pittsburgh. Chairman: James Wheeler, 1436 Riverview Dr., Verona, Pa.

SAN ANTONIO (ALAMO) CHAPTER meets 7 p.m., 4th Friday of each month at Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (3 blocks north of Austin Hwy.), San Antonio. Chairman: C. W. A. Hoffman, 4215 Shelton Dr., San Antonio, Tex.

SAN FRANCISCO CHAPTER meets 8 p.m., 2nd Wednesday of each month at the home of J. Arthur Ragsdale, 1526 27th Ave., San Francisco. Chairman: Isaiah Randolph, 523 Ivy St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8 p.m., last Wednesday of each month at the home of John Alves, 57 Allen Blvd., Swansea, Mass. Chairman: Oliva J. Laprise, 55 Tecumseh St., Fall River, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7 p.m., last Saturday of each month at the shop of Norman Charest, 74 Redfern Dr., Springfield. Chairman: Br. Bernard Frey, 254 Bridge St., Springfield, Mass.

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- Nine Patterns
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SPECIFICATIONS

OUTPUT:
R. F. only—low impedance
Approximately 50,000 microvolts into 300 ohm tuner
100% modulated carrier—composite video

Crystal controlled oscillators:
189 kc timing oscillator
3,563.795 kc offset color subcarrier oscillator
4,500 kc sound carrier oscillator
55.25 mc or 61.25 mc rf carrier oscillator

MODULATION:
Single dot
Single cross
Single vertical line
Single horizontal line
Full dot pattern
Full crosshatch pattern
Full vertical line pattern
Full horizontal line pattern
Keyed rainbow color pattern

POWER REQUIREMENTS
120 vac—1.0 watt or:
4 "D" cells—6.0 vdc at 130 ma.

REGULATED POWER SUPPLY:
Silicon diode bridge rectifier
Zener diode stabilized transistor regulator

SEMICONDUCTOR COMPLEMENT:
16 type 914 integrated circuits
3 type 2N2369 NPN silicon transistors
1 type 2N555 PNP power transistor
1 type 1N746A Zener diode
4 silicon rectifier diodes
1 modulator diode

GUN KILLER SWITCHES:
Permanently wired cable
Separate red, blue and green switches
Colored switches for rapid location

CONSTRUCTION:
Aluminum cabinet, chassis and panel for light weight
Printed circuit board, 6" x 9"

SIZE:
10" x 3" x 9" (WxHxD)

WEIGHT:
Less than 5 pounds with batteries
Less than 4 pounds without batteries

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