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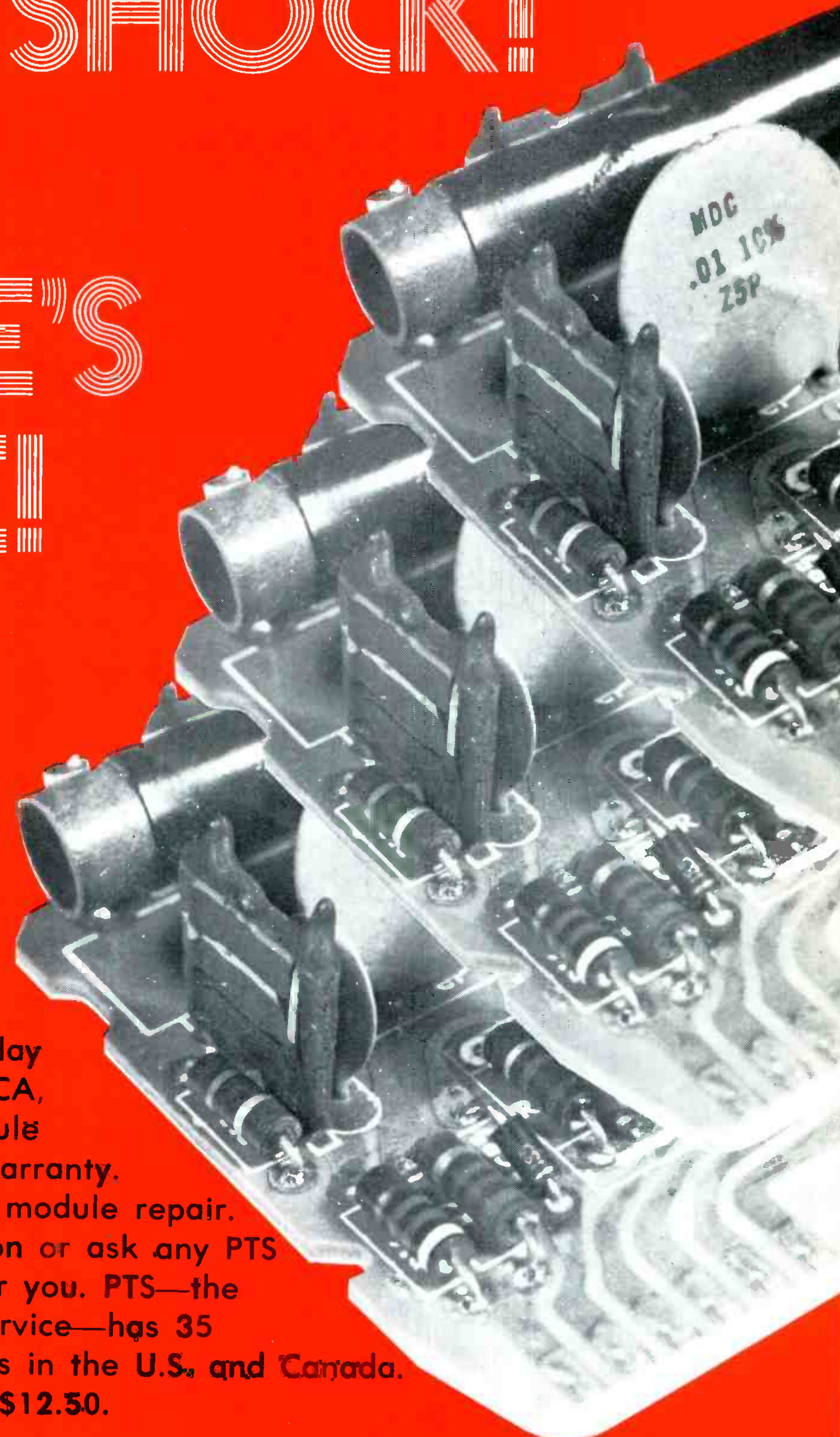

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For More Details Circle (1) on Reply Card

February, 1976 □ Volume 26, No. 2

Electronic Servicing

in this issue...

ABOUT THE COVER

Marvin Beasley demonstrates how to use a hand-held CB radio to pinpoint sources of noise.

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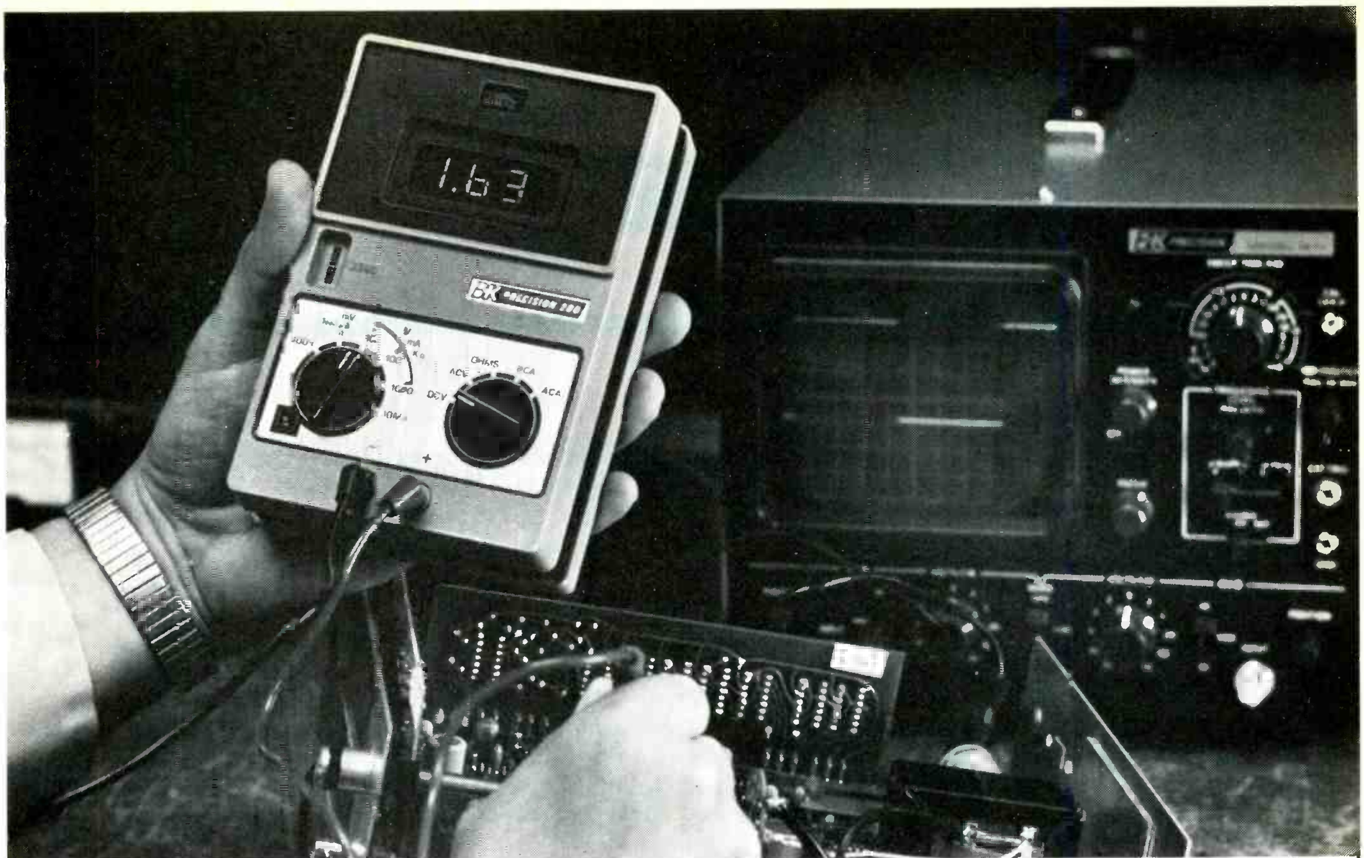

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For More Details Circle (6) on Reply Card

electronic scanner

news of the industry

Sales of microwave ovens should reach 3 million units annually by 1980, and about 5 million by 1985, according to an item in **Home Furnishings Daily**. The prediction was made by William George, president of Litton Microwave Cooking Products, who also said the dollar volume of microwave sales during 1975 probably equalled that of gas ranges.

Warwick Electronics might be up for sale, say reports and rumors in the trade. A majority of Warwick stock is owned by Whirlpool, and over 20% is held by Sears, who is a major customer of Warwick television receivers. Whirlpool is reported to have approached Sanyo Electric about selling its shares of Warwick stock. Warwick has lost money during the past two years, because of price competition from imported sets.

Radio Shack announces that prices in its annual catalog will remain unchanged, at least for the first six months of 1976. Since last July, 218 new stores have been opened in the USA and Canada, making more than 1200 participating-dealer stores, with another 400 planned. Sales of CB and scanner radios are "booming". Radio Shack has offered its housebrand Realistic transceivers since 1960.

The Federal Trade Commission (FTC) announced in December that it was starting a nationwide investigation of the appliance-repair industry, reports **Home Furnishings Daily.** The FTC survey in January of 1975 suggested the elimination of state licensing boards, because they restrict the entry of competitors into the repair business, and their regulations appear to have little effect in preventing "parts fraud".

E. F. Johnson has contracted for Magnavox to build Johnson Messenger 123A CB radios in the Magnavox plant at Morristown, Tennessee. Magnavox does not plan to build or market any CB products under its own name.

Production of microwave ovens should be started soon by Admiral. The line will include three models, and Admiral expects to manufacture between 35,000 and 60,000 ovens during the next year.

(Continued on page 6)

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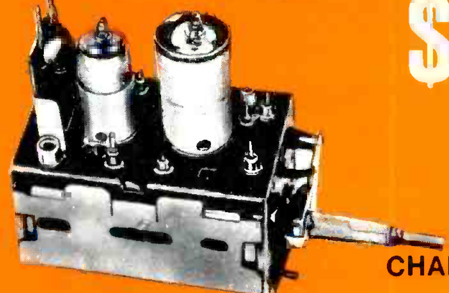

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For More Details Circle (7) on Reply Card

electronicscanner

news of the industry

(*Continued from page 4*)

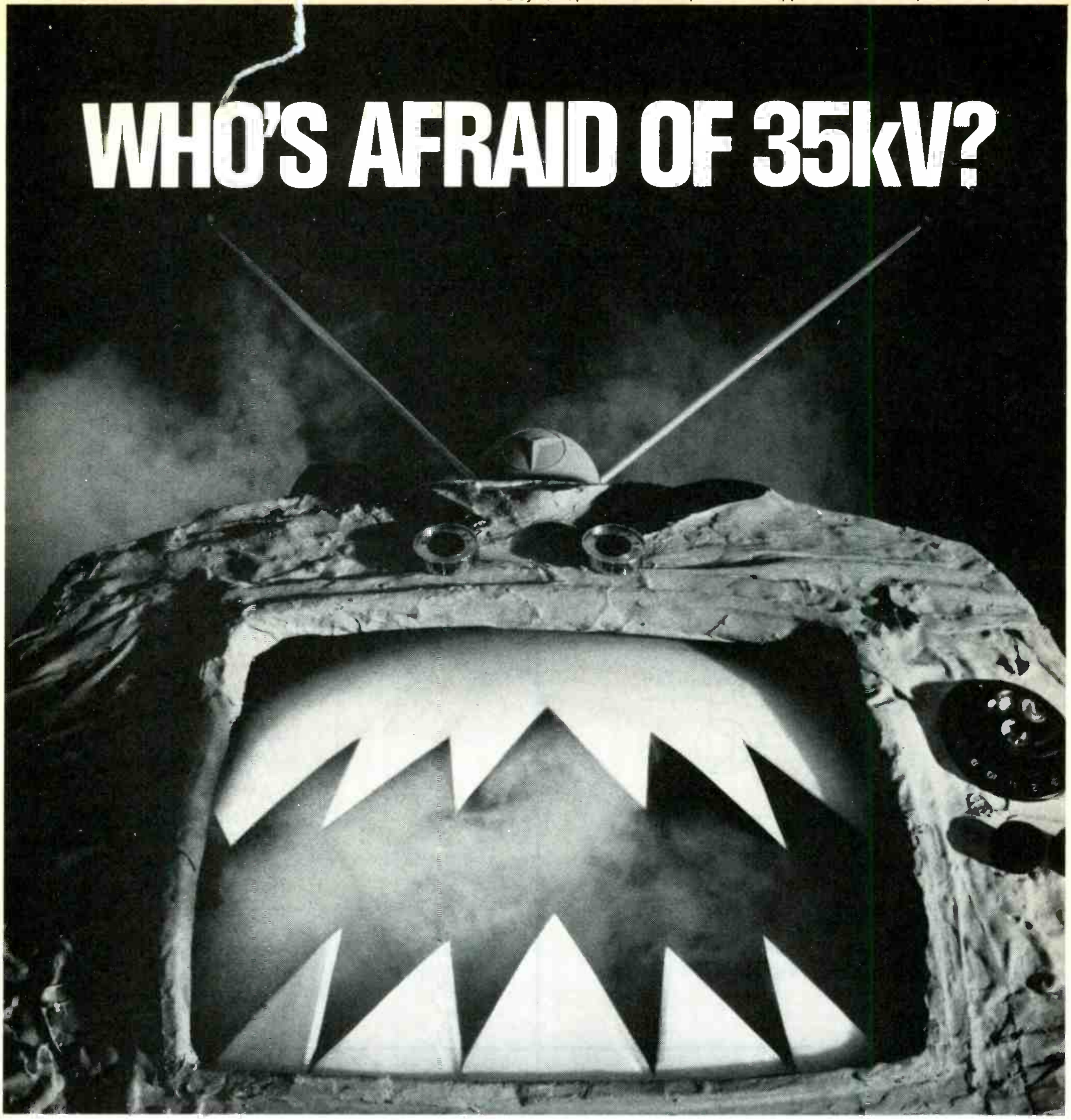
Attempts are being made to dissipate or predict lightning bolts. For many years, the only defense against lightning was the lightning rod, which attracted and then grounded any nearby high-voltage discharges. Now, according to the **Wall Street Journal,** scientists at National Oceanic And Atmospheric Administration (NOAA) of Boulder, Colorado have originated "chaff seeding" of storm clouds by dropping large quantities of tiny nylon fibers which have been coated with aluminum. The fibers "short" between positive and negative charges being built up in the clouds, thus dissipating the power before it reaches a dangerous level. This method was developed to protect rockets during space launches. A gadget for predicting the conditions that cause lightning is the Thor Guard Advanced Warning And Tracking System, which is mounted on a six-foot pole above a roof. When the electric field in the air builds up to a certain level, the machine sounds an alarm. The Thor system, developed by Electrofields Company, is said to be 95% accurate.

A calculator to show the three biorhythms of "ups and downs" in a person's life was to be introduced by Casio at the Consumer Electronics Show in January, according to a report in **Home Furnishings Daily.**

Modules now are being repaired by PTS Electronics, the world's largest tuner-repair service. Same-day service is offered on the repairs of Zenith, RCA, Quasar, and GE modules. After alignment and servicing, each module is tested and temperature cycled. All repairs are made at the Bloomington plant, and the modules carry a one-year warranty.

NESDA booster Norris Browne died December 28, 1975, leaving his wife and three sons. Owner of Houston TV in Houston, Texas, Norris had been president of TEA for 1970, president of NEA in 1971-1972, voted NEA Man-Of-The-Year in 1970 and 1972 Outstanding NEA Officer, and was the first member of ISCET.

Japanese imports of 19-inch color TV receivers have risen sharply, especially during last October, when the percentage of U.S. sales was 40%, compared to past percentages of 16%. According to **Home Furnishings Daily,** a Commerce Department study maintained that superior marketing skills accounted for the increased sales. However, industry leaders are certain the main reason is the prices of the imports, which have been slashed in an attempt to gain additional sales. □



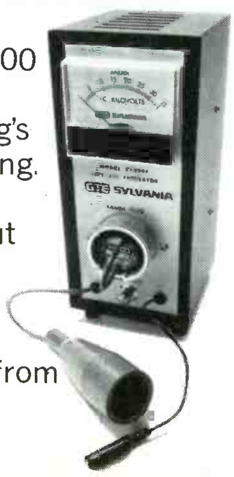
Now you can test new 35kV chassis with your 22kV test jig.

Introducing the CK2000 regulator.

It protects your test jig's picture tube against arcing.

It connects quickly to practically any jig without modification.

Secret of the CK2000 is a special varistor that takes any anode voltage from 22 to 35kV and converts it to 22kV. for your test jig. Voltages below 22kV simply don't activate the varistor.



Best of all, our CK2000 costs only about a quarter as much as many new test jigs.

Who's afraid of 35kV? With our new CK2000 regulator, there's probably not a TV set in the world that can scare you.

See your Sylvania distributor.

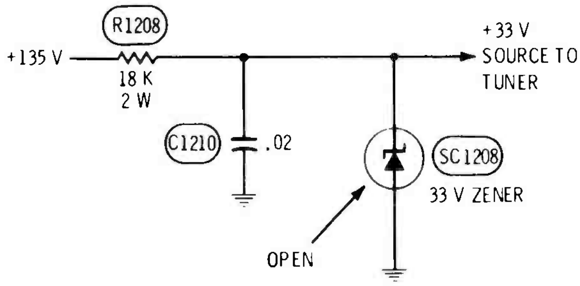
We're helping you make it.

GTE SYLVANIA

symcure

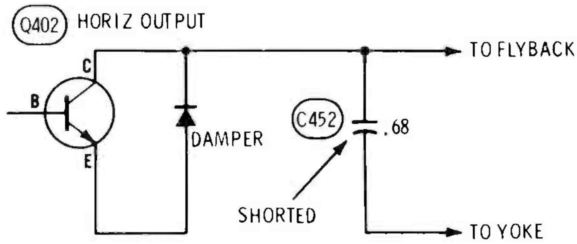
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Sylvania E11
PHOTOFACT—1503-2



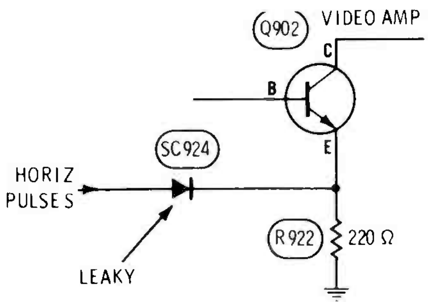
Symptom—Horizontal picture bending
Cure—Check voltage at zener SC1208, and replace it if reading is above +33 volts.

Chassis—Sylvania E08
PHOTOFACT—1481-2



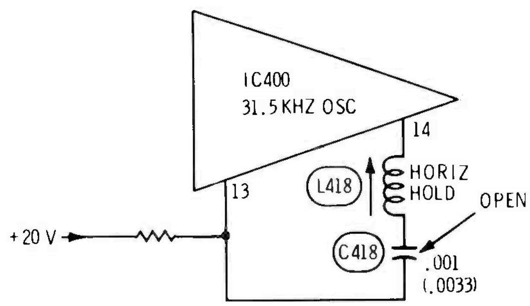
Symptom—Breaker trips instantly
Cure—Check C452, and replace it if shorted.

Chassis—Sylvania E08
PHOTOFACT—1481-2



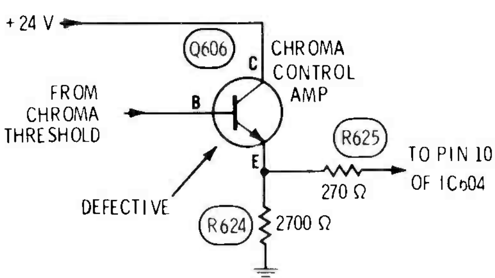
Symptom—Top bending and unstable horizontal
Cure—Check diode SC924, and replace it if leaky.

Chassis—Sylvania E08
PHOTOFACT—1481-2



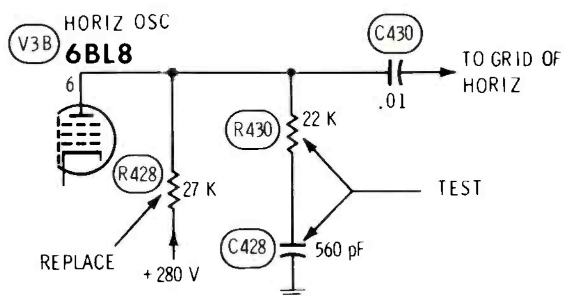
Symptom—Loss of raster and sound; might be intermittent
Cure—Check C418, and replace it if open or intermittent.

Chassis—Sylvania E03 (E04 and E05)
PHOTOFACT—1414-3



Symptom—Chroma cannot be turned off
Cure—Check Q606 transistor, and replace it if defective

Chassis—Sylvania D16
PHOTOFACT—1178-3



Symptom—Narrow width, insufficient drive at grid of horizontal output tube
Cure—Check R428, or replace with 1-watt 27K value

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Send in your helpful tips—we pay!

Rolling color bars
Motorola TSA914
(Photofact 912-2)

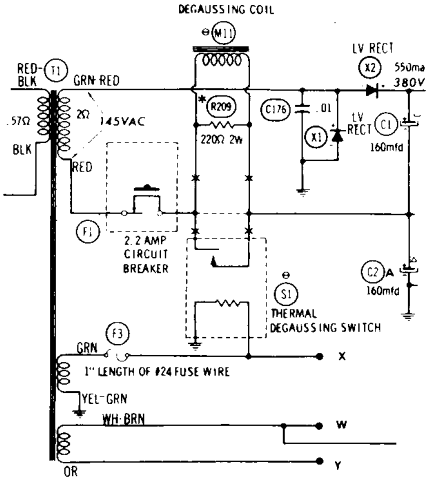
This old Motorola had no color, although it did have horizontal red, blue, and green bars rolling across the picture. In addition, I smelled a hot component in the vicinity of the drive controls.

Tests of all the chroma and video tubes only revealed a leaky 6LY8 video/killer tube. Replacing it eliminated the burning smell, but didn't change the other symptoms.

When I measured the +370 volts near the video-output tube, I found it was down to +225 volts. No shorts or excessive leakage could be found on the supply.

If any of the video-drive controls were adjusted the rolling color bars responded by moving faster or slower. From this, I concluded the +370-volt line had some kind of AC on it, and the AC was interfering with the chroma channel. I removed the video-output, chroma-bandpass, burst-amplifier, and demodulator tubes, but **the rolling color bars were still there!** Then I disconnected the convergence, and pincushion circuits, and bridged all the filters, without success.

The waveform at the +370-volt source was not normal, and the voltage was only +225. One time when the set was turned on when cold, I noticed the waveform was missing from the +370-volt source, although the DC was there. The waveform didn't appear for 3 or 4 minutes.



Finally, I started to trace the AC voltage from the power transformer to the rectifiers, and found it was 145 volts AC up to the degaussing switch and it was 100 volts on the other side. When I jumpered the switch, the B+ rose to normal and the ripple waveform was okay. More important, **the color bars disappeared!** The degaussing switch, S1, was defective, and R209 was open.

Replacement of the switch and resistor brought back a good b-w picture, but without any color. After more testing, I found someone had soldered one end of the 3.58-MHz crystal to the wrong lug of L32. Moving the lead restored the color. It seems this "dog" had been in two other shops, and one tech evidently thought the color bars were out-of-lock color.

William Pokorny
Rice Lake, Wisconsin

Editor's note: Reader Pokorny's experience reminds me of the time I was demonstrating color setup to about 30 TV technicians in 1956. The TV screen showed moving color bars, but dim ones. I tried to ignore them and go on with the convergence, until I accidentally touched the degaussing coil stored temporarily under the low-boy console. It was burning hot. Yes, you guessed it. Somehow the switch of the test degaussing coil had been left on, and the field from the coil was changing the **purity** in a moving hum pattern.

Poor focus
Sylvania D18 (Photofact 1322-3)

No hint of focus showed in the picture from a Sylvania color TV (D18-2 chassis). Adjustment of the focus control made no difference.

At the focus tap on the HV tripler was about 7.5KV. This seemed normal, but at the high side of the focus control (R452) I measured less than 1 KV.

With the focus components disconnected, they all tested okay. I

(Continued on page 16)

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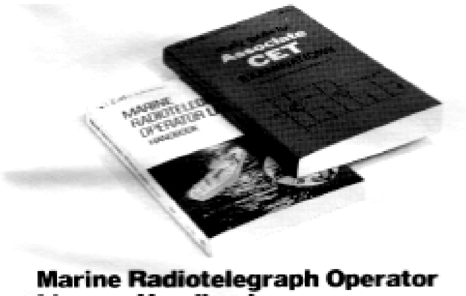

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H. B. Everette
R.R. #2, Box 151-B
Westville, Florida 32464

Needed: Schematic and parts list for Tektronix Model 512 scope.
H. A. Ashdon
108 Plymouth St.
Holbrook, Massachusetts 02343

Needed: Roll chart or a manual which gives "roll chart" data for Hickok Model 546 tube checker, mid-1960's or later. Hickok does not have. Will buy, or copy and return.
Peter J. Reno
5 Hoffman Road
High Bridge, New Jersey 08829

Needed: Information (such as age, battery voltages, etc.) about a Radiola III made by RCA.
Richard Clark
1811 Lee Street
Columbus, Indiana 47201

Needed: Service manual for Paco Model G-36 color generator.
Steve Huddle
112 W. Union, #3
Fullerton, California 92632

Needed: 6GZ5 tube for Admiral TV, Model #L3411C. Please send C.O.D., or best way.
Richard Small
Box 8
Pageton, West Virginia 24871

Needed: Schematic for Symphonic TV Model TPS 700. Will buy, or copy and return.
Ted Steinberg
2005 Glendale
Toledo, Ohio 43614

For Sale: RCA WR514A sweep/marker generator with cables and probes. New, $235.00.
Val Obal
3201 South 73rd Street
Omaha, Nebraska 68124

(Continued on page 14)

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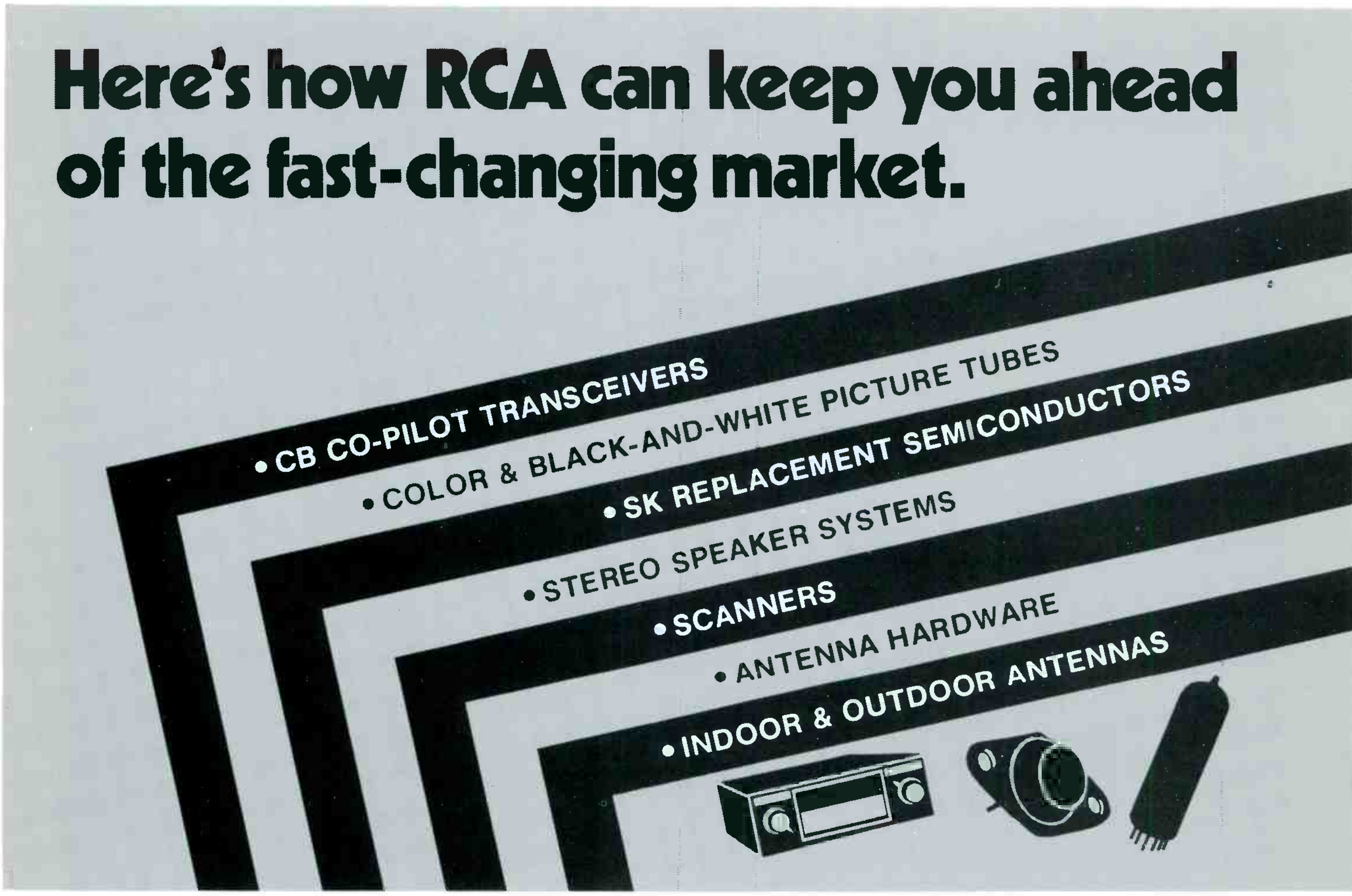


(Continued from page 12)

Needed: Schematic, owner's service manual, or other service data for two tube checkers: G.C. Electronics Model 36-500; and Mercury Electronics Model 202. Will buy, or copy and return.

Albert G. Smith
Electronic Department
Whitko High School
West Wayne Street Extended
South Whitley, Indiana 46787

Needed: New testing data for a Jackson Model 825 CRT tester. Will buy, or copy and return.

M. M. O'Brien
Rt. 2, Box 366
Owasso, Oklahoma 74055

Needed: Schematic for Superior Instruments Model 73 industrial analyzer. Will buy, or copy and return.

Gary Lorenz
11081 S. Eberhart Road
Clare, Michigan 48617

Needed: Power transformer for Eico 620 scope.

J. C. Martin
1104 First Street
Natchez, Mississippi 39120

Needed: B-W picture tube type AP12598D (C6407) for Symphonic 3" mini television receiver, Model TPS-5011. What other type is interchangeable?

Horst M. Schulze
8752 Longford Way
Dublin, California 94566

Needed: An old radio called "The Little General".

Harvey Grossman
105 Maxess Road
Melville, New York 11746

Needed: Power transformer for Utica, Model T&C III CB radio, part #3600-26.

Jerry's TV and Radio
Route 2
Muscatine, Iowa 52761

Needed: Schematic and alignment information for a Jemcor FM wireless microphone, Model 806, manufactured by Nihon Denshi Kogyo K. K.

Frank A. Stupnik, Jr.
704 B Wright Avenue
Klamath Falls, Oregon 97601

Needed: Distributor or manufacturer of "Wynford Hall" Model SM-418 mini-cassette.
H. D. Wright
P.O. Box 613
Dothan, Alabama 36301

For Sale: Heathkit vectorscope/color generator, Model 10-101, like-new condition, $100 with operator's manual.
Victor M. Ortiz
R.F.D. 3-98-A
Isabela, Puerto Rico 00662

Needed: Schematic and parts list for linear amplifier of 60 to 100 watts to operate in 5 to 30 MHZ range.
Schill TV
Box 3
Beaver, Kansas 67517

Needed: Schematic for Realistic musdeck, catalog number 65-1320.
Dean C. Farnham
10055 Willa Lane
Manassas, Virginia 22110

For Sale: Set of Rider's TV manuals, 27 manuals complete plus index. Giant books; only $135 for all, FOB. Scarce collector's find.
Lawrence Beitman
409 E. Chalmers
Champaign, Illinois 61820

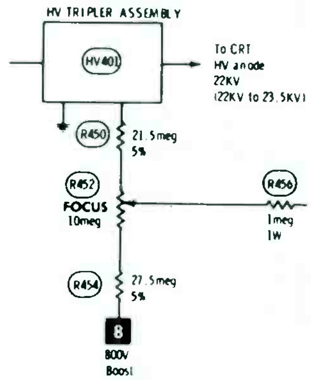
For Sale: Conar Model 311 resistance/capacitance tester, like-new, $15. Also, Eico cap tester, #955K, $15.
B. Kutilek
17215 70th Avenue
Tinley Park, Illinois 60477

Needed: Schematic/service data for an old Grunow 12B receiver, manufactured by General Household Utilities.
Pax-Tronix
Route 4, Box 447H
Great Mills Rd.
Lexington Park, Maryland 20653

Needed: Manual and schematic for Optigan Model #35001 organ.
W. N. Hubin
719 Cuyahoga Street
Kent, Ohio 44240 □

(Continued from page 10)

replaced the fixed resistors, because of suspicion, but there was no improvement. I removed the focus pot to measure it, and noticed a spot that looked burned on the chassis where the pot had touched.



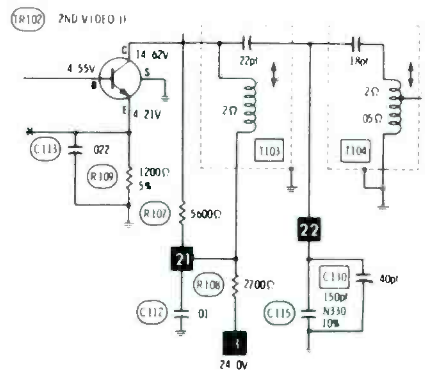
The insulating material, which mounted the pot to the chassis, had been leaking (probably carbonized), and a new focus pot cured the trouble.

Helton's Radio & TV Service
Hitchcock, Texas 77563

Low contrast
Panasonic CT606
(Photofact 1317-2)

Contrast was very weak, and neither the vertical nor horizontal would lock solidly. This pointed to an IF defect causing low gain, no AGC, and overload in the tuner.

Signal tracing tests located the loss of gain in the second video IF stage. All the DC voltages were within tolerance, indicating the transistors should have amplification.



Finally, I started paralleling capacitors, and obtained more contrast when the 22 picofarad capacitor inside the can of T103 was paralleled. Apparently, it was open, for replacement with a new one restored the performance.

George Alvarado, Jr., CET
Haverstraw, New York

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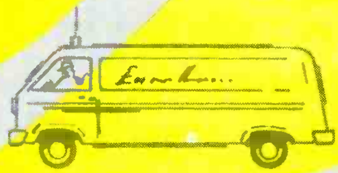
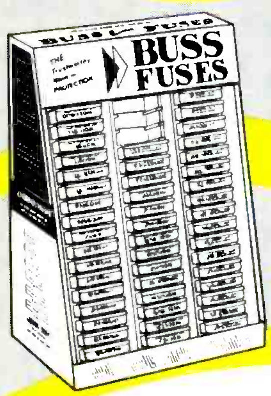
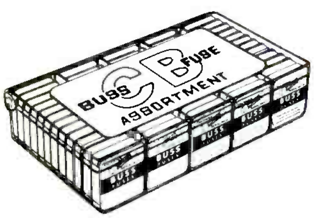


CB EQUIPMENT

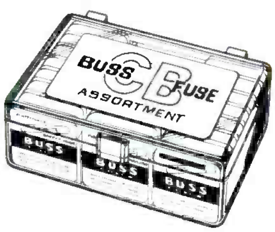


No. 240CB-3
Metal Display Stand

No. 80CB-1
Metal Display Stand



No. 240CB-4
Plastic Display Box



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TECHNIQUES FOR REDUCING IGNITION NOISE

By Marvin J. Beasley, CET
Land Mobile Regional Manager
E. F. Johnson Company

Elimination of ignition and alternator noise from radios and tape decks in autos might be either difficult or easy, depending on the car and other conditions. The following practical guidelines should show you how to remove excessive noise from most autos.

Communications equipment for automobiles has been improved immensely during the past fifteen years. Tubes were replaced by solid-state devices, giving low drain, better reliability, less heat, and smaller cabinets. At the same time, the circuits (such as noise-elimination gates) were greatly refined.

However, one adverse situation remains the same: those irritating electrical noises originating in the auto itself. Unless eliminated, such noises can spoil the usefulness or enjoyment of radio or tape equipment.

In addition to the strong noise pulses from the ignition (which operates as a spark transmitter, radiating energy through air and wiring), tiny arcs are generated by each closing and opening of regulator contacts, or switches for lights or fans. All these add to the noise pollution.

Most cars need only routine remedies to bring the noise level below the point where it bothers reception. Therefore, our advice is mainly about conventional methods. But we will give some tips about difficult cases, those requiring far above the average of skill, experience, and techniques.

Types Of Noise

Noises can be placed into one of two general categories. **Repetitive pulse noise** generally is produced by the spark plugs, coil, and wiring harness of the high-voltage ignition system. A similar noise, but erratic rather than repetitive, can originate in: the electro-mechanical voltage regulators; switches for lights, heater, horn, and wipers; and sensors that turn on warning lights.

A major source of **continuous noise** is the alternator or generator. Lesser offenders are motors, such as those for fans or wipers. For example, an alternator produces both a "hash" (regularly-spaced noise pulses) and a high-frequency whine.

Ignition and alternator noises vary exactly in step with engine RPM's. Hash from blower motors, for example, changes only slightly with engine speed, and that only because of the change of supply voltage.

Effects Of Noise

Audible noise makes listening to voices or music very tiresome and unpleasant. It also causes a radio problem that is less obvious: a loss of sensitivity. In addition to masking the desired sounds, noise can activate the AGC circuit so it reduces the gain as though the signal were stronger.

That's why a radio transceiver might have perfect sensitivity when operated on the bench, and yet appear to be weak in an auto. One fast test is merely to turn off the ignition, while you listen to the radio, and notice if the apparent sensitivity increases.

CB signals are amplitude modulated; therefore, spike noise is audible as a popping sound. FM two-way radios don't have the popping noises unless the signal drops below the level of limiting, but desensitization can occur.

Important Advice

Before attempting to minimize the noise produced by a car, **make certain the ignition system is working properly.** It's very disturbing to waste considerable time futilely trying to stop the noise, only to discover that an ignition defect was the source.

If the car is due for a tune-up, have it done first. Defective spark plugs and their harness are often the problem, and they can defeat

Today, many cars have several electronic communication devices, such as a stereo-tape player, a CB transceiver, and a commercial-type FM two-way radio. All are susceptible, in varying degrees, to ignition noise and other electrical disturbances.

all the noise-proofing techniques you can try.

When a car has 15,000 or more miles, the ignition harness (spark-plug wires) should be suspected. An open might not affect the operation of the car, but the added, **unshielded** spark gap across the open portion acts as a transmitting antenna to broadcast the noise pulses.

A single bad plug or plug wire produces noise pulses having a slower repetition rate than if the problem was with the coil, or the wire between coil and distributor. Later, we'll describe some tests for these conditions.

Ignition In Autos

Servicing any circuit is easier, I believe, when you understand how it operates. So, we'll describe briefly the conventional ignition system used in cars.

Power of the conventional internal-combustion engine comes from miniature explosions of the gasoline/air mixtures "ignited" in the cylinders by electric arcs. Schematics of the Kettering-type system and the newer electronic-ignition are shown in Figure 1.

Power from ringing

The basics of ringing, as given in the XL-100 article in January, 1976 ELECTRONIC SERVICING, apply to the Kettering ignition system. When an inductance (ignition coil, for example) has a DC current flowing, the current can't be stopped immediately. Instead, the current continues (but decreasing) as it discharges into an external resistance, inductance, or capacitance. When the coil current charges a capacitance, the capacitance has a voltage which then discharges back into the inductance. The action continues, with the electrons being forced from inductance to capacitance, etc., until the initial power is dissipated.

If there is no capacitance available to receive the current from the inductance, when the circuit is opened, then the current flows into the self-capacitance of the coil. All real-world coils have stray capacitance between turns and layers of the wire. However, this ringing produces extremely-high peak voltages having a short duration. That's why, for example, a DC-operated relay coil without a paralleling diode or capacitor is susceptible to failure; the peak ringing voltage is so high it might arc across and destroy the coil.

The "condenser" shown in Figure 1 has two uses. First, it series-tunes the primary inductance of the ignition coil to lower the frequency of the ringing. This gives a "hotter" spark in the plugs, acting somewhat as DC. Without the "condenser", the spark would be more fuzzy, resembling high-frequency AC or RF.

Secondly, the "condenser" minimizes the arcing across the points. Without a capacitor there, the points would be ruined much sooner.

Resonant action of the tuned circuit formed by the "condenser" and primary winding of the ignition coil produces far more AC voltage than the 12-volts DC obtained from the battery. As in all tuned circuits, the value of the capacitor determines the amplitude of the AC voltage. A larger-than-normal value, for example, would reduce the voltage.

After the AC voltage across the primary is produced by ringing, following opening of the points, the coil steps up the voltage. A conventional coil has a turns ratio of 1-to-100 or 1-to-150; therefore, the secondary voltage is equal to the primary AC voltage multiplied by the turns ratio.

This high voltage goes through the distributor (which switches it to each spark plug in turn) through resistive wire, and then on to the plugs (also through resistive wire). About 20,000 volts, or more, is required for dependable firing of the gas/air mixture by the plugs.

Noise Reduction By Car Makers

A typical modern car has several bypass capacitors paralleling the 12-volt supply, and high-voltage wiring having carbon-impregnated-fiber instead of copper conductors. A resistive wire between distributor and spark plug might measure around 10K or 12K.

No doubt the automotive designers must compromise when determining the values for the resistive cables. Higher resistances attenuate more of the radiated noise, but too much resistance

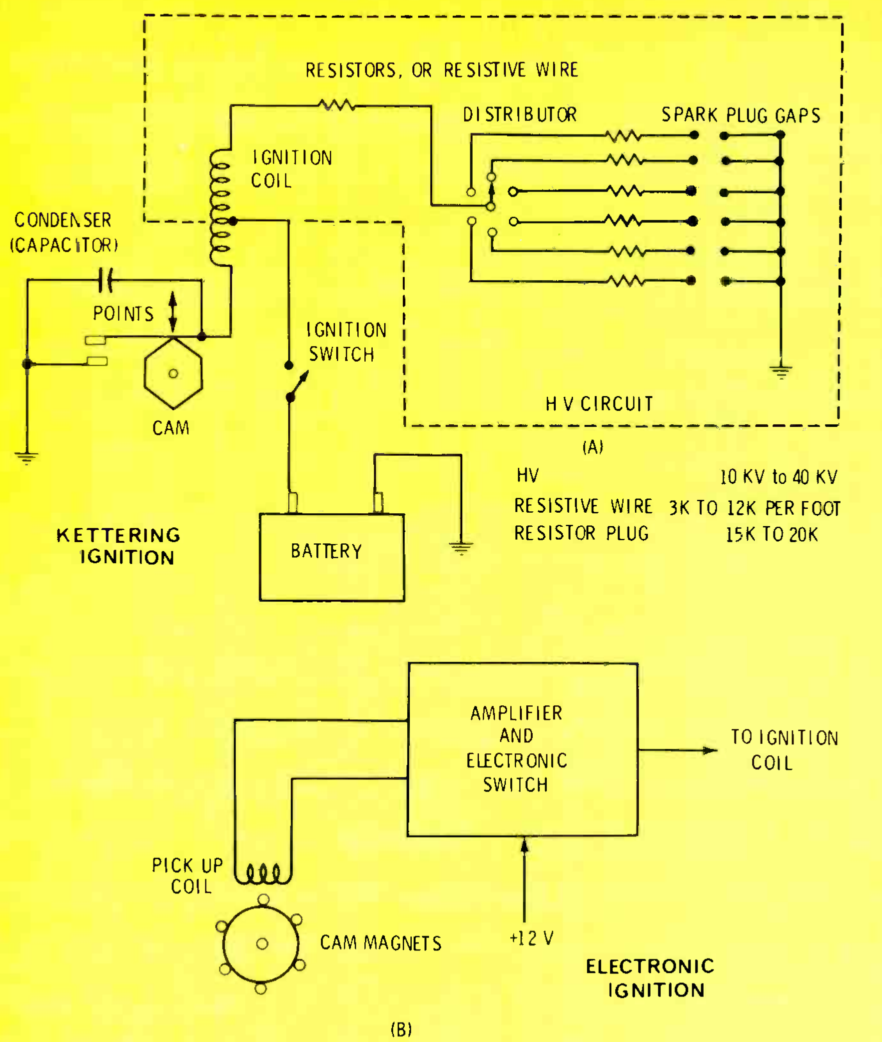


Fig. 1 In the basic Kettering ignition system (A), a switch called "points" breaks the current feeding the primary of the ignition coil. This starts ringing between the primary inductance and the capacitor that parallels the points. After the AC is stepped up by the coil secondary, and is routed through the distributor, it is applied to one plug at a time, where the arc ignites the gasoline/air mixture inside a cylinder. A cam, that opens the points, turns in synchronism with the distributor and the pistons, so the arc in each plug occurs at the desired time. To reduce radiation of noise pulses, resistance wire usually is employed for all high-voltage wires. Electronic ignition (B) eliminates the points by triggering from a magnetic signal and using a transistor for a switch.

limits the current available to the plugs, resulting in poor engine performance.

Noise-filtering kit

A noise-suppression kit is shown in Figure 2. Of course, you would not install individual distributor and plug resistive suppressors if the car already had non-defective resistive HV wires.

How Is Noise Entering?

Assuming that you have installed or found factory-installed suppressors, but the engine noise remains excessive, the next step is to prove whether the noise is entering through the power wiring from the battery or from the antenna.

Noise through antenna

Unplug the antenna lead at the receiver. If the noise is missing, then it is coming from the antenna or lead wire. Check these possibilities:

- Is the ground braid (shielding) properly connected to the auto chassis at the antenna?:
- Is the braided end of the shielding broken or corroded?:
- Is the antenna mounted on a bumper, mirror, or other part that is poorly grounded? (Door hinges and shock-absorbing bumpers often are inefficiently grounded.)

Where you suspect a poor ground, bridge between the shield and a known-good ground, using a piece of braided shielding, while you listen for any change of noise level.

Braided shielding can be purchased on a spool from Belden. Or, if you have scraps or short lengths of coaxial cable, strip away the outer insulation and remove the shielding. RG58 has small braid, RG8 has larger braid, and even some 75-ohm TV cables can be a source of salvaged braid.

Figure 3 shows an inferior example of mounting a bumper antenna. The exposed cable and connections commonly collect corrosion and rust, and create the possibility of broken wires. Automatic carwashes can cause damage. Also, the ground is through the bumper to the frame; a likely source of high-resistance grounds. Where the cable goes through a grommet in any sheet metal, a clamp should be used to prevent the wire from being pulled out of the base of the antenna.

Noise from ungrounded metal

Secondary radiation of the noise from the ignition system can occur at many points on the car body. For example, the exhaust components are connected to the motor block at the front, but other mounting brackets have rubber or other non-conducting straps that prevent grounding. Notice, in Figure 4, the hanger for the exhaust tailpipe at the rear of a Pontiac Ventura. A braid has been installed from the pipe to the frame to eliminate one source of spike noise radiation.

Poor grounding through the hinges of the hood also can permit noise to radiate. Braided shielding should be added across both of the hood hinges (Figure 5).

Engine mounts are insulators, and usually one strap connects engine and frame. In extreme cases, bonding is necessary from several points of the engine to frame.

Finding The Radiation Point

To locate points of noise radiation, I suggest you use a walkie-talkie CB receiver with the antenna extended only a few inches. Walk around the vehicle, and hold the shortened antenna near various suspected areas while you listen for the noise through the walkie-talkie speaker.

Checking FM noise

FM receivers (both two-way and stereo-broadcast types) require a different method of testing. As shown in Figure 6, a "T" connector should be used temporarily, allowing both a generator signal and the antenna signal with noise to reach the receiver simultaneously. Tune in a generator signal of a level sufficient to give 20-dB of quieting, then listen for popping noises, as you make tests.

An alternate method is to disconnect the antenna coax and substitute a coaxial cable that's long enough to reach all corners of the car. Strip the shielding back about 4-inches from the end, and use this as a probe to find any areas of excessive noise radiation.

Shielded harness

In extreme cases, the high-voltage wiring can be replaced by a special kit. The kit has shielded leads for the spark plugs and distributor, a shielded distributor, a coil cover, and several bypass capacitors.

This could be the **only** method of satisfactorily eliminating spark noise from a marine inboard-engine application where the engine compartment is not shielded.

Noise From Power Source

Noise suppression is more effective where it can be applied to the device causing the noise. Bypassing the 12-volt terminal of the ignition coil might help either the radiated noise or the noise conducted through the 12-volt source (Figure 7).

Continuous-noise sources

Common sources of continuous "hash" noise are generator or alternator, and motors of heater, air conditioner, or windshield wiper.

When generators were used for charging the battery, bypass capacitors were installed at the armature circuit to minimize the hash caused by arcing of the carbon brushes against the commutator.

Of course, alternators now are standard equipment, and they create different kinds of noise. (Alternators generate AC, which is rectified by internal silicon diodes; so the output is DC with ripple.) Hash is produced by the diodes, and the ripple appears as a whine superimposed on the A+ line.

Usually, the whine isn't strong enough to affect AM broadcast-band reception. Even so, it can be heard off station, if the volume is turned high. But tape players, reverberation units, and CB receivers

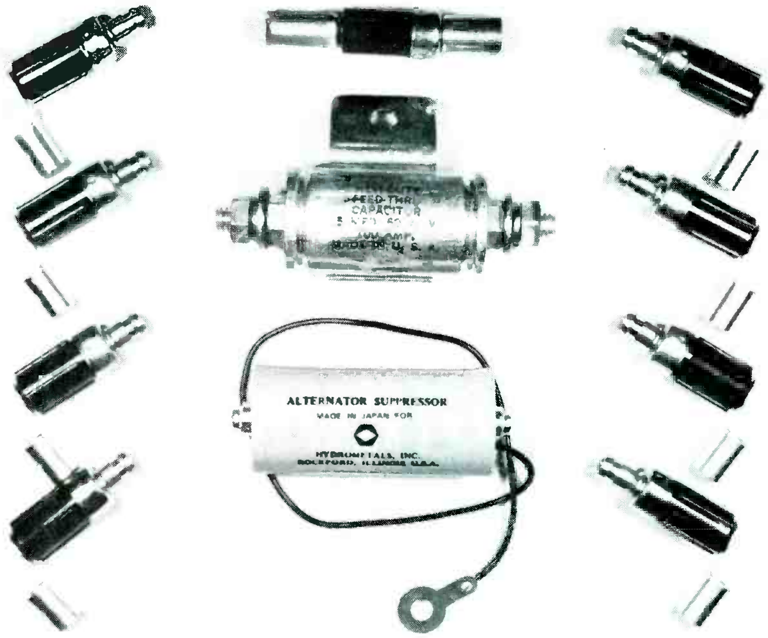


Fig. 2 A noise-suppression kit for cars without resistive HV wires is shown here. At the center is a coaxial capacitor for filtering the A+ applied to the ignition coil, and below it is a special suppressor for an alternator. The other nine components are resistance adapters for eight plugs and the center of the distributor.

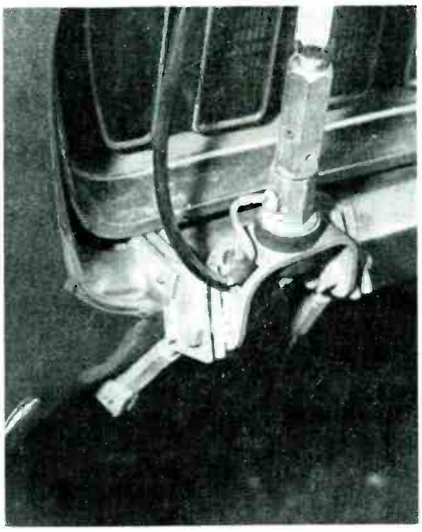


Fig. 3 Exposed connections of this bumper mount invite corrosion and broken leads. Also, many shock-absorbing bumpers are not grounded properly. With those bumpers, a length of braided shielding should run from cable ground to car frame.

Fig. 4 Because many exhaust systems have insulating hangers, a ground made of flexible braid should be tied from exhaust pipe to frame, if you have a stubborn case of ignition noise.

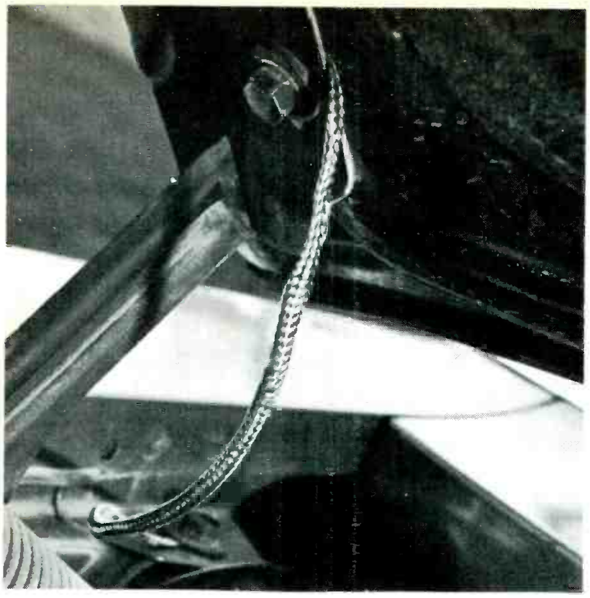


Fig. 5 Hood hinges often are not a good ground to RF and noise. Add a ground of braided shielding at each side hinge.

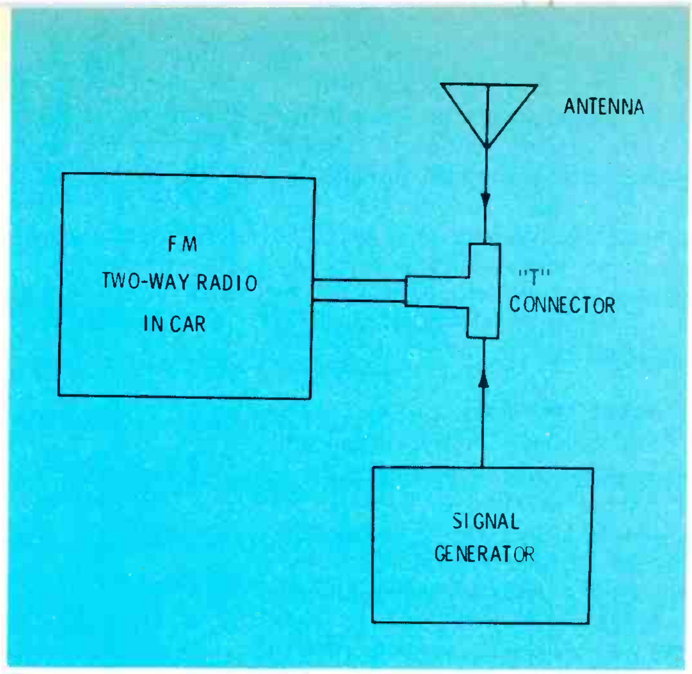


Fig. 6 The inherent noise-rejection ability of FM makes necessary a test carrier that's controllable in amplitude. A signal generator and a "T" connector allow the noise from a test antenna, and the generator carrier, to reach the FM receiver at the same time.

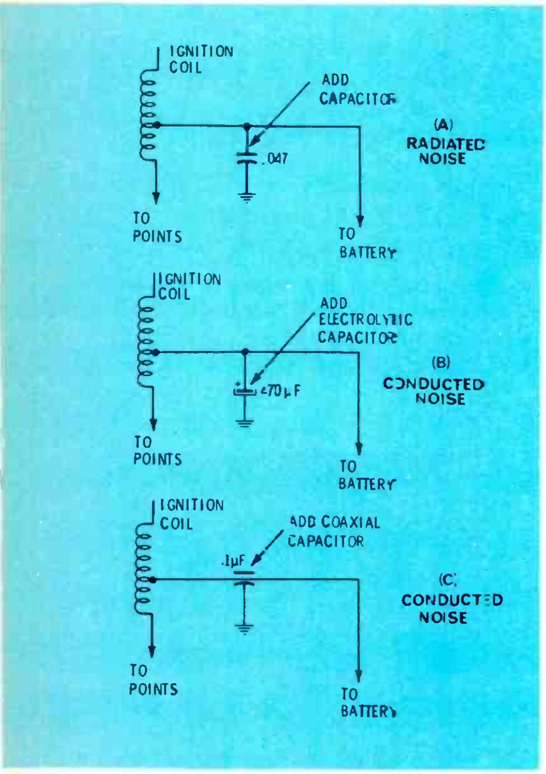


Fig. 7 Here are several methods of filtering noise from the A+ supply at the ignition coil. (A) Simple bypassing using a universal-type metal-cased capacitor mounted with short leads sometimes helps minimize radiated ignition noise. (B) Sometimes a large electrolytic at the coil will prevent ignition noise from following the A− wiring. (C) Perhaps the most-effective coil filter is a coaxial capacitor. The current flows through a solid, straight wire through the center, and the capacitor plates are wound around this core.

are all susceptible to whine and hash.

Alternator interference can be attacked either at the source or at the device bothered by the noise. **Suppression of the noise at the source is recommended.** Standard bypass capacitors at the alternator have little effect. Tuned high-current traps can be used, but I don't recommend them because they are difficult to keep tuned.

Coaxial high-current capacitors are best, considering price and maintenance (see typical installation in Figure 8).

If you use a portable tape player or CB radio and find it impractical to noise-proof the vehicle, another method of removing the hash and whine can be done. It involves "brute-force" filtering of the A+ supply to the player or radio (Figure 9). Current handling capacity is limited by the choke, typically 3 amperes through the .5-ohm winding.

Common Voltage Drop

A car battery has the filtering effect of a huge capacitor. Therefore, it's difficult to see how any AC disturbance could ride on the + 12-volt supply. If all the connecting wires and ground returns had **zero** resistance, the battery capacitance **would eliminate** all of that interference.

However, all automotive wire has resistance, and the smaller sizes have appreciable voltage drops. Figure 10 shows how the ripple and hash from an alternator can share a common supply wire with the CB radio or tape player, thus adding considerable interference through the supply.

Stubborn cases of noise often can be cleared by running a separate heavy-gauge power wire from the CB radio direct to the battery.

Editor's Note: I remember vividly an old battery radio, using 2-volt-filament tubes, that I was called on to remove the vibrator hash. After much experimentation, I found the only remedy to be running ***separate*** *vibrator power-supply wires and filament wires for the tubes right on to the terminals of the wet-cell battery. No amount of filtering could equal this simple solution, which removed the common voltage drop.*

Testing Spark-Plug Wires

I promised to detail some simple methods of testing the high-voltage ignition wiring. This is important, because it's possible for small arcs to cause ignition noise, but not be

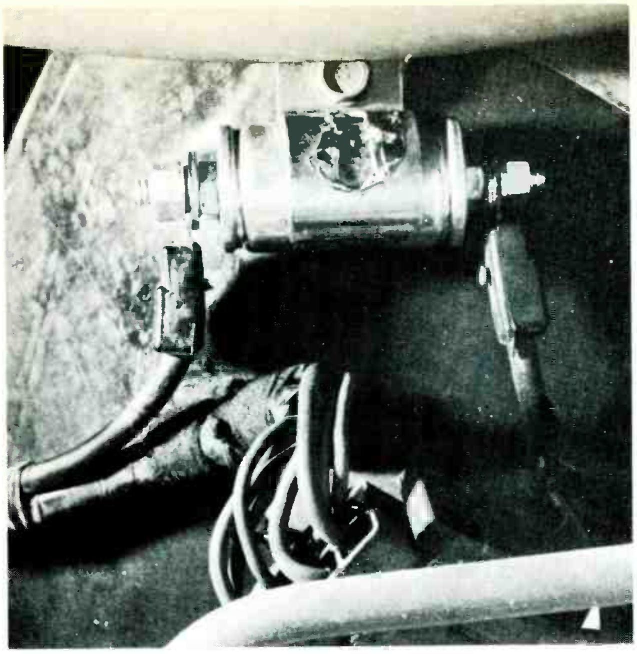


Fig. 8 Coaxial capacitors also help remove alternator hash and whine, as shown in this typical installation.

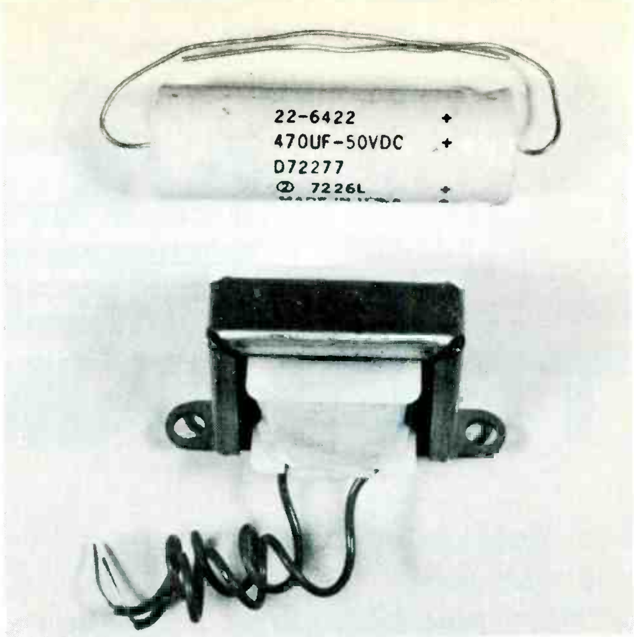


Fig. 9 Noise suppression should be applied to the car, not the receiver or player. But if that is not possible, an A+ filter consisting of a choke and an electrolytic capacitor can be added to a CB receiver or tape player.

found during a routine tune-up by many garages.

One way is to remove the spark-plug wires, one at a time, and test them with an ohmmeter. Most should be resistive types measuring around 10K to 12K. If the reading is "infinity", the wire should be repaired or replaced. I have had good luck repairing such wires. Except for a few cases where the wire had lain against a hot exhaust manifold and suffered ruined insulation, the defect was at one end. Slip back the rubber insulator and examine the connector. A black smudge shows where an arc has been. Cut off about an inch of the wire, and carefully re-do the connector. Remember, there is no center copper wire; instead a piece of dark twine string is the conductor. It can't be soldered. Instead it must be twisted and clamped mechanically by the connector.

Alternately, you could insulate yourself with a large, dry shop towel (remember that 20,000 volts!) and remove one wire at a time from the distributor. After each wire is disconnected, listen to see if the popping noises are different. If not, go to the next wire, until you find one that stops the noise. The problem will be either the wire or the plug.

Comments

A CB receiver with .5 microvolt sensitivity can't be used fully, if it is operated in a car that's radiating a noise level of 2 microvolts. Noise elimination could well make the difference between a successful or an unsatisfactory communications system. Excessive noise can be an "equalizer" between a $300 Deluxe rig and a $79 special. Use these noise-elimination suggestions to give your customers the good reception to which they're entitled. □

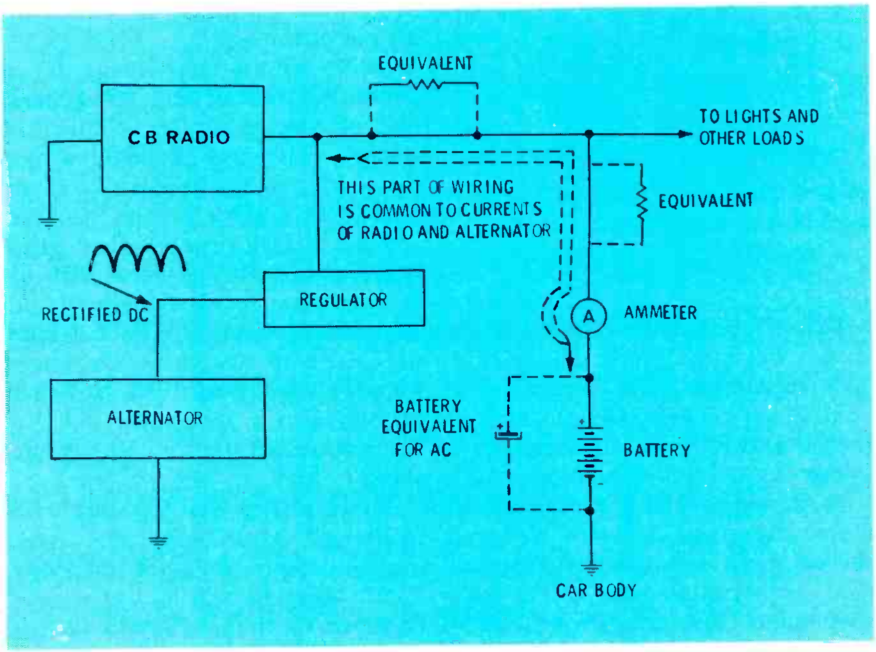


Fig. 10 If the usual remedies fail, you might consider the possibility of noise voltages being developed across the common resistances of the auto wiring harness. Sometimes, a heavy-duty A+ supply wire run direct to the battery will help reduce the noise. Removing and cleaning the battery terminals also has been known to minimize noise.

MODERN FIELD TECHNICIANS

The "outside" technician is a vital link between your customers and your electronic business. So, each field technician is worthy of being trained to reflect the image you want to project.

By Archie L. Campbell

Every modern field technician should be much more than just a "TV repairman". He should be a competent technician, of course, but he also must be a psychologist, salesman, and public-relations man.

In fact, your field technician is more important to your business success than any other person in your organization. He is the one who makes that critical person-to-person contact with the service customer. Everything he says and does (or doesn't say or do) directly reflects the type of company he represents. In most cases, he is the **only** person that the customer ever sees or talks with personally.

Selecting Field Techs

Although hiring on the basis of technical competence alone can be a serious mistake, you must know his abilities at the moment. You might have to make a choice between a genius with a serious character defect, or a man with a pleasing personality but only moderate experience and training.

Has he graduated from a technical school? What is his experience? Is he a CET? Some employers give a quick verbal test by stating the symptoms of several hypothetical repair jobs and asking the job-seeker to explain how he would proceed. Other shop owners have the prospect work at the bench for a time of testing.

While you are interviewing, try to determine the candidates general outlook, including his opinion of himself. Use any knowledge you have of "body English". If he slumps in a chair, wraps his arms around himself, evades some questions, or mumbles so he is difficult to understand, then beware, because he probably will do the same or worse with customers. Customers mainly judge field techs by their attitudes, so a tech must **not** give the impression that he has something to hide.

What about his personal appearance? Most applicants dress more carefully for a job interview, so it's likely he will look the same, or worse, on the job. Try to imagine yourself as a customer looking through the peep-hole of a door at him. Would you want to unlock your door for a person of that appearance?

You want a field tech who will be honest both with you and with your customers, but you can't merely ask him if he's honest. Sometimes, you can get an approximate idea by learning his attitudes. Is he resentful of all customers, believing they want to cheat him, so he wants to get them first? This is a danger signal. Remember, shop owners are more and more being held responsible for the actions of their employees.

Ask for character and business references, and check them out.

Training A New Tech

Regardless of his experience and technical background, you must train the new man in your way of doing business. Such things as your pricing system, rules for credit, what should be done and not done during service calls, and many more should be discussed thoroughly.

If your prices might seem high compared to local competitors, brief your new man on the reasons for the prices. Without this knowledge, a tech is tempted to fall back on the empty, "That's the way the boss wants it", type of answer, when a customer questions any prices. Confidence that your prices are fair can strengthen your tech, and help him transfer that confidence to the customers.

Examine yourself

While you are indoctrinating a new employee, examine your own appearance, attitudes, and business principles. Do you, as an example for your employees, dress as a professional should? Do you have well-marked trucks or wagons and require jackets, or other "uniforms" for identification and to project a

proper image? Do **you** get along well with customers? Remember, your employees either consciously or subconsciously will follow your leadership.

Perhaps it's time to make needed changes in your business and your own life.

Who trains?

Never allow the person who is leaving your company to train the new employee. Even if he is leaving voluntarily, without bitterness, his attitude will not be beneficial to your business.

One good possibility is your best technician, but only **if** he has some teaching ability, has a good personality, and gets along well with people.

However, in the final anaylsis, you might be the best teacher. Your lost time will be repaid many times by your new tech's efficiency.

Clothing for techs

Here are some suggestions about the type of clothing your technicians should wear. I recommend uniforms because they give a tech a sense of identity and belonging. Also, they assure the customer that the tech actually comes from your shop. If you include the company name, the cost and maintenance of the uniforms is tax deductible.

A dress shirt with tie (not a bow tie, they are for gas-station attendants), jacket and slacks makes a very presentable uniform, which looks professional. Color is important. Dark browns and blues are good, as they don't show dirt so quickly, and are not too flashy. Stay away from blazers; they are more appropriate for real-estate or used-car salesmen.

Uniforms represent authority, and the person wearing one automatically radiates some of the authority. I remember the first time I wore a shirt and tie while making service calls. After watching me work for awhile, the customer said, "I have never had anyone wearing a tie work on my TV before." My answer was, "Well, perhaps this is the first time you have ever had a professional technician work on it." A tech in street clothes is just another person.

The following are suggestions to guide you in training a new technician (or for instructing any field tech).

Good Manners For Technicians

How a technician enters the customer's home is very important. When he reaches the door, he should set down the equipment and caddies, ring the bell or knock, and **step back a couple of paces.** Never give the customer an impression you are forcing your way in. Wait until the customer opens the door, then announce yourself and your company in this way: "Hello, I'm Mr. Jones of XYZ Television Service. May I come in?" Pause, and don't pick up the equipment or make a move toward the door until the customer invites you in, or indicates clearly that you are welcome. Enter with as little confusion as possible.

If the TV isn't in sight, ask the customer where it's located. Set down the equipment in a place that will be convenient for you to work, but also where it's out of the customer's way. This is important from a psychological standpoint. You are there by invitation, so conduct yourself as a guest.

This consideration for the customer extends to protecting any belongings around the TV set, such as pictures or knick-knacks. Of course, you shouldn't overdo it as I did once years ago. I was checking a large combo, and the top was filled with knick-knacks. Because I might break some, and there was plenty of room inside on either side of the TV chassis, I carefully placed them inside the cabinet. Unfortunately, when I finished the repairs, I replaced the back, without remembering the knick-knacks.

Back at the shop, the service manager greeted me with a sour look. "Archie, what did you do with Mrs. Jones' knick-knacks?" I looked at him with a blank stare before it dawned on me what I had done. Well, to make a painful story short, I had to go back on a call-back next day, and open the set in full view of the customer, so she could see I had not stolen the knick-knacks. It was an embarrassing experience, and one that helped me remember to watch the customer's property after that.

If it can be done without appearing forced or unnatural, compliment the customer about something outstanding around the home. Perhaps there is a new rug or another item of furniture, or the television set might have a large, attractive cabinet. Be friendly, but don't talk too long or get personal. After all, **you are there to repair something,** not to be a stand-up comedian or a marriage counselor.

No negatives

Above all else, make only positive statements or none at all. Don't downgrade the TV or stereo. The customer's best judgement was used during the purchase. So, if you criticise the merchandise, you automatically criticise the owner.

Don't blame the manufacturer for any defect or malfunction. Often this appears to be the easy way out for a technician, when the customer is displeased about the problem and wants to blame someone. But shifting the blame solves nothing. In fact, I remember several cases where a tech talked too much. Each time, the technician complained so much about the product that the customer had him stop work. Then she made a formal complaint direct to the factory, eventually receiving a free repair.

Remember, many customers are upset that the machine failed, and often fear what the cost of repairs will be. Don't fan the flames. Be amiable, and don't argue, but interject a soothing sentence at times.

Appear ready to work

I have known technicians who habitually entered customer's homes with only a screwdriver, 1/4-inch nutdriver, and a pair of pliers tucked away in a hip pocket! Maybe that was enough until a preliminary look at the receiver suggested what equipment or caddy was required, but I'm certain many of the customers wondered what they were paying for.

In general, we point to all the expensive test equipment, when trying to justify our charges. Better than talking is to **show** some of it to the customers. For years, I carried in a color-bar generator. Not only does the equipment suggest an investment of money, but many color receivers benefitted from minor adjustments. An added bonus was the attention the customers paid the various patterns on the screen.

If you are to be a real professional, act it by displaying adequate tools and test equipment, along with the technical proficiency to use them.

Don't hurry

Outside technicians should make efficient use of their time. But don't be obvious in your hurrying. Customers can sense any undue rush, even though they know nothing about the technical aspects, and they will feel cheated. If you want pleasant, satisfied customers, treat them as though they (and their problems) are most important to you.

More tips

Involve the customer in some part of the operation. For example, ask about the present trouble and others since the last repair. And **listen** to what the customer says, even if it is not helpful at the moment. Besides the psychological impact, you might pick up some hints about other problems, perhaps intermittent ones, that should be repaired to prevent call-backs.

If you use a test instrument, such as a tube tester, that has a clear Good/Bad scale, demonstrate any abnormal readings to the customer. Check the tuner for any needed lubrication and measure the high voltage. Tell the customer of these extras, so he or she will appreciate your good service.

Look the customer straight in the eyes when you talk to him or her. The old saying about a crook having shifty eyes probably is wrong. But many people believe it. You are honest, aren't you? Then look like it.

Finally, write the invoice, explaining all charges to the customer in layman's language, and noting on the invoice any work that was needed but not authorized by the owner. All of these things help prevent nuisance callbacks.

Comments

The natural inclination of many electronic technicians is to concentrate all their attention and skill on the symptoms and repairs of the defective machines, while ignoring (or even resenting) any comments or suggestions from customers. There are strong reasons why this is not beneficial.

Irritations can lead to stronger irritations in a type of human feedback loop. Most service customers are upset already because they can't use and enjoy their machines. And some have fears of having to spend more money than they have to spare, or perhaps they have dark suspicions that the technicians might cheat them. Many things add to their unhappiness. Often they unconsciously "pick on" the technician, since he is the only person within reach.

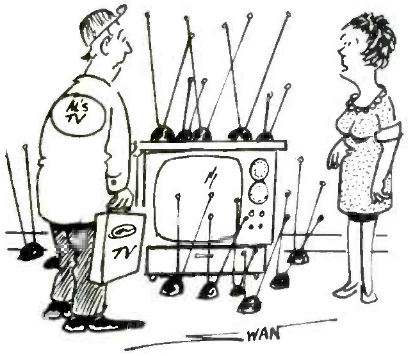
Now, if the technician responds in like manner, the feedback of anger spirals until someone's temper will explode. With electronic feedback, only one open circuit in the closed loop stops the oscillation. A technician, of course, can't always prevent a customer from being unhappy. But he certainly can open **his** section of the feedback loop, thus preventing a worse situation. Even better, many people will respond with kindness when they are shown kindness.

Why should you spend so much thought and trouble for strangers? Over the years, I have heard many a short-fused technician declare **he** would not bow down to any customer. I might reply that we are all human beings, and should help each other more. But, for all techs who won't buy that philosophy, there's another reason: **Getting along with customers indirectly places more money in the pocketbook;** whereas, sparring with customers costs dollars and ulcers.

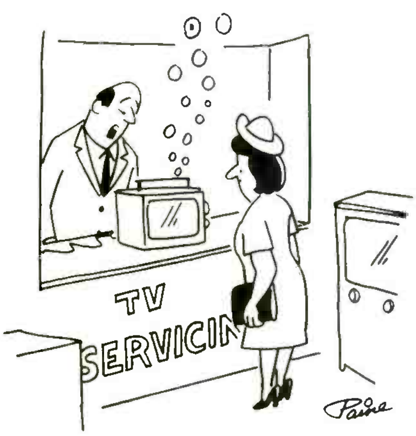
This article is directed mainly to employers. You, as "boss", have the right to insist that your employee technicians treat your customers with courtesy and their property with respect. In addition, they should act and look like real professionals.

Yes, having field technicians who can soothe customers as they make necessary repairs is one of the most-valuable assets any service business can have. □

"I guess you can cancel my call."



"We started with one set of rabbit ears, and they just kept multiplying."



"Based on a quick diagnosis, I'd say that either Lawrence Welk or the soap operas are the cause of the trouble!"

For More Details Circle (17) on Reply Card

Servicing stereo audio systems

Part 6, By J. A. "Sam" Wilson, CET
Technical Advisor For NESDA

All audio amplifiers have bandwidth limitations. If a wide bandwidth is desired, either or both of two basic methods can be used to achieve it. One is reduction of gain, particularly with negative feedback, and the other is to incorporate reactive filters to cancel the rolloffs. Both methods are discussed here.

How wide should the bandwidth of an audio amplifier be? We must hedge a bit and say it depends upon the application.

For example, the audio amplifier of an intercom might be acceptable if the response is flat between 100 Hz and 4 KHz. That's far from hi-fi specs. Human ears, on the average, hear between 16 Hz and 16 KHz. Most hi-fi amplifiers are flat within about 1 dB between 20 Hz and 20 KHz. Some hi-fi buffs insist their amps should be flat between 20 Hz and 100 KHz. The extra HF response is necessary, so they say, to preserve the phase and intermodulation characteristics.

In addition, speakers tend to minimize both the low and high frequency ends of the audible spectrum. Microphones are better, but few are flat. Therefore, some applications require the amplifiers to have rising response at either bass (low frequencies) or treble (high frequencies) to make up for losses in microphones or speakers. Also, many complete hi-fi amplifiers have adjustable compensators (called tone controls) to provide the user with a way of changing the bandwidth to suit himself.

It's not enough, therefore, merely to design and build amplifiers that are "flat" over the audible range. **Audio technicians should know what circuit elements limit bandwidth, and the two general ways of extending bandwidth.**

Circuits That Restrict Bandwidth

Low-pass filters

Figure 1 illustrates two kinds of "low-pass' filters. One is an RC (resistance/capacitance) type, and the other is RL (resistance/inductance). In TV circuits, a low-pass filter of certain characteristics is called an "integrator".

Generally, capacitors pass high frequencies, inductors pass low frequencies, and resistors affect all frequencies the same.

A capacitor connected from ground to the collector of a transistor (or the plate of a tube) is half of an RC low-pass filter. The resistance is the internal resistance of the transistor (or tube), as shown in Figure 1C. Learn to look for such "hidden" components in audio circuits.

Exactly where this HF rolloff begins depends on the values of resistance and capacitance (or resistance and inductance). Also, to a lesser extent, the exact curve depends on the impedance at the input and the impedance at the output of the filter. For example, don't assume that a circuit such as Figure 1A **always** attenuates the high end of the audio band. It might be there to minimize RF detection, or to eliminate the extra

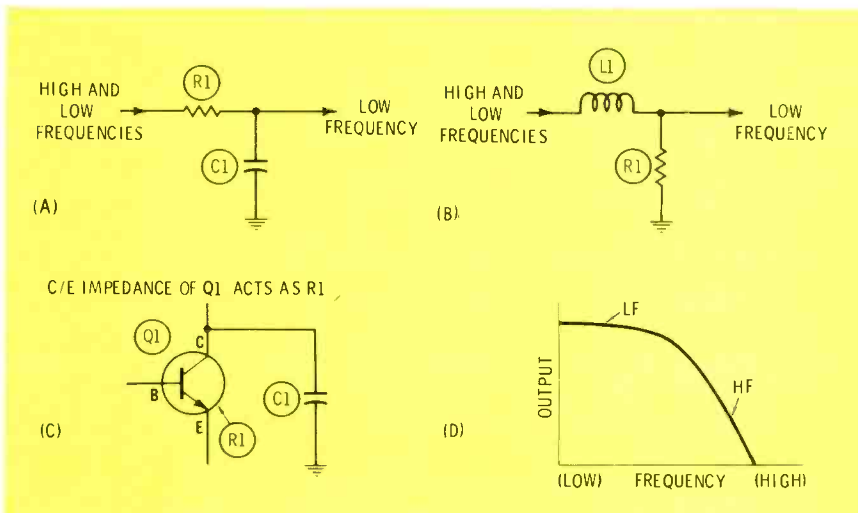


Fig. 1 Low-pass filters impede the passage of high frequencies more than low frequencies. **(A)** Capacitors decrease in capacitive reactance as the frequency is increased. Therefore, the voltage divider R1/C1 gives more loss at high frequencies. **(B)** Inductors increase in inductive reactance as the frequency is increased. Therefore, the voltage divider L1/R1 gives more loss at high frequencies. **(C)** A transistor acts as a signal voltage in series with the C/E resistance, so this impedance and C1 form a low-pass filter similar to that of Figure 1A. **(D)** This is the approximate curve produced by these low-pass filters.

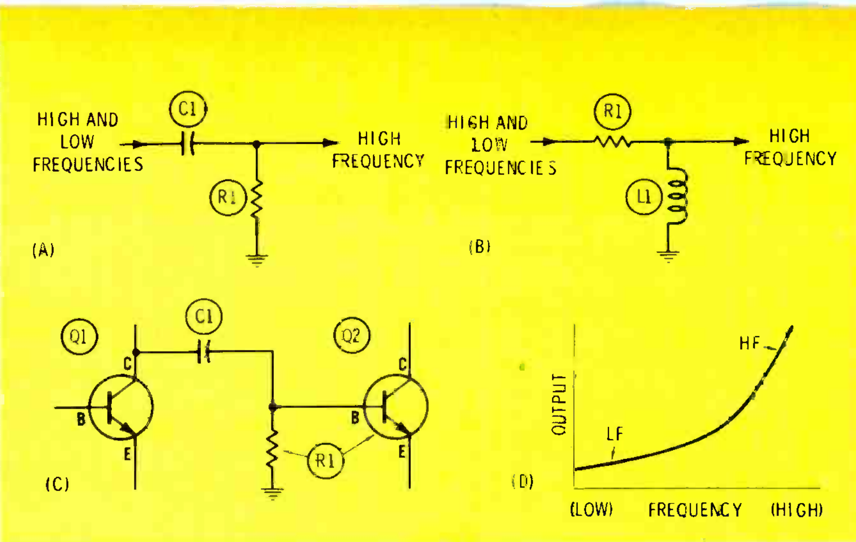


Fig. 2 High-pass filters impede the passage of low frequencies more than the high frequencies. **(A)** The capacitive reactance of C1 increases as the frequency is reduced, and the voltage divider C1/R1 gives a higher attenuation at low frequencies. **(B)** Inductors decrease inductive reactance as the frequency is decreased. R1/L1 acts as a voltage divider to decrease the low frequencies. **(C)** Input impedance of a transistor must be figured in parallel with any base resistors when calculating the frequency response of the coupling network, C1/R1. **(D)** These high-pass filters can give a curve similar to this one.

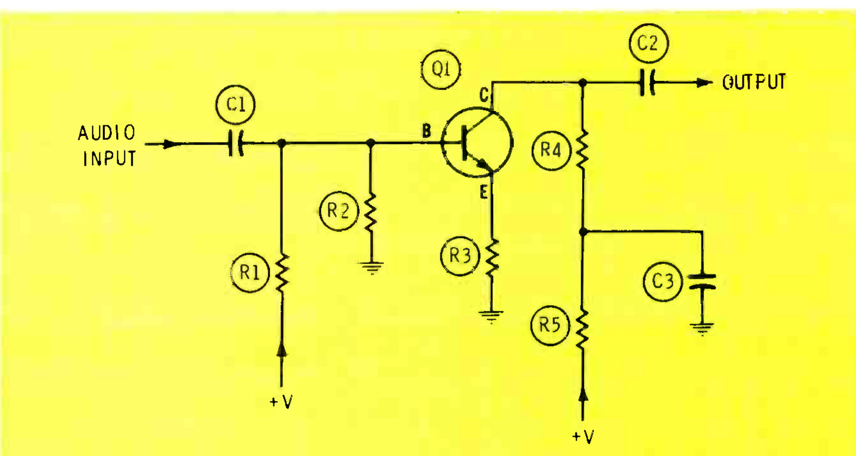


Fig. 3 At commonly-used collector loads, transistors produce higher gain with higher value collector resistances. A bass increase is obtained, when C3 bypasses all frequencies except low frequencies, because the collector load is R4 plus R5 at low frequencies, and is R4 alone at high frequencies.

signals of an FM/stereo program, which are above audible range.

High-pass filters

Two circuits and a hidden example of low-pass RC and RL filters are given in Figure 2. The basic filters are just the reverse of the low-pass ones.

In Figure 2C, the total impedance representing R1 is not readily apparent. Of course, the total of any discrete resistors at the base can be calculated easily. However, the input resistance of Q2 might be any value from 1500 ohms to 47K ohms, depending on the exact circuit. That's the reason so many transistor audio stages have coupling capacitors in the microfarad range, compared to a fraction of a microfarad for tubes.

Another high-pass filter that's even less apparent involves the iron-cored output transformer used with **all** tube-equipped amplifiers and a few solid-state ones. The circuit is a disguised variation of Figure 2B, where R1 is the plate resistance of the tube or tubes, and L1 is the output transformer, with the load of the speaker across L1. In actual amplifiers, the decreasing impedance of the output transformer at low frequencies is detrimental only below about 100 Hz for small, cheap transformers or 40 Hz for hi-fi transformers.

Incidentally, a high-pass filter of certain characteristics is known as a "differentiator", when used in the horizontal AFC of a TV set.

Comments

Although we will not give many exact figures at this time, it's true that a single-state low-pass filter (Figure 1A) **cannot** attenuate the high frequencies more than 50% each time the frequency is **doubled.** In similar manner, the high-pass circuit of Figure 2A **cannot** attenuate the low frequencies more than 50% each time the frequency is **halved.**

These truths are easier stated if we shift to decibels and octaves. Some musical terms have found their way into use in the audio field. Most experienced audio techs and their customers know that "bass" (pronounced base) is low frequencies, and "treble" refers to high audio frequencies.

In music, an octave is double or half the frequency. For example, an A at 880 Hz is one octave above middle A of 440 Hz. And A-220 is one octave below A-440.

A decibel is not restricted to any specific voltage; a decibel is a **ratio.** If a signal voltage increases by 11%, that is a change of +1 dB. Or if it decreases by 11%, it is -1 dB. Other handy figures to remember are: doubling a voltage represents +6 dB; and reducing it to half makes it -6 dB.

After adding these terms, we can say a single-stage low-pass filter **cannot** produce more than -6 dB per octave in the treble, and single-stage high-pass filter **cannot** attenuate the bass more than -6 dB per octave.

Amplifiers have many "filters"

By now, we should realize that multi-stage amplifiers have **many** high-pass and low-pass filters, both visible and hidden, all restricting

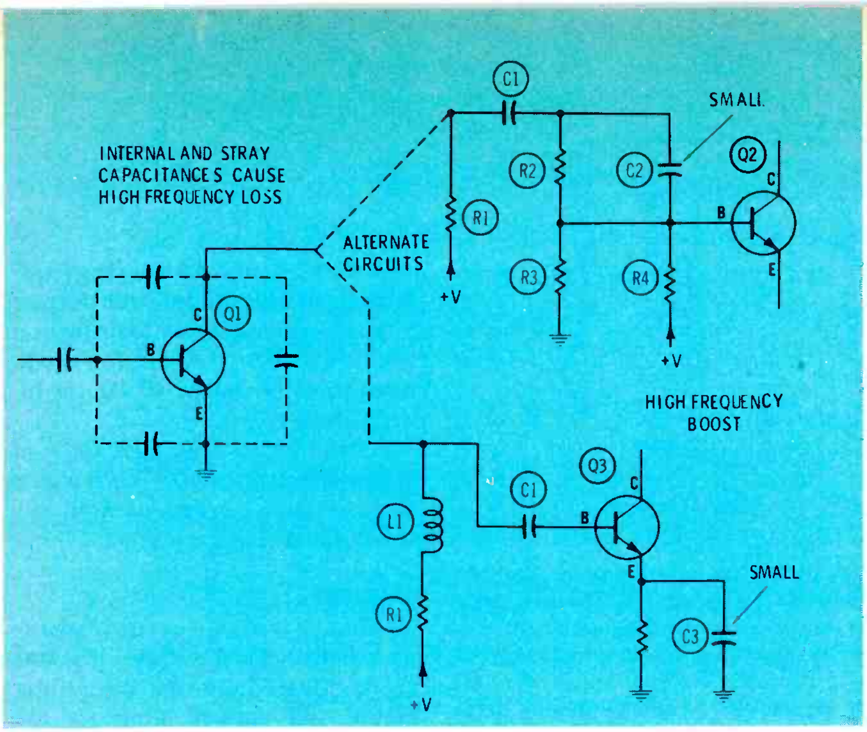


Fig. 4 Internal capacitances inside transistors and stray capacitances of circuit wiring cause loss of high frequencies by forming hidden low-pass filters. Three ways of giving high-frequency boost to flatten the response are shown here and explained in the text.

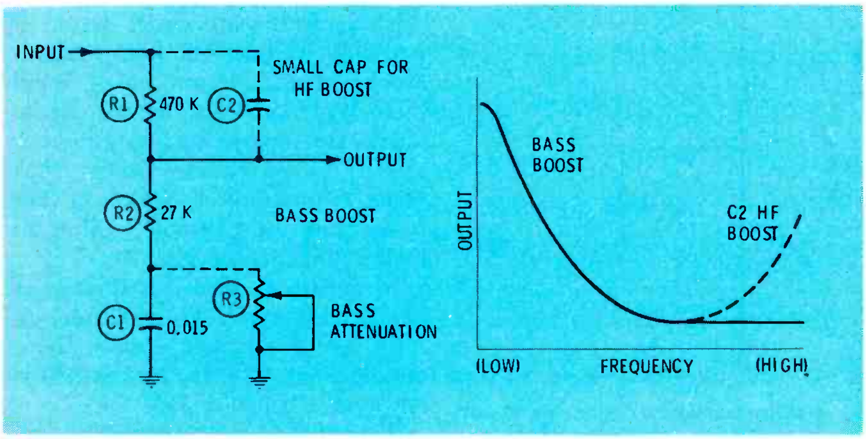


Fig. 5 One type of bass boost circuit works by attenuating middles and highs more than the low bass frequencies. It is a modified low-pass filter, with R1/C1 the usual components, and with R2 added to flatten the response at the middles and highs to prevent the loss of all treble. The capacitive reactance of C1 rises at low frequencies so most of the bass goes through. But at the middle and high frequencies C1 is nearly a short circuit, and the output there is determined by the R1/R2 voltage divider (R2 divided by the sum of R1 and R2). Incidentally, treble boost can be added easily by paralleling R1 with a small capacitor. This gives a direct path for the highs, bypassing the voltage divider.

the ideal flat response curve.

Frequency Compensation

If unwanted filters can restrict the bandwidth, then other opposite-action filters should be able to broaden the response.

Low-frequency compensation

The coupling capacitors, C1 and C2 of Figure 3, attenuate the low audio frequencies. If C3 were a large electrolytic, say 40 microfarad, R5 and C3 would be a B+ supply filter system, reducing hum and motorboating. But if C3 is made a smaller value, the low bass frequencies are increased in amplitude. The reason is that transistors have more gain with higher collector resistances (at least up to a point). C3 is chosen to be a short across R5 at treble and middle frequencies. Therefore, the collector load is the sum of R4 and R5 at low frequencies, but is only the value of R4 at all higher frequencies, thus giving less gain. If the values of R4, R5, and C3 are selected carefully, the overall bass response can be extended as far as desired.

High-frequency compensation

As shown in Figure 4, a transistor has three different internal capacitances. The B/E and C/E capacitances in conjunction with resistances of the circuit form low-pass filters. However, with most transistors this is of little consequence in the audio band. The C/B capacitance has a larger effect, because it is not only part of a low-pass filter, but gives negative feedback (Miller Effect) at treble frequencies.

This loss of treble response can be corrected by adding high-frequency boost in the next stage (Figure 4). The alternate circuit at the top has a modified high-pass filter at the base of Q2. C2 passes full-strength high treble from C1 to the base of Q2. Then **all** frequencies are attenuated by a voltage divider consisting of R2 versus the value of R3 and R4 in parallel, before they also are applied to the base of Q2. Therefore, the amount of treble boost is determined by the attenuation of this voltage divider.

Two kinds of HF boost are used in the alternate circuit at the bottom in Figure 4. The collector load impedance of Q1 is increased at treble frequencies by the addition of L1, thus giving more high-frequency gain. Also, the emitter of Q3 is bypassed by a small capacitance. We'll explain this effect later.

Effects of impedance

In connection with stray and internal transistor capacitances, and their effects on high-frequency response, we must add that the circuit resistances play a large part in how serious the rolloff of high frequencies will be.

Figure 1A shows that capaci-

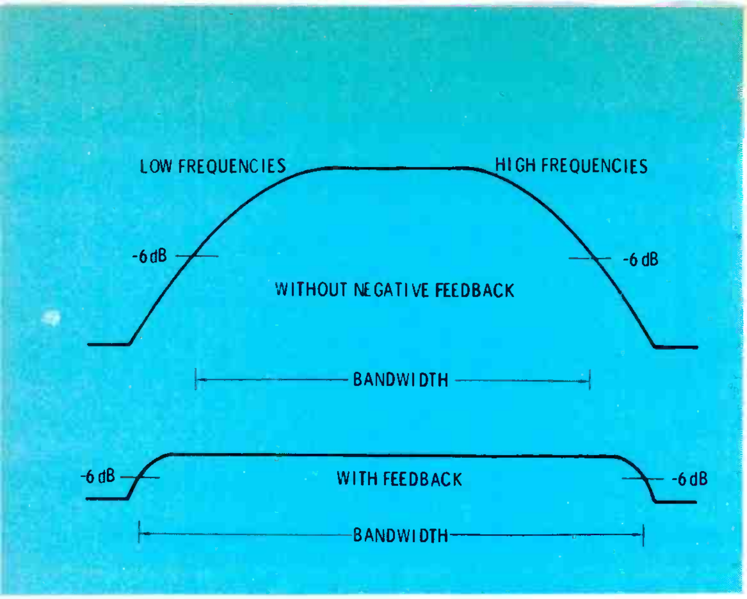


Fig. 6 The frequency response curve (Bode plot) at the top shows the possible bandwidth of an amplifier. Application of negative feedback (bottom curve) reduces the amplitude more at the high part of the curve, thus extending the bandwidth at the 6 dB point more than 25%. Also, the flat part of the curve is more than doubled.

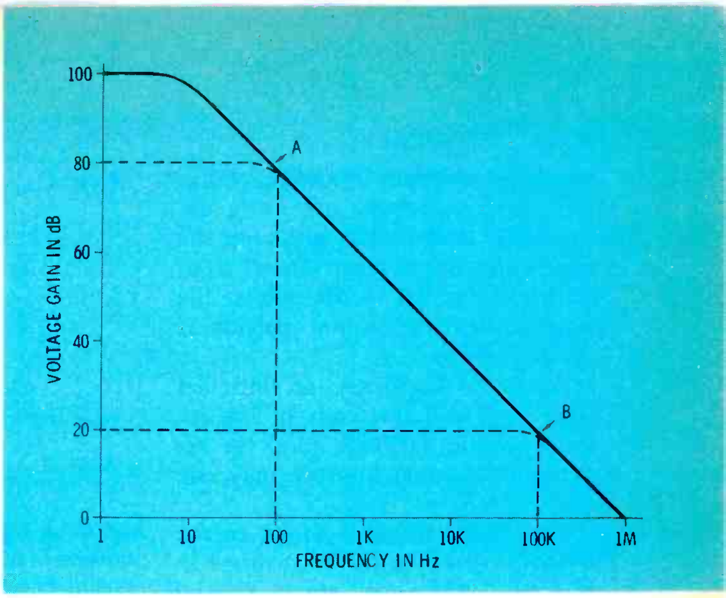


Fig. 7 Operational-amplifiers (op-amps) are designed to give a linear decrease of gain from negative feedback. A side effect is that increasing the feedback widens the high-frequency response. Feedback of 20 dB moved the cutoff out to 100 Hz, and 80 dB feedback flattened the response to 100 KHz. Most amplifiers have a much wider bandwidth before feedback is added; op-amps are unique devices.

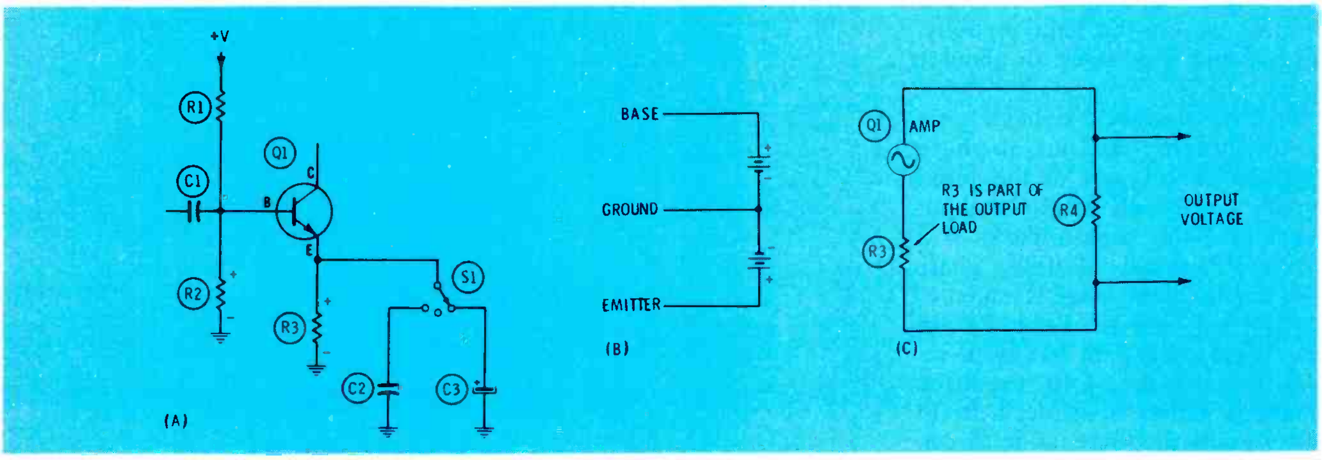


Fig. 8 A positive-going signal at the base in **(A)** produces a positive-going signal at the emitter, when R3 is not bypassed. Because transistor bias is base-to-emitter, any emitter-to-ground AC voltage must be subtracted from the base-to-ground AC signal to find the effective input signal **(B)**. Any AC emitter voltage reduces the gain by degeneration.

The gain can be increased to normal by bypassing R3 with a large capacitor, C3. Or, the gain at high frequencies only can be increased by bypassing R3 with a small capacitor (C2). Diagram C shows that the emitter resistor is a part of the output load, and any AC voltage across R3 is subtracted from the normal output signal, reducing the gain.

tances and resistances of low-pass filters are equally important in shaping a response curve. Because most of the circuit capacitances are fixed and not subject to juggling, it follows that the resistances which determine the circuit impedance should be reduced in value to extend the HF response.

Notice that plate or collector resistors in video amplifiers have much lower values than those in audio amplifiers (and those lower resistors reduce the gain from the maximum that's possible).

Bass and treble boost

A simple type of bass boost (with options for bass control and treble boost) is shown in Figure 5, along with an explanation of how it operates. Essentially, it is a voltage divider which varies with frequency, giving the most attenuation to middle and treble frequencies.

Additional tone-control and loudness-control circuits will be covered in a later article.

Compensation By Negative Feedback

Negative feedback flattens the response curve and extends the bandwidth (Figure 6). In addition, distortion is reduced; but that's another story. The price of feedback is a loss of gain.

In the graphs of Figure 6, the cut-off point is shown as -6 dB, which is common practice. However, hi-fi standards are more demanding. Notice that, although the bandwidth is widened from feedback even at the -6 dB points, the improvement of the flat portion is much greater.

Also, the improvement flattened both high and low ends of the response curve (a Bode plot). A reactive filter could improve only one end.

Another example is found in the behavior of op-amps, as graphed in Figure 7. Op-amps are a special case because they have tremendously high gain at DC, and are designed to rolloff **all** audio frequencies at -6 dB per octave. (This unique frequency response is necessary to prevent instability when there's a large amount of negative feedback.) Increased feedback widens the bandwidth, so when feedback lowers the gain to unity, the response is good up to about 1 MHz.

Negative feedback reduces gain by introducing an out-of-phase signal to cancel part of the input signal. Assume an amplifier input signal of 1-volt peak-to-peak. If a .9-volt PP signal of 180° phase from a subsequent stage is added to it, the result will be .1-volt PP. In other words, the gain has been reduced by a factor of 10. Feedback usually is expressed in decibels; in this example the feedback is 20 dB.

Now, suppose the internal gain of the amplifier increased. The output voltage would attempt to increase by the same amount, and also send more negative-feedback signal back to the input (which has not changed). However, an increased feedback signal would cancel more of the input. So, the net result would be a very-slight increase of output signal amplitude. Minor peaks or valleys in the response curve are smoothed in the same way.

If the amplifier has a loss of gain **only** at high treble frequencies, the feedback of **those** frequencies is decreased, resulting in less cancellation of the input signal, and driving the amplifier more at that end of the audio band. Therefore, the output with feedback is down only slightly at the treble.

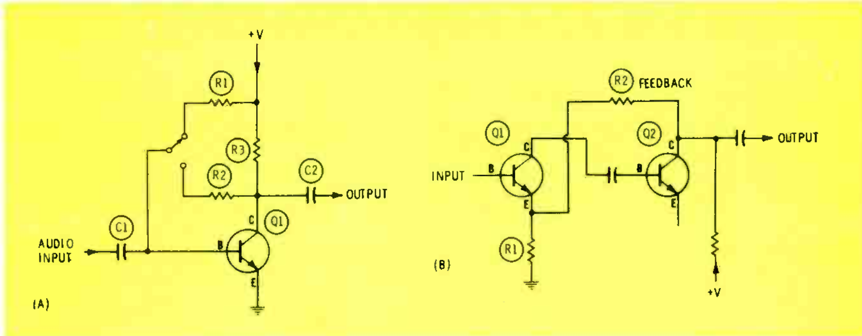


Fig. 9 A base-bias resistor also can supply some negative feedback, if it is connected base-to-collector, rather than base-to-B+ **(A)**. A different value of resistor is required to provide optimum bias for each way. **(B)** Feedback over two stages is even more effective.

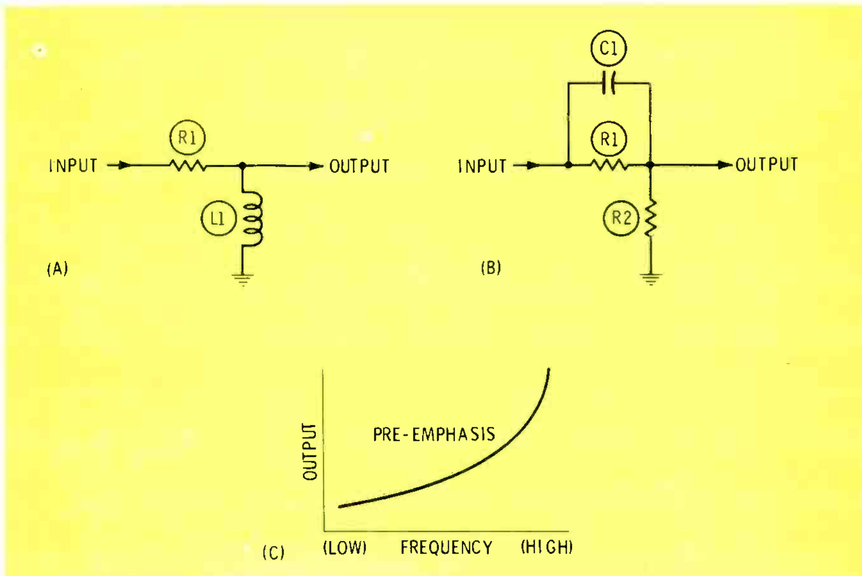


Fig. 10 In FM stations, a high-pass filter, such as **(A)** or **(B)**, produces a precise amount of high-frequency boost **(C)**.

Did you notice that the negative feedback partially corrected both an increase and a decrease of gain? What's more, negative feedback minimizes gain changes from other defects, such as drifting bias or a variation of tube emission, and many others.

However, there is a limit to the amount of correction. As the feedback is "used up" to correct the gain and response, less feedback remains. When the feedback is weak, the correction is less; and if the feedback becomes zero, no correction is possible. Negative feedback is one variety of closed loop, and no closed loop can give 100% correction. However, a high loop gain permits a high degree of correction.

Some Feedback Circuits

Negative-feedback circuits are found in many different forms. Probably the most simple is called "degeneration", and often consists of nothing more than an emitter resistor (or cathode resistor with tubes) that is not bypassed. Let's analyze what happens when the selector switch of Figure 8A is set to the center position so no capacitor is connected. Suppose the positive peak of a sine wave reaches the base of Q1, which is a NPN type. The increased forward bias produces more C/E current, increasing the voltage drop across R3, the emitter resistor. In other words, a positive-going base signal produces a positive-going emitter signal (they are in phase).

Next, visualize this as a plus sign at the base, and a plus sign at the emitter (Figure 8A). When these voltages are drawn as though they were batteries (Figure 8B), it's clear that **any** emitter-to-ground voltage (either DC or AC) is **subtracted** from the base-to-ground voltage (at least so far as the transistor is concerned) to produce the instantaneous bias.

Assume a base-to-ground AC signal voltage of 1-volt PP, and an emitter-to-ground AC signal of .4-volt PP. Subtract the emitter signal (.4 volt) from the base signal (1 volt), and that gives a true input signal of only .6-volt PP. So, the stage only has 60% of the gain it would have without emitter degeneration.

A large emitter bypass capacitor (one whose capacitive reactance is only a fraction of the value of R3 in Figure 8A) removes the degeneration, restoring full gain.

On the other hand, a small value for C2, removes the degeneration **only** at high frequencies, thus giving a treble boost.

One rule for feedback

Amplifier frequency response can be changed as desired by including reactive filters (such as high-pass and low-pass) in the negative feedback or degeneration. In such cases, the **modified frequency response of the amplifier will be exactly opposite the frequency response of the filters used in the feedback.**

For example, if the feedback incorporates a low-pass filter (that reduces the treble), and the amplifier without feedback has flat response, then the amplifier with feedback will have rising treble response.

Or, feedback having a high-pass action (low-frequency attenuation) gives bass boost when applied to a flat amplifier.

Part of the collector load

An unbypassed emitter resistor reduces the gain in yet another way, because it actually is a part of the collector load and subtracts from the output signal.

Figure 8C omits the ground to show the C/E load in two parts. If R3 and R4 are equal in value, the useful output from R4 is only 50% of that possible wihout emitter degeneration. Lower values of R4, collector load, and higher emitter resistances (R3) cause more loss of gain.

Emitter bias?

Although there are several valid similarities between the actions of an emitter resistor with a transistor and a cathode resistor with a tube, one important distinction needs to be made.

A cathode resistor usually is the **sole** bias source for a tube; it limits the amount of plate/cathode current. But, **a class-A transistor stage cannot amplify with an emitter resistor and no DC forward bias at the base.**

Bypassed emitter resistors stabilize against temperature effects. Unbypassed emitter resistors do that too, plus giving degeneration to help stabilize the AC gain. That's why they properly are called "emitter stabilization resistors", and not bias resistors.

But keep this in proper perspective: an emitter resistor is not the **source** of forward bias, but it definitely **affects** the bias (true bias is emitter voltage subtracted from base voltage). Remember, **bipolar transistor bias is base-to-emitter voltage, not base-to-ground.**

Single-stage feedback

Previously, we stated that negative feedback voltage must be out-of-phase with the main signal at the point of insertion. Therefore, the only negative feedback possible in a single-stage amplifier (transistor, FET, or triode tube) is between the input and the inverted output elements (base and collector for transistors).

R1 in Figure 9A furnishes DC forward bias to the base, without any AC feedback. When R2 is switched in, it biases the base, but also gives negative feedback, both AC and DC.

The circuit with R2 from collector to base is not very flexible, because the bias required takes precedent over the feedback. But it's a very useful circuit, for it stabilizes against heat changes, and makes thermal runaway impossible. Obviously, this circuit can be used only with devices that require the same polarity of DC voltage at input and output elements.

Two-stage feedback

Feedback over two stages increases the loop gain, thus giving the possibility of more feedback and better performance.

The circuit most often used (Figure 9B) has feedback from the second collector to the previous emitter (another possibility is feedback from the second emitter to the first base).

Many tape and magnetic-phono pre-amps use the basic idea of Figure 9B, but insert reactive RC filters in with R2 to boost the bass or treble.

Reactive Networks Change Frequency Response

Several situations have been mentioned already where a non-flat response curve is necessary. There are many more, and the majority incorporate reactive RC or RL filters to shape the response curves.

FM pre-emphasis

The principle behind FM pre-emphasis and de-emphasis is a good example of the benefits of modifying frequency response.

Noise is distributed about equally over the audio spectrum, but the high-frequency portion is more objectionable to listeners. That's why most noise-reducing systems attempt to reduce the high-frequencies in the noise.

In the audio amplifiers at the FM station, a high-pass filter circuit (perhaps similar to Figure 10A or 10B) gives a certain amount of high-frequency boost (Figure 10C). Then, following demodulation in the receiver, a simple low-pass de-emphasis filter (Figure 11) rolls off the highs to restore the original flat response.

Notice that the system minimizes **only** the noise in the propagation path and the receiver, because this noise is not pre-emphasized, but goes only through the low-pass filter. The system has no effect at all on any noise that might be mixed with the original audio signal source at the station.

Crossover networks

It's not desirable to feed expensive audio power to a speaker that will ignore it. So, most multiple-speaker systems have some kind of **crossover** network to separate the frequencies, feeding lows to the woofer, and highs to the tweeter.

As shown in Figure 12, the most simple crossover is a capacitor in series with the tweeter, and an inductor in series with the woofer. Better results are obtained if a suitable capacitor also parallels the woofer, and an inductor parallels the tweeter. Elaborate systems have two LC networks in cascade for each speaker; these give rolloffs of 12dB-per-octave.

Comments

Many of the techniques applied to widen the bandwidth also reduce the amplifier voltage gain. These include negative feedback, or degeneration, low-value resistors, and most reactive filters. Of course, such things as wrong bias, low supply voltages, and variable volume controls will affect the gain without changing bandwidth significantly.

One excellent method of flattening bandwidth is to combine negative feedback with reactive-network filters. □

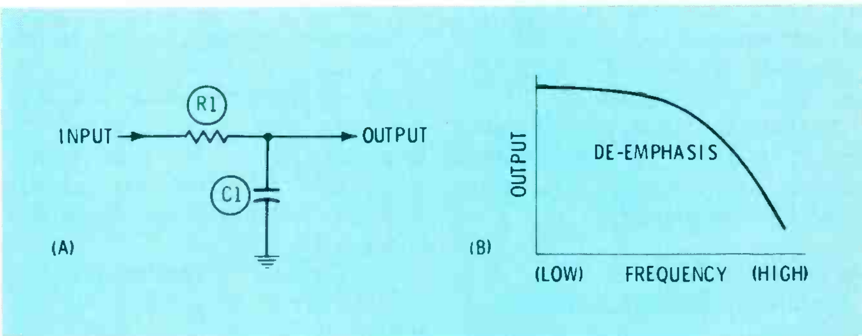


Fig. 11 A low-pass filter **(A)** in the FM receiver restores the flat frequency response of the music. However, any noise reaching the receiver is made less objectionable by the rolloff action **(B)** of the de-emphasis filter. This improves the signal-to-noise ratio.

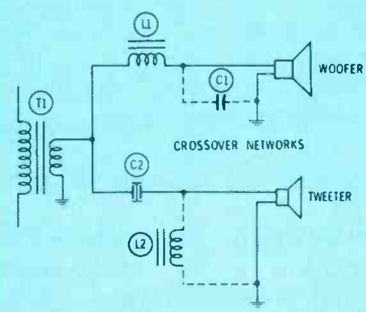
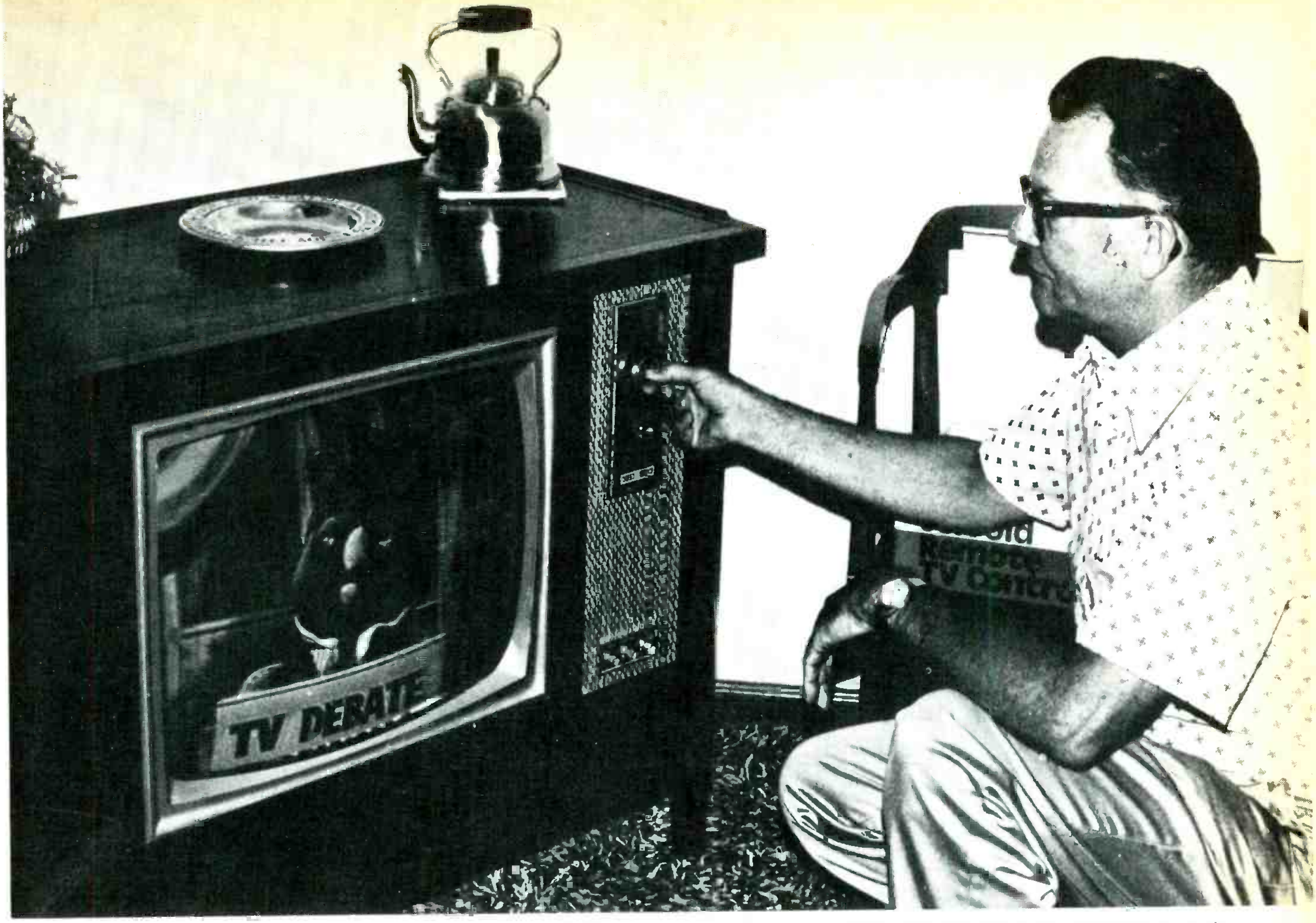


Fig. 12 Crossover networks improve the frequency response and power-handling ability of multiple speaker systems. Non-polarized capacitor C2 removes the bass tones from the tweeter (some crossovers include L2 to give a sharper cutoff), and inductor L1 filters out most of the treble from the woofer (C1 across the woofer helps the filtering).



Frank Presson's first step in selling a Jerrold universal TV remote control is to repair the TV receiver, making sure it works properly on all channels.

Extra income from remote controls

Everyone needs additional income to offset inflation. Here's an example of a service dealer who increases his income by demonstrating and selling remote controls during service calls. Study the techniques, and perhaps you too will be inspired to sell some type of accessory.

By Bert Wolf, General Manager, Jerrold DSD Division

Frank Presson of Presson TV Service in Wichita, Kansas makes eight to ten service calls a day. His son, Gary, is the bench man who repairs the sets his father brings in, plus one or two per day that customers drop off at the shop.

The business is operated out of Frank's home, using just one service truck, and a modest amount of test equipment. Presson has been in the business since TV started, and enjoys an excellent reputation, so he doesn't have to spend time and money searching for customers. Frank and Gary have all the business they can handle. That's why the phone number is unlisted!

So far, Presson TV appears to be typical of a small—but successful—service operation. However, one unique difference is that Frank, for the past year, has sold two or three Jerrold TV Remote Controls each week, making an extra profit of $100.

Of course, Frank doesn't get this bonanza by mumbling, "You wouldn't wanna buy a remote control, would you?" No, the secret is the in-home demonstrations.

Demonstrate, Then Sell

After his customers see how the remote control works, and try it for themselves, more than half of them buy the unit for $99.95.

Frank doesn't try to sell remote controls on every service call. He picks his spots carefully, choosing people he feels can afford the unit and are likely to buy it. Of the 40 or 50 calls he makes a week, he demonstrates to only five or six customers.

Presson carries remote-control units in his service truck. His first step in selling remote controls is to repair the TV set as quickly and inexpensively as possible. A very fast and competent trouble-diagnostician, Frank repairs a surprising number of sets in the home—not just tube changes, but defective resistors, capacitors, etc. He charges $12.50 for a service call, plus parts. Whereas some service organizations average five to seven tubes per call, Presson averages less than two tubes per call. His customers trust him and he lives up to that trust.

Once the set is fixed, he shows the customer that it works. Then, he says something similar to this: "I'd like to show you something new; it's the slickest thing they've come out with since the invention of color TV. Let me show you how it works." Frank displays the remote-control box, and usually the customer asks what it is and how much it costs. However, Frank sidesteps a direct answer about price.

"If I told them the remote control cost $100, I'd lose the sale right there," he says. "So, I just put them off, saying I want to demonstrate it first."

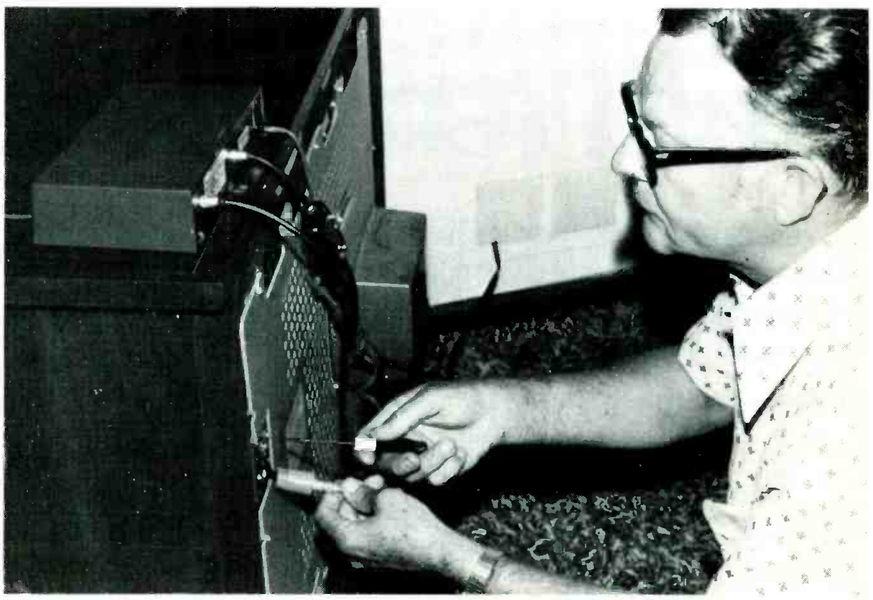
As he talks to the customer, Frank hooks the unit to the antenna terminals of the TV receiver (he carries pre-wired cables), and in about a minute the installation is complete.

First, Frank shows how to use the remote to turn on and off the TV power, then how easy it is to go from one channel to another, without bothering with the ones in between. Finally, he shows the fine-tuning action.

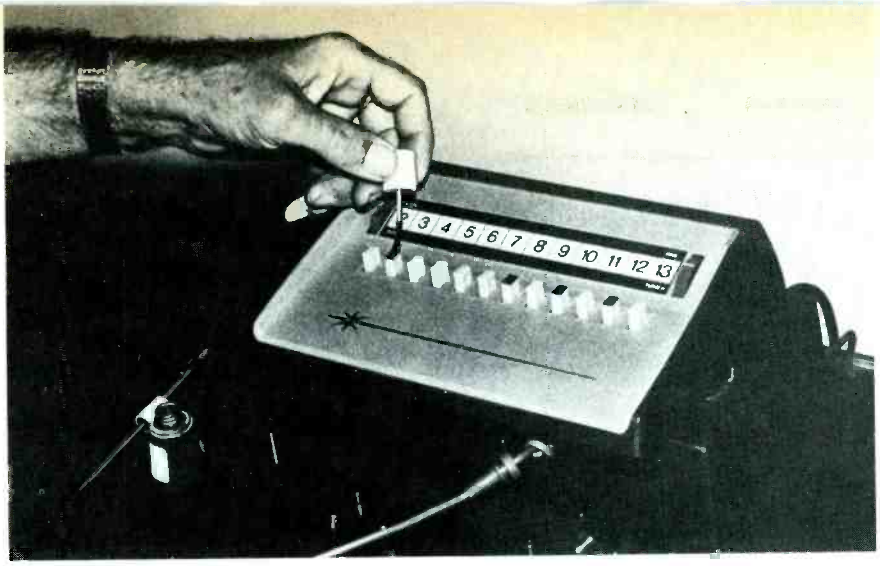
The most important part of the demonstration is to let the **customer** operate the controls. Frank is patient while the customer pushes buttons, because most people are fascinated by the remote control. Also, the more they play with the controls, the more they want to own the unit.

While the customer is operating the remote control, Frank tells them some of the not-so-obvious sales features. "This remote control will pay for itself within a few years, because it saves a lot of wear-and-tear on the TV set."

"Notice that the TV channel knob doesn't move when you change channels with the remote buttons. This means that you won't have to call me in as often to clean or repair your tuner. I know you worry about the kids spinning the tuner around and changing channels all the time. Well, they can push these buttons all they want to and it won't hurt the TV. It won't affect the operation of the TV set any more than if someone at the studio switches from one camera to another. All it does is change the signal into the TV set."



To demonstrate the remote control, Frank connects the converter between the antenna downlead and the terminals on the receiver, and plugs the receiver's power cable into the converter. That's all the wiring.



Nail polish applied to the buttons of the channels in use help the customers (especially those with poor vision) to find the stations easily.

This is one of the customers of Presson TV, enjoying the remote control.

"And the remote control itself is very rugged. When you decide to retire this set, you can hook the remote control up to a new set in a few minutes. The remote control will outlast two or three TV sets."

If the customer tells of some acquaintance that has a remote control, Presson says, "But it's probably the old type that wears out tuners." He goes on to explain about the motor drive which operates only in one direction, requiring more turning to find the desired channel. Also, the expense of repairing the motor-drive types often is excessive, and the machinery can't be transferred to another TV.

By this time, the customer is usually very eager to own the remote control and Frank is ready to discuss price. Frank tells the customer that the unit normally sells for $99.95 plus installation. However, if they make a buying decision right away, Frank offers to do the installation free.

Installation

Since the unit already is attached and operating by the time the sale is made, you might think that the installation is complete. But Presson doesn't believe in taking shortcuts. He takes great pains to be sure the customer gets maximum satisfaction from his new remote control.

First, he asks where the remote control customarily will be used, then he plans how to run the 25' control cable. The wire has a small diameter and usually is easy to hide. Sometimes Frank runs the cable under the rug, along the baseboard, or over door moldings. In rare cases, he drills holes in the floor, routing the cable through the basement and up beside a couch or easy chair.

Next, Frank mounts the converter. For the demonstration, the converter was laid on top of the TV set. But, as a permanent installation, he hangs the converter on the TV back, using the bracket supplied. For portables, he sometimes mounts the unit in an out-of-the-way place several feet from the TV receiver, using a longer output cable.

Finally, as an extra touch, Frank uses nail polish to mark the channels available in Wichita. This makes it easy—especially for older people—to locate the right button.

Rentals

Recently, Frank found a new way of profiting from remote controls: rentals. Where there's a sick child or an invalid in a home, he offers to rent a remote-control unit for only $7.50 per month. To a busy housewife, the unit can be a blessing, for she no longer is called into the sickroom just to change a channel or turn on the TV.

Presson usually rents with an option to buy, and most rentals lead to sales. Viewers enjoy using the remote control so much they are reluctant to give it up.

Remarks

If you want to know more about the Jerrold Model TRC-12 remote control, refer to "Reports From The Test Lab" starting on page 25 of ELECTRONIC SERVICING for January, 1975. □

Medical Electronics Notebook, Part 3

CARDIAC PACEMAKERS

By Edward J. Bukstein

The following article is reprinted by special permission of Howard W. Sams & Co., from "Introduction To Biomedical Electronics", book number 21005.

The ability to control heart rate by means of electrical stimulation has given the cardiologist an important tool for the management of patients suffering from heart block. Battery-operated pacers, both temporary and implantable, are available with characteristics suitable for various clinical situations. Pulse rate and stimulating current are adjustable and can be selected according to the circumstances of each individual case.

Conduction Defects

The sinoatrial (SA) node is a region of specialized tissue in the wall of the right atrium. This is the natural pacemaker of the heart; it emits a series of electrical pulses, each of which triggers a cycle of cardiac activity.

As the pulse from the SA node spreads across the atrial walls, it initiates atrial contraction to pump blood into the ventricles. The pulse is then picked up by another area of specialized tissue known as the atrioventricular (AV) node. From here, the pulse is conducted through special pathways of conductive tissue to the ventricles (Fig. 12-1). While the pulse is passing through the conductive tissues to the ventricular walls, atrial contraction moves the blood into the ventricles. Therefore, by the time ventricular contraction begins, the blood is already in the ventricles and ready to be pumped out into the lungs and the circulatory system. After each contraction, the heart relaxes, the atria refill with blood, and another pulse is generated in the SA node to start the next cycle of cardiac activity.

If the conductive pathways to the ventricles are for any reason disrupted, atrial-generated pulses can no longer trigger ventricular activity, and ventricular contractions will no longer be synchronized with atrial activity. The atria will continue to beat at a normal rate, but the ventricles, deprived of the stimulating pulses, will assume an independent, unsynchronized rhythm. The ventricular rate, typically about 30 to 40 beats per minute, is referred to as an idioventricular rhythm. This low rate may produce a deficiency of cerebral blood flow with such symptoms as faintness, dizziness, or complete blackout. It is in situations of this type that the electronic pacemaker finds one of its most important applications. The pacemaker takes over the task of stimulating the ventricles at a normal rate, typically 70 beats per minute.

If the conduction pathways are completely blocked so that no pulses from the atrial region can reach the ventricles, the condition is known as *complete block*. In some patients, the conductive pathways function normally at times but become blocked at other times. This is known as an *intermittent block* and is another type of situation in which the use of an artificial pacemaker may be indicated.

Temporary Pacemaker

Temporary electrical pacing of the heart is employed in cases of heart block as a complication of myocardial infarction, for disturbances of atrioventricular conduction following cardiac surgery, in the initial operative stages for the implantation of a permanent pacemaker, and in the management of certain tachyarrhythmias. The temporary pacemaker is a small, battery-operated pulse generator, such as the one shown in Fig. 12-2. This unit will operate either in an asynchronous mode (pacing the heart at a fixed rate) or in the demand mode (pacing the heart only when the natural rate falls below the preset rate of the pacemaker). The rate is adjustable in the range of 50 to 150 pulses per minute, and stimulating current can be varied through a range of 0.1 to 20 milliamperes. The width (duration) of each pulse is 1.8 milliseconds.

The pulses from the pacemaker are applied to the heart through pacing leads, such as shown in Fig. 12-2. This is a transvenous endocardial electrode and is popular for temporary pacing because its insertion is accomplished with a simpler technique than that required for placement of myocardial electrodes. The endocardial electrode is introduced through a peripheral vein and is pushed along until its tip is within the ventricle of the heart. In the *bipolar* type of lead shown in Fig. 12-2, there are two electrodes: a platinum tip at the distal end of the lead and a platinum ring a short distance back from the tip. The tip and ring electrodes are

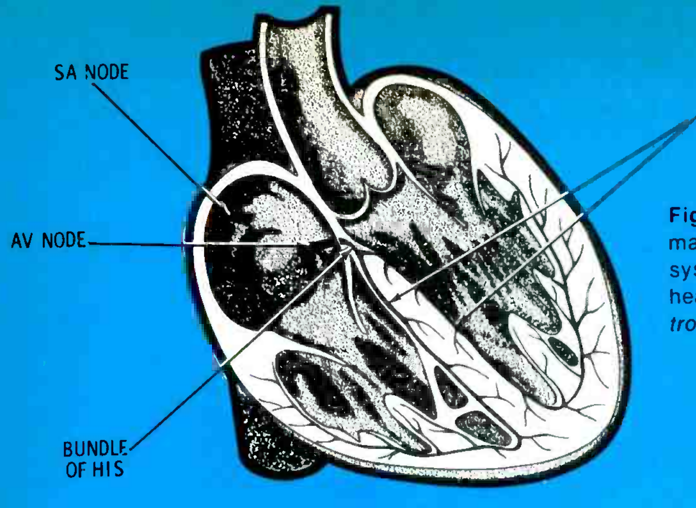


Fig. 12-1 Natural pacemaker and conduction system in the human heart. (*Courtesy Medtronic*).

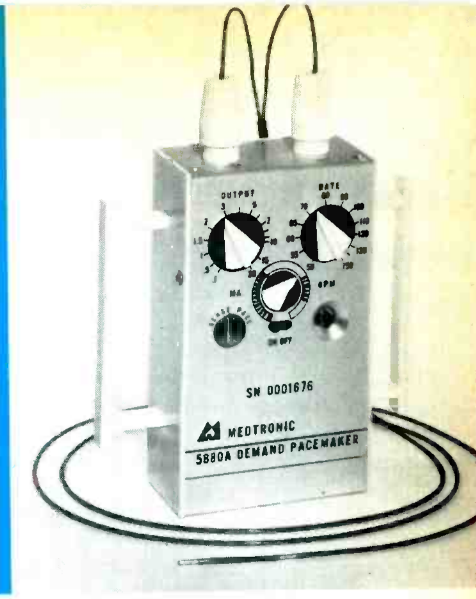


Fig. 12-2 Model 5880 Medtronic demand pacemaker. (*Courtesy Medtronic*).

connected to the pacemaker through two coil-spring conductors inside an insulating sleeve of silicone rubber.

When operating in the demand mode, the pacer in Fig. 12-2 is programmed from the R-wave potential (which it senses through the same lead used to stimulate the heart). Whenever it senses an R wave, the pacer resets its timing circuit for one cycle of operation. At a rate of 60 pulses per minute, for example, one cycle would be 1/60 minute or 1000 milliseconds. During the first 250 milliseconds after the timing circuit is reset, the pacer is in a refractory condition, and its sensing circuit is blocked. This prevents it from being reset a second time by the T wave. During the remaining 750 milliseconds of the cycle, the pacer is in a sensing mode and will respond to an R wave. If an R wave occurs during this interval, the timing circuit is reset for another cycle. If an R wave does not occur by the end of each 1000-millisecond cycle, the pacer will emit a stimulating pulse. The pacer thus remains "inactive" if the intrinsic R waves occur within 1000 milliseconds of each other (heart rate of at least 60 beats per minute), but emits stimulating pulses if the natural rate drops below 60 beats per minute. The timing cycle is illustrated in Fig. 12-3.

A *sense-pace* indicator in the form of a miniature meter (Fig. 12-2) provides an indication of pacer activity. Each time the pacer senses an R wave, the pointer momentarily deflects toward the left; each time the pacer emits a pulse, the pointer momentarily deflects toward the right. The sensing and pacing activity can therefore be quickly verified by observing the meter.

Implantable Pacemakers

Temporary pacers are employed for short-term applications, usually less than one week. When long-term pacing is required, an implantable instrument is employed. The implantable pacer is a miniaturized pulse generator encased in materials compatible with the body —epoxy, with a covering of silicone rubber, is a common type of casing. Some of the newer units are shielded by a housing of titanium to keep out interference that might affect the operation of the pacer. Such interference, for example, may be generated by microwave ovens, gasoline ignition systems, radar equipment, or diathermy units.

The pacer is implanted subcutaneously, either in the abdominal area or below the collarbone, as shown in Fig. 12-4, and leads from the pacer are connected directly to the heart. Either *endocardial* or *myocaridal* electrodes may be used. Endocardial electrodes are inserted transvenously into the heart; myocardial electrodes are attached to the myocardial wall.

Four general types of implantable pacers are currently in use. One of these is the *fixed-rate* (asynchronous) type and the other three are *demand* (synchronous) pacers. The characteristics of these pacemakers are described below.

Asynchronous Pacemaker

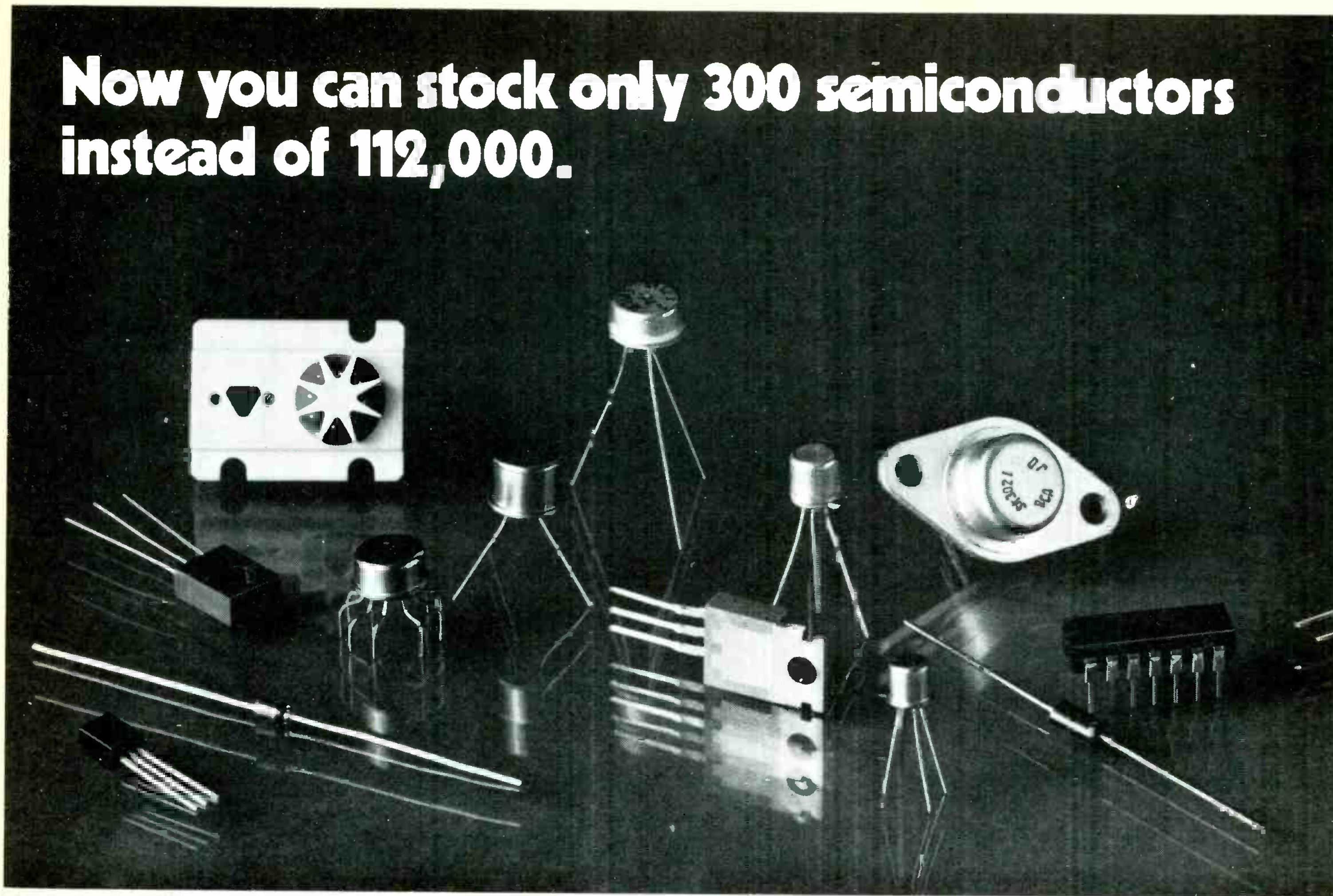
The fixed-rate pacer emits stimulating pulses at a rate of 70 pulses per minute (the pacer may be ordered for other rates in the range of 60 to 80 beats per minute).

This type of pacer is particularly suitable for older patients suffering from complete heart block. Because of its fixed rate, the pacer does not permit the patient's heart rate to increase with physical activity and workload. However, in these patients, physical activity is limited by other considerations.

R-Wave Triggered Pacemaker

The *synchronous* or *demand* pacer is more widely used than the fixed-rate type. The demand pacer contains a sensing circuit that responds to the electrical activity of the heart. As long as the natural rate of the heart remains above the preset rate of the pacer, the pacer remains quiescent. However, if the natural rate should drop below the instrument rate, the pacer will assume control of the heart. Synchronous pacers are particularly suitable for patients with intermittent heart block. The pacer remains quiescent until the heart block occurs and the ventricular rate tends to drop below normal; the pacer then takes over to maintain a normal rate.

The R-wave triggered pacer, also



known as an *R-wave synchronized* or a *synchronized standby* pacer, senses each depolarization of the ventricles and synchronizes its own pulse with this depolarization. The pacer pulse is thus emitted during the natural R wave, and therefore does not affect the heart rate. However, if a natural depolarization (R wave) does not occur within a preset interval of time, the pacer will spontaneously emit a pulse.

The design of the pacer is such that it remains refractory for a period of time after each emitted pulse. This refractory period prevents pacer response to a large-amplitude T wave or to other extraneous stimuli that may cause pacer-induced tachycardia. After the refractory period, the pacer returns to the sensing mode. If it does not detect an R wave before the end of a preset interval, the pacer emits a pulse and again becomes refractory.

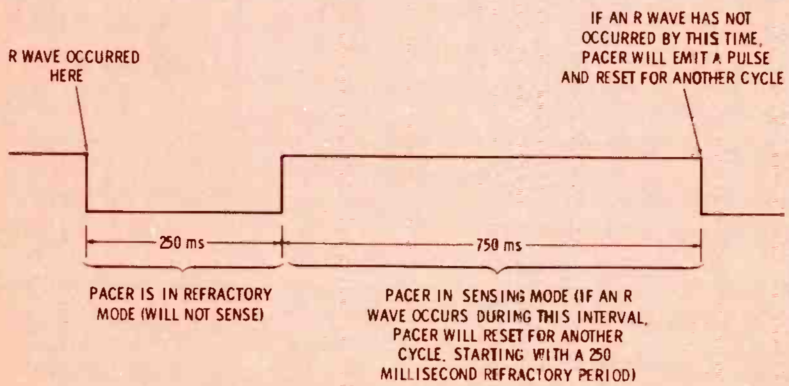


Fig. 12-3 Timing cycle of pacemaker.

R-Wave Inhibited Pacemaker

The R-wave inhibited pacer, also known as an *R-wave blocked* or a *blocked standby* pacer, also senses ventricular depolarization, but it responds by blocking itself so that no pulse is emitted. This inhibiting characteristic of the pacer prevents driving the heart in response to external interference. If a natural depolarization (R wave) does not occur within a preset interval of time, the pacer will emit a stimulating pulse.

Because the pacer does not emit pulses during intervals of normal heart activity, a method of testing the competency of the pacer is desirable. For this purpose, a magnetically operated switch is included within the pacer. When a magnet is placed on the patient's chest above the pacer, the magnetic switch is actuated. This converts the pacer to a fixed-rate mode of operation. The competency of the pacer is now verified by noting the effect on the patient's pulse rate or on an electrocardiogram. When the magnet is removed from the patient's chest, the pacer reverts to the demand mode of operation.

An implantable pacer of the inhibiting type is illustrated in Fig. 12-5. This pacer emits a stimulating pulse only if ventricular depolarization fails to occur within the standby period. The rate of the pacer is preset to 70 pulses per minute but is adjustable in the range of 50 to 120 pulses per minute. This adjustment is accomplished by inserting a Keith surgical needle through the rubber covering of the "nipple" protruding from the right of the case in Fig. 12-5. The triangular cross section of the needle mates with an opening in the shaft of a variable resistance. As the needle is turned, the resistance changes, and the rate of the pacer changes accordingly. Rate changes can be accomplished in this manner even after the pacer is

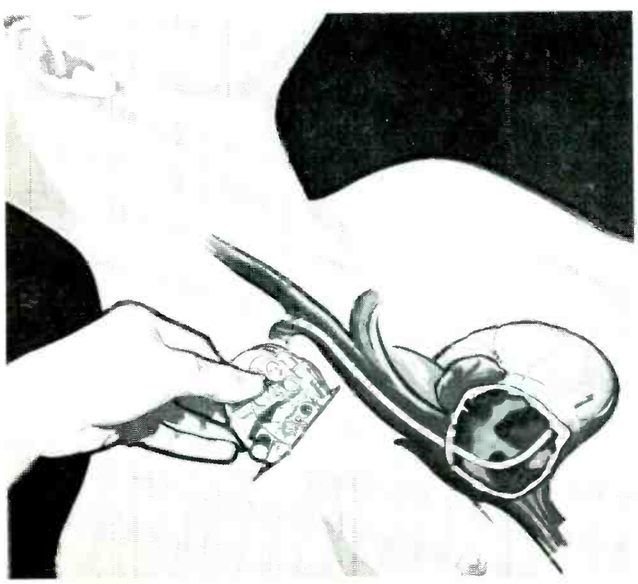


Fig. 12-4 Implanted pacemaker. (*Courtesy Medtronic*).

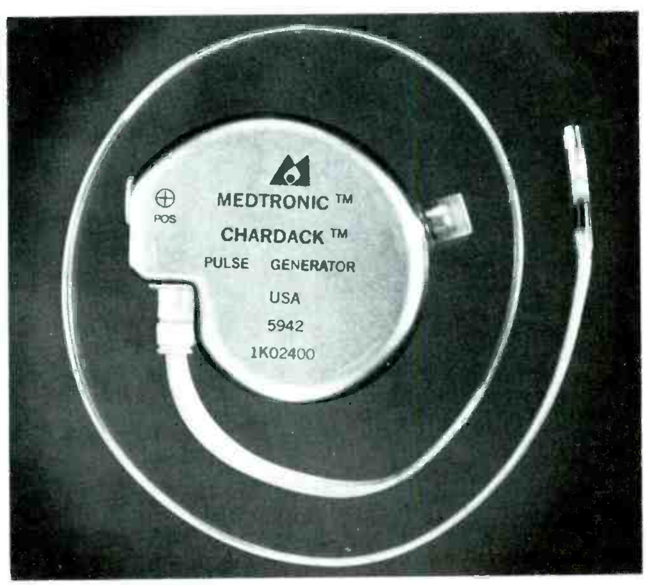


Fig. 12-5 Pacemaker of inhibiting type. (*Courtesy Medtronic*).

implanted (by inserting the needle through the skin overlying the nipple of the pacer).

The titanium housing of the pacer in Fig. 12-5 shields the circuit against electrical interference from outside sources.

The Atrial-Sensing Pacemaker

In contrast to ventricular-programmed pacers which sense depolarization of the ventricles, the atrial-programmed pacer responds to the P wave. An atrial electrode senses the activity in this region of the heart, but the stimulating pulse from the pacer is applied to a ventricular electrode. The pacer circuit has a built-in delay to simulate normal AV conduction time so that the ventricles do not contract until there has been sufficient time for blood to transfer from the atria.

Because it responds to atrial activity, this type of pacer increases the ventricular rate in response to the patient's physical activity. However, to prevent tachycardia triggered by a rapid atrial arrhythmia, the pacer is designed to have a maximum rate in the range of 120 to 150 pulses per minute.

In the event of loss of atrial rhythm or of failure of the atrial electrode, the pacer becomes a fixed-rate instrument of about 60 pulses per minute.

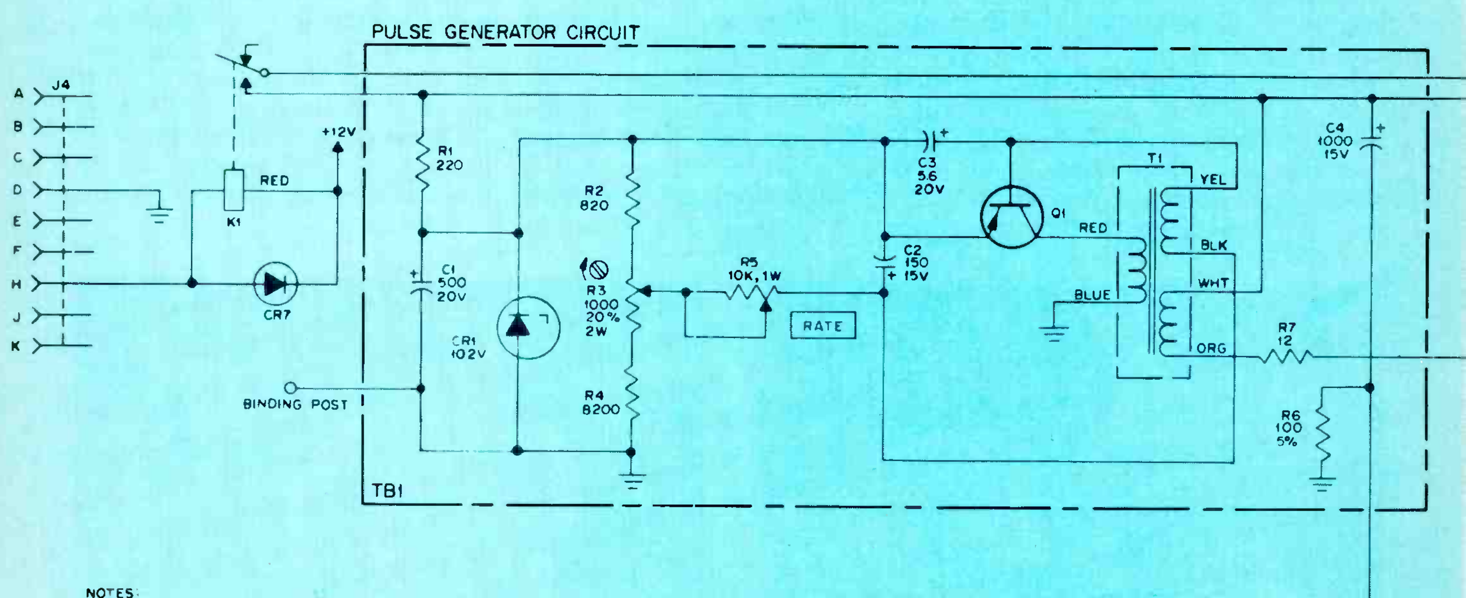
Special Precautions

The use of a temporary pacemaker requires special precautions, because the leads to the heart are exteriorized. Care should be exercised to avoid touching the bare wires or connector at the proximal end of the leads. Touching the bare metal may inject a leakage current that will flow directly to the heart. Under these conditions, relatively few microamperes of current may produce ventricular fibrillation. The pacemaker—particularly the terminals and connecting wires—should be covered or placed inside a large surgical glove to prevent accidental contact.

Another possible danger is that the pacemaker, because of its small size, may be accidentally bumped or brushed aside, possibly pulling out the intracardiac electrodes. To prevent this occurrence, the pacemaker should be pinned or taped in position beside the patient.

Before each use of the pacer, a fresh battery should be installed. Ideally, if facilities are available, the pacer should be tested immediately before use.

Synchronous pacers, both temporary and implanted, are designed to sense electrical activity. They are, therefore, susceptible to electrical interference. In a hospital environment, such interference may be generated by diathermy or cautery equipment. In a nonhospital environment, interference may be produced by electric shavers, microwave ovens, and automotive ignition systems. Although the pacer is not likely to be affected unless it is in very close proximity to the source of interference, patients with implanted pacers should be warned of the possible hazard. Depending upon the design of the pacer and the nature of the interference, the pacer may be either shut off or accelerated by the interfering signal. Symptoms may range from a feeling of faintness to a rapidly



NOTES:

1. SWITCH S1 SHOWN IN POSITION NO.1, FULLY COUNTERCLOCKWISE, VIEWED FROM FRONT OF SWITCH

POSITION	CONTINUITY
1; EXT ON	7-12, 1-2-4
2; STBY EXT	8-12, 1-2-4
3; OFF	NONE
4; STBY INT	10-12
5; INT ON	11-12

2. UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS, ±10%, 1/2W
ALL CAPACITORS ARE IN MICROFARADS

Fig. 12-6 Pulse generator circuit of Pacemaker 808. (*Courtesy Zenith-Travenol*).

pounding heart. The pacemaker patient should be instructed to withdraw from the presence of any electrical apparatus which produces these symptoms.

Zenith-Travenol Pacemaker 808

The 808 Pacemaker produces output pulses 2 to 3 milliseconds in width and variable over a range of 20 to 120 pulses per minute. It is suitable for both external pacing (through the chest wall) and internal pacing (electrode in direct contact with the heart muscle). The pacer is battery-operated and has a built-in regulated charger. By means of a front-panel switch, it can be operated independently of other bedside equipment, or it can be set to a *standby* mode and activated automatically in response to an alarm signal.

The pulse generator circuit of the 808 Pacemaker is shown in Fig. 12-6. The 12-volt supply can be applied to the pulse generator either directly through switch S1 or through the contacts of relay K1. When the voltage is applied through S1, the pacer operates independently of other bedside equipment. When the supply voltage is applied through the contacts of K1, the pacer is activated in response to an alarm ground at pin H of J4.

Zener diode CR1, operating from the 12-volt supply, provides a regulated potential of 10.2 volts for blocking oscillator Q1. Transformer coupling from the collector to the base provides the feedback necessary to pulse Q1, and the pulsing rate can be varied by means of R5 which controls the base current.

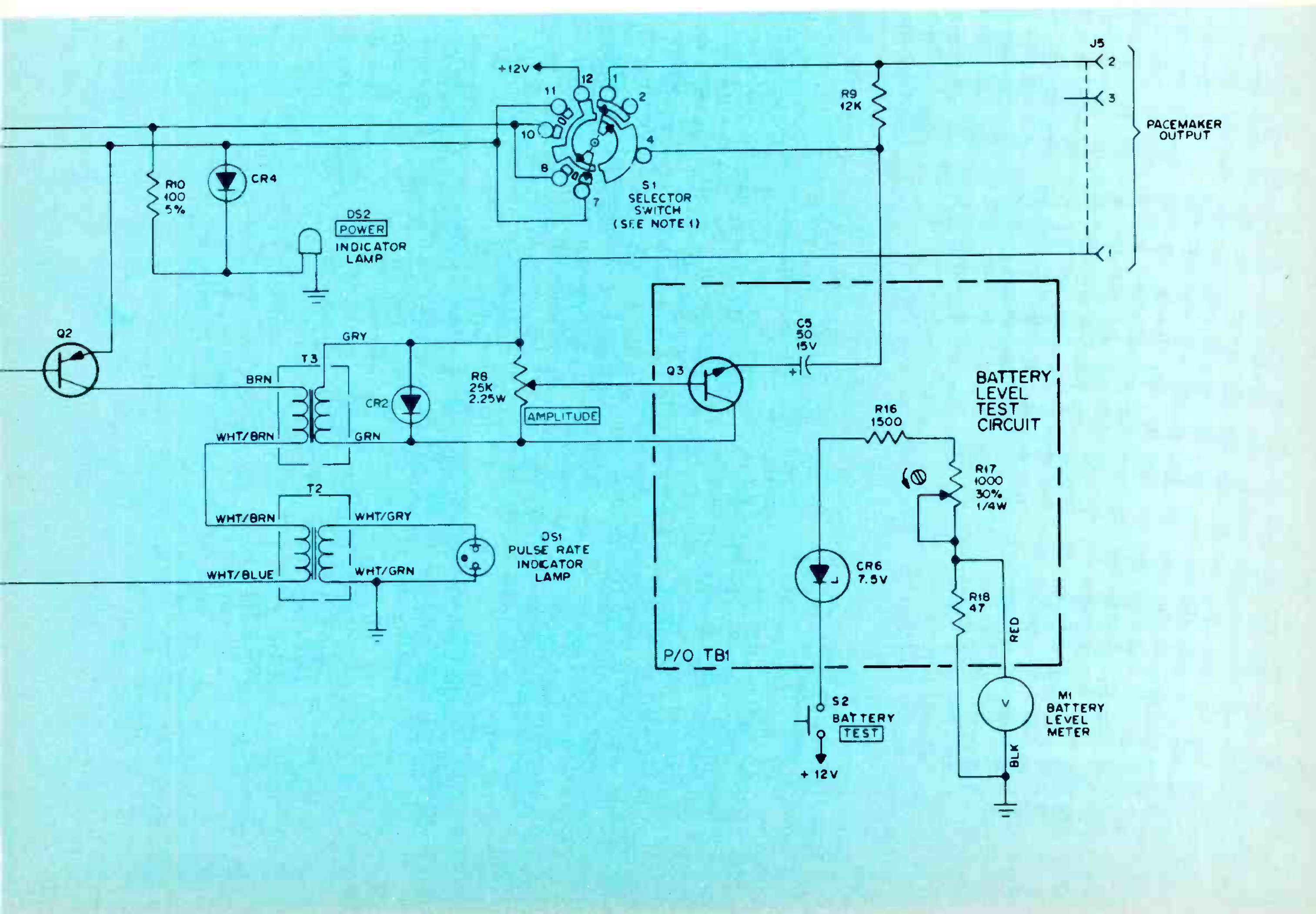
An additional winding on pulse transformer T1 couples the pulse to the base of Q2, and collector current of this transistor flows through the primaries of T2 and T3. Transformer T2 couples the pulse to a neon lamp to provide front-panel indication of the pulse activity.

From transformer T3, the pulse is coupled to Q3 through AMPLITUDE control R8. Each pulse turns Q3 *on*, and the pulse is then coupled through C5 to the patient. Transistor Q3 functions as an emitter-follower with the patient as the emitter load (connected between pins 1 and 2 of J5).

When the pacer is used in the *internal* mode (direct connection to the patient's heart), resistor R9 limits the amplitude of the stimulating current. Higher levels of current are required for *external* pacing (through the chest wall). Resistor R9 is shorted out by selector switch S1 in the *external* position.

The POWER lamp provides a front-panel indication of the mode of operation. When switch S1 is in the *on* mode, the 12-volt supply is applied through CR4 to the POWER lamp. Under these conditions, the lamp is illuminated to *full* brilliance. When S1 is in a *standby* position, the lamp is connected to the 12-volt supply through resistor R10. The lamp is now illuminated at *half* brilliance.

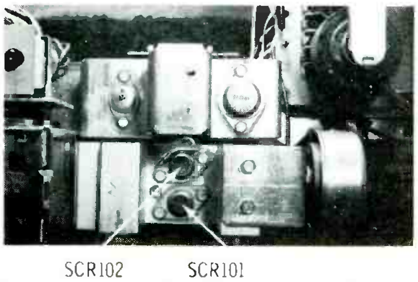
Meter M1 provides a front-panel indication of the level of battery charge. The meter is switched into the circuit only when TEST push button S2 is pressed. Battery charge is maintained by a line-operated charging circuit (not shown in Fig. 12-6). □



SERVICING RCA XL-100

Part 4/By Gill Grieshaber, CET

Interesting surprises are in store for any tech who tries to understand the exact operation of the RCA horizontal-sweep circuit that uses diodes and SCR's to switch different resonant filters for trace and retrace. Most explanations in the past have been superficial, and the usual voltage waveforms show little of the true actions. In this article, we are presenting many unique waveforms of AC signal currents, to help you visualize the many steps forming the sweep, and thus enable you to service more efficiently.



The cases of SCR102 and SCR101 are good test points for the DC voltages and waveforms of the retrace and trace halves of the horizontal sweep in RCA CTC58 color receivers.

For several years, I thought I understood the theory of the RCA SCR-sweep horizontal circuit. I had heard the usual explanations, and had repaired many defects in the sweep circuit, without excessive problems. The basic idea seemed simple enough. SCR's and diodes are used to switch the yoke current from a low-frequency tuned circuit (trace) to a higher-frequency one for retrace.

But when I actually started to photograph the waveforms and make accurate measurements, the questions arose more quickly than the answers could be formulated.

One surprise was in finding that the retrace circuit also supplied a substantial portion of the trace as well. Another mystery was what forced the change each time from trace ringing to retrace ringing, and back again. **How can a positive voltage appear in the trace circuit without any DC path?** There are many more puzzling questions; however, we'll deal with them at the proper time.

Ground Rules

Trace, retrace, and HV regulation of the RCA CTC 58 chassis all operate by inductance/capacitance (LC) tuned circuits. And tuned circuits usually are either series-tuned or parallel-tuned types. In the RCA versions, they **appear** to be series.

Last month, however, we pointed out that only the method of injecting the input signal was different. **Both** types operate by forcing electrons from coil to capacitor, then capacitor to coil, etc.

Figure 1 shows how the closing of any "switch" connects coil and capacitor in parallel. Only the ground point is different from that in conventional circuits.

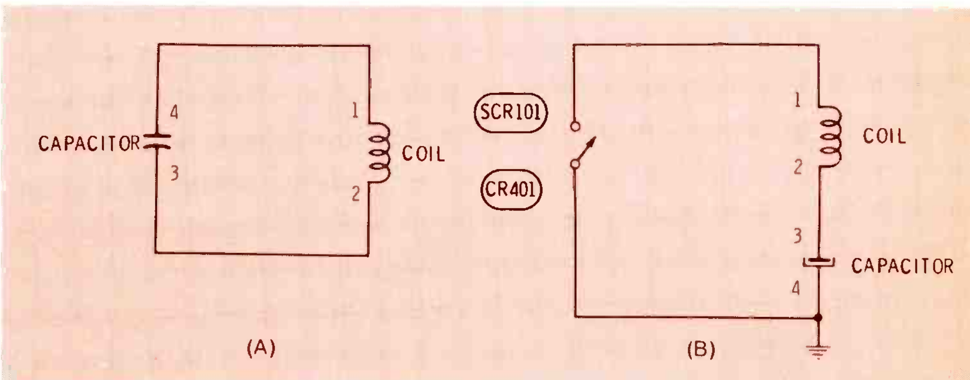


Fig. 1 The schematic of (A) illustrates a parallel-tuned LC resonant circuit. In the yoke circuit of the CTC58 (B), the capacitor and inductor are paralleled when either of the switching devices conducts, even though the wiring seems to be a series circuit. Notice that #2 connects to #3, and #4 connects to #1 in both cases.

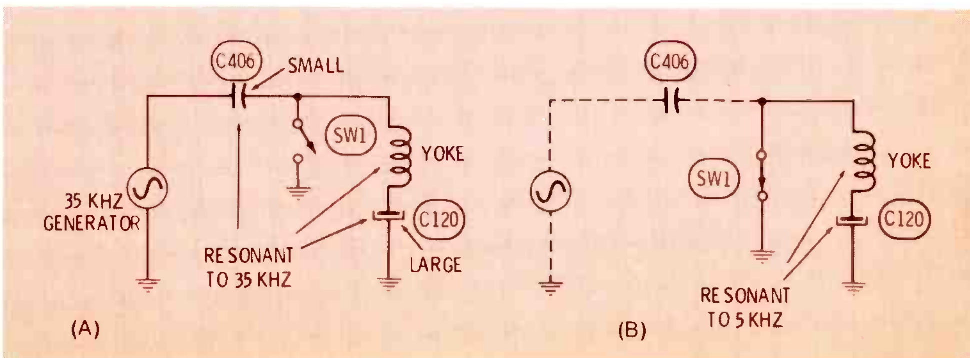


Fig. 2 Simplified retrace and trace tuned circuits are shown here. In (A) C406 and C120 are in series, so they resonate with the yoke at about 35 KHz, when SW1 is open. With SW1 closed (B), C120 and the yoke resonate to about 5 KHz (measured with an audio oscillator).

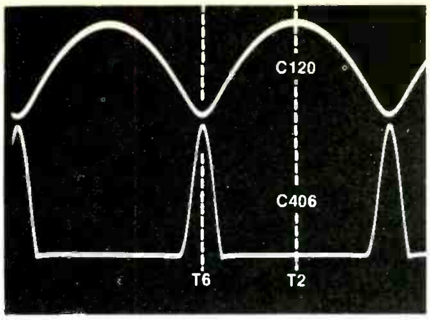


Fig. 3 Ringing is never allowed to proceed long enough to produce a complete sine wave, although several half cycles are formed. The frequency of the C120 ringing is so low that the half cycles meet. Maximum voltage occurs at the center of trace. The frequency of ringing at C406 is so high that each half cycle resembles a pulse. Maximum voltage of C406 occurs at the middle of retrace. C406 has 1/40th of the capacitance of C120, and has almost 20 times the voltage charge.

Tuning capacitors

The RCA circuit (simplified in Figure 2) has **two** tuning capacitors connected in series with the yoke. This produces a relatively-high resonant frequency. For trace, the smaller capacitor is shorted out, reducing the resonant frequency accordingly.

Notice, as we go through the detailed explanation later, that **both** of these capacitors are charged and discharged as they become load or power source (refer to the details of one cycle of ringing on page 25 of the January, 1976 ELECTRONIC SERVICING). However, the retrace circuit has the smaller capacitance (larger "Q"), so the charge on C406 at the center of retrace is very large (about 500 volts PP). In fact, this is the pulse at the anode of SCR101 that we consider the principal sweep waveform. By comparison, C120 has only about 22 volts PP of parabolic waveform with the maximum positive occurring at the center of trace (Figure 3).

We tend to overlook C120 in practical servicing, but this should not be. Trace uses C120 as the resonant capacitor; without it, trace is impossible.

All of the horizontal-sweep and high-voltage power is funneled through C406. That's why C406 must have special construction to

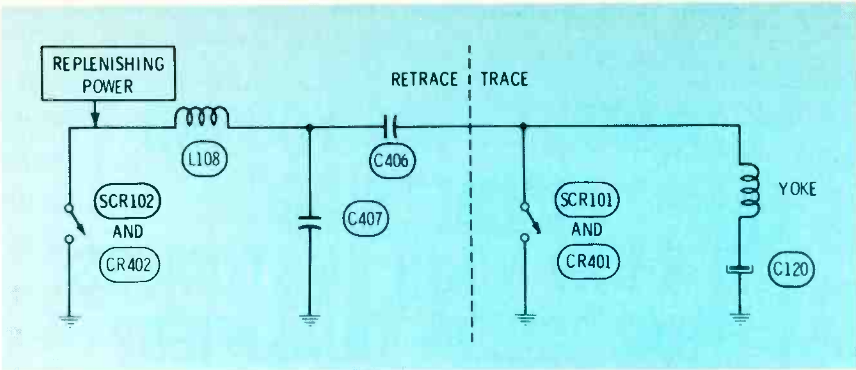


Fig. 4 Retrace components have been added, but the SCRs and diodes are represented by switches.

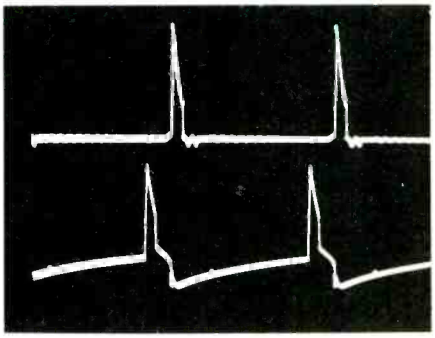


Fig. 5 Oscillator drive to the gate of retrace SCR102 (bottom waveform) occurs considerably before either the sync pulse (top waveform) or the HV pulses. That's because retrace current starts much sooner in the SCR circuit than it does with tubes. The faint vertical edges of these and the following waveforms have been widened to make them more clear.

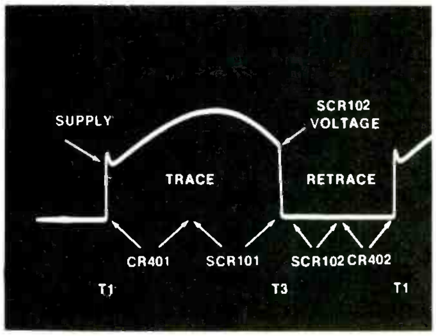


Fig. 6 Conventional voltage waveforms show very little of the complex operation. This waveform of the retrace circuit, taken at the anode of SCR102, indicates no activity during retrace when SCR102 and CR402 take turns conducting. Neither does it show any trace operation. Actually, the waveform shows only some things about the HV regulation.

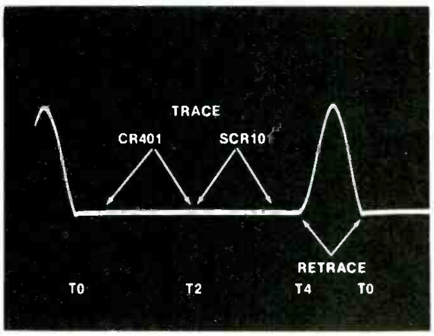
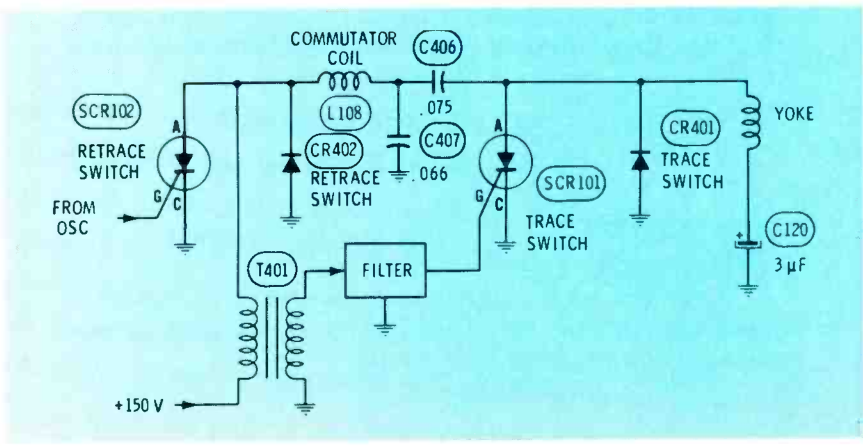


Fig. 7 The usual voltage waveform at the anode of trace SCR101 also shows no trace activity, and nothing else except the HV pulses at the output of C406.

Fig. 8 All of the essential CTC58 sweep components are shown in this partial schematic, along with the capacitor values.



withstand the high AC currents without excessive heating.

It's well known that the trace section (anode of SCR101) can be shorted to ground without damage (of course, there's no deflection or high voltage). This is one step in finding the cause of a tripping circuit breaker. Better a dead short than an erratic one.

Probably the reason for this strange reaction is that the sweep circuit is very sensitive to double-triggering of the oscillator, or to off-frequency operation. And many sweep defects drive the oscillator far away from the correct frequency. We'll comment more about this in the troubleshooting roundup.

The Basic Circuit

The complex circuitry action is easier to understand when presented in small steps. Figure 4 shows the basic circuit, with the diodes and SCR's represented by switches. For this part of the explanation, the reasons will not be given, nor the extent of the action, but just the approximate steps.

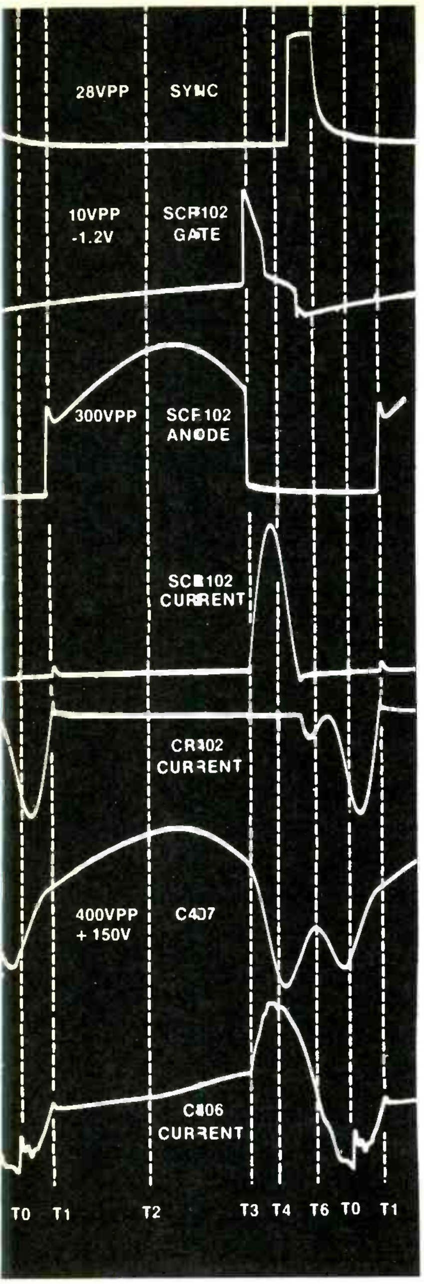
DC power has been stored in C406. When SCR102 is gated into conduction by a pulse from the oscillator, current flows through L108, C406, the yoke, C120 and back to the SCR. This is the first half cycle of retrace ringing.

At the start of the second half cycle of retrace, CR402 conducts a reverse-polarity current through the same components. Then ringing of the retrace circuit stops because SCR102 is not gated on. Current continues to flow through the yoke, but through SCR101 (which disconnects C406 and the retrace circuit), and charging C120. When the yoke current drops to zero, C120 is fully charged, and its voltage biases on CR401, conducting a current through the yoke for the second half of trace. At this time, another gate signal at SCR102 starts the next retrace cycle.

If that sounds simple, it's only because some essential details were omitted. For example, the previous circuit description did not mention any job for L108, yet the sweep will not operate without it. The functions of L108 and C407 will be explained in detail later.

Unique Facts

Here are a few interesting facts



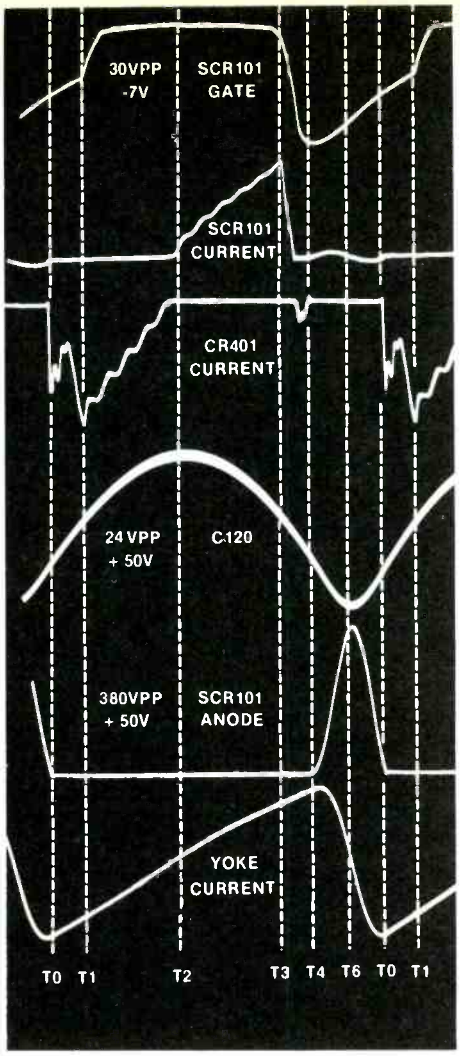


Fig. 9 These are the important waveforms of the CTC58 SCR-sweep circuit, arranged with correct phases (checked two at a time with a dual-trace scope). Faint vertical lines have been drawn in for better clarity. Retrace is between T4 and T0. Notice that SCR102 and CR402 supply all of the retrace current plus part of the trace current at each edge of the TV screen.

waveform shows merely a baseline (Figure 7).

Current waveforms are required to show how the sweep really works.

Diodes And SCR's

At the voltages and currents encountered in the sweep circuit, a **silicon diode can be described as a electronic switch,** one operated **only** according to the voltage and polarity across it. When the **anode** of such a diode is **negative** relative to its **cathode** (or the cathode is positive compared to the anode), it is an open circuit. But when the **anode** is more than about .8 volt **positive** relative to the **cathode** (or the cathode is .8 volt or more negative compared to the anode), the internal resistance of the diode is just a few ohms, nearly a short circuit.

An SCR has some similarities. In fact, SCR stands for Silicon **Controlled Rectifier.** Control is by means of another external lead called a "gate". If a constant voltage of about +.8 volt (relative to the cathode) were to be applied to the gate, an SCR would function exactly the same as a silicon diode.

If a positive voltage is applied to the anode of an SCR, it will not conduct current until a sufficiently-positive voltage is fed to the gate. This turn-on point is very critical, because the action is regenerative; the SCR either conducts none at all or completely. After the SCR conducts, the gate voltage can be removed without stopping the current flow. Unlatching, so the SCR becomes open, can occur only when the current falls below a certain point.

In the RCA horizontal-sweep circuit the unlatching is done either by a reversal of the polarity of the anode voltage during ringing, or by a negative-going pulse through a capacitor to the anode.

The nearly-complete schematic in Figure 8 shows that SCR102 and diode CR402 (the retrace switches) are connected in reverse polarity. If the cathode of CR402 becomes negative, CR402 conducts automatically. However, SCR102 will not start conducting unless the gate and anode **both** are positive.

In the trace circuit, the same situation applies. A negative voltage there **always** causes CR401 conduction, but SCR101 does not conduct

that you probably would not know before analyzing the circuit thoroughly. A considerable phase difference exists between the horizontal sync (also the HV pulses) and the pulses that trigger SCR102 to start retrace (see Figure 5). The reason is because the retrace action around SCR102 and C406 starts long before any retrace current actually reaches the yoke. Of course, the phase difference is not noticeable unless dual-trace waveforms are used.

Horizontal deflection is accomplished chiefly by current; voltage plays a secondary part. But all schematics show **voltage** waveforms.

In addition, the SCRs and diodes are not like transistors that emit a signal when conducting. Instead, they are short circuits when working. The voltage waveforms usually taken of SCR102/CR402 or SCR101/CR401, therefore, show a near-zero voltage when they conduct!

For example, the waveform of SCR102 anode (Figure 6) shows a base line during retrace time (SCR-102 and CR402 conduction), and part of the high-voltage regulation during trace.

In like manner, the SCR101 anode voltage waveform shows only the high-voltage pulse formed by a charge on C406. All of the trace currents flow during the time the until **both** gate and anode are positive. These characteristics are essential for correct operation of this sweep circuit.

Time Markings

Because there are many more steps than two for trace and two for retrace, and they occur at irregular intervals, it's necessary to mark the voltage and current waveforms with time designations, such as T1, T6, etc. That way the phase of all the waveforms can be compared directly.

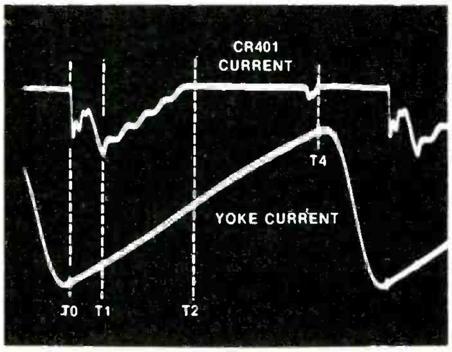
Speaking of phase, Figure 9 has 13 of the basic waveforms arranged in correct phase, and with dotted lines showing the time designations. It is helpful to go back and refer to these waveforms, if you have a question.

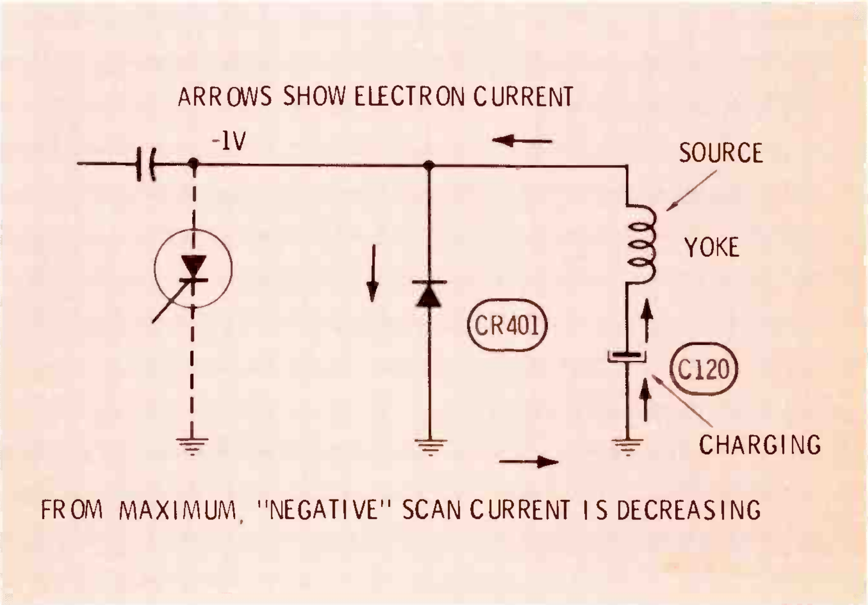
Deflection Step-By-Step

All power for both trace and retrace enters by way of the retrace circuit. So, from that viewpoint, it would seem an explanation of all steps should start with retrace. But that gets into some hairy operations, with retrace and trace currents flowing together, and other complications. Instead, we'll assume a starting point at time T1, with maximum trace current flowing through CR401 to the yoke. On the screen of the picture tube, this is about 1/8th of a screen width from the left edge of the screen. Additional waveforms and explanations will be given later.

Step 1: Trace From Left To Center

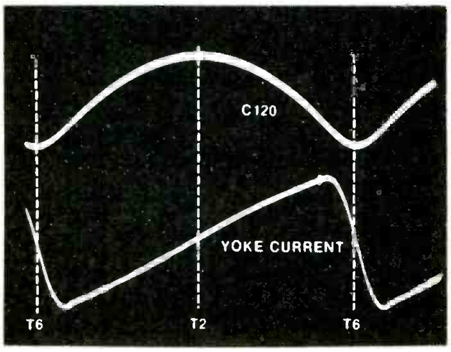
With the yoke as the source of power from the current, the negative trace current through trace diode CR401 is maximum at T1, and it decreases towards zero at T2, the center of trace.

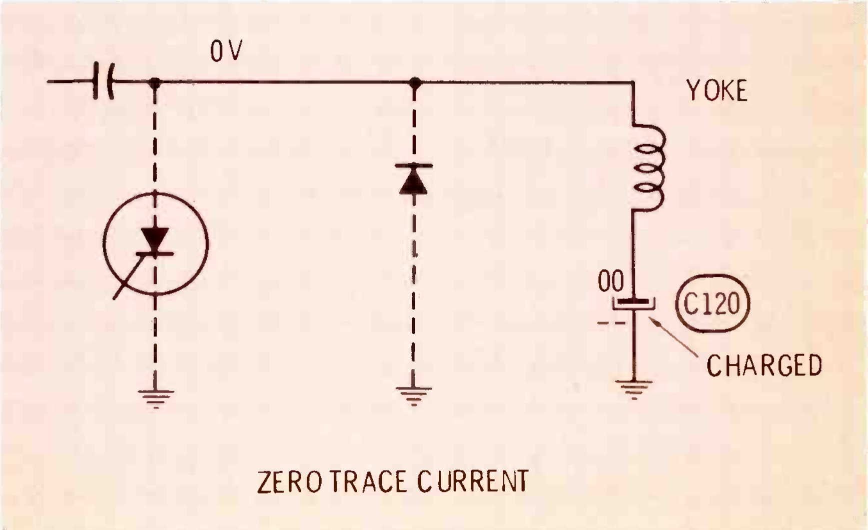




Step 2: At The Center Of Trace

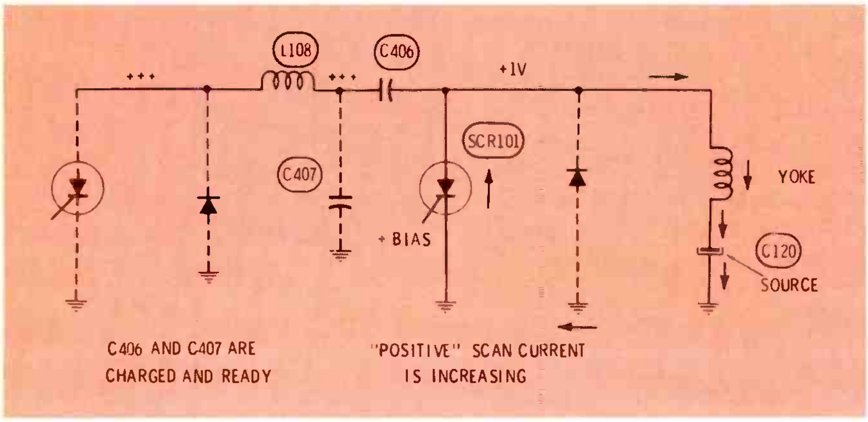
The yoke current has been dissipated in charging C120, which is now fully charged, and current has stopped at T2.

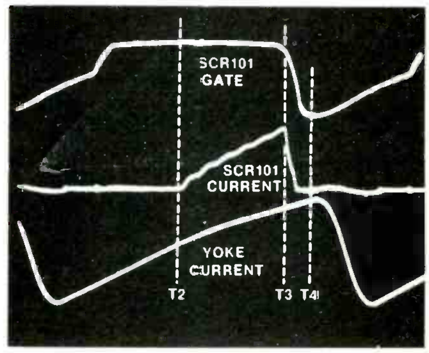




Step 3:
Trace From Center to Right

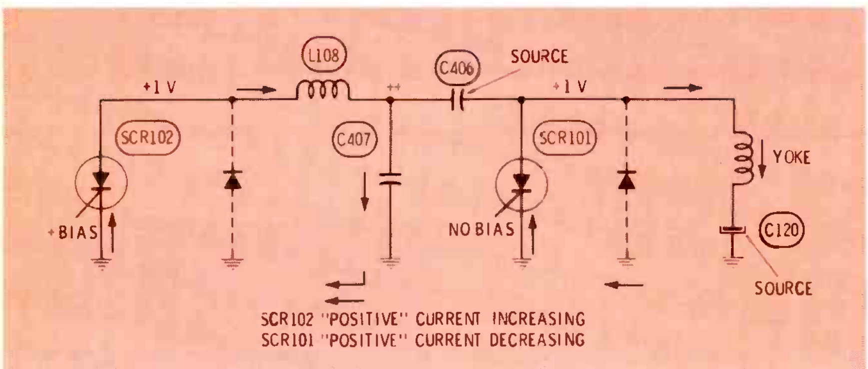
C120 begins to discharge, but the positive voltage can't go through CR401. The positive voltage goes to the anode of SCR101, which has been waiting with a positive gate signal for some time; therefore, SCR101 conducts positive current through the yoke, with maximum current at T3. C406 has been charged with B+ from the regulation circuit, and it is ready to release that power.

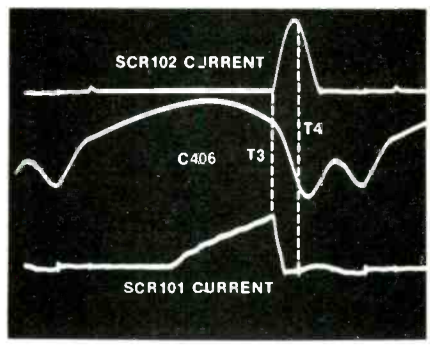




Step 4: Retrace Begins, Unlatching SCR101

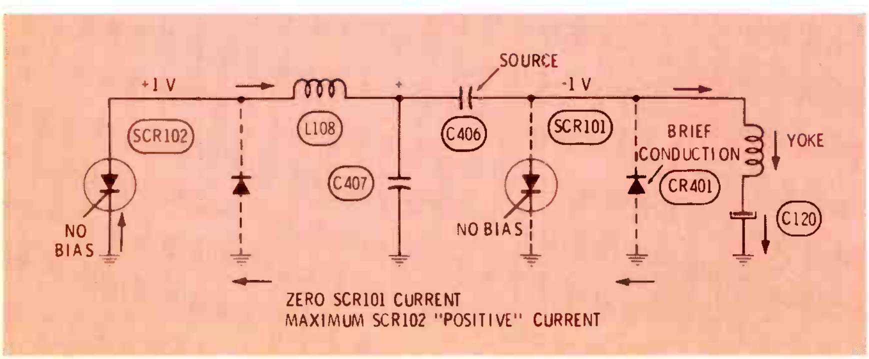
A pulse from the oscillator triggers the gate of SCR102 at T3, starting one full cycle of "retrace ringing" (lasts longer than just retrace). For a time both SCR101 trace current and SCR102 retrace current (through C406) flows through the yoke. The gate pulse of SCR101 has just gone negative, and the C406 current forces the anode of SCR101 to zero DC; therefore, SCR101 loses anode current, and drops out of latching condition just before T4.

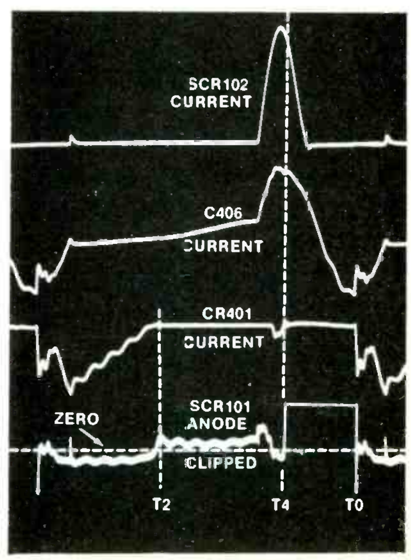




Step 5:
SCR102 Completes Trace

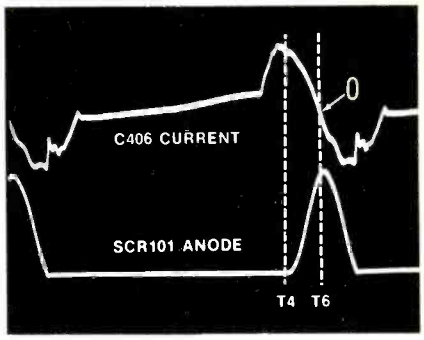
SCR102, the retrace SCR, pulls maximum positive "trace" current through C406 and the yoke at T4, bringing the scanning to the right edge of the screen. When the anode of SCR101 was forced negative (just before T4) to turn it off, the cathode of CR401 also was negative, causing it to draw a small amount of current for a short time. This current is too small to be important, but it does show in the CR401 current waveform. By now, the original B+ charge of C406 has been depleted by furnishing maximum SCR102 current.

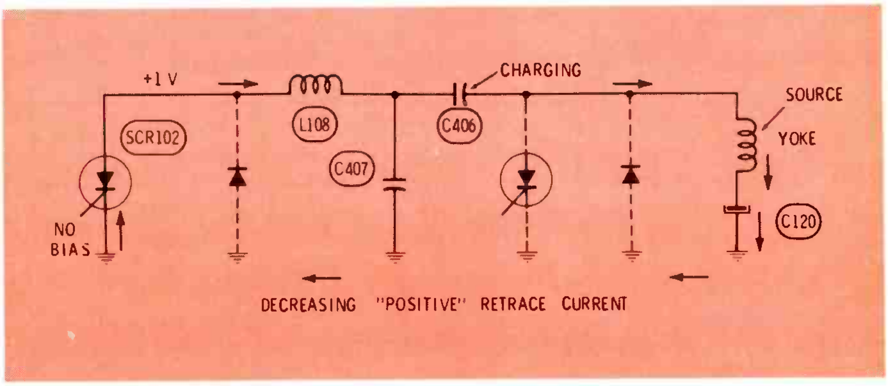




Step 6: Retrace From Right To Center

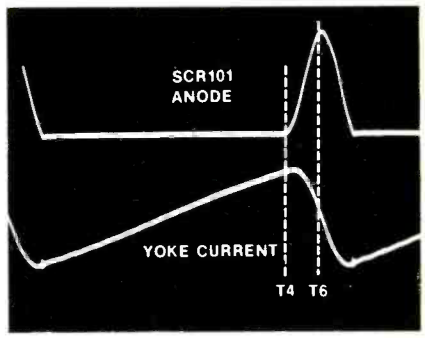
Now the yoke is the source of power, and its current decreases (through C406 and SCR102) as it charges C406. When ringing makes the anode of SCR102 negative, SCR102 unlatches and becomes open until the next gate trigger. Current through SCR102 actually stops at T5; but at the output of C406, zero current occurs at T6, the center of retrace.

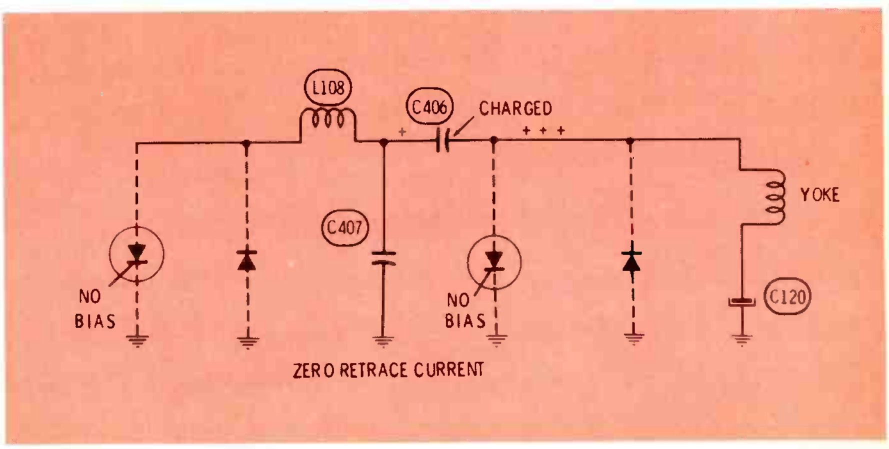


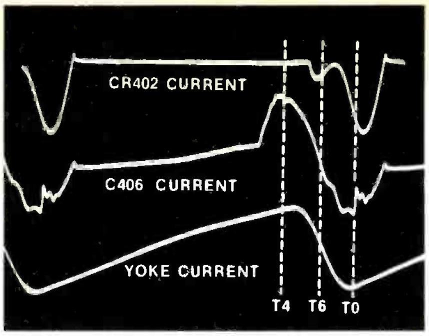


Step 7: Zero Current At Center Of Retrace

Power of the yoke has dropped to zero current at T6, and C406 has been charged to the maximum ringing voltage.

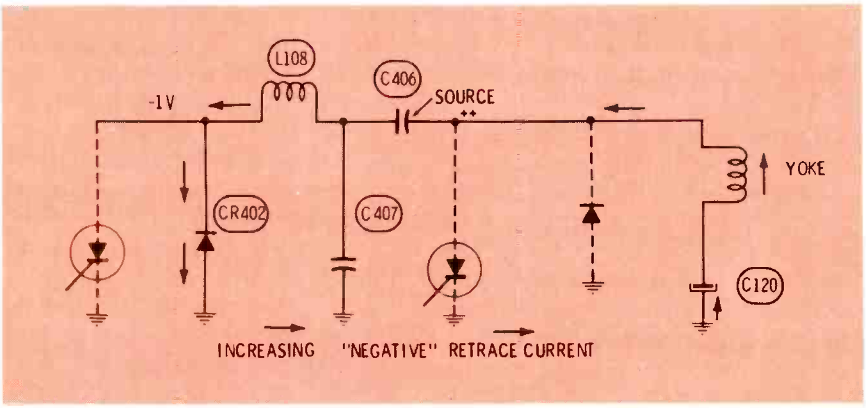






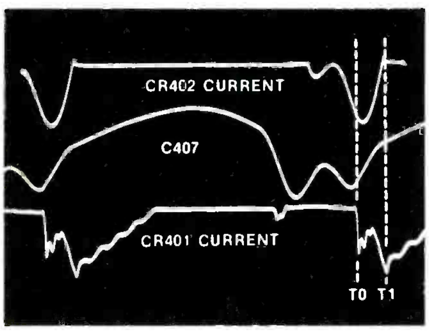
Step 8: Retrace From Center To Left Edge

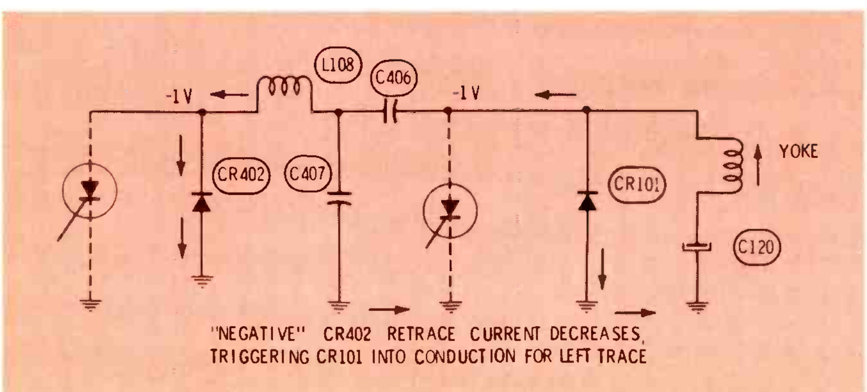
The yoke end of C406 has a large positive voltage, but SCR101 has no gate pulse, so it can't conduct. However, the L108 end of C406 is negative, allowing CR402 to conduct and bleed C406 as the negative yoke current increases. This starts the second half-cycle of retrace ringing. At time T0, the voltage of C406 has been exhausted, and yoke/CR402 current is maximum.



Step 9: Retrace Triggers Trace

Just before T0, the second negative tip of C407 voltage (acting through C406) makes the cathode of CR401 negative, so it starts to conduct. However, CR402 current still flows, and for a time both supply the yoke with current. Then ringing reduces the CR402 current. With interference from the CR402 current decreasing, CR401 current increases, reaching maximum at T1. CR402 current reaches zero also at T1. Retrace ringing tries to continue by making the anode of SCR102 positive. However, SCR102 has no gate signal, so the ringing cannot continue. This is the end of one horizontal scanning line of trace and retrace, plus the beginning of the next.





Why Are L108 And C407 Used?

Very little has been mentioned about L108 and C407. As we followed the various steps of deflection, we probably saw no need for them. But, in actual operation, **the circuit works poorly without C407,** and **cannot be forced to operate at all without L108.**

L108 sometimes is called a "commutator" coil. In electric motors, a commutator switches the current from circuit to circuit, and that's roughly what L108 does in the sweep circuit. It makes possible the switching from trace to retrace, and from retrace to trace.

The design engineer avoided switching problems of the retrace circuit by extending the time of operation over into the normal trace time. Two complete half-cycles of ringing occur before any switching is needed. Then the switch-off is done without outside force. After the negative ringing current through CR402 reaches zero, the ringing tries to continue by making the anode of SCR102 positive. However, no conduction is possible, because the gate has no signal. Consequently, ringing stops gently during the time of zero current.

Starting retrace ends the trace

In contrast, CR401 trace diode conduction must be started at maximum current, and the ending of SCR101 trace conduction must occur at maximum current. Both of these are done by force applied by the retrace circuit, and that's where L108 and C407 are essential.

If you should short across L108 and remove C407, the voltage at the input of C406 would abruptly go to zero at time T3, when SCR102 fired. The sudden rush of current through C406 would force the anode of SCR101 negative, cutting off its current before the SCR102 current could increase and supplement it. This would make a gap in the yoke current, resulting in poor linearity at the right edge of the picture.

But with L108 and C407 added, the decrease of input voltage to C406 is slowed to a gradual change that reaches minimum at about T4 (Figure 10), thus decreasing the SCR101 current gradually in step with the increase of SCR102 current..

Starting the trace

Without L108 and C407, there could be no beginning of trace at T1. This would be the sequence: retrace diode CR402 stops conduction at T1, and the DC voltage at the cathode instantly rises to B+, forcing a large positive-going pulse through C406 to the trace section; the positive voltage is reverse bias for CR401, so it can't conduct, even though that's the next normal step; SCR101 has a positive anode and a positive gate (because the gate waveform is different without L108), and it draws a huge current out of sequence, causing a severe overload that kicks the breaker.

The current through CR401 should not begin with maximum current instantly, but should increase in step with the decrease of CR402 current. For this, a sloping negative-going pulse to C406 is

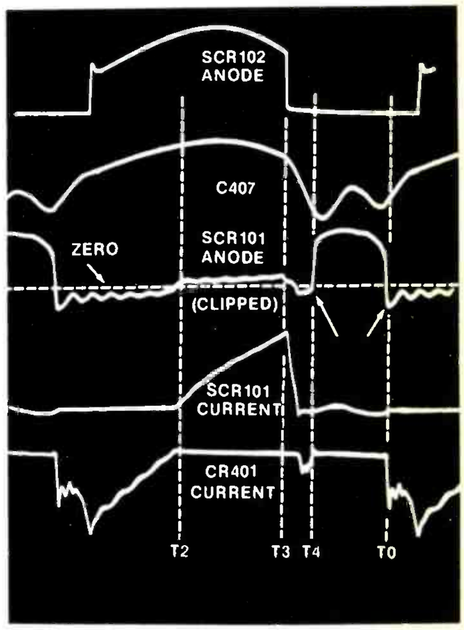


Fig. 10 Without L108 and C407, the voltage at the output of C406 would be a negative-going pulse at T3, and a positive-going pulse at T1 (caused by the falling and rising sides of the SCR102 anode waveform; and assuming that the circuit would work without L108, which it will not). Such pulses could not properly stop and start the trace conductions. Those two components are required to supply the two negative-going tips to the C407 waveform, at the input of C406. Proof is supplied by the center waveform marked (clipped), which is an enlargement of the baseline between HV pulses at the anode of SCR101. Arrows inside the retrace area show the two negative pulses that trigger conduction of CR401.

needed at about T0. A second use for L108 and C407 provides the solution.

With L108 isolating the retrace switches from C406, an alternate path is needed to allow C406 to charge properly with pulses during retrace. C407 provides that path, and the pulses charge both C406 and C407 in series. Also, the pulses of C407 serve another useful purpose, as we shall see.

Without a signal coming in through L108, C407 would have a waveshape of HV pulses. Or, without the pulses through C406, the retrace circuit would supply a rounded valley to C407 during retrace. A combination of both waveforms produces a double tip. The positive-going HV pulse is narrower than the valley, so it pushes up a small peak in the center of the valley, thus forming two negative-going tips. CR401 is biased into gradual conduction by the second tip at about T0.

Proof of the theory

Additional proof (that these sweep voltages and currents actually operate as described) is contained in the waveforms of Figure 10, and especially the one marked "SCR101 ANODE (CLIPPED). This waveform shows the negative voltage drop across CR401 (T0 to T2), the positive voltage drop across SCR101 (T2 to T3), the down slope to zero that gradually stopped the current of SCR101 midway between T3 and T4, the negative voltage (just before T4) after SCR101 stopped conduction (this caused the small extra conduction of CR401), and the negative overshoot at T0 that biased CR401 into conduction.

Next Month

High-voltage regulation, troubleshooting techniques, and the waveforms from many parts defects will be highlighted next month. □

In Appreciation

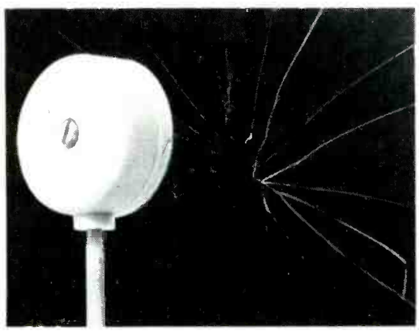
We want to express our thanks to B&K Dynascan and to Tektronix for the loan of equipment that made possible the unusual waveform pictures of the RCA SCR-sweep circuit. The scope was a Model 1470 by B&K. You have seen in past issues many waveforms made originally on the Model 1470, because B&K has generously allowed us to keep it in our Test Laboratory much longer than usual. And Tektronix loaned two of the Model P6021 current probes, which enabled us to photograph two separate current waveforms at the same time, and without breaking any circuits. A hearty "Thanks" to both companies.

productreport

These features supplied by the manufacturers are listed at no-charge to them as a service to our readers. If you want factory bulletins, circle the corresponding number on the Reply Card and mail it to us.

Glass-Breakage Detector

M11 Window Bug, which warns of glass breakage, has been introduced by **Mountain West Alarm Supply Company.** When door or window glass is broken, a shock wave travels across the glass. This sound is detected by a tuned fork and cavity in the Window Bug, operating a switch for about 1/2-second to activate the burglar alarm.



The M11 installs in a vertical position; on glass with a self-adhesive mounting, or with a screw mounting for other surfaces. Contacts can be set to act as either a normally-open or normally-closed switch (SPST).

The M11 comes with instructions, costs $11.20, and works with all closed-circuit burglar alarm systems.

For More Details Circle (28) on Reply Card

CB Accessories

Four additions to its line of CB accessories has been announced by **Hy-Gain Electronics.**

The mobile power mike features extra modulation from a self-contained 2-transistor IC preamp with adjustable gain control. The desk mike has an integrated preamp with adjustable gain control, and a push-to-talk button with lock.

For use in noisy vehicles or at home, Hy-Gain offers a push-to-talk telephone handset. It comes complete with a spring-grip cradle. The power speaker with a large IC amplifier puts

out 3 watts RMS. A 6' cord and swivel bracket included.

For More Details Circle (29) on Reply Card

CB Co-Axial Feed-Thru

Cornell-Dubilier Electric offers a new coaxial feedthrough capacitor Model CBFT-864, having a rating of 30 amperes, 50 DC working volts, and .25 microfarad. It has a crimp splice for easy installation, and commonly is used to minimize noise from heater motors, rear-window defoggers and air horns.

For More Details Circle (30) on Reply Card

Dip Grip Compound

The Brookstone Company has available a "dip-it-yourself" compound that makes plastic grips for hand tools. Just dip the handle, remove, and let dry. After 24 hours, there's a tough, protective gripping surface. The compound's bright red color personalizes your tools, and helps discourage "permanent borrowers". A can of 13 fluid ounces sells for $5.30 post-paid.

For More Details Circle (31) on Reply Card

Controlled Soldering Gun

The **Weller** Model GT 150-watt soldering gun accepts the 6B power-head with 1/8" cone-point tip for 600° F, and the 7A chisel point 3/16" tip for 700° operation.

This light-weight gun is especially intended for solid-state work, because the temperature is controlled.

For More Details Circle (32) on Reply Card

photofact bulletin

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis.

ADMIRAL
Chassis 1M30B 1542-1

BROADMOOR
2609A 1554-1

GENERAL ELECTRIC
Chassis 12XB, 15XB 1557-1

HITACHI
I-28, I-48 1557-2

JC PENNEY
1725 (855-0048) 1556-1

MGA
CS-1980 1555-2

MIDLAND
15-269 1546-1

PANASONIC
Chassis T128-A 1552-1

QUASAR
Chassis 12TS-/Y12TS-481 1550-1

RCA
Chassis CTC71R 1552-2

SANYO
21T69 1550-2

SEARS
564.50090500 1544-1

SONY
KV-1520R (Ch. SCC-25C-B) 1557-3

SYLVANIA
Chassis E12-1/-2 1549-3

TOSHIBA
Chassis TAC-9110 1547-1

WARDS AIRLINE
GAI-16426A, GAI-17536A 1556-2

ZENITH
Chassis 12FB22X 1556-3

What would you like to read in ES? Send in your ideas.

The MARKETPLACE

This classified section is available to electronic technicians and owners or managers of service shops who have for sale surplus supplies and equipment or who are seeking employment or recruiting employees.

Advertising rates in the Classified Section are 35 cents per word, each insertion, and must be accompanied by cash to insure publication.

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Minimum classified charge $3.00.

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Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or a distributor.

FOR SALE

FOR SALE (CONT.)

EDUCATION-INSTRUCTION

BUSINESS OPPORTUNITY

BUSINESS OPPORTUNITY

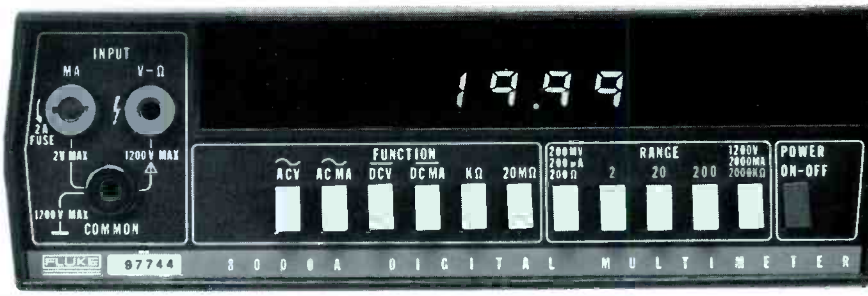
advertisers' index

Your VTVM is obsolete!

This may sound like a harsh claim, but it's true. Thousands of TV technicians are using instruments designed in the 1950's to trouble-shoot circuits designed in the 1970's.

And now, most color TV's have solid state circuits. So use of out-of-date test equipment just compounds the problem.

The generation gap has grown too big.



Resolution is 100 microvolts, 100 nanoamps and 100 milliohms

The Fluke 8000A 3½ digit multimeter

Solid state calls for new performance standards.

Your "old fashioned" test equipment simply doesn't measure up to today's requirements. For example, the typical VTVM gives you 5% accuracy and 2% resolution. In the old days, that was good enough. Not so today.

Now you need an instrument to look at the voltages at each pin of an IC with sufficient accuracy and resolution to determine proper IC operation.

For example, a reading of "around 2.8 volts" is no longer sufficient. You must be able to distinguish between 2.80 and 2.82 volts.

You need a test instrument that gives you 0.1 ohm resolution so you can reliably measure resistance of switch contacts, circuit breakers, and low value resistors.

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The 8000A gives you up to 50 times the accuracy and 20 times the resolution of a VTVM, so you can measure the various voltage levels in a solid state chassis with absolute confidence.

You get the sensitivity you need for low level dc measurements. The 200 millivolt range with 100 microvolt resolution tells you *exactly* what your values are.

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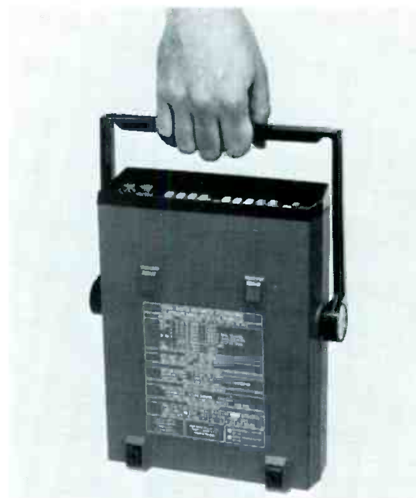
Don't be caught in the typical trap. Many electronic service shops don't really update their equipment when they decide to update. Switching to a TVM or a FET voltmeter doesn't really give you the accuracy and resolution you need today, or for that matter, tomorrow.

But with the 8000A on hand, you know you have a *true* solid state testing device.



Carry it anywhere. Use it on line or with optional rechargeable battery power ($50 extra). Note the conveniently mounted specs on the bottom decal.

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For More Details Circle (2) on Reply Card

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