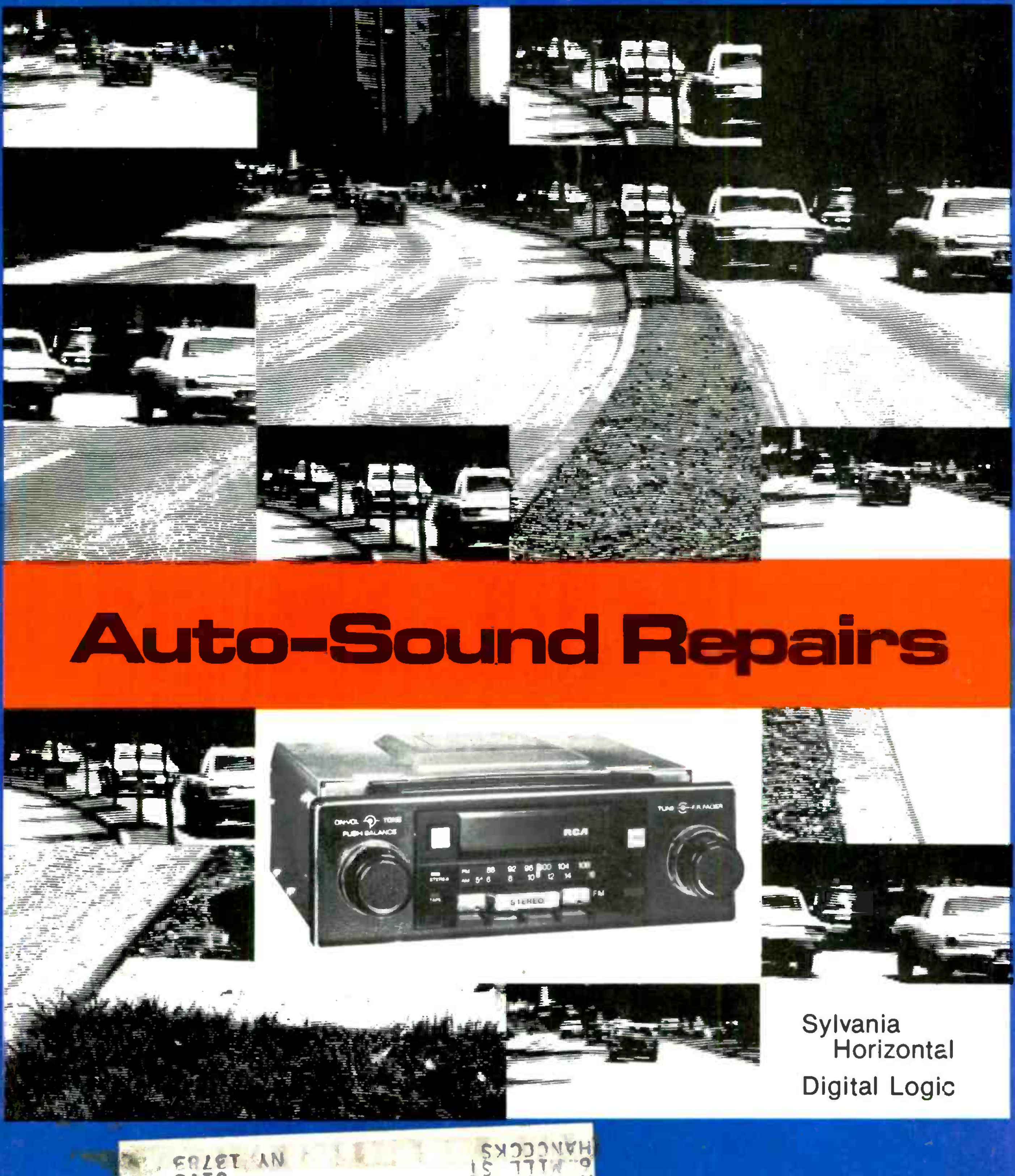
March, 1978 ☐ $2.25

Electronic Servicing

A HOWARD W. SAMS PUBLICATION



Auto-Sound Repairs

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March, 1978 ☐ Volume 28, No. 3

Electronic Servicing®

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About the cover—The montage design that symbolizes auto-sound products is by Mary Christoph. Picture of the auto radio is shown by the courtesy of RCA.

DEPARTMENTS

New Subscription Rates

Effective January 1, 1978, subscription rates for **Electronic Servicing** were increased to $8.00 for one year and $13.00 for two years; there is no longer a three-year subscription. Single copy price (for non-subscribers only) was increased to $2.25; back issues are $3.00. Because of a printing error, rate cards in the February issue reflected the lower subscription prices. Therefore, persons subscribing in March at the lower rates will receive their subscriptions at those rates. Anyone subscribing after March 31, 1978, at the lower rates will have their payment returned.

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Next month,

Electronic Servicing

begins a series about the

circuits and servicing of

Sony Betamax videocassette

tape recorders.

Watch for these informative articles.

Electronic Servicing

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GENERAL ELECTRIC

electronicscanner

news of the industry

Brian J. Marohnic, national service manager for the Zenith Radio Corporation, retired on January 31, 1978, after 44 years with the company. Brian (sometimes called "Bronc") had been national service manager since 1963. He is succeeded by Richard C. Wilson, former West Coast field engineer, who has been with Zenith for more than 25 years.

American Telephone And Telegraph (AT&T) has widened the bandwidth of its audio microwave and phone lines (that distribute network TV programs over the United States) from the former 100-to-5,000 Hz to the new 40-to-15,000 Hz bandwidth. For the first time, high-fidelity TV sound is possible. However, before this improved frequency response can be heard, new TV receivers must be designed with better audio amplifiers and speakers. Therefore, about two years will be required before any new models can feature hi-fi sound. If stereo TV sound is wanted, AT&T can add an identical second channel.

The FCC has begun a nationwide crackdown on the sale of illegal 23-channel CB radio transceivers. U.S. marshals and FCC agents seized 350 23-channel CB radios from a retail store in Alabama last month. In October of 1976, the FCC announced a ban on the 23-channel CB radios, to become effective January 1, 1978. The radios were banned because they did not meet the new specifications that are necessary to minimize interference with TV receivers. (Owners who purchased 23-channel radios before that date may continue to use them.) Similar raids are planned for other localities. Persons convicted of these violations might face a fine and a prison term.

The FCC has banned the manufacture and sale of linear amplifiers (of the kind often used illegally to increase the power of CB transmitters). According to *Electronic News*, the agency also decided to require type-acceptance of linear amplifiers for radio amateur use, so the units could be designed to prevent operation in the 24-to-35 MHz CB range. The ban will begin 30 days after a notice is published in the *Federal Register*.

For many motorists stranded in the February blizzards, CB radio was the only method of communications available for emergency rescue operations. A bulletin from the Electronic Industries Association (EIA) credits CB volunteers with saving four lives in Lowell, Indiana. Numerous state police headquarters and other emergency officials reported that without the volunteer help of CBers, snowmobilers, and four-wheel-drive enthusiasts, rescue work would have been delayed and many lives lost. The manager of React International (a national volunteer group with 2,000 local chapters that monitor CB channel 9 offering help and assistance) also reported a large effort by the Massachusetts React chapters.

Color TV sales to dealers for 1977 were the second highest in history, reaching 9,106,826. According to the EIA, color sales to dealers in January of 1978 increased 2.3% over January of last year; however, B&W receivers declined 12.4%. January sales to dealers of radios with FM increased 33% over January of 1977, while AM radio sales decreased 2%. □

Needed: Schematic and parts list for B&K-Precision 120 VOM. Will buy, or copy and return. *Carl W. Higgins, 2242 South 85th East Avenue, Tulsa, Oklahoma 74129.*

Needed: TA-33 or equivalent tri-band antenna. *Kenneth Bullard, 107 Fulton Drive, Kings Mountain, North Carolina 28086.*

Needed: Schematic and service manual for a Clough Brengle oscillator model OC; also need a 9QP4 picture tube. Will buy tube, and copy or buy schematic. *Charles L. Gauket, 14 Bell, Florence, Kentucky 41042.*

For Sale: Spectrum analyzer, H/P model 3580A, just calibrated and in mint condition. Best offer. *Ron Lemke or Joe Flanner II, Flanner & Hafsoos Music House, 2500 North Mayfair Road, Milwaukee, Wisconsin 53226, [414] 476-9560.*

For Sale: B&K-Precision instruments with cables and manuals (never used): 1077 Analyst, $375; 415 sweep/marker, $375; 1246 digital/IC color generator, $100; and E200D solid-state RF generator, $125. All prices FOB. *Q. S. Hoshal, 1513 Hillside Drive, Bel Air, Maryland 21014.*

For Sale: 1077B Analyst (new), 415 sweep/marker, 467 CRT analyzer/restorer (new), and 162 transistor tester, all by B&K-Precision, and less than two years old. Also, Leader color-bar generator; EICO tube tester model 667; Leader FET-VOM; B&K-Precision 501A curve-tracer; Leader 5-inch scope model LB-501; Sprague capacitor analyzer model TO-6A; about 300 TV and radio tubes; and one lot of new TV parts. *Milton Obuch, 1308 North 4th, Sayre, Oklahoma 73662.*

Needed: Old service magazines and pre-1940 publications about all facets of radio. State cash price. *Donald Erickson, 6059 Essex, Riverside, California 92504.*

For Sale: Southwest Technical Products prescaler for any frequency counter, 500 millivolts maximum input level, divides by 10 up to 175 MHz, perfect condition, $30. *John Augustine, 530 North 9th, Reading, Pennsylvania 19604.*

Needed: Service information for United Scientific Labs, Contact 23, CB radio. Will pay for copying and mailing. *Don Gross, Vision Enterprises, Cameron Mills, New York 14820.*

Needed: Schematic for Sencore caddy-bar junior model number CG22. *Active TV, 14547 South Halsted, Harvey, Illinois 60426.*

For Sale: Printed-circuit-board supplies, valued at more than $40 for $10; high voltage section of a Heath GR270 color TV, $20, and 5 years of Radio Electronics magazines, $4 per year or 60 issues for $15. *Douglas Mace, R.D.4, Box 84, Bellefonte, Pennsylvania 16823.*

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"Can't you hum something other than 60 cycles?"

reader's exchange

continued from page 7

Needed: Service or operating manual for Precise power-lab model 713. *Roger Mosley, de Young Museum, Golden Gate Park, San Franscisco, California 94118.*

Needed: Schematic for Knight solid-state Star Roamer II, five-band receiver. *Tiny's Radio & TV, 18606 Gable, Detroit, Michigan 48234.*

For Sale: Radiola III manual, 26 pages from 5 sources, $5; Rider's Radio Master Index for volumes 1 to 15, $12.50 or volumes 1 to 23, $15; early Rider's volume 1, 1919 to 1927, 200 pages, $17.50; Rider's Radio volumes 9, 10, 12, 15, 16, 17 and 19, $10 each; also, send for a list of other Riders books. *Antique Radio Shop, 3403 Broadway, Long Beach, California 90803.*

Needed: A power transformer part number 101408 for a Knight scope model KG-630, or the equivalent. *William Mayer, 5722 SW 1st Court, Cape Coral, Florida 33904.*

For Sale: Sencore SM152 sweep/marker generator, $175; and Sencore TF-1S1 transistor tester, $60. Both in A-1 condition, with cables and manual. *Val Obal, 3201 South 73, Omaha, Nebraska 68124.*

For Sale: Heathkit scope model IO-4540, completely assembled, used only a few hours, $145. *P. T. Hauser, 190 Alexander Avenue, Upper Montclair, New Jersey 07043.*

For Sale: Bell & Howell (Heathkit) digital multimeter, like new, $25 plus postage. *Robert M. Dorman, 1917 Ridge Lake Drive, Chesterfield, Missouri 63017.*

For Sale or Trade: Bell & Howell radio and TV course of 10 volumes, scope, TVOM, circuit-design board, plus all parts for the experiments; sell for $275, or trade for a triggered-sweep scope. *Daniel Seidler, 5827 South Campbell, Chicago, Illinois 60629.*

Needed: Power transformer part number 23213084 for Singer TV model HE-8050. Also, an on/off switch number 24056003. Please, state price and condition. *Aurie Antilla, 4066 Mount Everest Boulevard, San Diego, California 92111, ES3-876-R462787.*

Needed: Schematic for a H. H. Scott L. K. 72 stereo amplifier kit, 80 watts, around 1962-1963. Will buy, or copy and return. *Anderson Electronics, Box 859, Oakhurst, California 93644.*

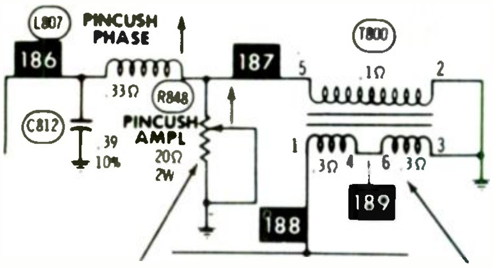
For Sale or Trade: 25 Radiart car-radio vibrators, assorted; and 12 assorted Delco volume, tone, and switch controls. *Troch's TV, 290 Main, Spotswood, New Jersey 08884.*

Needed: TV service equipment: dual-trace scope; transistor curve tracer; scope calibrator; ATC-10 color generator; EICO 685 transistor analyzer; B&K-Precision 970 analyst; Sencore YF-33 yoke and flyback checker; and Heath IO-4101 vectorscope. Please advise condition and price. *Thomas Walls, 6360 Montgomery, Philadelphia, Pennsylvania 19151.*

troubleshootingtips

Pincushion components run hot
GTE-Sylvania D19 (Photofact 1269-3)

Several similar models have these defects, which produce varied symptoms, such as: no high voltage; no vertical sweep; intermittent height; or the smell of hot components.



On the convergence board, check the pincushion-amplitude control (R848) for burned appearance or erratic operation, and look at the T800 pincushion transformer for burned windings.

It is not clear which of the two components fails first. Current from the cold end of the vertical yoke flows through L807, R848, and one winding of T800. The other winding of T800 has horizontal pulses from the flyback. The vertical current permits T800 to load-down the horizontal-sweep circuit near the top and bottom of the picture, thus reducing the width and pincushioning there. That's normal operation.

Several times, after the two bad components were replaced, the horizontal pulses at T800 have measured too high (also the HV was excessive). It seems likely that the abnormal pulse amplitude caused shorted turns in the original T800, and this changed the primary-to-secondary turns ratio, thus applying an excessive pulse amplitude to the "pincushion-amplitude" control (R848). In turn, R848 operated too hot and failed.

In any event, make certain the high voltage is no higher than 25KV with a black raster, and that neither T800 nor R848 operates too hot after they are replaced.

Sargent's Distributing Company
Bellflower, California

Blackout after warmup
RCA KCS169B B&W (Photofact 984-2)

Gradually, the sync weakened; and after 15 to 30 minutes of operation, the raster disappeared.

These symptoms seemed to indicate a problem with either the 8FQ7 oscillator or the 33GY7 horizontal-output tubes. However, replacement of both tubes did

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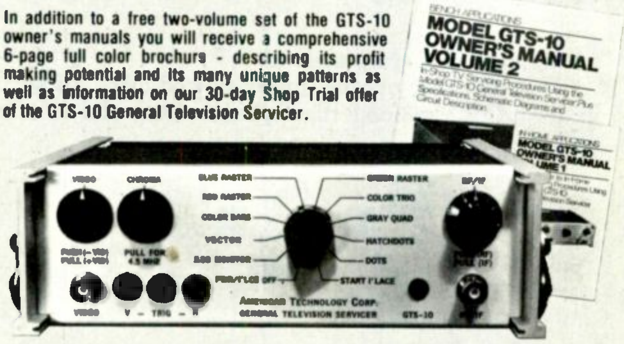
"Of course this will be just an estimate. The actual cost will be more."



troubleshootingtips

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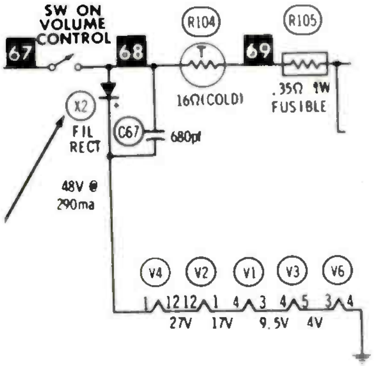
not change the symptoms.

Because the output tube glowed red after the blackout, I replaced the flyback. That did not help either.



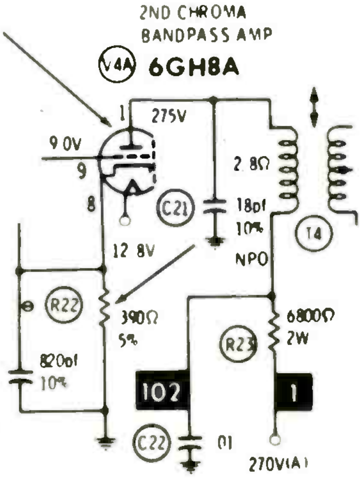
Finally, after many other tests, I noticed that the heaters of this hybrid chassis were supplied through diode X2, which reduced the heater-string voltage by eliminating the negative peak of the line voltage. I looked more carefully at the tubes, and realized their heaters all were too bright. Replacement of the shorted diode cured the twin problems.

Evidently, the overloaded heaters had caused grid leakage (or other defects) from the excessive internal heat, thus affecting the sync clipping and the operation of the horizontal oscillator.

Robert Marchant
Manomet, Massachusetts

Black area moved upward
RCA CTC51/52 (Photofact 1361-2)

A black triangle near the right edge of the screen moved slowly upward, and the color had foldover at the same area.



Now, the black triangle **might** have originated in a video stage or the power supply, but **the effect on the**

color indicated a defect in a color stage.

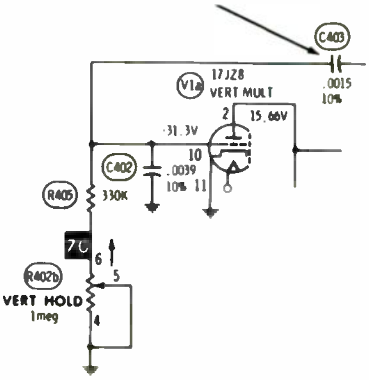
This trouble was traced to the V4A second-chroma stage, where the R22 cathode resistor had been overheated.

After the 6GH8 tube and the 390-ohm cathode resistor were replaced both symptoms were gone. According to our tube tester, the tube was shorted.

Vidal V. Cantu, Sr.
Laredo, Texas

Vertical won't lock and linearity poor
Magnavox B&W T960 (Photofact 1406-2)

Over the years, I have found a component failure that happens often and is a bit hard to find.



The symptoms range from a complete loss of vertical sweep, to severe non-linearity, and a failure to lock. Also, the frequency often is half the correct rate, showing two complete pictures with one above the other.

In all of these cases, the bad part had been C403, the .0015 capacitor that couples the positive feedback to the grid of the vertical-oscillator tube.

Eddie C. Lane
Champaign, Illinois

Vertical flip or poor locking
Panasonic CT-26 and others (Photofact 1371-1)

Some of these hybrid TV receivers are labeled Singer, or other house brand. They can be recognized by the 12FQ7 phase splitter in the sync circuit and the 25HX5 vertical tube.

Usually, the original complaint is no-picture or no height. After repairs have eliminated the primary symptom, they often display poor sync, vertical flip every 16 seconds, horizontal jitter, or a buzz in the sound.

There problems usually are caused by an open electrolytic capacitor on the IF/sync/AGC circuit board. There are six or seven of them, all mounted near one end of the board. It's so much trouble to remove and test them all (and sometimes more than one is bad), that I have started "shotgunning" the circuit by replacing all of these capacitors. Heat appears to hasten the failures, so I clean out the dust with a paint brush, and also clean the air-vent holes in the cabinet.

John Couter, Sr.
Roanoke, Virgina

Practical Tips for Repairing Auto Radios

By Homer L. Davidson

Auto-radio/tape-player sales and service continue to be a booming market. Veteran servicer Homer Davidson gives many helpful tips for finding the source of typical defects in auto-sound equipment.

Quick Radio Repairs Are Profitable

Whenever a technician knows *which* section or stage the defect is in, he always can save much time during repairs of any electronic product. With auto-sound equipment, this saving of time often determines whether the shop makes a profit or suffers a loss, since the low original cost limits the maximum amount that can be charged to the customer.

The practical tips and shortcuts in this article should enable you to identify more rapidly the area where the problem is located.

Comparison Methods

An excellent first step of efficient troubleshooting is to make comparisons of the performances of a malfunctioning item of equipment and another *identical* unit that's working correctly.

However, in the repairing of auto-sound equipment, two radios or two tape players of the same model often aren't available for testing simultaneously. Second choice for valuable comparisons is between *similar* models. These can be very informative, and often tell you enough.

For some symptoms, radios that have several functions (such as radio and tape player, or AM radio and FM band) permit comparisons between these functions. Examples will be given later.

Other valuable comparisons are those between the instrument being tested at the time and the performances of similar radios or tape players that are *remembered* by the technician. Experienced techs always know which FM stations *should* be received noise-free at that locality. Or, he knows how the music of his test cassette should sound on a typical tape player.

Although these remembered past performances can't allow accurate evaluations, they nevertheless serve as important guideposts to the quality of performance that *should* be obtained. Any significant deviation from the average indicates a need for repairs. In fact, the type and general location of many defects often can be identified.

Play The Percentages

Some defects are more likely to occur than others are. Capacitors fail more often than resistors. Bad solder joints occur most often where the current is highest, or around heavy components. Some bad components can be found by moving them physically.

Defective components tend to fail in patterns. For example, the same component fails in many individual machines of the same model. A knowledge of such repetitive or recurrent failures permits a tech to find those defective parts in quick time.

The technique of starting with the most probable component failures sometimes is called "Playing The Percentages."

Go On To The Next Level

In those cases where the comparisons, memory, and probability of defects don't locate the problem area, you should go on to more accurate and technical methods. These involve additional test equipment, coupled with logical troubleshooting.

Specific Tips

Now that we have covered the types of repair methods that are recommended for auto radios and tape players, we will give some specific examples.

Types Of Radios

Although a small percentage of present-day radios have AM band only, FM operation is very popular with the drivers and passengers. In fact, many listeners tune in FM-stereo programs because of the better tone quality and the noise-free reception.

Also, many car radios of today are combined with Stereo-8 or cassette tape machines (Figure 1). Naturally, radios with FM-stereo and tape players require more service, including the possibility of several problems when repairs are needed.

The majority of radio-service problems are no reception (radio is dead) and intermittent reception. Of course, noise and audible distortion also are common complaints.

Isolating The Problem

For the first step of troubleshooting, verify the complaint that's listed on the service ticket. Then, if the radio works at all, quickly test the operation for yourself.

Dead receiver

Total loss of sound might be caused by an open fuse, an open or intermittent connection in the "A" power lead, or a defective on/off switch.

While your ear is near the speaker, turn on the power switch, listen for a click or a thump, and look for lighted dial lamps. Any noise from the speaker proves the voltage is reaching the output transistor.

Remember that the dial lamp in some receivers is controlled by the car's light switch. If so, a lighted dial lamp is not a reliable symptom.

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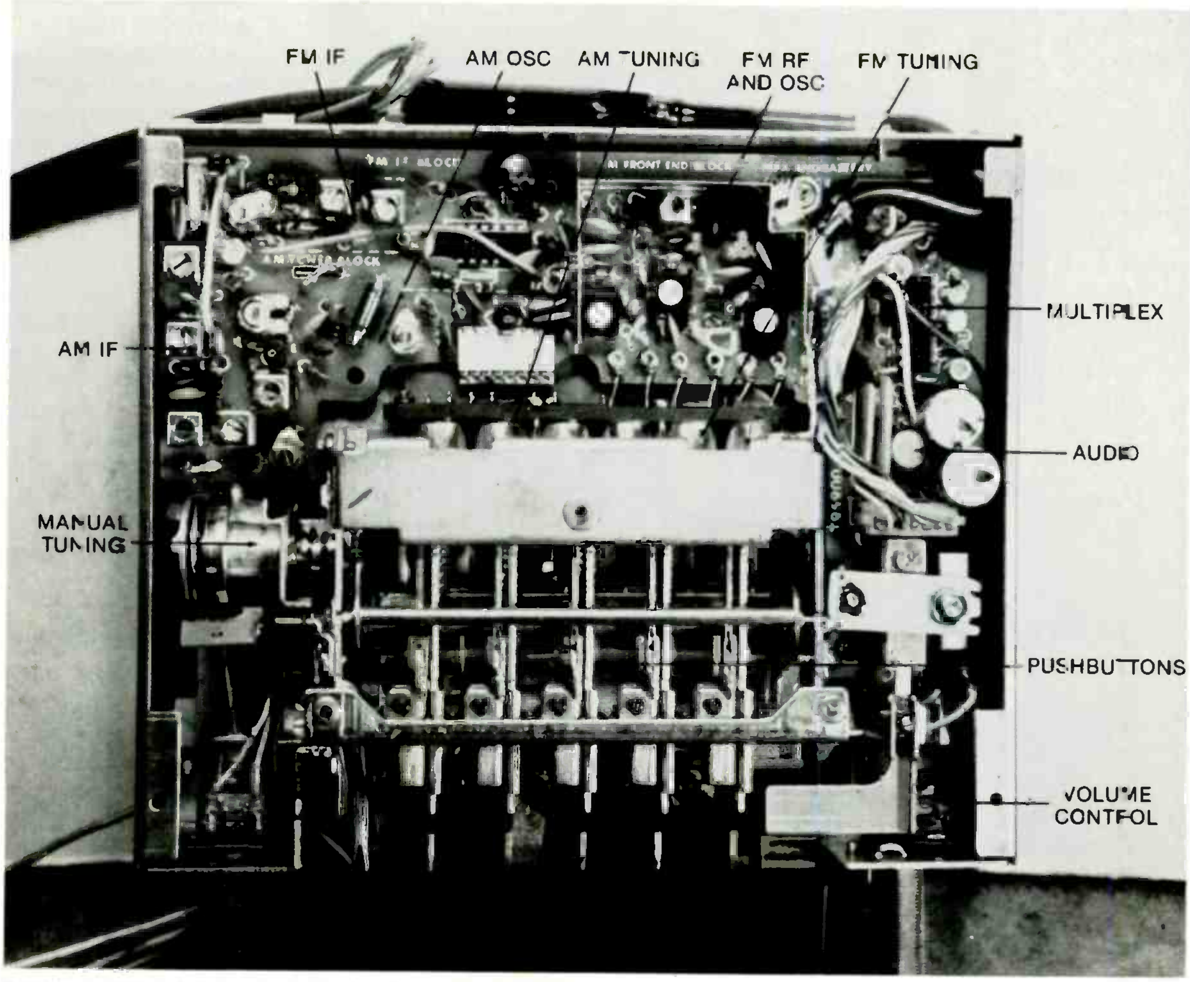
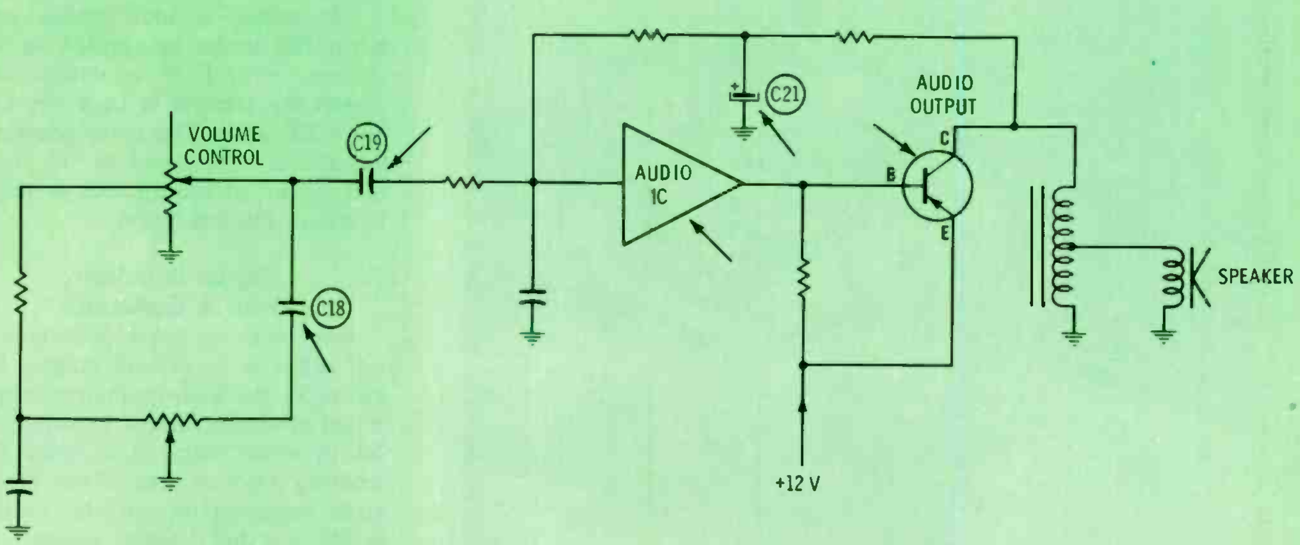


Arrows point out the principal circuits and mechanisms of a typical auto radio.



Capacitors, ICs, and power transistors are the audio components most susceptible to failures.

Radios

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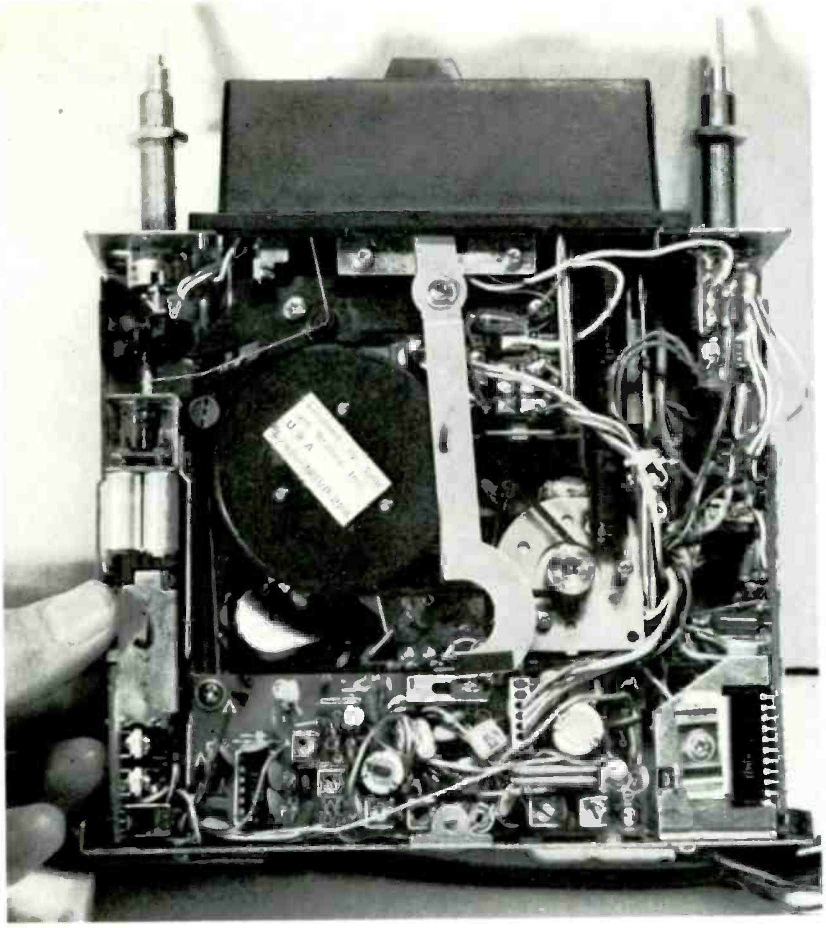

Figure 1 Many modern auto radios also have a Stereo-8 tape player.

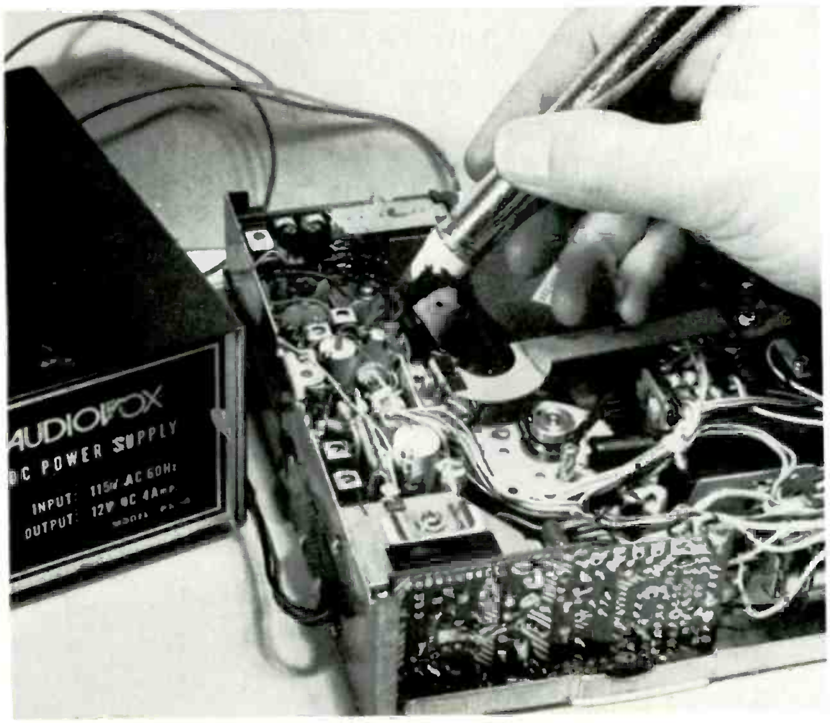

Figure 2 A small noise generator can locate many defective stages in minimum times.

Intermittent reception

If the radio has intermittent volume, use another function to determine whether both the AM and FM reception are affected, or if the radio bands are intermittent and the tape-player volume is not. Use these symptoms to find the basic circuit that has the intermittent. For example, if both AM and FM sounds are intermittent, but the built-in tape player works normally, the problem is in the radio RF or IF sections. If AM, FM, and tape sounds are all intermittent, the defect must be in the audio or speaker.

Incidentally, the two identical audio channels for FM or tape stereo make possible a comparison of volume, distortion, and gain between a bad channel and a good one.

Simple Signal Injection

A hand-held noise generator (see Figure 2) can be used for signal injection in the RF, IF, and audio stages. Touch the probe to the hot end of the volume control to prove if the audio is operating. If no audio tone can be heard with the control adjusted to maximum, you can use the probe to inject the tone at each audio stage in turn. A dead stage will be identified when a tone can be heard with the probe at the output of a certain stage, but no tone comes through when it is injected at the input of the same stage.

Of course, a loud audio tone when the probe is applied to the volume control of a dead radio proves the trouble is in a previous IF or RF stage. The noise-generator signal can be injected at the input and output of those previous stages to locate the dead one.

Signal Injection From A Generator

Sometimes a noise generator is not effective in certain stages. For example, the high-frequency output is not always sufficient to supply an RF or mixer stage. Also, good FM limiting tends to remove the amplitude modulation, so the results might not be definite enough for FM IF stages.

For such conditions, a single (but

adjustable) frequency from an RF signal generator is best for injection. With a generator, the exact AM or FM IF frequency can be used, as needed.

In the same way, an audio signal generator can be used effectively to localize the stage causing weak or distorted signals. Connect the generator through a small capacitor (perhaps a .01, or a .1 in series with 1,000 ohms) to the input and output of each audio stage. Keep the generator output level low, to avoid overload in stages that have high gain after them.

For example, an open coupling capacitor can be found by connecting the audio generator capacitor first to one end of the suspected capacitor and then to the other end. When the coupling capacitor is good, the same volume should be heard as the audio tone is injected at either end.

Connect your scope to the speaker terminals, and watch for any distortion during these tests of various stages.

Dead Stages

A dead stage is much easier to locate than one that is weak or intermittent.

The signal-injection method, described earlier, is not effective if the output audio stage is dead. For those conditions, connect an audio generator to the volume control and trace the following stages to find where the signal stops.

Experience has shown that most dead and distorted symptoms in car radios have been caused by shorted or open output transistors. Also, shorted transistors usually ruin the small-value collector or emitter resistors. So, look for burned or split resistors. Replace them and any that have changed value from the overload.

Smaller pre-amp and low-level transistors usually can be tested in-circuit with fair accuracy. However, driver transistors and output transistors require removal before leakage or gain measurements can be made accurately.

Intermittent Operation

Intermittent sound can be caused by almost any component in a car radio. In addition, poor connection in a fuse holder or an antenna jack can be mistaken for an internal radio problem.

Before you pull the radio for the bench, check the antenna and shielded lead wire. While you listen to the radio, flex the vertical antenna rod, and notice if the volume becomes intermittent. Sometimes the lead wire breaks at the bottom of the antenna or where it plugs into the radio. Check those spots first.

Occasionally, water leaks into the shielded cable, causing weak and noisy reception. In such cases, it's advisable to replace the antenna and lead wire.

Other intermittents inside the radio include cracked connections on the circuit boards, broken coil connections, and erratic transistors. Many conditions that cause intermittent operation can be found by slightly moving the suspected components. IF transformers and RF coils should be tested this way.

Intermittent transistors often can be identified by alternately applying heat (perhaps from a soldering iron) and canned coolant to each transistor.

Volume controls can become erratic, causing noise when they are turned and intermittent volume if they are stopped at a bad spot of

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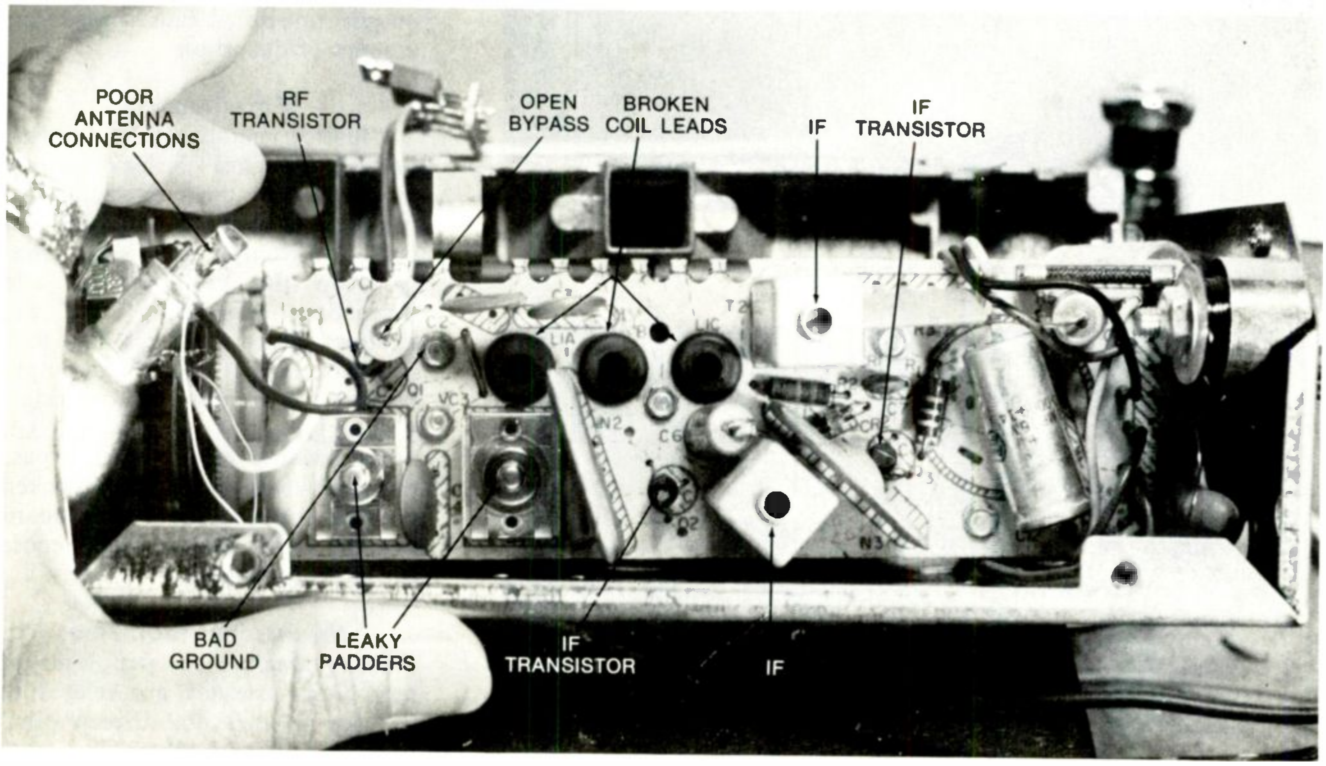

Arrows point to the radio RF and IF components that are most likely to cause trouble.

Radios

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the internal element. Sometimes tuner spray applied to the carbon element will stop the noise temporarily. This positively identifies the defect, but the control should be replaced to avoid future problems.

Speakers also can become intermittent. Substitute a test speaker while the radio is still in the car. That test works fine, too, for suspected bad antennas. Unplug the car antenna, plug in a replacement antenna, and hold it out the car window while you notice the performance.

Weak Volume

Many of the components that cause intermittent volume also can cause weak sound. The symptoms vary according to the extent of the defect.

Open coupling and emitter-bypass capacitors can reduce the gain greatly, without always causing distortion. Open coupling capacitors produce high-pitched sound quality, or no volume at all. Open emitter capacitors often reduce the volume, but the tone quality is okay.

Cracked cores in RF or IF transformers reduce the gain seriously, without changing any of the DC-voltage or resistance readings.

Sometimes an output transistor that's drawing too much current will reduce the supply voltage to the oscillator. The symptoms can be weak reception of all stations; or the radio might be weak below about 700 KHz and dead above that point on the dial.

Check the voltage drop across the emitter or collector-decoupling resistor to prove whether or not an RF or IF transistor is conducting. Transistors can feed a weak signal through the internal capacitance, even when the transistor is dead or biased to cutoff.

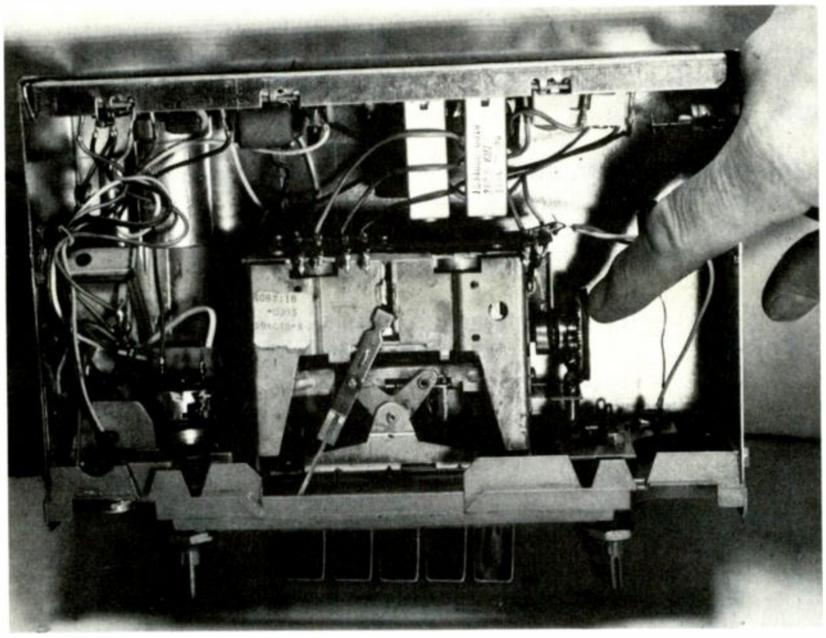

Figure 3 Many mechanical problems originate in the slip-clutch that disconnects the manual tuning when a pushbutton is used.

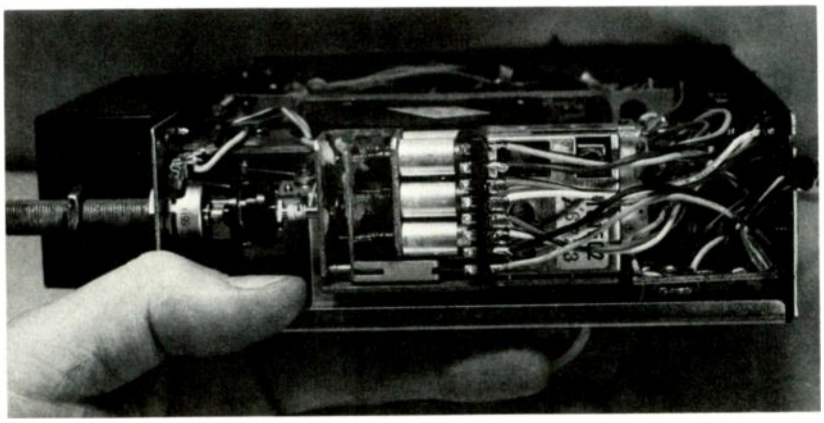

Figure 4 Both mechanical and electronic problems often originate in the permeability tuning system of car radios.

Distortion

A leaky AM-detector diode can cause distortion of the AM sound only. Failure of the AM AGC might overload the last IF transistor and produce distortion, along with excessive AM volume. Unbalanced or mistuned FM discriminators typically generate much distortion.

However, except for these individual sources of distortion, most distortion originates in the audio stages. This diagnosis is proved if *both* AM and FM sounds have the same amount of distortion.

When distortion is combined with weak sound, one or more leaky transistors should be suspected.

Open or shorted bias diodes (those between the bases of the output transistors) cause a moderate amount of distortion.

Motorboating

Usually, motorboating (put-put noises) originates in leaky output transistors or open A-supply decoupling capacitors. In some circuits, leaky output transistors merely drop the volume and add distortion. However, when the emitter voltage furnishes bias to a previous stage, leakage in an output transistor can cause motorboating.

Oscillation and motorboating can occur because of an open bypass capacitor in the IF circuit. Broken grounds between the circuit board and the metal cabinet might cause the same symptoms.

Mechanical Problems

Most mechanical problems of auto-radio receivers are related to the tuning and dial-drive mechanism (see Figure 3). This clutch mechanism usually disconnects the manual-tuning knob when the pushbuttons are used. Part of the clutch is a flat washer with an attached rubber washer. If the rubber becomes loose from the metal washer, the clutch slips, and the manual tuning can't be operated. The parts usually can be fastened together by rubber cement (or phono-grip, for stubborn cases).

When the iron-core tuning assembly (Figure 4) can't be moved, one of the cores might be "frozen" inside the coil form. Or, if the radio has been in an accident, one or more of these cores could have been broken, jamming the mechanism.

Stringing of the dial cable can be a tricky job, especially if the cable broke before you could examine the way it goes around the shafts and pulleys. I recommend that you refer to the Photofact "AR" auto-radio series for dial-stringing drawings.

Comments

Auto radios contain more dust and be more compact than comparable table models. However, they are serviced by the same methods.

When you replace any power transistors, remember to apply silicone grease to the transistor and to the heat sink (or chassis), and reinstall the mica insulator between the transistor and the heat sink. However, don't install more than one; this mistake allows a transistor to run excessively warm.

If you specialize is just one brand, it save time to make up a cable harness to connect the radios to the power source and the test speaker. Makeshift connections can cause intermittents, or they can blow output transistors. Paint the plug of each cable harness a distinctive color to remind you to remove the harness before returning the radio to the customer.

Your equipment should include an RF generator for those alignment jobs where an unskilled tech or car mechanic has turned all of the adjustments. Also, for best sensitivity, you should tune in a station around 1400 KHz (after the radio is in the car, with its own antenna) and adjust the antenna-trimmer capacitor for maximum volume. ☐

Service Management Seminar, Part 3

By Dick Glass, CET

Profit-and-loss statements are valuable for more than helping compute the income tax. Use them as a management tool to spot unprofitable areas of your operation.

What's The Score?

Can you imagine a football game between Notre Dame and Texas, with no one totaling the score? The players continue to run, pass, block, punt, and make touchdowns in brilliant displays of power and skill, while the fans cheer wildly for each successful play of their team.

However, many mistakes are made, because there's no scoreboard or time clock. A coach might take unneccessary risks, not knowing his team is safely ahead. Or, he omits a play that could bring a fast touchdown (but would not be good long-term strategy), because he doesn't know his team is behind and the clock is running out.

After a time, the enthusiasm of both fans and players begins to falter. Much of the excitement is gone when neither team wins.

The moral is obvious: games of sport *must* have scoreboards and time clocks. Your business, too, needs (for proper planning and good morale) a scoreboard called a "profit-and-loss" statement, covering a definite period of time. It's not enough to "play the game hard" by repairing all the machines you possibly can. You must know if you're winning or losing the economic "game."

A few dollars in your pocket after you have paid all of the bills doesn't prove your business is profitable. **Instead, you must compare total income with total expenses.**

P&Ls Are Easy To Understand

If studying your profit-and-loss (P&L) statements required two or three hours of your time each week, or if you were forced to do complex mathematical computations, perhaps you would be justified for giving the work to your accountant. Fortunately, that isn't the case. P&L statements are easy to understand. After you become skilled at interpretation, you probably will spend only minutes a month in checking your "score."

Many shop owners feel uncomfortable with a P&L because they don't understand all the advantages and uses. Perhaps only one is supplied to them per year. Often it's used solely as a step in the calculation of taxes. Unfortunately, this neglects some valuable applications of P&Ls.

Instead, **a P&L statement should be prepared each month** (each week for large operations), **and used first as a management tool** to monitor your business constantly.

DICK'S TV SHOP
Profit and Loss Statement
1-1-77 to 12-31-77

INCOME	
Total labor and parts sales	$100,000
EXPENSES	
Wages, parts costs, and overhead expenses	$90,000
NET PROFIT	$ 10,000

Figure 1 Although very short, this is a complete P&L. It shows total income, total expenses, and net profit.

What Can I Learn From A P&L

A P&L statement shows you these three basic things:

- The amount of money you received (total sales).
- The amount of money you spent (total expenses).
- How much money you have left (total profit).

Figure 1 shows a condensed profit-and-loss statement. Although it might appear to be too simple, it is complete. It probably doesn't provide as much information as you need, but it's far better than evaluating your profit or loss by the thickness of your wallet.

DICK'S TV SHOP
Profit and Loss Statement
1-1-77 to 12-31-77

INCOME			
Labor income		$50,000	
Parts income		$50,000	
Total sales			$100,000
COST OF SALES			
Labor sales	$50,000		
Direct wages	$25,000		
Gross labor profit		$25,000	
Parts sales	$50,000		
Parts costs	$25,000		
Gross parts profit		$25,000	
TOTAL GROSS PROFIT			$50,000
OVERHEAD EXPENSES (general and administrative expenses)			
Accounting	$ 2,000		
Clerical and administrative salaries	$20,000		
Rent	$ 6,000		
Truck expenses	$10,000		
Utilities	$ 2,000		
TOTAL OVERHEAD EXPENSES			$40,000
NET PROFIT			$ 10,000

Figure 2 Income from all basic sources should be listed, along with the associated expenses, and the items of overhead should be given separately. Showing gross profit from each source of income allows you to judge the relative profitability. What's more, you can spot trends by comparing the gross profits of successive P&Ls.

Balance sheets

At this point, perhaps you're wondering about balance sheets, and whether or not they accomplish essentially the same things as do P&Ls. Balance sheets show what you owe and what you own at the end of an accounting period. They are important in their own right, and we will explain them thoroughly next month. For now, it's enough to know that balance sheets and P&Ls work together.

Expanding the P&L

In addition to the three items mentioned above, other helpful information which can be obtained from P&Ls includes:

1. A comparison of your present statistics with last month or last year, to prove whether you are doing better or worse.
2. You can compare your expenses with industry averages, to determine if improvements are needed in any certain areas.
3. Your gross profit can be shown (gross profit is found by subtracting "direct labor" and "direct parts costs" from income).
4. Overhead expenses can be listed individually, and totaled, thus helping you to determine efficiency.
5. It can show the actual costs, allowing you to bill labor and parts charges more accurately.

Tips for P&Ls

Even if you have a one-man operation, you should have a P&L statement each month and annually.

An inventory is not necessary for each monthly P&L. One inventory per year should be sufficient.

Small business should not handle "parts inventory" and "owner's wages" by the conventional method. Later, we'll tell you why and how.

The P&L is not an end in itself, but is merely one tool to help you answer your financial questions.

Gross profit

The term "gross profit" probably is a leading cause of confusion about P&L statements.

Perhaps gross profit would be more understandable if we thought of it as being an "intermediate frequency" of accounting. Although it's important, gross profit is not the *final* figure we're after.

Gross profit is the "paper" profit remaining after you subtract from the total income all the *direct* costs (such as wages for your techs, and the money paid for the components). Net profit is calculated by subtracting the overhead (general and administrative) expenses from the gross profit.

Figure 2 shows another P&L for Dick's TV, with figures for the gross profit included. This P&L contains the same information as the less complicated one of Figure 1; however, it shows the individual items of expense and the computation of gross profit. Perhaps your yearly P&L appears to be much more extensive, yet it contains the same basic elements as the one of Figure 2.

The greatest value of the Figure 2 P&L is that it shows how much you are spending on the three

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Dick's TV Shop
Profit and Loss Statement
1-1-77 to 12-31-77

INCOME				
Labor income		$50,000		50%
Parts sales		$50,000		50%
Total sales			$100,000	100%
COST OF SALES				
Labor sales	$50,000			
Direct wages	$25,000			25%
Gross labor profit		$25,000		25%
Parts sales	$50,000			
Parts costs	$25,000			25%
Gross parts profit		$25,000		25%
Total Labor and Parts costs			$50,000	50%
TOTAL GROSS PROFIT			$50,000	50%
OVERHEAD EXPENSES				
Accounting	$ 2,000			2%
Clerical & Administrative salaries	$20,000			20%
Rent	$ 6,000			6%
Truck expenses	$10,000			10%
Utilities	$ 2,000			2%
TOTAL OVERHEAD EXPENSES			$40,000	40%
NET PROFIT (before taxes)			$10,000	10%

Figure 3 Adding percentages to P&Ls allows you to compare those of different months without confusion.

Dick's TV SHOP
Profit and Loss Statement
Period ending June 30, 1978

INCOME	**June '78**		**Year to date**		**Last year**	
Labor sales	$ 6,000	55%	$30,000	55%	$ 50,000	50%
Parts sales	$ 5,000	45%	$25,000	45%	$ 50,000	50%
Total sales	$11,000	100%	$55,000	100%	$100,000	100%
COST OF SALES						
Labor sales $6,000		55%		55%		50%
Direct labor $2,500 (42%)*		23%	$14,000	25%	$ 25,000	25%
Gross labor profit	$ 3,500	32%	$16,000	29%	$ 25,000	25%
Parts sales $5,000		45%		45%		50%
Parts costs $3,000 (60%)**		27%	$15,000	27%	$ 25,000	25%
Gross parts profit	$ 2,000	18%	$10,000	18%	$ 25,000	25%
Total Labor and Parts costs	$ 5,500	50%	$29,000	53%	$ 50,000	50%
TOTAL GROSS PROFIT	$ 5,500	50%	$26,000	47%	$ 50,000	50%
OVERHEAD EXPENSES						
Accounting	$ 167	1.5%	$ 1,000	1.8%	$ 2,000	2%
Salaries-Clerical & Admin.	$1,666	15%	$10,000	18%	$20,000	20%
Rent	$1,000	9%	$ 5,000	9%	$ 6,000	6%
Truck expense	$ 950	8%	$ 4,200	7.6%	$10,000	10%
Utilities	$ 200	1.8%	$ 1,300	2.4%	$ 2,000	2%
TOTAL OVERHEAD EXPENSES	$3,983	36%	$21,000	39%	$40,000	40%
NET PROFIT (before taxes)	$1,517	13.8%	$ 4,500	8.1%	$10,000	10%

Figure 4 The recommended P&L combines all of the essential data and the percentage figures of several P&Ls.

Service Management

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largest expense categories: wages; parts or components; and overhead. Efficient operation demands that you keep these in balance for the type of store you have.

Notice that the direct wage cost is 50% of the total labor produced. Usually, in this business, 50% wage costs is too high. The owner should increase the labor income or reduce the wage costs. The parts costs are 50% of the parts sales. This is about right for shops not doing much warranty work. Shops having a high rate of warranty repairs might only realize 20% to 30% of parts profits. Lastly, we see that the overhead expenses are 40% of total sales. Because the boss (who's not a technician) has included his own salary in the "clerical and administrative salaries" section of overhead expense, the 40% overhead figure probably is normal for this shop.

Percentages

While the Figure 2 P&L is quite informative, it lacks one thing: *percentages*. Otherwise, when you want to compare the figures for each month and year, you will be lost in a maze of figures. Using percentages provides a common denominator that makes comparisons easy and fast. Figure 3 is the same P&L, but with percentages added.

There is no limit on the time period of a P&L. It can be daily, weekly, monthly, quarterly, yearly, or whatever is needed.

Exceptions For Service Businesses

Two important differences in accounting methods are necessary for small service businesses: the method of handling parts costs and inventory; and the owner's salary.

Inventory

I advise that a parts inventory be taken only once per year. Owners of small service shops ordinarily are so involved in the details of the business that they are aware of inventory changes at all times. Also, the proliferation of small parts makes an inventory a difficult and expensive task. Of course, a monthly inventory is desirable, but the benefits are less than the effort required. And the year-end inventory eventually will provide the adjustment.

Here is an example of a year-end parts inventory adjustment:

Parts inventory value 1-1-77	$6,000
Parts purchases 1-1-77 to 12-31-77	$60,000
Total	$66,000
Less inventory 12-31-77	$16,000
Actual parts cost for 12 months	$50,000

Owner's salary

If the owner does no work of any kind (neither technical nor management), his salary must come from the net profits of the business. Therefore, a non-working owner's salary should not be included in the single-proprietorship or partnership P&L. It is advisable to have a notation of the "Owner's Drawing Account" added at the bottom of the P&L to show the amount the owner has withdrawn during the accounting period. (Incidentally, a non-working owner will pay taxes only on the net profit shown by the year-end P&L, regardless of the amount he "draws.")

However, if the owner performs technical or management functions, his salary properly belongs on the P&L under the correct expense category.

For example, if you as the owner spend 75% of your time working as a technician and the other 25% in managing the business, you should list 75% of your salary as "Direct Wage Cost," and the other 25% under the "Clerical And Administrative Salaries."

Comparisons

Now that gross profit and percentages have been included, one more step is needed: comparison of the latest P&L with the previous one. Although there are many possible comparisons, the method I like is shown in Figure 4, which contains all the data listed before.

Analysis of the Figure 4 P&L can spot trends and identify any unusual changes before they become more dangerous. Notice that the net profit for the first six months is down by 19%. It's likely a problem is indicated, but the analysis to determine the source of the loss should be continued.

The overhead percentage is 39%, which is down slightly from last year, despite the big rent increase; and the gross labor profit is higher. However, the gross **parts** profit **dropped** from 25% to 18%. Evidently, **the lower parts sales (50% went down to 45%) and the rising parts costs (from 25% to 27%) combined to make the parts sales less profitable.**

Also, notice the two percentages marked * and **. The first is the June percentage of labor costs to labor sales, which has decreased from 50% last year down to 42%. The other is the June percentage of parts costs to parts sales, and it increased from last year's 50% up to 60%. Some shop owners are more concerned about those two percentages than about any others. Certainly, they are very important.

Not all the percentages discussed were listed in Figure 4, but they were calculated from the figures given there.

In the example, both the total parts sales and the profitability of those sales are exposed as the problem that needs to be solved first.

The ability to pinpoint individual increases or decreases is the great value of the gross-profit listings, particularly when there are several entries.

Comments

Your P&Ls undoubtedly have other income categories (perhaps "merchandise sales," rentals, or others). Also, under General and Administrative I have shown only a few items instead of the long list most P&Ls have. Later in this series, we will return to Profit-And-Loss statements and explain how to split your P&L, separating the service and sales departments. Also, we will clear up that old nemesis called depreciation.

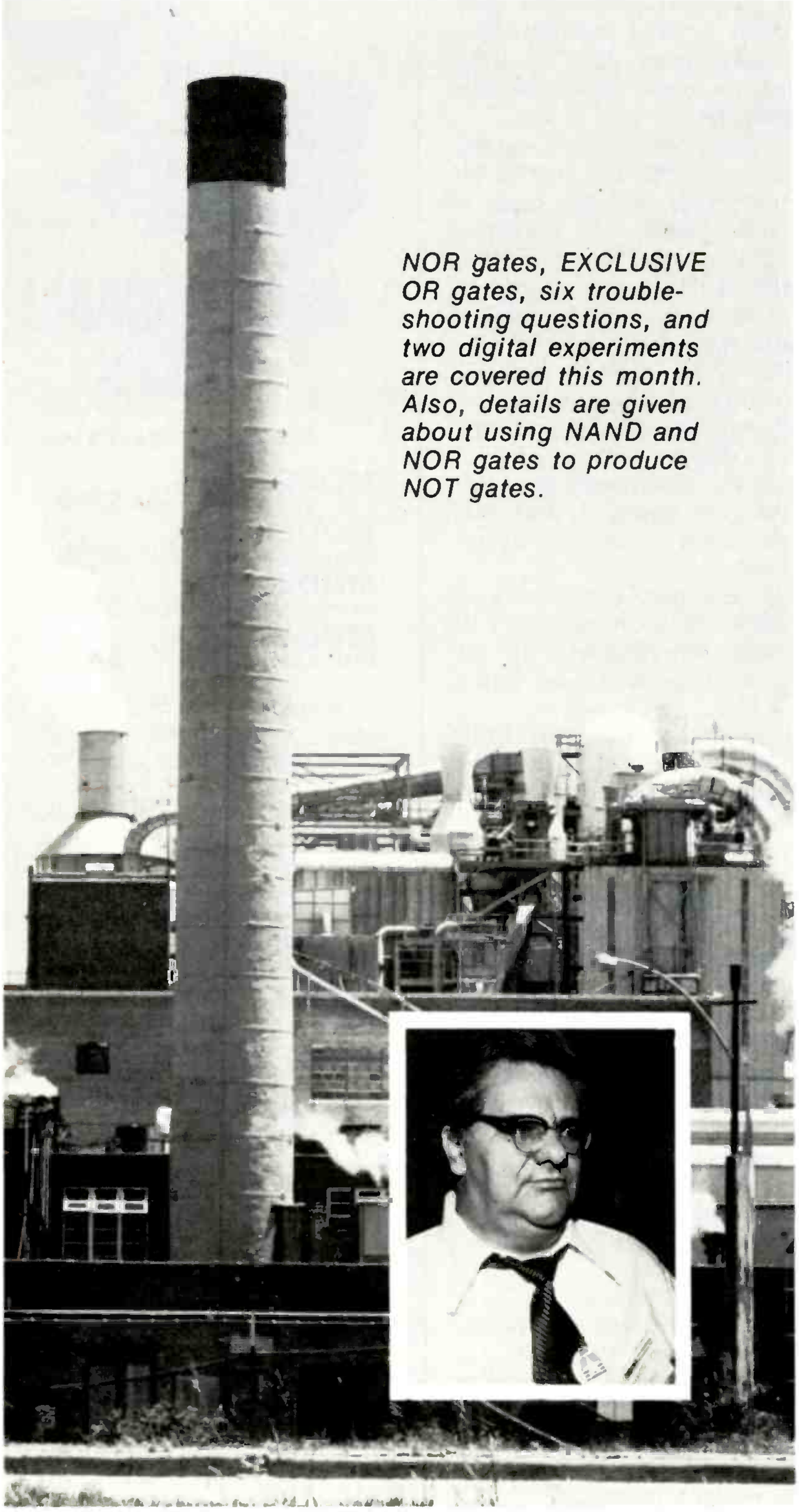
However, if you now are comfortable with P&Ls and understand how to use them, it's likely you won't have trouble with more complicated ones.

Use these suggestions about P&Ls to help make profitable decisions for your business operation. ☐

The Basics of Industrial Electronics, Part 9

By J. A. "Sam" Wilson, CET

NOR gates, EXCLUSIVE OR gates, six troubleshooting questions, and two digital experiments are covered this month. Also, details are given about using NAND and NOR gates to produce NOT gates.



NOR Gate

With NOR gates (Figure 1), the only way of obtaining a logic 1 output is to have logic 0 at *both* inputs. All other combinations of inputs produce a logic 0 at the output. The NOR formula is derived from: NOT A OR B EQUALS L.

NOR gate symbols are the same as those for OR gates, except for an indication that the output is inverted. In the MIL symbol, the small circle at the output shows inversion.

This is an important point, because it hints that a NOR gate can be constructed from an OR gate followed by an inverter (NOT gate).

In the basic industrial circuit, the normally-closed relay contact is energized (logic 1 at the load) only when both switches are open (logic 0). When either or both switches are closed, the relay opens the contact, producing a logic 0 at the load. This is in agreement with the truth table.

The math formula is read: NOT A OR B EQUALS L. The overbar must be across both the A and B, or the equation is written incorrectly.

Changing A NAND To A NOT

In the February article, I said that any of the basic logic gates could be constructed, if a sufficient number of NANDs (or NORs) is used. In other words, specific wirings of the NAND gates can produce any of the basic gates that we have described so far. The same is true of NOR gates.

It's easy to wire a NAND gate so it performs as a NOT (inverter), as shown in Figure 2. The two inputs are connected together; therefore, both inputs always have the same logic level. A conventional truth table is used, except the two conditions when the inputs have different logic levels are not possible. In Figure 2, these entries are removed from the truth table, leaving only the one with both inputs at logic level 0 (producing a high output) and the other with both inputs at logic level 1 (for a logic 0 output). Whenever the output always is reversed from the input, the circuit is an inverter (or a NOT gate).

Changing A NOR To A NOT

A NOR gate also can be wired to operate as an inverter. Figure 3 shows the two entries of the truth table that are impossible when the two inputs are connected together. The only valid inputs are logic levels 0 and 0, which produce a level 1 output, and logic levels 1 and 1, producing a logic level 0 output. These characteristics fulfill the requirements for a NOT gate (inverter).

These last two illustrations prove that NOT gates can be constructed by connecting together the inputs of either NAND or NOR gates.

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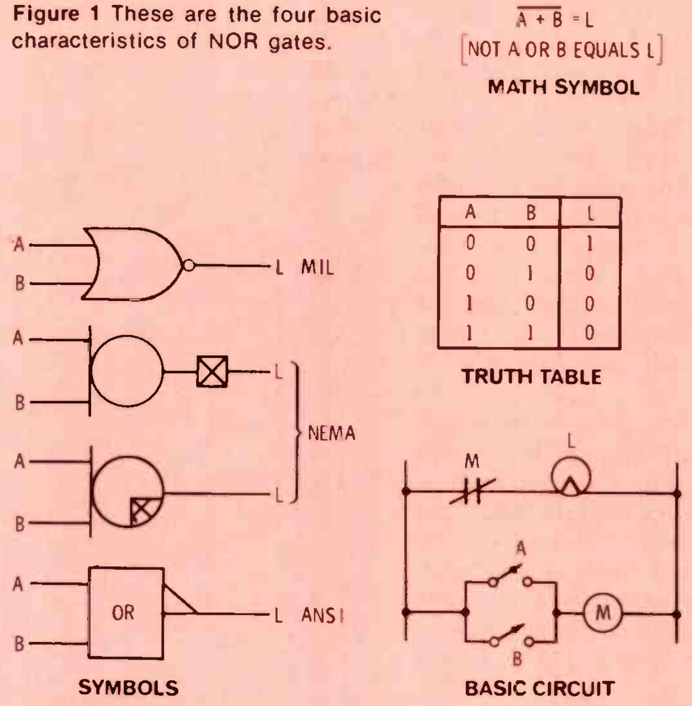
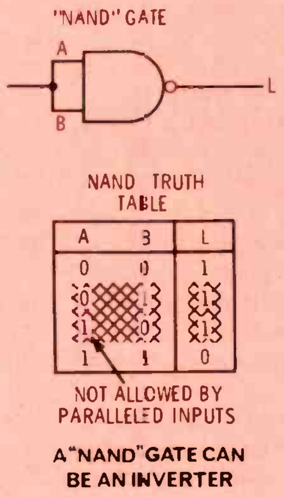


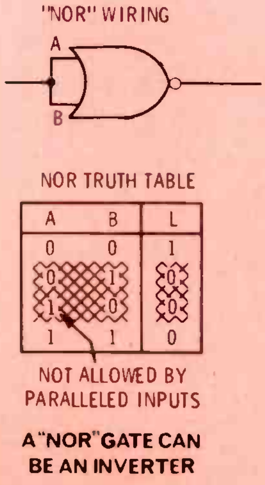
A	B	L
0	0	1
0	1	0
1	0	0
1	1	0

Figure 1 These are the four basic characteristics of NOR gates.

Figure 2 Connecting both inputs of a NAND gate together eliminates half of the truth table, allowing it to function **only** as a NOT gate.

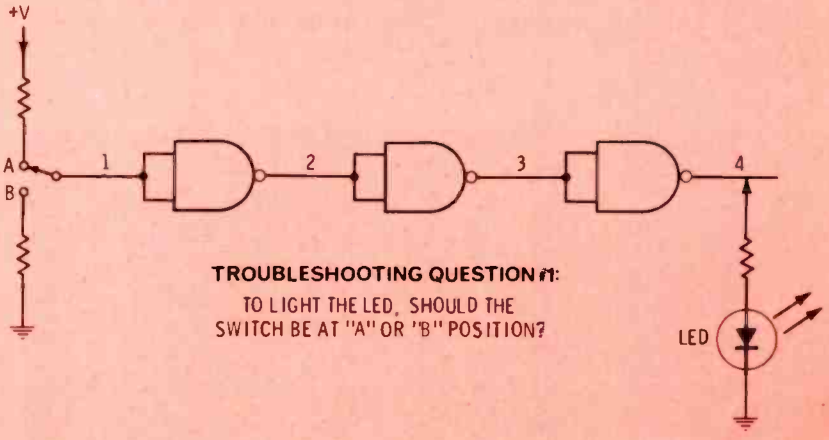


A	B	L
0	0	1
~~0~~	~~1~~	~~1~~
~~1~~	~~0~~	~~1~~
1	1	0



A	B	L
0	0	1
~~0~~	~~1~~	~~0~~
~~1~~	~~0~~	~~0~~
1	1	0

Figure 3 Connecting both NOR gate inputs together also eliminates half of the truth table, leaving **only** the function of a NOT gate (inverter).



TROUBLESHOOTING QUESTION #1:
TO LIGHT THE LED, SHOULD THE SWITCH BE AT "A" OR "B" POSITION?

Figure 4

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Troubleshooting Question #1

Figure 4 asks a question about a series of NAND gates that are connected as NOTs. What is your answer?

Troubleshooting Question #2

Answer the troubleshooting question of Figure 5, concerning two NOR gates connected as NOTs that feed the two inputs of another NOR gate.

Exclusive OR Gate

The symbols, truth table, basic circuit, and math symbols for an EXCLUSIVE OR gate are shown in Figure 6.

During a previous discussion of INCLUSIVE OR gates, we mentioned the two different meanings of the English word "or." When someone says, "John or Mary may go to the store," it could mean, "John or Mary or both may go to the store." This is the inclusive form. On the other hand, the intent might be to say, "John or Mary, but not both, may go to the store." This is the exclusive form of "or."

The OR gate discussed in the January issue was the inclusive type where *either or both* of the inputs having a logic 1 produces an output of logic 1.

From the truth table in Figure 6, we learn that a logic 1 at either (but *not both*) input produces a logic 1 at the output. **Another way of defining an EXCLUSIVE OR gate is that the inputs must be at opposite levels to obtain a logic 1 output.** Notice that a plus sign is used both in the NEMA symbol and the first formula. In logic symbols, the plus sign indicates OR.

The basic industrial circuit needs some explanation. Two relays are provided, each with one normally-open and one normally-closed set of contacts. The normally-open contact of M is in series with the normally-closed N contact. Also the normally-closed contact of M is in series with the normally-open N contact.

When neither relay is energized, no path exists through either pair of contacts (one normally-open is in each path). When both are energized, all of the contacts reverse, but still there is no path through the series contacts. The only way to light the lamp (logic 1) is to energize relay coil M or N, but not both.

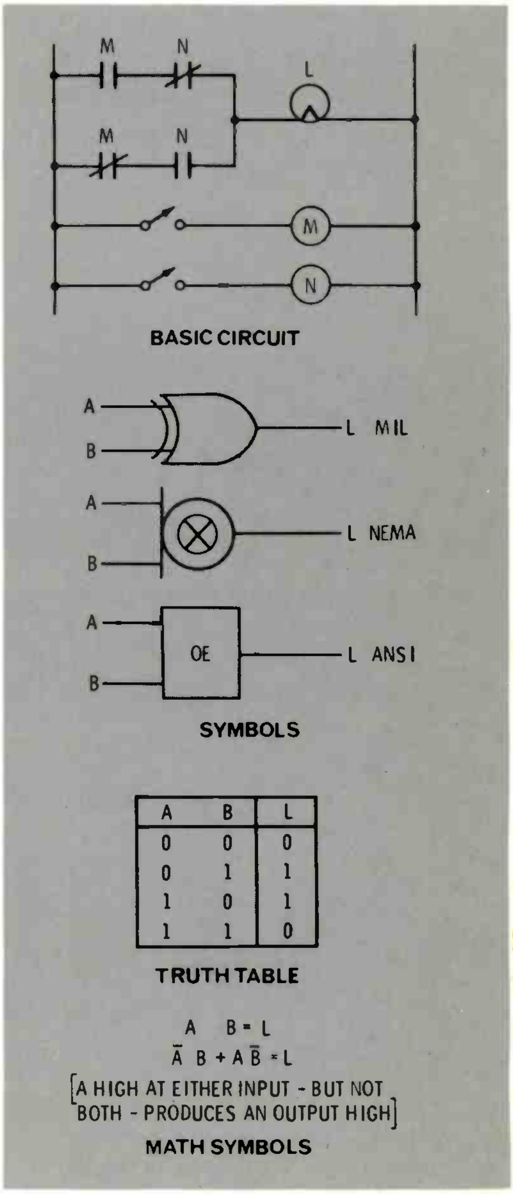
Three-way switch

Let's analyze the operation of the so-called three-way lamp circuit of Figure 7A. It's used often to operate a hall lamp from the top or bottom of the stairs, or to control a garage light from the house or the garage.

With the light switches flipped as shown, the circuit is completed, and the lamp will light. Also, if *both* switches are flipped to the opposite positions, the circuit again has continuity (although through a different path) and the lamp is energized.

However, if just one of the switches is flipped, the power source and the lamp are connected to different wires. Therefore, the lamp does not light.

The logic of the circuit can be understood more easily, if the



A	B	L
0	0	0
0	1	1
1	0	1
1	1	0

TRUTH TABLE

$A \quad B = L$

$\bar{A}\ B + A\bar{B} = L$

[A HIGH AT EITHER INPUT - BUT NOT BOTH - PRODUCES AN OUTPUT HIGH]

MATH SYMBOLS

Figure 6 Here are the basic characteristics of EXCLUSIVE OR gates.

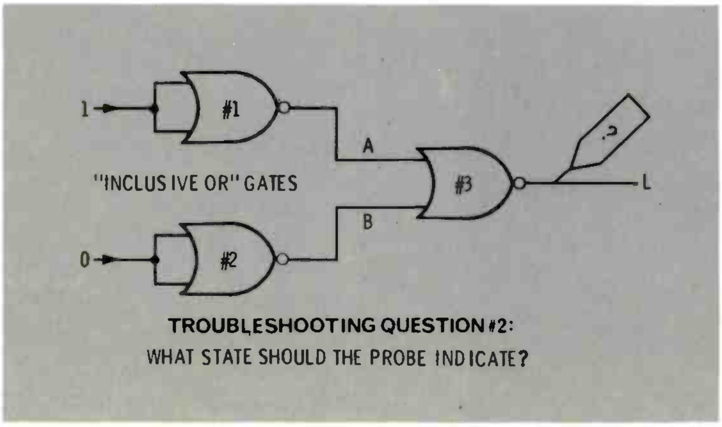


Figure 5

circuit is redrawn (Figure 7B) in industrial style similar to the basic circuit of Figure 6. The results agree with the truth table of Figure 6.

Troubleshooting Question #3

In Figure 8, given the B input level and the output level of the EXCLUSIVE OR gate, what must be the logic level at the A input?

Combinational Logic

Many logic circuits are made by combining gates. These are called **combined-logic gates or combinational-logic gates.** One example is shown in Figure 9. The two inputs of a NOR gate are tied together, making it function as a NOT gate, and it is located between the A input and one input of an OR gate. The B input goes direct to the OR gate.

It's important that you determine what the output level *should be*, so you can know if it is operating properly or not.

There are several ways of determining the output logic level (one is by Boolean algebra, but it will not be explained now). Perhaps the easiest method is to draw up a truth table (see Figure 9). Write in all combinations of logic levels for the two inputs.

We know that a NOT gate inverts the state, so we can fill in the NOT A column, as shown in Figure 10. The original A column is not used anymore, because the NOT A and the B logic levels are the input of the OR gate. Next, knowing that the only way to obtain logic level 0 at the output is to apply level 0 to both inputs, we can complete the truth table (Figure 11). The last step is to ignore the column, and to use the A and B logic levels plus the output level.

Notice that the inputs and outputs were taken a step at a time starting with the NOR which is wired as a NOT, continuing on to the two inputs of the OR gate

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(allowing us to know the output, and finishing by going back to the original A and B inputs.)

Troubleshooting Question #4

Figure 12 shows the logic circuit of Figure 9, but both inputs are supplied with logic level 0. What level should the probe indicate at the output?

Troubleshooting Question #5

In the circuit with three NAND gates of Figure 13, what should be written in the blank spaces of the truth table?

Experiment #1

This experiment is in two parts. The circuit of Figure 14 shows a 7400-series IC containing four NAND gates that have been wired to make them perform as NOT gates. First, use your knowledge of digital circuits, by completing the truth table at the left, both for an input of logic 0 and for logic 1.

Second, wire the circuit as shown. Apply a ground (logic 0) to input A and use a logic probe to test each of the four points, writing down the logic states. Repeat the test with the A input connected to +5 volts (logic 1), and write down the other four logic levels, as measured by the probe, in the spaces of the truth table at the right.

Of course, the experimental results should be identical with the predicted performance.

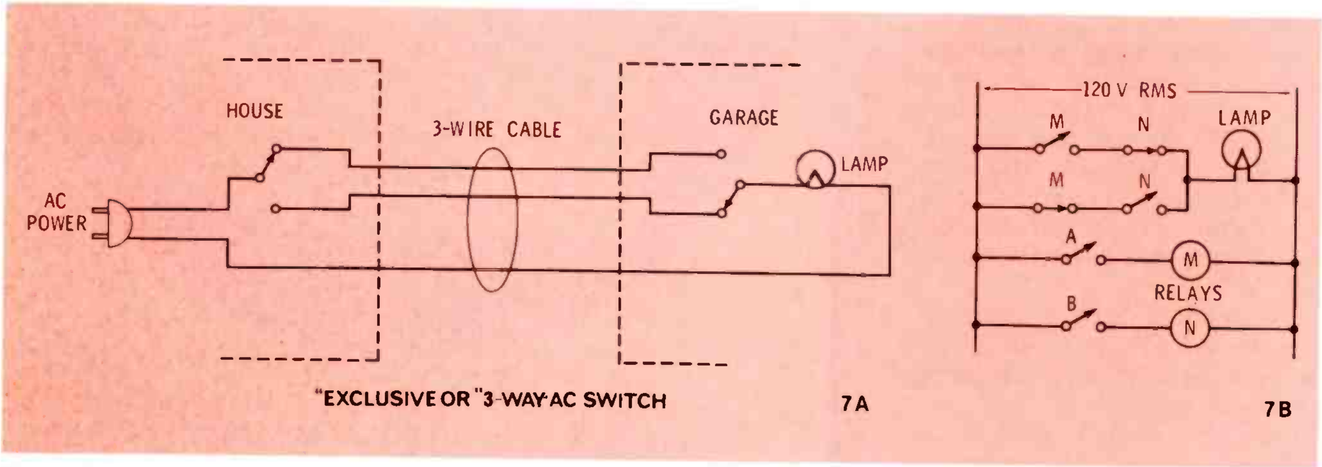


Figure 7 This "three-way" lamp wiring (A) has been used for years. It is a practical example of an EXCLUSIVE OR gate. (B) Drawn in industrial style, the circuit is almost identical to that in Figure 6.

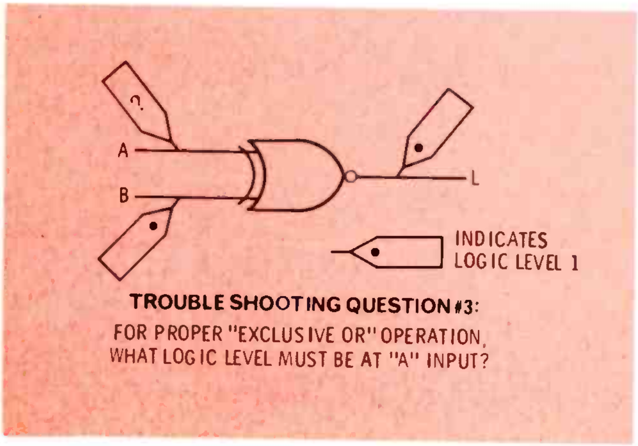
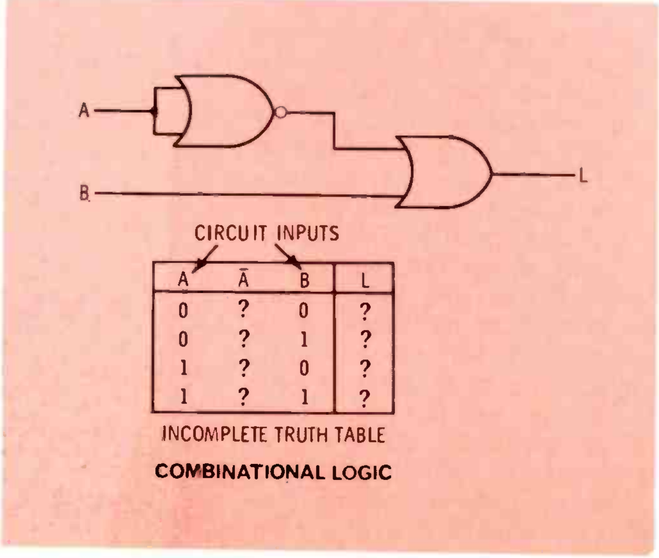


Figure 8



A	$\bar{A}$	B	L
0	?	0	?
0	?	1	?
1	?	0	?
1	?	1	?

Figure 9 Logic circuits composed of two or more logic gates are called "combination logic." A NOR gate is wired as a NOT, and it feeds one input of an OR gate. From this information, complete the truth table.

Troubleshooting Question #6

When you have completed the truth tables in Figure 14 (and both are the same), have you completely checked all of the NAND gates?

Experiment #2

Construct the circuit of Figure 9. Using a logic probe, measure the output when the inputs have the logic levels shown there. (Obtain a logic 1 by connecting the input to +5 volts of the power supply. Simulate a logic 0 by connecting the gate to common of the power supply. Complete the truth table, trying each combination of inputs separately. The finished truth table should be identical to the one in Figure 11.

Answers To The Troubleshooting Questions

Answer #1. The switch of Figure 4 must be in the "B" position to produce a logic 1 at testpoint 4, thus lighting the LED. The NANDs are wired as NOTs, so a logic 0 at point 1 produces a logic 1 at point 2, a logic 0 at point 3, and finally a logic 1 at point 4 for the LED.

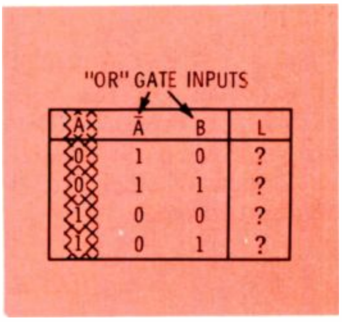
Answer #2. The probe of Figure 5 should indicate a logic level 0. NOR gates #1 and #2 are wired as NOTs, which places a logic 0 at "A" and a logic 1 at "B" of NOR gate #3. With inputs of 0 and 1, the output must be logic 0, which can be confirmed by the truth table of Figure 1.

Answer #3. The logic level at input "A" in Figure 8 must be 0, if the gate is operating properly. The output is level 1, and the inputs of an EXCLUSIVE OR gate must be opposite to obtain that result. Input "B" has logic 1; therefore, input "A" must be logic 0.

Answer #4. In Figure 12, the logic probe should show a logic 1 output. The NOR gate has been wired as a NOT, making the inputs of the OR gate a logic 1 and a logic 0. This calls for a logic 1 output level, which can be verified by the truth table of Figure 11.

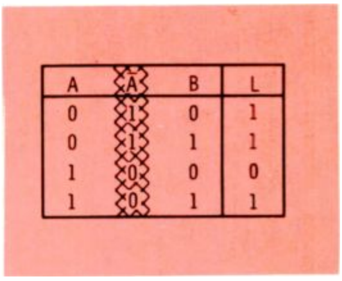
Answer #5. The completed truth table of Figure 13 is shown in Figure 15. That answers the question, but there's more. Eliminate the NOT A and NOT B columns, and the truth table that remains

continued on page 30



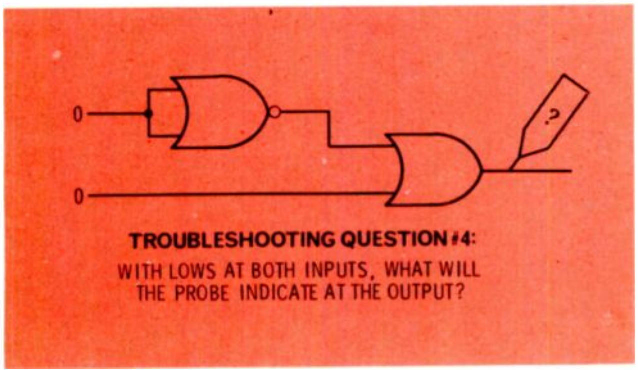
~~A~~	$\bar{A}$	B	L
~~0~~	1	0	?
~~0~~	1	1	?
~~1~~	0	0	?
~~1~~	0	1	?

Figure 10 The NOT A column can be filled in easily, since the output of an inverter always is opposite to the input. As shown, this identifies the two inputs to the OR gate (NOT A and B inputs). From the information complete the output logic states.



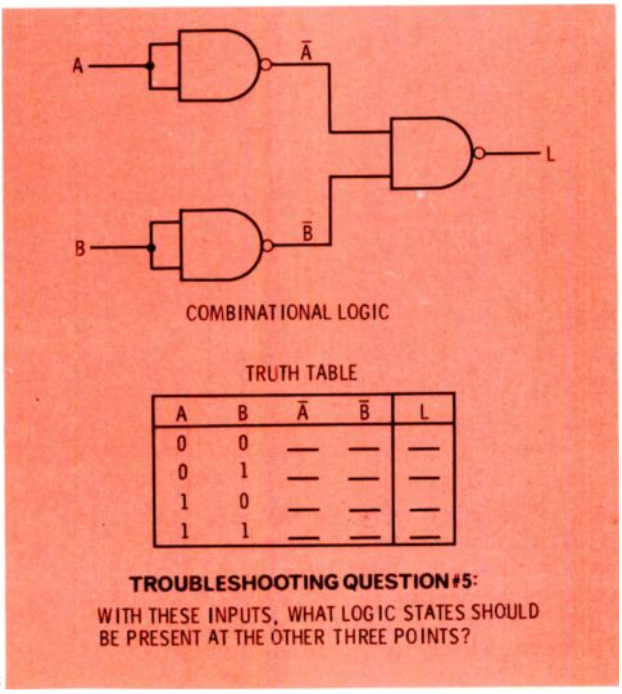
A	~~$\bar{A}$~~	B	L
0	~~1~~	0	1
0	~~1~~	1	1
1	~~0~~	0	0
1	~~0~~	1	1

Figure 11 After the OR output is determined, the NOT A column is not needed. Use the A and B columns of the truth table as the inputs of the combinational logic system.



TROUBLESHOOTING QUESTION #4:
WITH LOWS AT BOTH INPUTS, WHAT WILL THE PROBE INDICATE AT THE OUTPUT?

Figure 12



TRUTH TABLE

A	B	$\bar{A}$	$\bar{B}$	L
0	0	—	—	—
0	1	—	—	—
1	0	—	—	—
1	1	—	—	—

TROUBLESHOOTING QUESTION #5:
WITH THESE INPUTS, WHAT LOGIC STATES SHOULD BE PRESENT AT THE OTHER THREE POINTS?

Figure 13

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(Figure 16) is for an INCLUSIVE OR gate. **An OR has been constructed from three NANDs!** Other examples of gates made from combinations of other gates will be given next month.

Answer #6. No, you have not completely checked all of the NAND gates. You *have* proved correct operation when both gates are switched together, but not with inputs of opposite logic levels. However, it's likely that NANDs which pass this test actually are okay. Quick tests have value, but keep in mind that additional testing might be required (for example, to determine the propagation delay). ☐

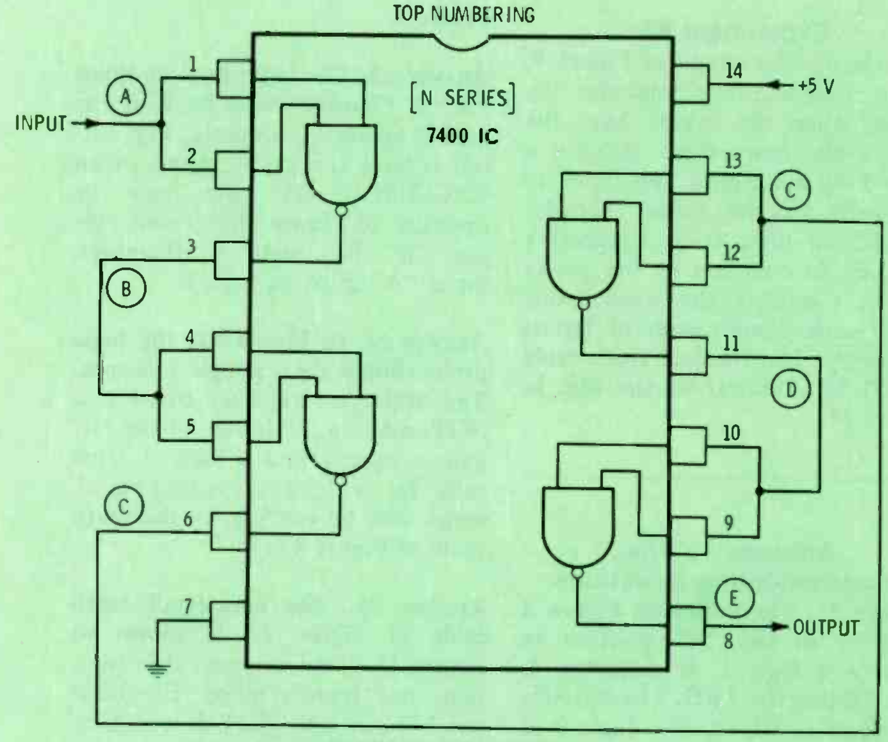


Figure 14 Calculate the truth table at the left. Then, construct the experimental circuit and use a logic probe to determine the logic states at each point, filling in the truth table at the right. If the four NAND gates are not defective, the two truth tables should be identical.

WIRING FOR THE EXPERIMENT

EXPERIMENT#1:

A	B	C	D	E
0	___	___	___	___
1	___	___	___	___

THESE "NAND" GATES ARE WIRED AS "NOT" GATES. USE YOUR DIGITAL KNOWLEDGE TO WRITE IN THE CORRECT STATES FOR BOTH POSSIBLE INPUTS.

A	B	C	D	E
0	___	___	___	___
1	___	___	___	___

TEST THE IC CIRCUIT YOU HAVE WIRED, AND RECORD THE RESULTS IN THIS TRUTH TABLE. CONNECT "A" TO +5 VOLTS FOR A LOGIC 1, OR TO GROUND FOR A LOGIC 0.

TROUBLESHOOTING QUESTION #6:
HAVE THESE TESTS COMPLETELY CHECKED THE NAND GATES?

Figure 15 This is the truth table of Figure 13, after it is completed.

A	B	$\bar{A}$	$\bar{B}$	L
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

TRUTH TABLE FOR THE COMBINATIONAL LOGIC OF FIGURE 13

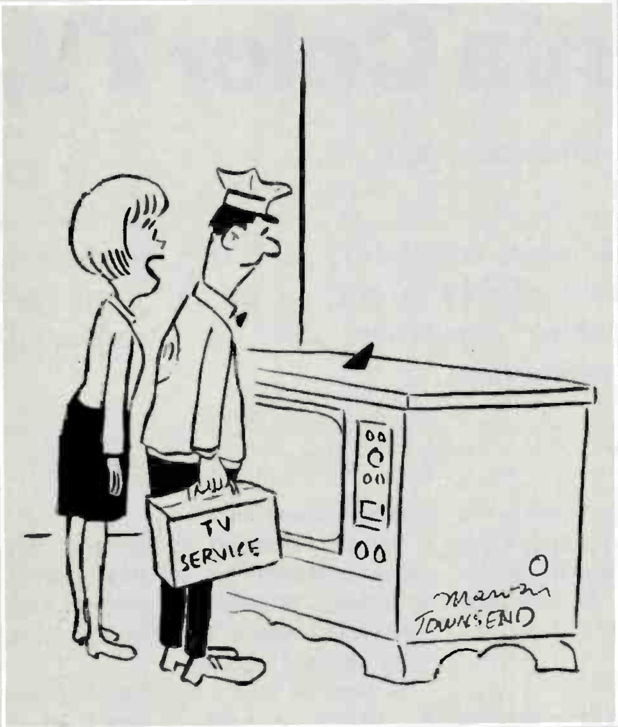
Figure 16 (far right) After the NOT A and NOT B columns of Figure 15 have been eliminated, the truth table that remains is the one for an INCLUSIVE OR gate. Therefore, three NAND gates have been wired to produce an INCLUSIVE OR gate.

A	B	L
0	0	0
0	1	1
1	0	1
1	1	1

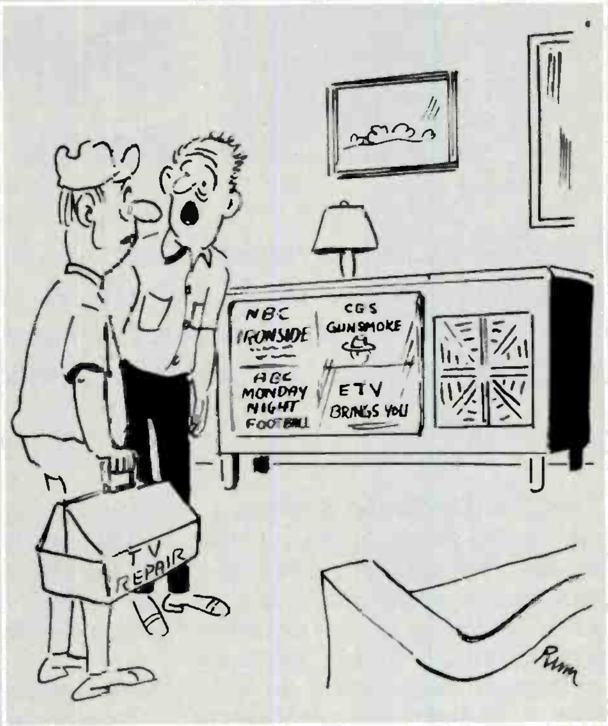
TRUTH TABLE FOR AN "INCLUSIVE OR" GATE

[COMPARE WITH FIGURE 15]

CARTOON CORNER



"It's been there since they showed a rerun of 'Jaws' last week."



"I was trying to modify the stereo component to give it four-channel sound."

"Mr Alpert and Mr. Yukon will each conduct half of the meeting. You might call them semiconductors."

"Turn the rotor off! Turn it off!"

Servicing Sylvania Color TV,

Part 2

By Gill Grieshaber, CET

The E44 chassis Sylvania does not have a vertical oscillator, and the horizontal oscillator operates at 31,468 Hz. A countdown digital circuit in an IC develops both vertical and horizontal frequencies. Also explained are the horizontal sweep/HV circuits and the side pincushion correction.

Horizontal-Sweep System

Horizontal-sweep stages of the Sylvania E44 chassis before the horizontal driver are quite unique, and the following stages are more conventional. Two ICs and one driver power transistor are the only active solid-state horizontal-sweep devices on the 02-41656-1 deflection module, which is at your right when you face the rear of the chassis (Figure 1).

IC400 is a 16-pin IC that performs the functions of noise inverter, video amplifier, IF AGC, sync separator, sawtooth source for the phase detector, and 31,468-Hz oscillator. (IC400 is shown in the picture of Figure 2.)

The other IC (14-pin IC300) accepts the 31,468-Hz signal from IC400 and divides by two to produce the horizontal frequency. Another divider chain in IC300 supplies the vertical frequency.

Perhaps you wonder why such a roundabout method is used to obtain the horizontal frequency. The answer involves an understanding of composite video and interlaced scanning. If the horizontal frequency of 15,734 Hz (for colorcasts) could be divided by 262.5 (the number of horizontal lines in one vertical field), this would produce the correct 59.94-Hz vertical frequency. However, dividers can't divide by fractional ratios. Therefore, the oscillator works at twice the horizontal frequency (31,468 Hz), and the desired 59.94-Hz vertical frequency is obtained after a division by 525.

Perfect locking?

Because both sweep frequencies are obtained by dividers from just *one* oscillator, it seems reasonable to expect perfect horizontal and vertical locking. (After all, that is the method used at the TV stations to generate the sync pulses.) However, this is only partially true. After the oscillator is locked to the station sync, the sweep *frequencies* will be correct. But, remember that the sweeps must start and stop in step with the TV picture. Of course, normal locking of the 31,468-Hz oscillator synchronizes the horizontal sweep with the picture. However, **the phase of the vertical-sweep frequency must be varied** by the IC circuitry to insure perfect vertical synchronism.

Because IC300 is a "proprietary" IC, no one outside of the OEM manufacturer seems to know exactly how the system works. We are told that IC300 contains logic circuitry which examines the sync and decides whether or not it is good quality NTSC sync. Then the logic switches to one of two possible methods of locking the vertical sweep to the station signal.

Symptoms and tests

In an effort to understand the sweep dividers, we collected visual symptoms, analyzed waveforms, and performed some experiments. But without total success.

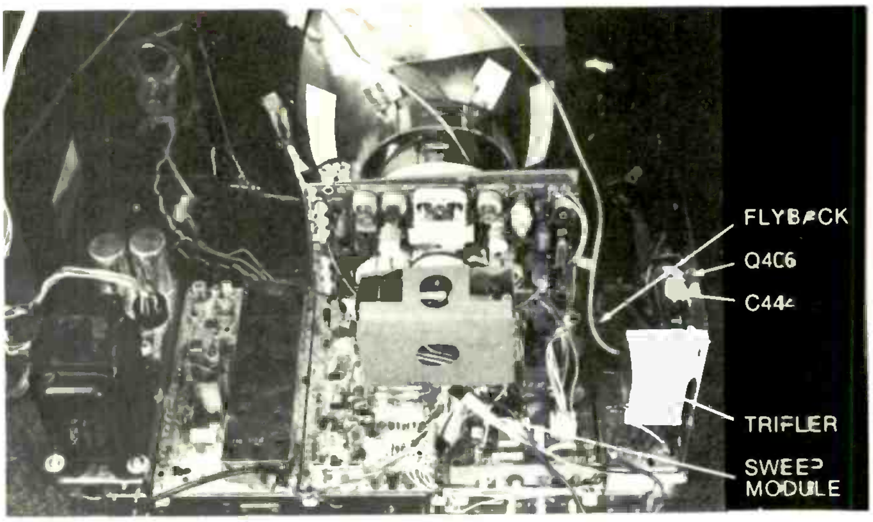
When the tuner is changed from a channel without a signal to a normal TV carrier, usually the vertical-blanking bar is visible near the top of the picture. Then, with a movement too fast for the eye to follow, the picture speeds into perfect vertical lock.

While attempting to determine the function of the two kinds of sync that are applied to the dividers in IC300, I bypassed the composite sync at pin 4 with a 0.22 microfarad capacitor. This nearly eliminated the sync, leaving only a small amplitude of integrated vertical sync. No large change of the vertical locking was noticed, but a small amount of vertical shimmy could be seen during some scenes.

However, when the integrated vertical sync at IC300 pin 14 was bypassed in the same way, the picture rolled upward at moderate speed after a change to another station.

One more unusual situation was not so apparent. While checking the DC voltages and waveforms at each pin of IC300, we found strange symptoms when attaching test equipment to pins 8 and 9.

Figure 1 Components of the Sylvania E44 horizontal-sweep system are located at the right (as you face the rear of the TV receiver). The module has the sweep-oscillator, vertical-countdown, horizontal-countdown, horizontal-driver, vertical-drivers, and vertical-output circuits. The flyback is mounted on the chassis at the right of the module, while the tripler, safety capacitor, and horizontal-output transistor are mounted on the upright metal panel that serves as shield and heat sink.



These pins apparently are used in the vertical count-down circuit to supply a capacitor that is too large to include inside the IC (C318—.027). The symptoms varied somewhat depending on which instrument was attached. One measurement produced a fast vertical roll, along with a decrease of height. Another test connection caused a loss of the raster.

These results do not indicate any shortcomings of the circuit. They just warn you of some nonconventional effects of attempting measurements in sensitive circuits.

Comments

Although failures of the dividers, ICs, or the comparison circuit can cause loss of vertical sweep or a rolling picture, this is not very likely.

The factory states that the 31,468-Hz oscillator is stable and has a large pull-in range of about ±6 bars (normally, more than enough to compensate for the usual amount of drift from aging components). So, chances of the horizontal oscillator needing a frequency adjustment are negligible. The oscillator coil does have an adjustable core, and it can be retuned, if necessary. (Ground testpoint "W"—which removes the sync—and adjust the

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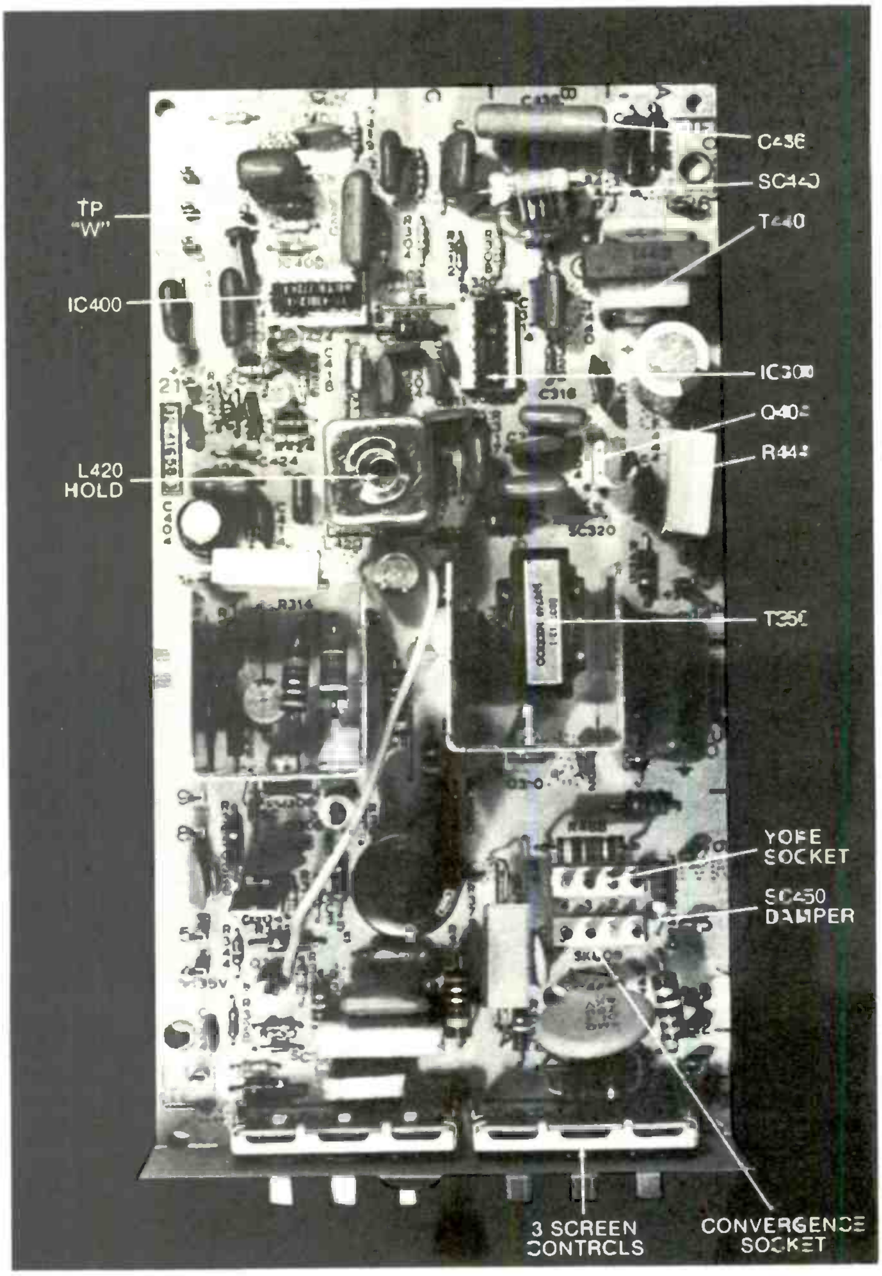

Figure 2 Locations of several horizontal-sweep components are shown by arrows on the 02-41656-1 deflection module.

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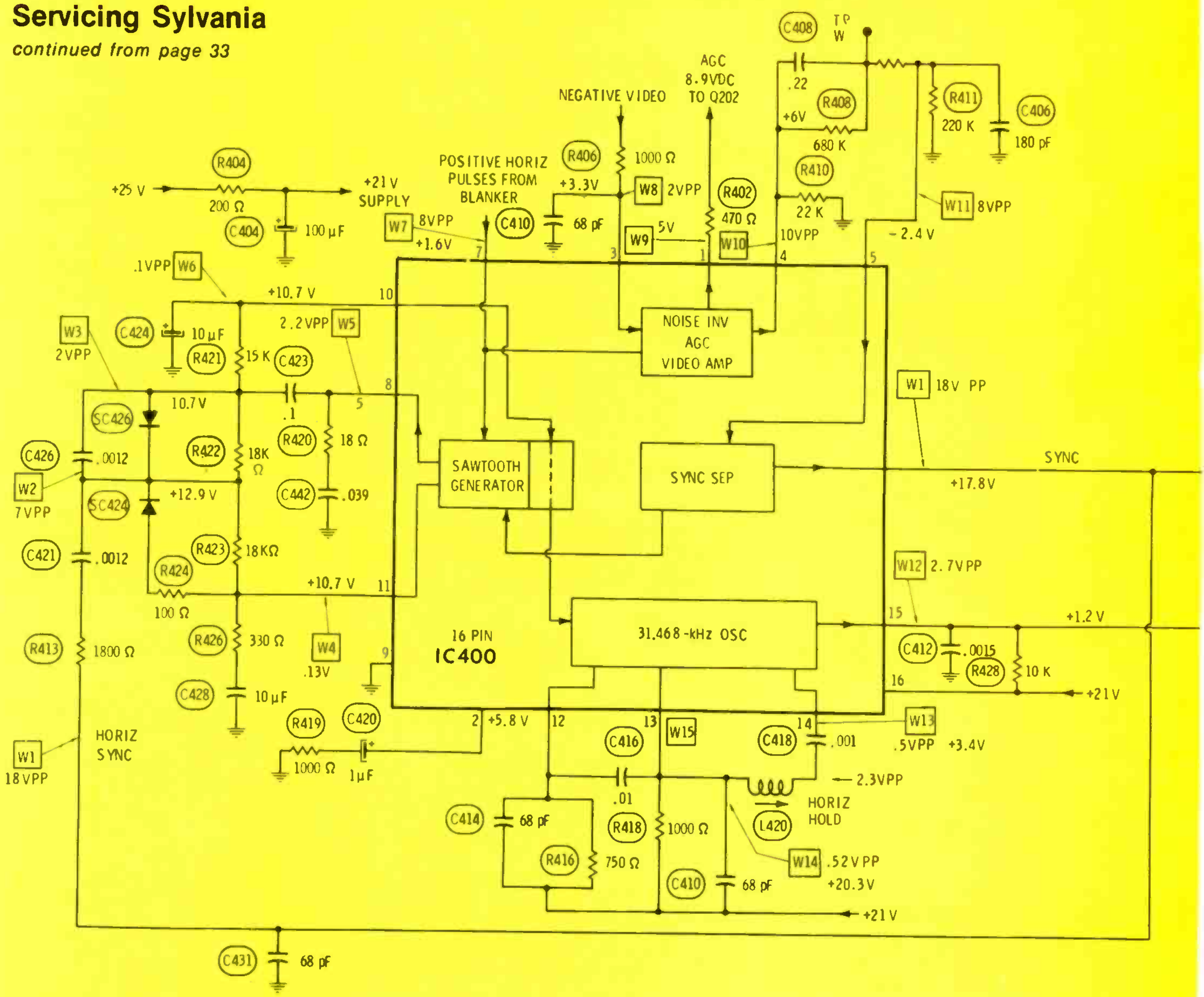

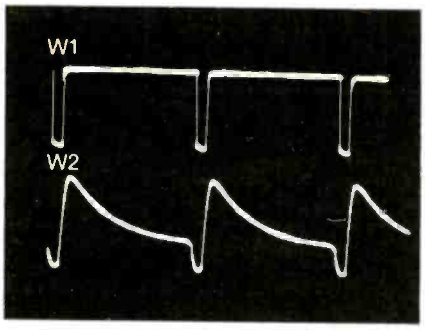

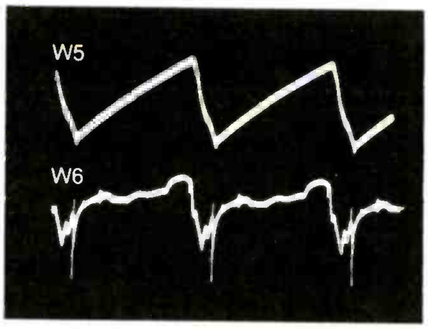

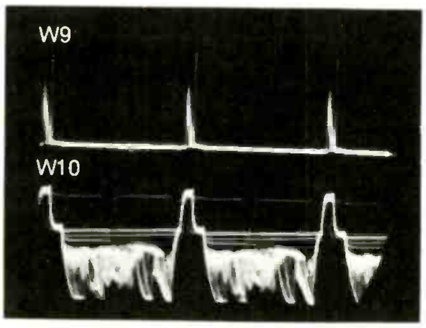

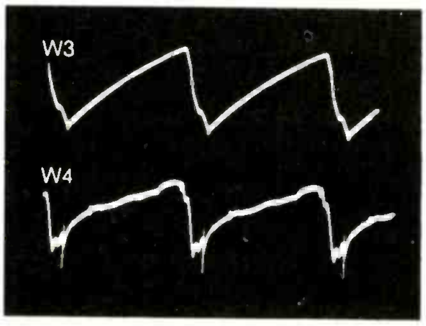

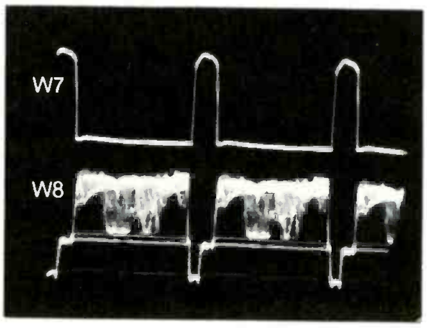

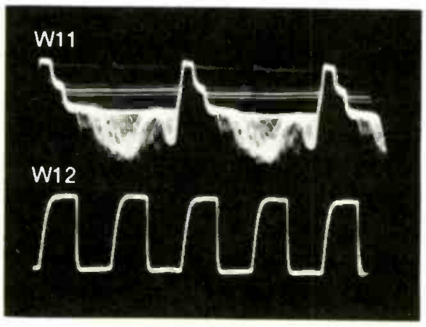

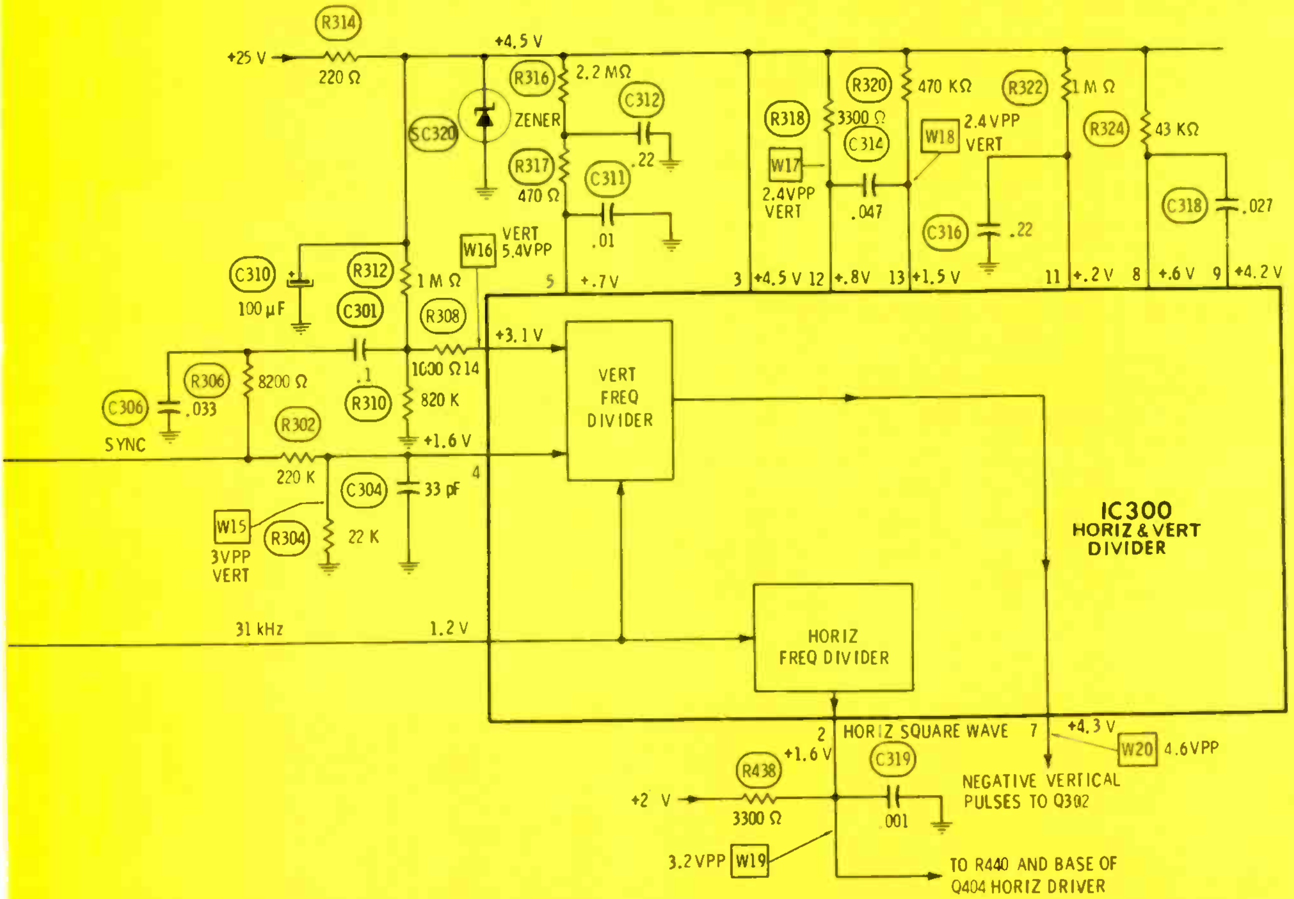

Figure 3 Here is the schematic of IC400 and IC300, including circuits for AGC, sync, sweep oscillator, vertical countdown, and horizontal divider.

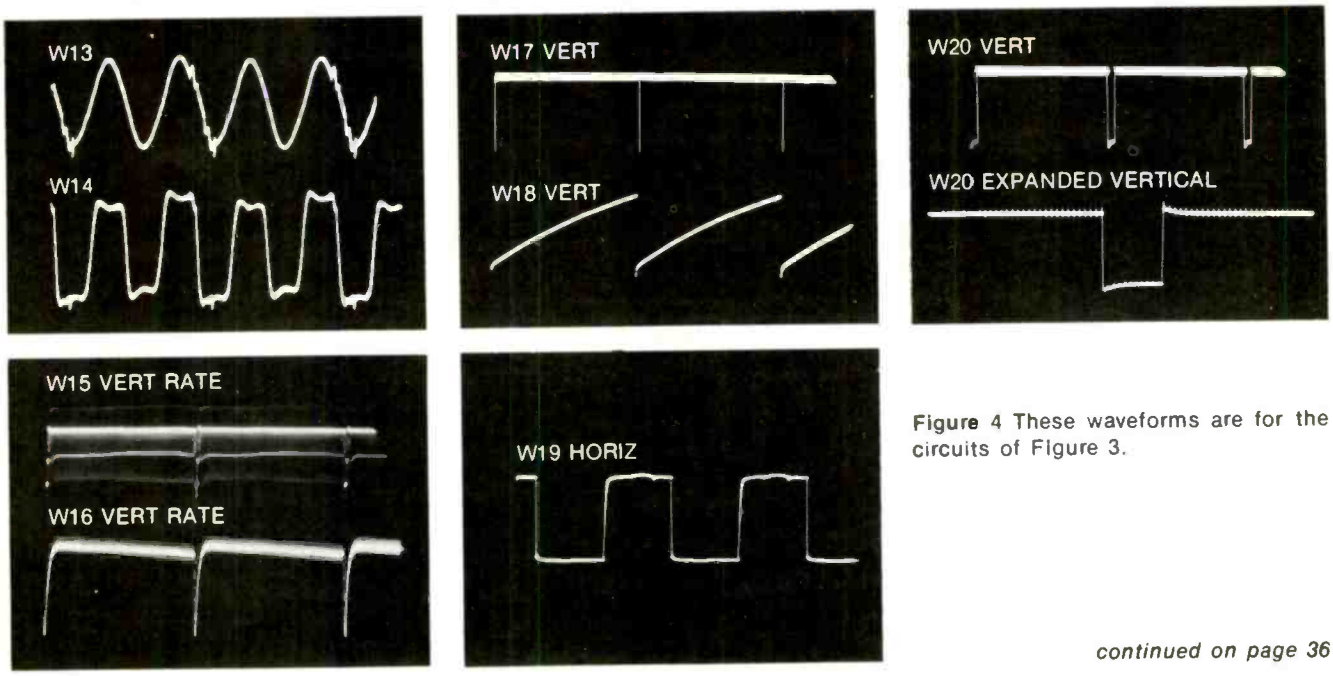

Figure 4 These waveforms are for the circuits of Figure 3.

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Servicing Sylvania

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core of L420 until the picture moves upright and slowly across the screen. Remove the ground from "W". That's all.)

This completes the preliminary explanations, so let's continue with an examination of circuit functions.

Horizontal-Phase Detector

As we discuss the phase detector, oscillator, and divider circuits, refer to Figure 3 for the schematic, and to Figure 4 for the waveforms. Remember that the DC voltages were measured accurately with a digital voltmeter, and the results often are shown to two decimal places. **This does not mean that the voltages must be maintained within such critical tolerances to insure proper operation.** Undoubtedly, other individual chassis will vary the usual amount from these readings.

Two signals are required for all horizontal-phase detectors. In this case, the horizontal-sweep pulses from the blanker circuit enter IC400 at pin 7. An internal circuit changes the pulses to sawteeth, which exit the IC at pin 8 before they pass through C423 and reach the anode of phase-detector diode SC426.

The other signal is negative-going horizontal sync that comes from IC400 pin 6, is shaped by R413 and C421 before reaching the common cathodes of SC426 and SC424. These diodes rectify the two wave-

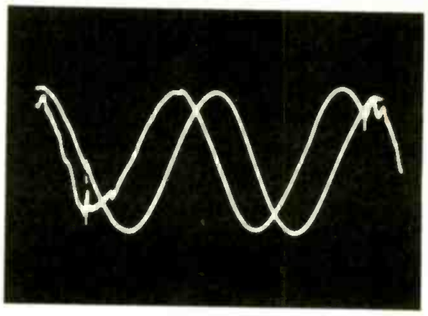

Figure 5 The 90° phase difference between waveforms proves that C418 (in Figure 3) is part of a tuned circuit. At the left is the waveform at pin 14 of IC400; the waveform at right came from the junction of C418 and L420.

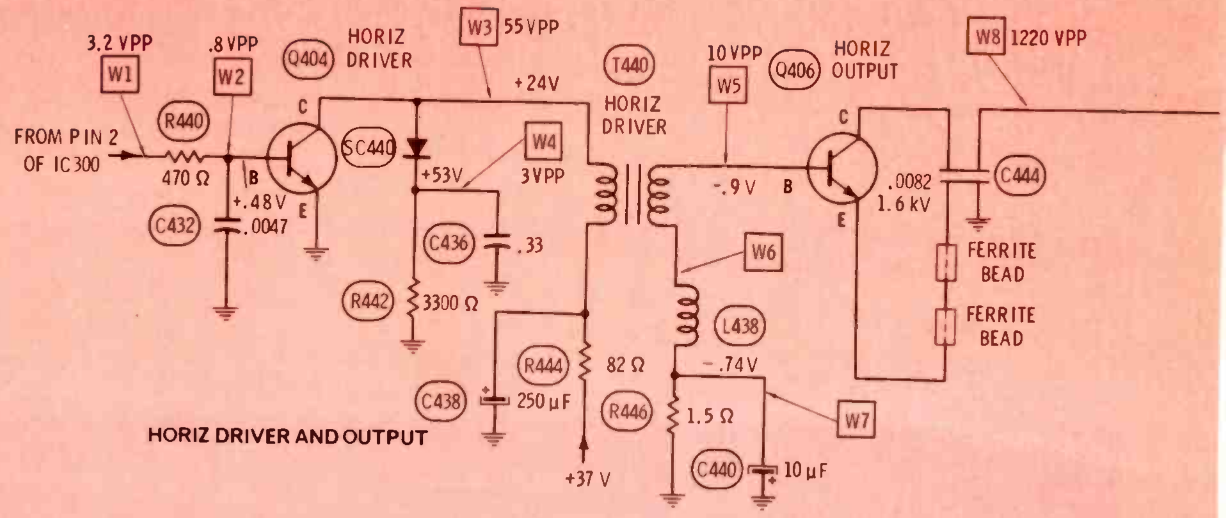

Figure 6 This schematic includes the horizontal-driver, horizontal-output, flyback, and high-voltage circuits of the Sylvania E44 chassis.

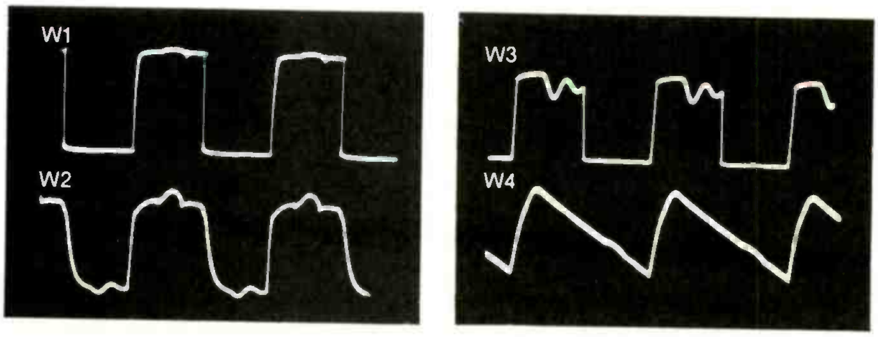

Figure 7 These are the sweep waveforms for Figure 6.

forms, producing a small positive voltage at the common cathodes. Therefore, **the DC voltage between the two anodes is about zero, when the horizontal is locked properly.** Any drifting of the phase between the two signals unbalances the rectifiers, and the DC voltage between the two anodes no longer is zero. Notice that the anode of SC424 is not grounded (as it probably would be with tube circuits), instead this point is supplied with slightly less than +11 volts by pin 11 of IC400.

The correction DC voltage at the anode of SC426 is filtered by R421 and C424 before it is applied to pin 10 of the IC. Evidently, the DC voltage reaches the oscillator transistor inside the IC, varying the frequency when needed.

This phase detector is nearly conventional, and it is supplied with 15,734-Hz signals, although the *oscillator* operates at 31,468 Hz.

Sync And AGC

Negative-going composite video enters IC400 at pin 3. Inside the IC, automatic noise inversion removes most noise pulses before the video goes to the AGC keyer and to the sync separator.

Sync separation appears to be conventional, with the components between pins 4 and 5 shaping the video for proper clipping. Notice that testpoint "W", that's used for removing the sync during oscillator frequency adjustments, is located in that path. Pin 5 measures about +0.8 volt when the IF cable is unplugged to remove all snow and signals, about -0.1 volt for snow without a station, and varies around -2.5 volts with a normal signal and picture. These readings are nearly identical to those in transistorized sync-separator circuits.

A single AGC voltage comes out at pin 1. This is a positive voltage that becomes more positive with a stronger station signal. A transistor on the IF module amplifies and inverts the AGC voltage before sending it to the tuner RF stage and to the IF transistor. Details of those circuits will be presented when we analyze the IF section.

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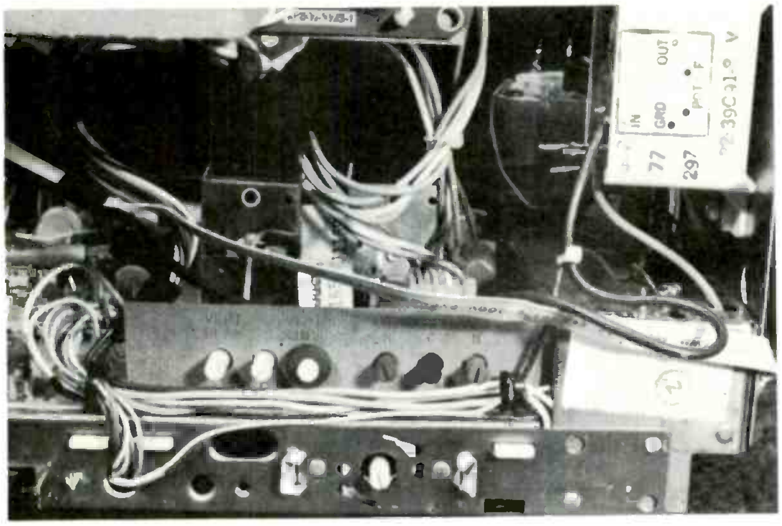
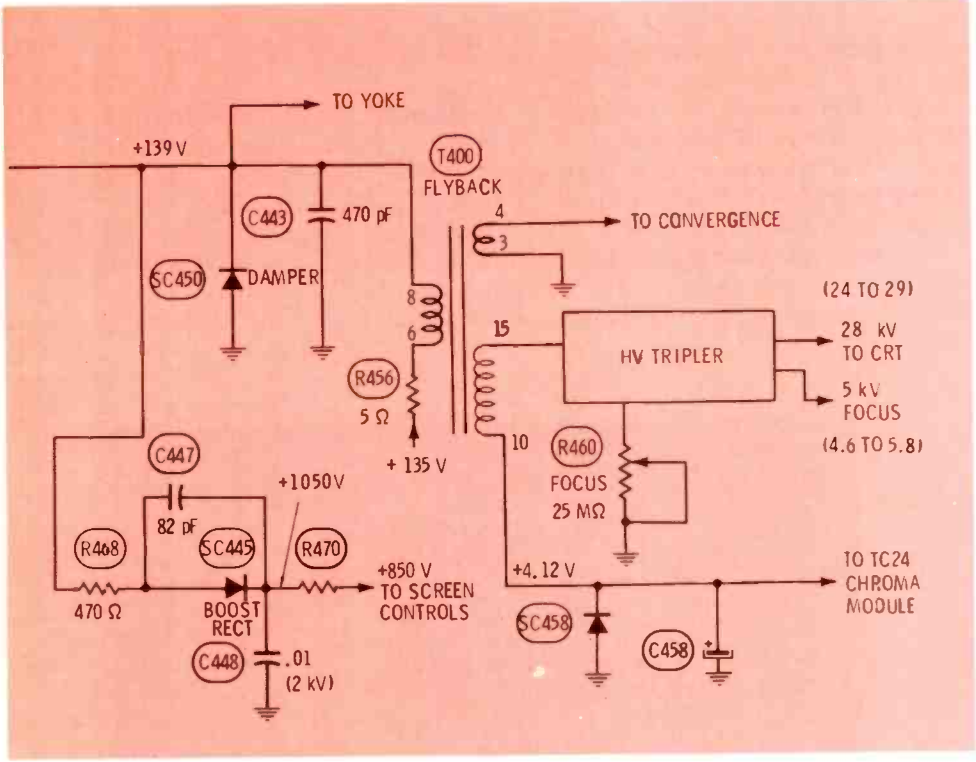
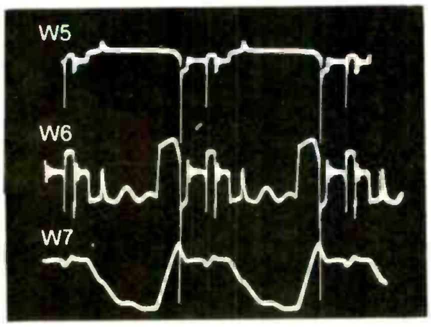
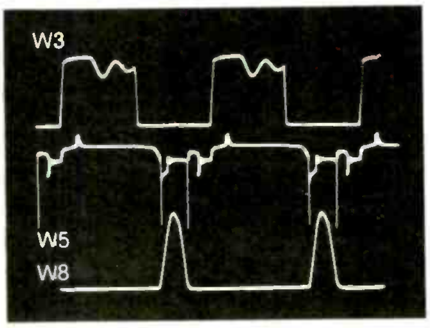


Six adjustment controls along the rear identify the deflection module. The white rectangle in the upper-right corner is the HV tripler, and the flyback is beyond it.







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Oscillator

Transistors for the 31,468-Hz oscillator are inside IC400, making a thorough analysis impossible. C418 and L420 (hold control) comprise the oscillator tuned circuit.

Incidentally, dual-trace waveforms allow us to prove that C418 is part of the tuned circuit, and not just a DC-blocking capacitor (see Figure 5). The phase shift across a capacitor in a series-tuned circuit always is 90°. The near-sine wave at the L420 end of C418 has larger amplitude and lags 90° the more distorted waveform at the pin 14 end of C418. Also, the two ends of the series-tuned circuit (pins 13 and 14) are in phase. This proves that an equal and opposite phase shift exists across L420. Therefore, L420 and C418 make up the tuned circuit that determines the free-running 31,468-Hz oscillator frequency.

Output of the oscillator at pin 1 is a squarewave signal, which is connected to pin 1 of IC300, the IC with the dividers and digital logic.

Sweep Dividers

Vertical and horizontal sync from IC400 is reduced in amplitude and filtered slightly by R302, R304, and C304 before it enters IC300 at pin 4. It is believed this feeds the logic circuitry that selects the type of vertical locking, according to the type of signal.

Also, the same sync is integrated by R306 and C306, leaving vertical sync pulses. These pass through C301 and R308 to pin 14 of IC300. It seems likely that the vertical sync pulses are used by the logic circuitry to establish the correct starting point of the vertical-frequency signal that's sent to the vertical sweep circuit. In any event, loss of sync at pin 14 allows the vertical to roll sometimes.

Many of the other IC300 pins bring in proper DC voltages. Four pins are used to filter waveforms or connect large external capacitors to the internal circuits. Pins 12 and 13 have vertical waveforms (see Figure 4). Pins 8 and 9 also have DC voltages and waveforms, but they are very sensitive to the addition of external capacitances, such as scope and meter leads. This was explained in the preliminary discussion.

Narrow negative-going vertical-rate pulses emerge from IC300 at pin 7. In Figure 4, the pulses are shown in the conventional way, and then expanded. Small-amplitude horizontal pulses broaden the base line and the pulse tips of the vertical waveform.

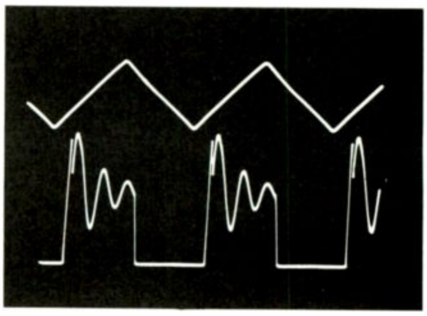
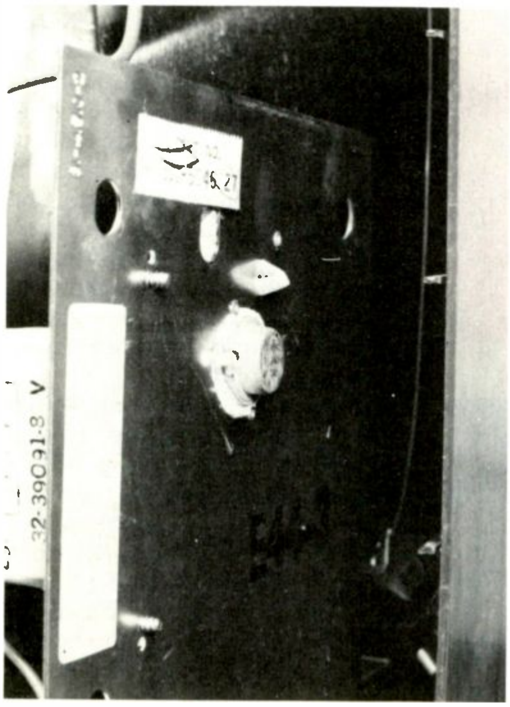


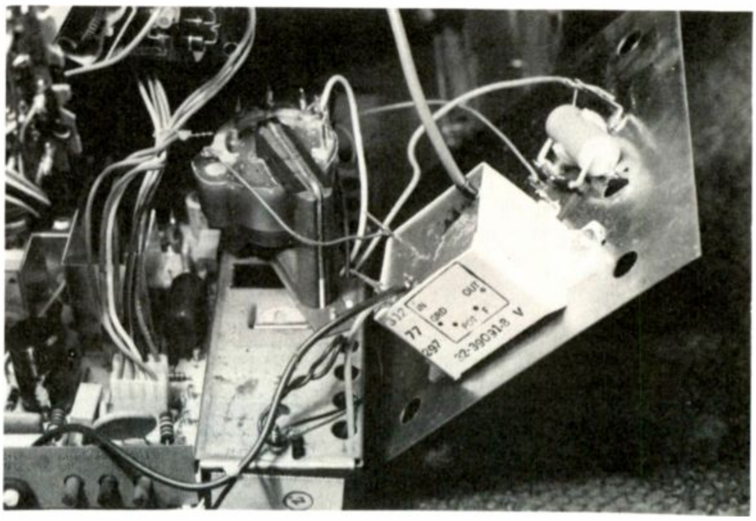
Figure 8 Defects of diode SC440 change the waveform at the collector of Q404. The top trace is the triangular waveform caused by a shorted SC440; and the ringing waveform of the lower trace is produced by an open SC440.

Horizontal Driver And Output

Refer to Figure 6 for the driver and output schematic, and to Figure 7 for the waveforms.

Horizontal square waves (of 50% duty cycle) come out of IC300 at pin 2, and they go through R440 to the base of Q404, the horizontal-





After a couple of screws are removed, the metal panel can be moved or laid down at an angle, allowing access to the flyback.

Q406 (at left), the horizontal-output transistor, is mounted in a socket on the outside of the metal panel.

driver transistor. C432 is connected from base to ground to filter the waveform slightly.

DC waveforms show that the square waves from IC300 are the only forward bias for Q404. Zero voltage is at the bottom of the square waves; therefore, the peak-to-peak amplitude is exactly the same as the maximum instantaneous forward bias (about 0.8 VPP).

Square waves at the base produce square waves at the collector of Q404 (which is a plastic-type TO-22 intermediate-power transistor). Ringing is minimized at the driver transformer (T440) by diode SC440. The diode conducts at the beginning of each square wave, thus charging C436. When the square wave amplitude decreases slightly below the voltage of C436, SC440 is reverse biased, and stops conduction, permitting a small amount of ringing by T440. Actually, SC440 and C436 are a peak-reading rectifier circuit. R442 bleeds C436 moderately fast, so the voltage of C436 will be lower at the start of the next square wave. This causes SC440 to draw a heavier current, load T440 more, and therefore damp the ringing more effectively.

One peculiarity of the circuit is that the "rectification" of SC440 produces a higher DC voltage at C436 than is available at the power supply! Look at it this way: if the collector load of Q404 was a resistor (rather than a transformer), the collector voltage would change from zero (during saturated conduction) to the supply voltage (when cut off). In this case, the supply voltage is +25 volts (because the square-wave voltage drop across R444 is averaged-out by C438, the filter. Therefore, the maximum peak-to-peak voltage at Q404's collector would be 25 volts.

With the transformer operating as the collector load, the measured collector voltage was 57 volts peak-to-peak. This proves that transformer ringing is supplying the extra 32 volts! When SC440 is open, the collector waveform has a huge amount of ringing (Figure 8), although the picture is not affected. (Of course, it's possible that the excessive ringing might overload the output transistor, causing an eventual failure. I suggest checking this diode and the collector waveform before you install a replacement output transistor.)

On the other hand, a shorted SC440 changes the collector waveform to triangles (Figure 8), and the picture is dark with a large foldover in the center of the raster.

Horizontal Output Circuits

The horizontal output and flyback circuits of the E44 are similar to those of some other models, so troubleshooting will be about the same.

However, a few of the waveforms are slightly different. L438 is added at the low end of the T440 secondary winding, and this changes the base waveform of Q406. Other waveform variations occur because of the two ferrite beads that are added to the wire between the emitter of Q406 and C444 (the four-legged safety capacitor). Q406, the horizontal-output transistor is mounted on the right side (as you face the rear of the receiver) of the chassis. The metal panel can be loosened and moved out at an angle to provide added room for diagnosis or parts replacements.

Ferrite beads on a wire force the wire to act as though it is a small inductance. It's better than a choke in many circuits, however, because it does not have any self-resonance. This means it can't ring when shock excited. A fast-rise-time square-wave current through such a wire/bead circuit would show narrow positive- and negative-going voltage pulses at the edges of the square waves.

The same thing happens here. The beads cause pulses in the Q406 base waveform, at the cold end of the base winding, and at the emitter. In fact, I was surprised to find negative 30-volt pulses at the Q406 emitter, even though the emitter path goes only through the bead/wire and the foil of the safety capacitor before reaching ground. It does illustrate that perfect

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grounds are not possible. When the beads were removed from the lead of C444, the amplitude of the pulses went down to 2 VPP.

Of course, these unusual pulses are normal for the circuit, and they are not harmful to the transistors. I mention the situation only to explain about the beads, and so you will not believe the pulses indicate a defect, when you see them during troubleshooting.

Boost supply

Only one voltage supply comes from rectification of the horizontal-sweep pulses. Diode SC445 and C448 perform peak-reading rectification of the positive pulses of horizontal sweep, producing about 1050 VDC that is reduced to +850 volts for the screen (G2) controls.

Flyback operation

In addition to the primary, the T400 horizontal-output transformer has only two more windings. One is for the high-voltage tripler (which also supplies the focus voltage), and the other is a 330 VPP source of horizontal (for the convergence circuit) and blanking (for the service switch during set-up adjustments).

The yoke current does not come from the flyback, but the yoke is connected to the collector of the horizontal-output transistor, and it returns to ground through the side-pincushioning transformer and and C348.

Technical question

While measuring the DC voltages around the horizontal-output stage, I was amazed to find the DC voltage at the collector of Q406 (output transistor) measuring higher than the supply voltage. After making a few more measurements and looking at an unusual waveform, I found where the extra voltage came from.

Can you explain how the Q406 collector DC voltage can measure higher than the voltage source?

Yoke And Pincushion Circuits

Figure 9 shows the schematic of the horizontal yoke and the side-pincushioning circuits.

Excessive width of the picture near the top and bottom of the raster is corrected by varying an inductance that's in series with the cold side of the horizontal yoke.

Specifically, the hot end of the yoke is connected to the collector of Q406 (after C444). The cold end of the yoke goes through windings of T350 before being bypassed to ground by C348.

Vertical-sweep voltage from the cold end of the vertical-convergence system is filtered by R370 and C352. (See the waveforms in Figure 10.) At C352, the waveform is roughly a sawtooth, which causes a parabola of current through the center winding of T350. A small DC current from R366 provides the core magnetism that's necessary for proper operation of the saturable-reactor transformer (T350).

The vertical-sweep current through T350 changes the inductance of the windings carrying yoke current, so the inductance increases during times the sweep is at the top and bottom of the raster. This reduces the width more at the top and bottom than it does near the vertical center of the raster. Therefore, the side pincushioning is eliminated.

Next Month

Vertical-sweep circuits and the operation of the IF stages (including the IF AGC) will be the subjects of our Sylvania analysis next month. ☐

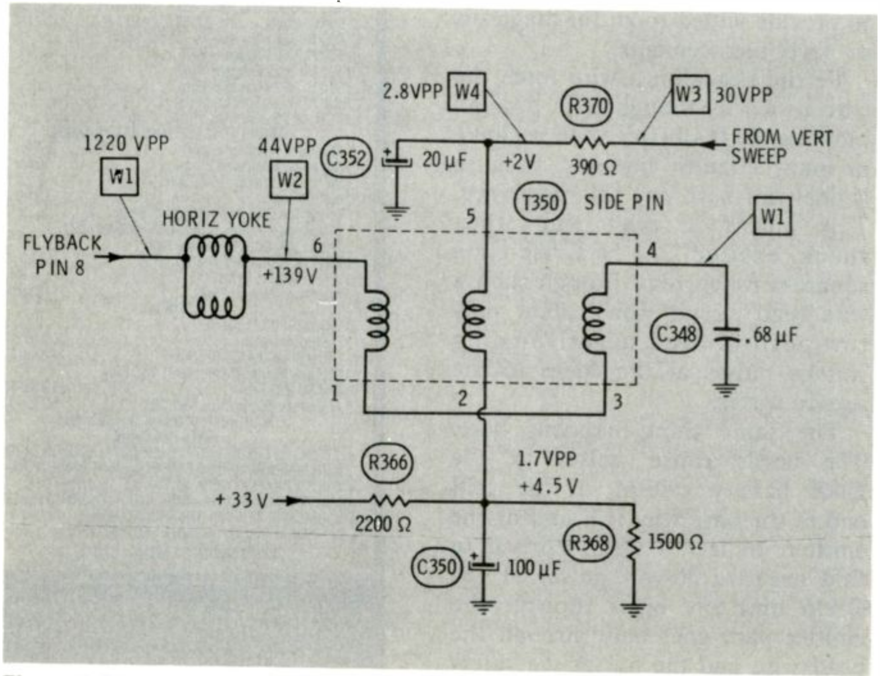

Figure 9 The side-pincushioning circuit has this schematic.

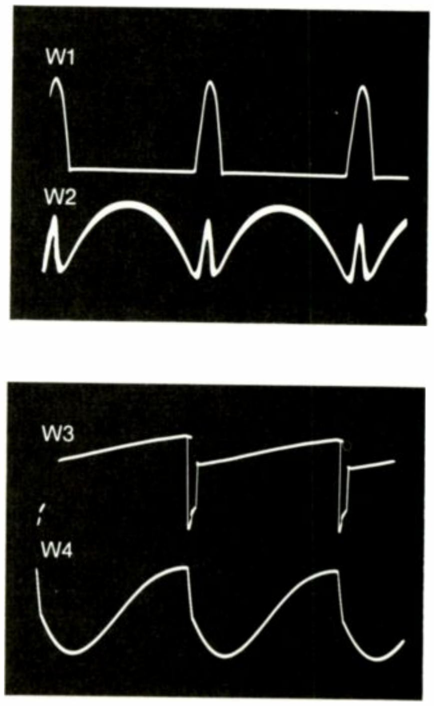

Figure 10 These are the waveforms of the pincushioning circuit of Figure 9.

Sam Wilson's Technical Notebook

By J. A. "Sam" Wilson, CET

Measuring Resistors "In Situ"

My dictionary defines "in situ" as "in position" or "in its original place." Therefore, this discussion is about the measurement of resistances in-circuit, without disconnecting them first.

Diode resistance varies with voltage

Regardless of the equipment or the method used, all resistance measurements involve application of a voltage to the circuit under test. This voltage changes with the resistance value, and it is different for each resistance range.

Those changing voltages are the reason why the resistance of a diode (or a transistor junction) depends on the type of meter circuit and on the range selected. For example, the base/emitter junction of a

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Sam Wilson's monthly "Technical Notebook" will present a variety of subjects and ideas. Sam has strong opinions, and possibly some will provoke conversation and controversy. The ideas and opinions of this column are not necessarily those of the editor or other employees of Electronic Servicing.

Your letters are welcome, so long as you give us permission to quote from them. Address all letters to:

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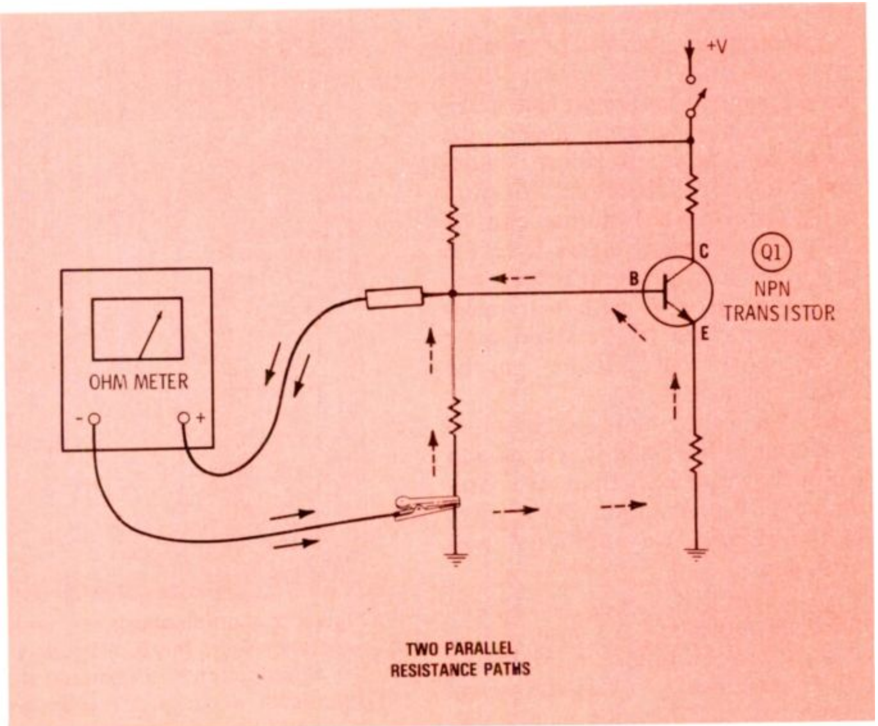

Figure 1 Conduction of diodes (or the junctions of transistors) add non-linear resistances that cause errors during in-circuit resistance tests.

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germanium transistor might measure 5 ohms when the X1 range of a VTVM was used, 29 ohms for X10, 170 ohms for X100, and 1,000 ohms with the X1000 range. The ohmmeter is not producing **wrong** resistances. Instead, **the diode is changing forward resistance according to the actual voltage applied to it.**

Not all ohmmeters apply the same voltage. Therefore, diodes and transistor junctions will measure many different resistances according to the type of meter.

Circuit paths through diodes

Problems begin when a tech tries to measure the value of a resistor that's in a circuit along with a diode or a transistor junction (Figure 1). Because diode resistance varies with the applied voltage, **it's not possible to assign a definite resistance to each diode.** As shown, the base resistor and the B/E junction of the transistor are in parallel. So, the ohmmeter current flows through both. The diode conduction causes an erroneous reading, which varies with the range and with the type of meter.

Low-power ohmmeter readings

Some late-model meters (particularly multimeters) offer "low-power" ohms functions. The maximum voltage is kept below the conduction point of silicon diodes and transistors. Therefore, "in situ" resistance measurements can be made without many errors from the silicon diode-or-junction resistances. Of course, circuits with extremely-high resistances might show some errors, but other circuits can be tested accurately.

On the other hand, germanium diodes and transistor junctions can conduct with less than 0.1 volt applied. If germanium devices are in the circuit, use additional precautions.

Reversed voltages

Another effective method of eliminating nearly all of the errors from diode and junction conduction is to take a reading, and then reverse the test leads before making the same measurement again. If the two resistance readings are identical, there's little chance of errors from diode conduction. When the two readings are very different, the higher reading will be more accurate.

This method has some limitations. For example, circuits having two or more semiconductor devices might have leakage through a diode during the test with one polarity, and leakage through a transistor junction when the polarity is reversed.

Combining the low-power ohms feature with the reversed-voltage measurements should eliminate most diode-conduction resistance errors.

Resistances in parallel

Neither of the previous methods can measure the individual resistors of Figure 2. Any ohmmeter will read the resistance of R1 in parallel with the sum of R2 and R3.

One solution is to determine the proper resistances (from a schematic or the color codes of the resistors), **calculate** the total resistance, and **measure the actual resistance** with your ohmmeter. **If the calculated and actual resistances are equal, it's likely all three resistors have the correct values.** (Of course, that's assuming the resistors do not have widely different values. For example, if one resistor is supposed to have more than 10 times the resistance of the other two, an open in the large resistor would not change the total resistance reading enough to be significant.)

If the measured resistance is incorrect according to the calculated value, one of the three resistors must have a wrong value.

To calculate the resistance of the combination, use this formula:

$$R = \frac{R1 \times R2 + R1 \times R3}{R1 + R2 + R3}$$

If you have an electronic calculator, it's easy to do the math. An alternate method is to add the resistances of R2 and R3. Then use

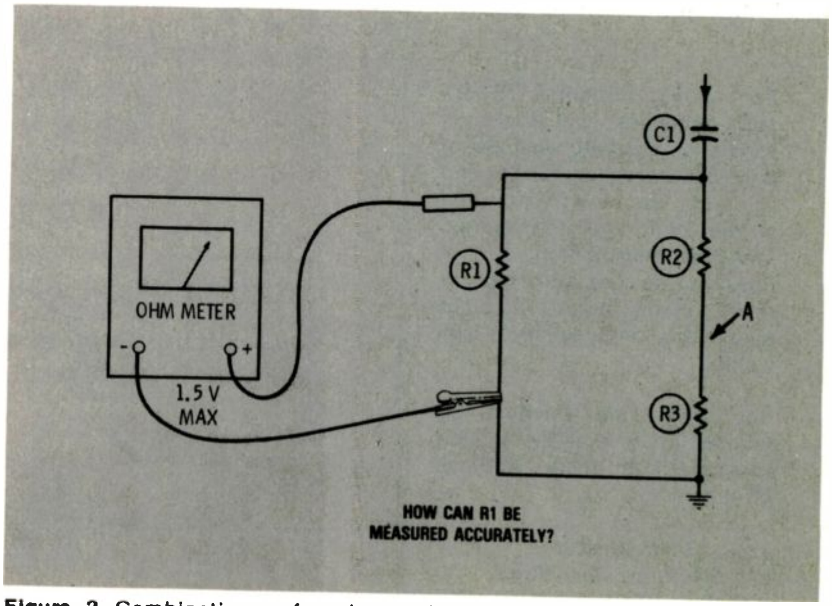

Figure 2 Combinations of series and parallel resistors make in-circuit resistance tests more difficult. One way is to calculate the correct value of the combination and compare that with the total measured resistance. Any significant variation between the two figures suggests that one of the resistors has a wrong value. As a last resort, R2 and R3 can be disconnected at point A. This allows testing of all three resistors with a minimum of unsoldering.

that value and the resistance of R1 in the formula for **two** resistors in parallel.

If these tests indicate a wrong resistor value, open the circuit at point A, and test each resistor separately.

Use a bucking voltage

Figure 3 shows a way of measuring R1, without errors from R2 and R3. Connect a variable-voltage source to the junction of R2 and R3, and adjust the voltage until it is exactly equal to the ohmmeter voltage that's at the R2 end of R1. This places equal voltages at both ends of R2, thus eliminating all current through R2. The zero R2 current gives the same effect as an open R2, which breaks the R2/R3 path that parallels R1. **The ohmmeter now reads only the resistance of R1.**

Editor's Note: I tried this test by using the ohmmeter function of a VTVM and found the method to be valid. However, the balancing of the two voltages was so critical that a digital meter was required to determine when the two voltages were equal. This matching of voltages is made difficult also by the ohmmeter voltage changing as the variable voltage is adjusted. For example, as the variable DC voltage was increased from zero, the ohmmeter voltage across R1 increased, along with the resistance reading. When the variable voltage is less than the ohmmeter voltage, the R1 resistance reading is too low. At the other extreme, a variable voltage that is higher than the ohmmeter voltage produces R1 resistance readings that are too high.

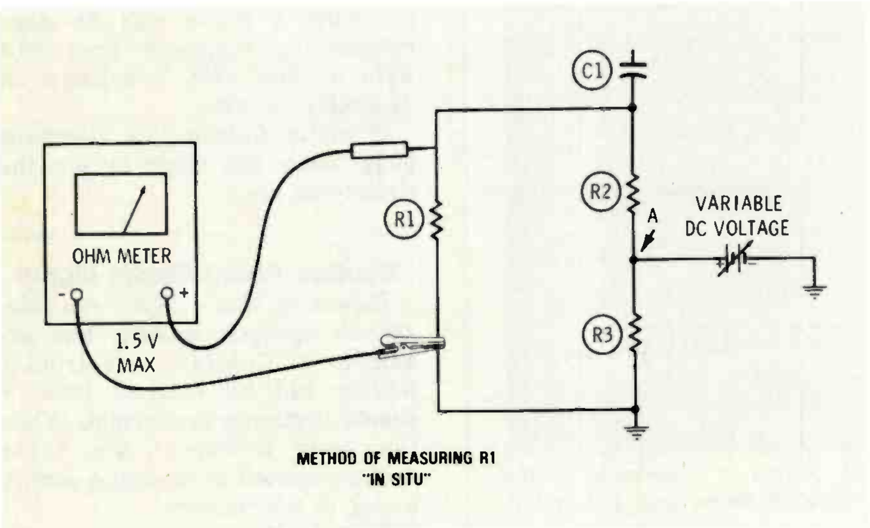

Figure 3 Specific resistors in a series-plus-parallel configuration often can be isolated for test by applying a bucking voltage that is equal to the DC voltage applied by the ohmmeter.

……

Tuning By Resistance Change

Last year, I was in Indianapolis at an ISCET board meeting. I had discussed the resistance-tuned circuit of Figure 4 in a previous issue of my Technical Notebook, and several technician friends were giving me a hard time about it.

In the article, I pointed out that varying either the resistance in series with the capacitor or the resistance in series with the inductance would change the resonant frequency of the tuned circuit. The first question from a "friend" was, "So what?" A question like that is nearly impossible to answer!

Another tech asked if the circuit had any practical uses. I could answer that question. It has been used in automatic frequency-control circuits. Also, it is useful for adjusting low-frequency filters where the capacitance value is so high that a varactor diode won't work.

But the next comment stopped me cold. One man said that the change of frequency is *too small* to merit any discussion.

Although I knew the basic theory was correct, I never had calculated the *amount* of change before. Now was the time to use my calculator.

The equation for the resonant frequency of parallel capacitance and inductance **when there's resistance in the circuit** is shown in Figure 4, along with the schematic and values of the circuit.

In schools, there is an unfortunate tendency to ignore the general (complete) equation. Instead this partial equation is given for parallel resonance:

$$Fr = \frac{1}{2\pi\sqrt{LC}}$$

Actually, this is a special-case equation that is correct only when the resistances of the inductor and the capacitor are equal, or when the two resistances are small enough to be ignored.

The general equation is important because it shows that the value of a resistance in series with either the inductor or the capacitor of a parallel-tuned circuit will affect the resonant frequency.

Incidentally, there are two resistant conditions that completely eliminate all resonance. In the general equation for parallel resonance, if the inductor resistance squared times the capacitance equals the inductance, the numera-

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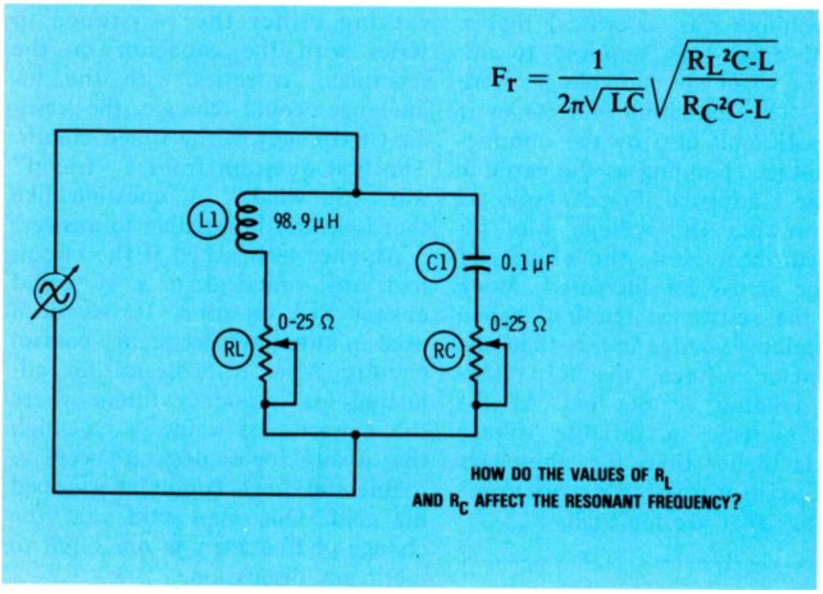

Figure 4 A resistance added in series with the inductance of a parallel-tuned circuit reduces the frequency of the resonance point. A resistance added in series with the tuning capacitor increases the resonant frequency.

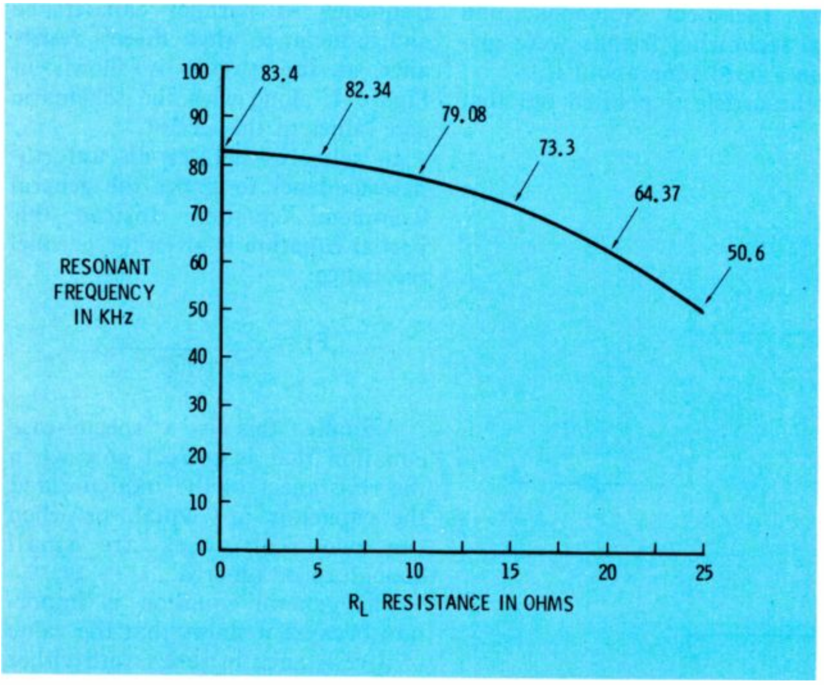

Figure 5 This graph shows the calculated change of resonance (in the circuit of Figure 4) when the resistance that's in series with the coil is varied from zero to 25 ohms.

tor becomes zero, thus making the resonant frequency zero. This indicates that larger inductor resistances lower the resonant frequency.

Also, if the capacitor resistance squared times the capacitance equals the inductance, the resonant frequency is infinite. This indicates that increasing the value of the capacitor resistance raises the resonance frequency. In both of these examples, there is no resonant frequency. Compare this with series RLC tuned circuits that *always* have a resonant frequency.

Back to the mathematical proof. I chose the values shown in Figure 4 and calculated in 5-ohm steps from zero to 25 ohms for the resistance in series with the inductor. These are the results:

Inductor Ohms	Frequency in KHz
0	83.40
5	82.34
10	79.08
15	73.30
20	64.37
25	50.60

A graph of these values is shown in Figure 5. Notice that 25 ohms reduces the frequency from 83.4 KHz to 50.6 KHz, a decrease of 32.8 KHz (or 39%).

If you're designing an electronic buggy whip, this might be just the circuit you need.

……

Caution About Strobe Lights

Repeating strobe lights can trigger an epileptic seizure. For example, a Colorado electronics teacher had his students build a simple electronic strobe light. While they were testing it, the rapid flashing started an epileptic seizure in one of the students.

To cause the problem, the repetitive frequency must be slow enough to be seen as individual flashes of light.

After I heard of this incident, I researched the subject and found that almost any repetitive low-frequency energy seems to do the same thing. Other triggers are windshield wipers (especially under certain kinds of street lights), shower sprays, and rapidly-flashing neon signs.

Advise any epileptics to avoid looking at flashing lights or repeated movements of any kind.

Sound Sickness

Very low-frequency sounds can cause fatigue or nausea. The sound level must be high, and the frequency should be around 10 Hz, although the critical frequency depends on the individual person.

Could the constant thumping noise of car wheels passing over the tar strips of a pavement be the real cause of "car sickness"?

Also, think about the low-frequency beats caused by intermodulation distortion in a hi-fi system that is operated at loud sound levels. Could they be the cause of fatigue, which is the first stage of nausea?

Inserting IC Pins

Have you ever had trouble inserting all of the pins of DIP ICs into a socket at the same time? Well, it can be an exasperating job, that often results in bent pins.

Try this tip: insert all the pins in *one* side of the socket; then, use a stiff rectangle of plastic or cardboard to gently bend the other row of pins into line with the socket holes (see Figure 6). Usually this last row of pins will slip easily into place, when they are all moved at once. Finally, press down gently with your fingers on top of the IC, to seat all of the pins tightly.

Protect CMOS ICs

The manufacturers of CMOS ICs have nearly solved the problem of gates being destroyed by static voltage charges. Zener diodes are connected from the leads and common inside each IC. Voltages that are higher than the zener rating cause the zener to conduct, thus reducing the transient high voltage to a harmless value.

Caution: If you build or repair a digital clock that has CMOS ICs, be very careful and use all of the usual MOSFET precautions. Many (perhaps most) CMOS clock chips are NOT protected.

Mystery Of The Magnetic Poles

If you give me the slightest encouragement, I'll readily launch into stories about the brilliant students I've taught, and the clever solutions they have found for difficult electronic problems.

But one problem has defied their best efforts so far, although it appears to be very easy. Here are the conditions: magnetize a 3-foot length of steel welding rod so one end has a north pole and the other end has a south pole, but there are no other poles in between.

After you have magnetized the rod, check your result by using a small pocket compass. My students have tried to do this for so many times that I'm beginning to believe it can't be done. Figure 7 shows what usually happens to the magnetic poles.

Technician Shortage?

You sometimes are told there are too many electronic technicians. At other times you hear about the shortage of technicians. (Or, is it too many short technicians?) I heard of one who was really "short," and I'm not referring to his height, but to his brain power.

This next event actually happened in a Youngstown, Ohio, "Ma and Pa" store. They needed a good outside technician, and advertised in the local paper. Out of several applicants, they selected a man who claimed 27 years of experience.

The new employee had a couple of unusual characteristics. He was built like a gorilla (about 260 pounds), and he even looked a bit like one in the face. But, who's to say that large ugly people can't be

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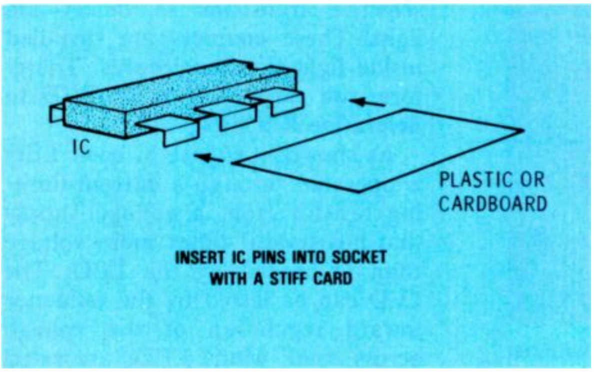

Figure 6 To make installation of ICs easy, insert all of the IC pins of one side into the socket. Then, **slightly** bend all pins of the other row toward the body of the IC, using a rectangle made of plastic or stiff cardboard. These pins should slide easily into the socket.

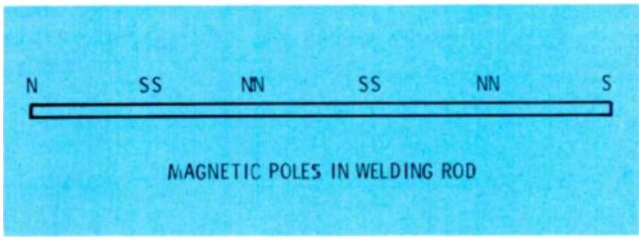

Figure 7 Can you magnetize a 3-foot length of steel welding rod so the north pole is at one end, and a south pole is at the other end, but without any extra poles in between? Sams students always obtained several poles, as shown.

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competent technicians? Also, it's not smart to become unpopular with the ugly-lib people.

Out of the eight calls he made the first day, he brought in *eight* TV sets. He didn't pull the chassis, but brought in cabinets with all the works. Now, these were huge consoles that usually require two strong men to lift them, but he carried one under each arm!

The "Pa" end of the business sat down with him and explained that it wasn't a good practice to bring in complete machines, especially since many of them suffered dings and scratches in the process.

"Fix them in the home. If the TV *must* be brought in for shop work, bring only the chassis," Pa said.

The new man went out on calls the next day, with "Fix them in the home" ringing in his ears. But, within an hour the first customer was on the phone, and she was MAD. "What kind of a fool outfit have you got there, you idiot?" "Ma" got to field this problem. "Is something wrong?" "Well, that turkey you sent out to fix my set took out all of the tubes, put them in a paper bag, and told *me* to go down to the drug store and test them!"

After "Ma" calmed the customer, she turned to "Pa." "You get out there and *stop that nut*, while we still have a business. Here's a list of his calls."

"Pa" (who probably weighed 140 pounds, soaking wet) didn't dash for the door. "Maybe we could just call the customers..."

"Get him!"

As he started out the door, "Ma" called after him, "Pa!"

"Yeah?"

"And don't hurt him."

……

Alternator Question

This request for information was received from Brian Cook, CET: "Is it possible to cheaply rewire an automobile alternator for use at low RPMs?"

My answer

Mr. Cook, thanks for the letter, and a special thanks for the self-addressed stamped envelope.

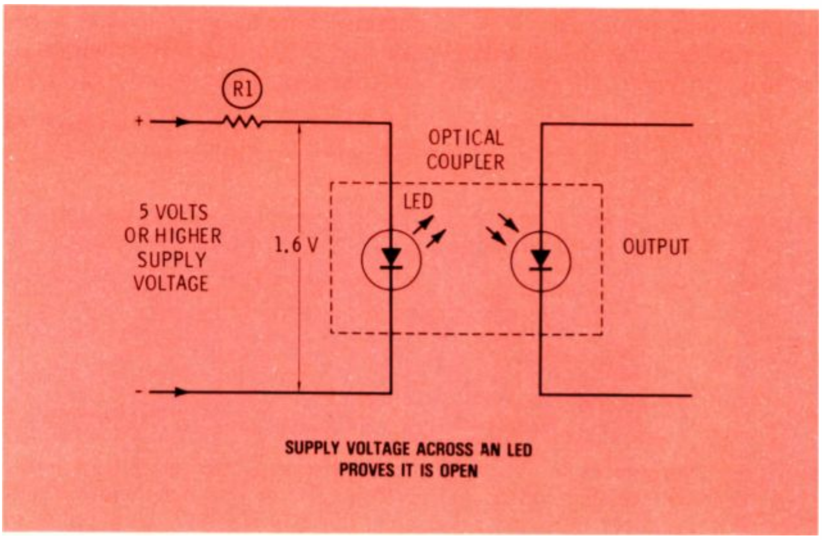

Figure 8 Two characteristics of LED circuits allow you to determine whether or not an LED hidden inside an optical coupler is lit. Current-limiting resistors are necessary, and LEDs tend to act much like zener diodes to stabilize their voltage at a certain DC voltage. Therefore, if you measure the full supply voltage at the leads of such an LED, it proves the LED is open (not lit). But if the rated DC voltage for that type of LED is measured at the leads, the LED is okay (emitting light).

The original battery-charging device in cars was a DC generator. However, it had two inherent problems. The first problem was excessive maintenance (brush replacements and repairing the commutator). Secondly, generators could not produce a charging current when the engine was idled.

After the auto makers added more and more electrically-powered equipment, better battery charging was necessary. Then came the changeover to alternators, which basically are AC generators. Solid-state diodes are built inside the case to rectify the AC power.

Alternators will produce some charging power at idling speeds, without requiring any modification.

Perhaps you need increased charging current at slower-than-idle RPMs (your letter didn't say how you wanted to use the modified alternator). If only *slightly* more charging current is needed, you could install a pulley of a smaller diameter on the alternator itself.

Give me more details about what *result* you want, and the uses for the increased current, and I'll try to give other answers. Or, perhaps another reader of Technical Notebook can supply a better answer. Write to me in care of **Electronic Servicing.**

……

Is The LED Lit?

Many optical couplers have an LED to furnish light and a light-sensitive transistor to detect the light. These couplers are installed inside light-tight enclosures. Therefore, **you can't look at the LED to determine if it's lit.**

As shown in Figure 8, each LED is operated through a current-limiting resistor from a voltage supply that has several times more voltage than is needed by the LED. The LED can be tested by the tendency toward regulation of the voltage across itself. Many LEDs are rated at 1.6 volts; therefore, a measurement of 1.4 to 1.7 volts across the LED leads proves the LED is emitting light. □

……

test equipment report

Portable Digital Multimeter

The **Leader Instrument Corporation's** model LDM-851 digital multimeter features pushbutton selection of AC volts, DC volts, K-ohms, megohms, and DC milliamperes, plus a range button that provides semi-automatic high-range or low-range switching of the 16 ranges. Polarity indication for DC measurements is automatic.

A separate overrange indication is located near the 3½-digit LED display. Overload protection operates for all ranges.

Power is provided by four internal "C" cells for portable operation, plus an optional AC adapter that's available at extra cost. Test leads are included, and model LDM-851 sells for less than $200.

For More Details Circle (16) on Reply Card

Function Generator

B&K-Precision's model 3010 low-distortion function generator offers wide frequency coverage spanning 0.1 Hz to 1 MHz in six ranges, with each range providing a linear 100:1 frequency control. The unit generates sine, square, TTL square, and triangle waveforms.

Range and function selection is pushbutton-controlled for fast operation. Frequencies originate from a voltage-controlled oscillator (VCO), which can be varied over each range by the front-panel frequency control or by the VCO external input. When a 0 to 5.5 V ramp is applied to the VCO external input, model 3010 will provide a 100:1 frequency change to serve as a sweep generator for response measurements in audio and IF circuits.

The unit also features a variable DC offset control, which provides up to ±5 VDC (into 600 ohms) that is combined with the selected audio signal.

For square-wave operation, the 3010 offers both a fixed TTL output level for digital logic applications and a variable-amplitude output for other measurements.

The unit is priced at $175, including a detailed instruction manual.

For More Details Circle (17) on Reply Card

Scope

EICO's new model 480 solid-state triggered-sweep oscilloscope was designed for testing TV receivers, and other electronic equipment.

Model 480 has DC to 10 MHz vertical bandwidth, AC and DC coupling, 11-position calibrated attenuator, 10 mV/cm sensitivity, and pushbutton operation.

A built-in TV-sync separator allows easier troubleshooting of video waveforms. Frame or line triggering is selected automatically by the scope in conjunction with the sweep speed setting. The calibrated time base helps to identify unknown frequencies. A fully regulated power supply provides stable voltages regardless of line and load fluctuations.

Price of the factory-assembled scope is $425.

For More Details Circle (18) on Reply Card

Features of these products were supplied by the manufacturers, and are listed at no charge to them. If you want factory bulletins, circle the corresponding number on the Reply Card, affix a stamp, list the required information, and mail the card.

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For More Details Circle (13) on Reply Card

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Telephone (714) 755 1134 TWX 910-322-1132

For More Details Circle (14) on Reply Card

productreport

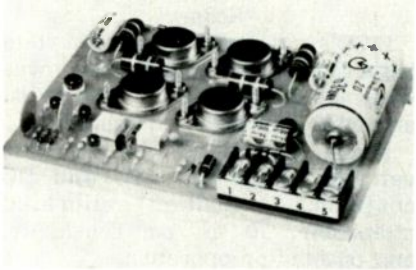
CB Accessories

Winegard has made available a mobile CB antenna and accessory self-merchandiser package. The rack, model ID-500, includes two each of 17 different products. Four CB antennas: trunk-lip mount models, TL-100 and TL-300; roof/deck mount model RM-100; and magnet-mount model MG-100 are featured. The remaining products are mounting-hardware replacement parts and various types of stainless-steel whips. A rack with 100 CB-antenna stuffers is included.

For More Details Circle (19) on Reply Card

Electronic Siren Driver

Mountain West is featuring an electronic siren driver which has variable sweep rate and sweep range.



This adaptable siren driver is for use in alarm systems where siren tone and whooping or sweep rate must be varied. Often required to make siren output distinct from background noises, this driver can be connected to produce either a steady or a sweeping tone as needed.

Rate can be varied from .1-second sweep to 6-second sweep. Range is from 2500 Hz to 400 Hz. The circuit board fits easily in a control box.

The unit comes with connecting instructions and is priced at $49 each.

For More Details Circle (20) on Reply Card

Packaging Tester

ITT Pomona Electronics has designed the "Micro-Grabber" for testing high-density packaging. Model 4233 is 1.53 inches long and uses a plunger action between the thumb and two fingers.

Made of molded glass-filled nylon, it withstands 240°C at 40% R.H. Other features include a stainless-steel spring, beryllium-copper contact, and gold plating.

For More Details Circle (21) on Reply Card

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For More Details Circle (23) on Reply Card

productreport

Fuse Holder

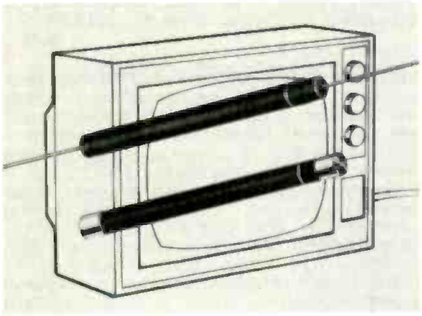
A new coil-spring fuse holder by **Oneida** minimizes the need for the more expensive pig-tail fuses and the cutting and resoldering of pig-tail leads. The permanent device also does away with the need to pull a chassis or tuner for fuse replacement.

The fuse holder is constructed of tempered spring steel with dip-soldered leads. It comes five-pair per package on dealer cards; it also is available in bulk for OEM use.

For More Details Circle (24) on Reply Card

Rectifiers

Electronic Devices has added a series of half-wave, high-voltage rectifiers designed for B&W and small-screen color television sets. The diodes are available with ratings of 22 KV, 30 KV and 35 KV. Average forward current is 2.2 milliamperes.



Two mounting styles are available. Series TVS has end caps, and series TVSL has wire leads.

For More Details Circle (25) on Reply Card

Bolt Cutter

An improved bolt-and-rod cutter that will cut threaded fasteners to any desired length (down to 3/16" under the head) is available from **Sentinel Tool Works.**

Bolts of sizes from #4 to 3/8" diameter can be cut off, for the cutter is said to be made of hardened tool steel which can be resharpened.

For More Details Circle (26) on Reply Card

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2SA 606	1.90
2SA 624	1.10
2SA 627	3.60
2SA 628	.59
2SA 634	.90
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2SA 663	4.90
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OUTSIDE SERVICE TECHNICIANS. Paying top wages for best qualified men. Qualifications for position: total honesty, industrious, ten or more years direct television experience, non-drinker, non-smoker, must be able to work without supervision. Present employees grossing over $20,000 yearly. Send resume to American Television Service, 1032 South State, Orem, Utah 84057. 2-78-4t

TUNER TECHNICIAN NEEDED with ability to manage an established tuner and module service in the Dallas/Fort Worth area. Wages is $7.00 per hour. Recent experience at one of the major tuner services required. Texas Tuner Service, 4210 N.E. 28th Street, Fort Worth, Texas 817/834-8201. 3-78-1t

ELECTRONIC TECHNICIANS—MOTOROLA, leader in two-way radio communication, presently has openings throughout the U.S. for technicians and supervisors experienced in the installation and maintenance of communications systems (two-way, paging, microwave and CCTV). If interested in good salary and excellent fringe benefits send your resume and geographical preference to: BOB CLENDENIN, MOTOROLA, COMMUNICATIONS & ELECTRONICS, INC., 1821 N. Office Square, Room 200C, Schaumburg, IL. 60196. Equal employment opportunity/affirmative action employer. 3-78-3t

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Model 530 Semiconductor Tester
• Measures unity gain (f_T) to 1500MHz instantly.
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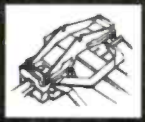
• Fast good/bad test indications
Model 501A Curve Tracer
• Displays characteristic curves on most any scope
• Complete with unique Dynaflex probe

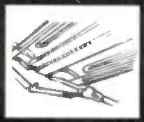
Zenith's full line of antennas, featuring

CHROMATENNA™ II

with 18 ways you can count on for optimum picture quality!



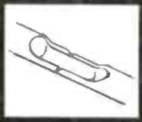
Transmission Line Termination bleeds off static charges thru antenna system ground. Terminal stub improves front to back ratio on lower channels.



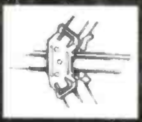
Aluminum Construction of all key metal parts works to eliminate rusting—provides long life.

Golden-Color Alodine Finish is conductive—helps improve electrical performance!

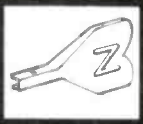
High-Impact Plastic Insulators double-lock each element to the boom for extra bracing and durability.



FM Block reduces FM gain up to 12dB. Remove to receive full FM gain.

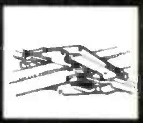


Corner Reflector Bracket improved with larger tabs. (Combination models only.)

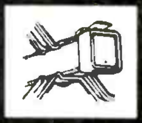


Zenith Dipole on UHF. (Combination models only.)

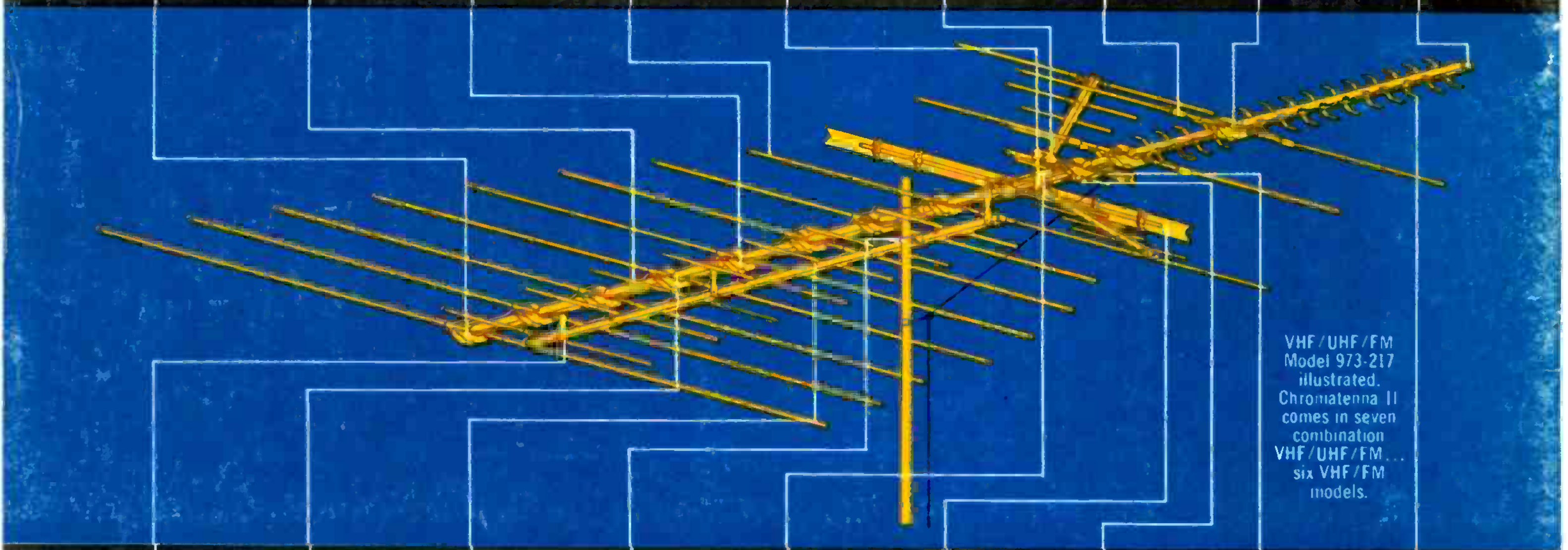
VHF Colinear Directors provide extra signal boost on both low and high band VHF.



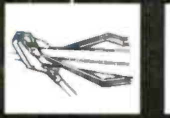
Loading Straps—metal plates close to first VHF element insulators provide compensation for Lo and High band by tuning the first driven element with extra capacity.



Rugged 1" Square Boom provides extra strength compared to many round-type booms.

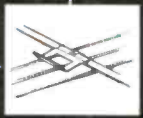


VHF/UHF/FM Model 973-217 illustrated. Chromatenna II comes in seven combination VHF/UHF/FM ... six VHF/FM models.

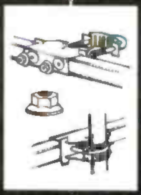


Wide-Spaced, Heavy-Duty Feed Lines help prevent shorting from heavy build-ups of snow or ice.

Sleeved Elements of heavy-duty construction afford extra bracing and protection.



Hi-Bracket with angled ends for added strength.



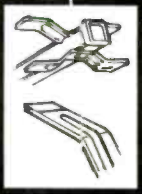
U-Bolt Mounting provides a larger clamping area; larger locking nut with teeth an integral part assures a more rugged U-BOLT arrangement.

Dual Isolator Bars insure no loss of UHF to VHF signal transfer. (Combination models only.)

Proximity Spaced Signal Balancer (Z elements) provides automatic taper control of periodic driver, improves impedance matching and signal leveling on both Lo and High band channels. Improves Channel 7 pattern.

Electrically Matched Terminals With Stainless Steel Screws eliminate mismatch... protect against rusting, and provide positive electrical contact with improved no-strip stainless steel serrated washers for the take off terminals.

Strain Relief Insulator accomodates either 300 OHM twin-lead, Foam lead or Coax download.



Optional Break-away UHF Wing Directors provide maximum gain of standard UHF channels with optional coverage of Hi UHF channels and translator frequencies when broken off (Combination models only.)

Zenith has quality do-it-yourself antenna kits—UHF only, VHF YAGI and Stereo FM antennas as well as a complete line of reception aid equipment. See your Zenith distributor for news of his exciting, money-making Spring programs and Catalog No. 902-1760!

ZENITH

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