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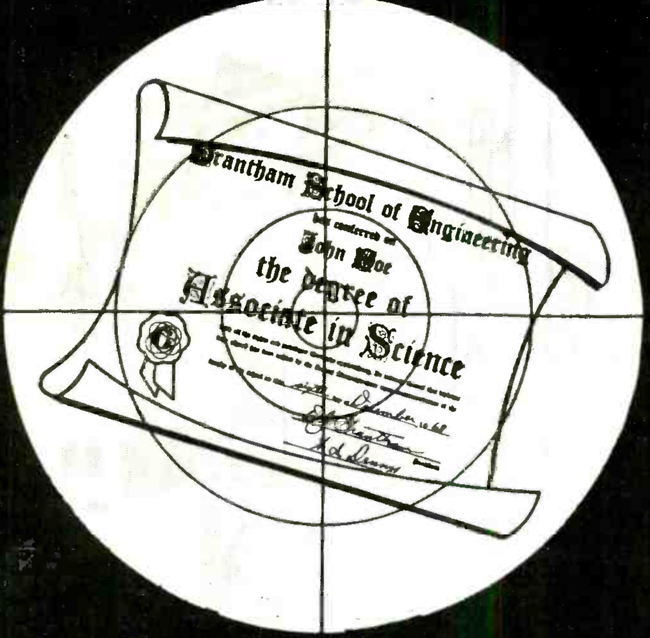

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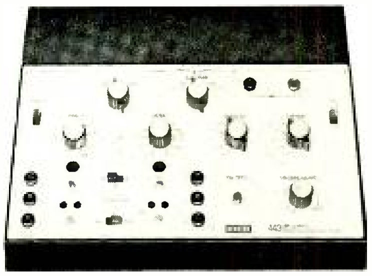
Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

November 1972

ON THE COVER

A GOOD PORTION of the R-E Digital Grinchwal System is shown on this month's front cover. You can see the mainframe, described in this issue, along with several plug-ins. For those who wonder how the picture was made, our photographer, Walter Herstatt set the plug-ins on the colored burlap background. He then placed a sheet of glass over the top of modules and positioned the main unit on the glass. This resulted in the floating in space look of the unit.



THE CURVE TRACER CAN BE VALUABLE to all who work in electronics. But first you must know how it works and what it can do. For a truly important article......................see page 63

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looking ahead

An LP videodisc

A new development in the videoplayer field has the television industry buzzing, and there are some predictions that it could be as revolutionary as color TV. Whodunit? RCA. At press time, RCA was making no comment except to concede that the development did indeed exist and that our description was substantially correct.

RCA has quietly been demonstrating to a few select television set manufacturers and others in the TV industry a long-playing color videodisc system that is said to use an inexpensive player and low-cost conventional-appearing records. We have not seen the device, nor has any representative of the press. But we have talked with enough qualified engineers (none from RCA) who have witnessed a demonstration to feel that it is of major significance as a potential new home product.

What RCA is demonstrating to the select few is a device that resembles a conventional phonograph, plays 12-inch discs, but is attached to a color TV set and is capable of playing 20 minutes of color picture plus stereo sound from each side of the disc—a total of 40 minutes for both sides. It is a playback-only device and cannot make recordings. **Radio-Electronics** readers learned about the German-British color videodisc developed by A.E.G. Telefunken and Decca in last December's issue. It is a major technical achievement, using a cushion of air to suspend a flexible disc, that whirls at 1800 rpm and uses a specially designed "pressure stylus" to read out the picture. A single disc will play for five minutes.

What is dramatic about RCA's development is its differences from the Telefunken-Decca system and its similarities to standard audio disc equipment. It spins at 400 to 500 rpm, and apparently uses the traditional needle-in-groove pickup system. The discs are rigid, rather than flexible, and are pressed in the conventional record-pressing manner. Those who have witnessed RCA's demonstration were impressed with picture, color and sound. The eventual retail price of the playing equipment is expected to be somewhere under $400—perhaps far under—with discs costing less than a dollar for material and pressing. This compares with $35 or more for an hour's worth of blank video tape.

Although RCA's system is still in the developmental stage, the target date for marketing is understood to be late 1974, which will also mark the tenth anniversary of the start of work on the system at the RCA Laboratories in Princeton, N.J. What is the secret? Nobody is saying. But in this day of sophisticated computer memories, it would be ironic indeed if the phonograph disc—an invention of the 19th century—turned out to be the most practical information-storage medium.

Smaller uhf band?

Under federal law, all television sets manufactured must be able to tune all 70 channels from 2 through 83. But in 1970, the FCC turned over the top 14 uhf channels—69 through 83—to the land-mobile radio services. The only broadcast facilities still occupying these upper channels are about 800 low-powered translators, that have been given FCC permission to move to lower frequencies. Television set manufacturers, through the Electronic Industries Association, now have petitioned the FCC to cut the knot once and for all, lopping the top 14 channels from the TV broadcast band and relieving them of the responsibility to build sets which can adequately tune to stations which aren't there. The EIA argues that reducing the size of the uhf band would make it easier to build tuners and help improve tuning accuracy by reducing the compromises needed to span the huge uhf band with one tuning instrument.

Cable TV's growth

More than 10% of the nation's homes are now receiving television by cable, according to figures in the latest issue of *Television Factbook,* which keeps track of such things. As of the start of this year, the publication's statistics show, 6 million homes were connected to cable systems, an increase of 700,000 during 1971. On March 31, 1972, there were 2,839 CATV systems in operation, the average system serving 2,272 subscribers. Fewer than half of the existing systems merely supply subscribers with programs picked up from TV stations, and 594 originate their own programming—live, film and/or videotape. An additional 920 have "automatic originations" only—channels served by automatic time and weather reports, news tickers and the like. Some 210 systems insert commercials in their own programming. The country's largest systems are in San Diego, with 65,000 subscribers as of March 31; New York City, 45,000; Northampton, Pa., 45,000; a second New York system with 43,000; Altoona, Pa., 42,500, and Allentown, Pa., 38,275.

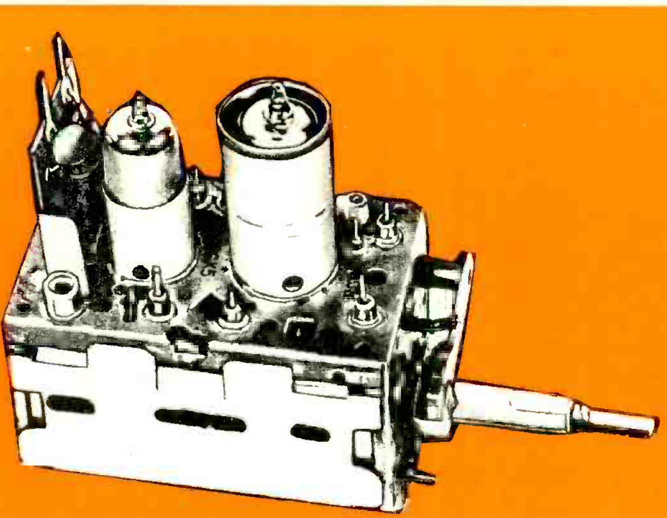
It's no accident that Pennsylvania is so heavily represented among the largest systems—that's where CATV started, as a means for bringing clear reception to cities in areas where mountains made it impossible to receive satisfactory direct off-the-air television.

It adds up

Soon everybody will have one and manual arithmetic will be obsolete. Or so it seems, with prices on electronic calculators dropping like autumn leaves. The pocket calculator has now moved into the home product category, as the result of rather startling prices. As little as a year ago, $200 or $220 was a bargain price for a calculator. Today, thanks to a single-chip MOS, calculators are coming within the range of housewives and students.

American, not Japanese, manufacturers have taken the lead in bringing calculator prices down into the consumer-product range. Bowmar Instrument Corp., the biggest manufacturer, has sold about 250,000 pocket units with LED readouts, with a list price of $179. North American Rockwell has been making units with liquid-crystal readout designed to sell at about $100. Texas Instruments, which makes the MOS chip, has a pocket unit at $150 and will soon introduce a desk-top model at about $85. The Japanese, whose prices on calculators has been higher than those of the lowest-priced U.S.-made models, have now begun to fight back. Sharp, probably the leading Japanese calculator manufacturer, is readying an under-$100 model for the American market. But the lowest price yet is from Casio of Japan, which has introduced a six-digit model on the American market at under $60 retail. The same unit sells in Japan at less than $42. Next year it's forecast that some pocket calculators will be available at less than $50 in the United States.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR



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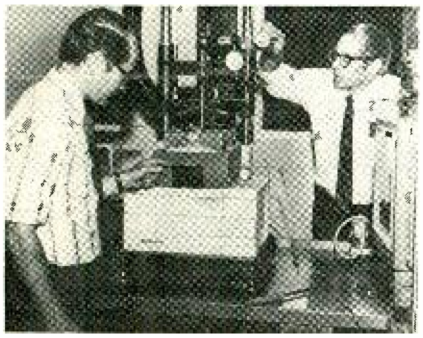
new & timely

Lithium tantalate crystals to improve communications

A new man-made crystal, now in production at Western Electric's Merrimack Valley Works in Massachusetts, the first practical alternative to quartz for use in communications equipment, may improve and simplify crystal filters. It may also find use as a light modulator and as a detector of infrared light frequencies.

Piezoelectric crystals (crystals that deform under an applied voltage and that produce a voltage when stressed mechanically) are widely used as filters in communications equipment. The bandwidth of quartz crystals, heretofore the universal material for crystal filters, is limited by a weak electromechanical coupling characteristic; its efficiency in converting mechanical to electrical energy or the reverse is not as high as might be desired.



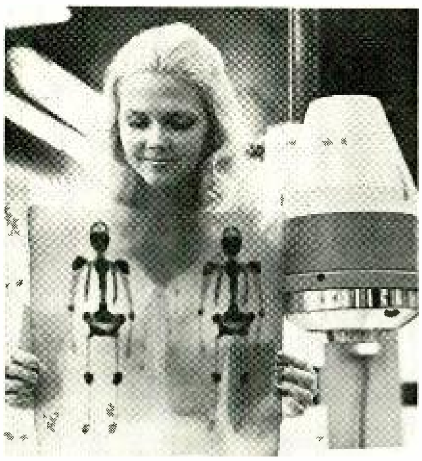
CRYSTAL MAKERS AT WORK—Albert Ballman of Bell Laboratories and David Rudd of Western Electric Co., with the crystal pulling machine.

Lithium tantalate has an electromechanical coupling constant five or six times better than that of quartz, according to Albert Ballman of Bell Laboratories, who developed the new crystal. Its temperature-frequency characteristic compares favorably with that of quartz, and it has low impedance, high Q, minimum coupling to unwanted modes, good machinability and low water solubility.

"Minified" X-ray pictures possible with new technique

A new minification system that permits taking pictures of the whole human body on a single piece of standard X-ray film has been announced by the Medical Electronics Operation of the Raytheon Co., Waltham, Mass. This will make faster and more accurate diagnoses possible.

The equipment provides for two minification levels: 5-to-1 for whole-body scanning and 2-to-1 for individual organs. In the 5-to-1 mode, two passes of the scanner take full-size views of right or left lateral or of back or front, plus minified whole-body views. In the 2-to-1 mode, substantial film savings are possible; it is necessary to load film into cassettes only once instead of four times to obtain a complete photo record.

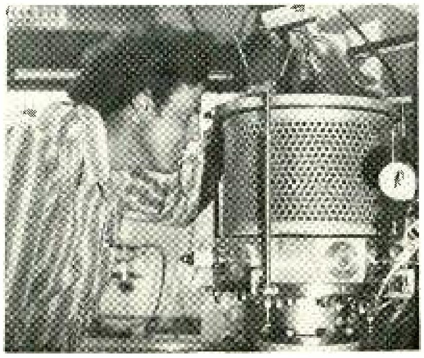


NANCY BRACKETT, former Miss Massachusetts, holds a film demonstrating the new X-ray technique.

The system is completely compatible with the company's single and dual-head nuclear scanners and is available as optional equipment.

Practical superconductivity with new cryogenic material?

Superconductivity has been reported at temperatures above 20° Kelvin (–254° C) by researchers at the RCA laboratories in Princeton, N.J. This research advance may make superconductive electric motors, generators and transmission lines possible. The material that retains its superconductivity at these "high" temperatures is a compound of niobium and gallium.



Dr. GEORGE W. WEBB, ACHIEVER of the breakthrough in cryogenic research, continues to search for higher temperature superconductors.

A superconductor, produced by cooling a metal to a temperature near absolute zero, has no resistance. Thus it can carry practically unlimited amounts of current. Unfortunately, a slight increase in temperature destroys superconductivity, as does a magnetic field above a certain strength.

Superconductivity has in the past been obtained only a very low (cryogenic) temperatures—a few degrees above absolute zero. Cooling to such low temperatures is expensive—the new material may make a cost reduction of 75% possible.

The new compound not only retains its superconductivity at relatively high temperatures, but also in magnetic fields far stronger than is possible with other superconducting materials.

It is possible that practical niobium-gallium superconductive systems can be made to operate efficiently in magnetic fields greater than 100 kilogauss and at temperatures higher than 14° K. That temperature can be reached with liquid hydrogen refrigeration, instead of the much more costly helium refrigeration required for lower temperatures.

Experiments with superconducting transmission lines have already been made, and a variety of applications may become practical with the new, more economical, approach to superconductivity.

Communications Technologist Honored

Dr. Eugene O'Neil (left in the photograph) has been awarded the 1971 IEEE Award in International Communications. Among the outstanding contributions to the communications field for which he was cited are technologies developed for the first operational Telstar communications satellite and transoceanic cable.

(continued on page 12)

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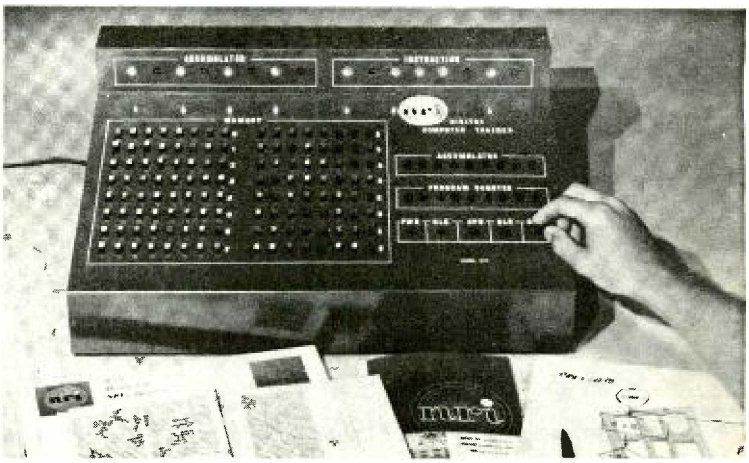

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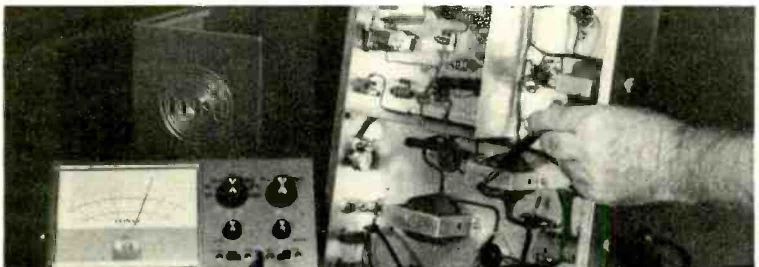

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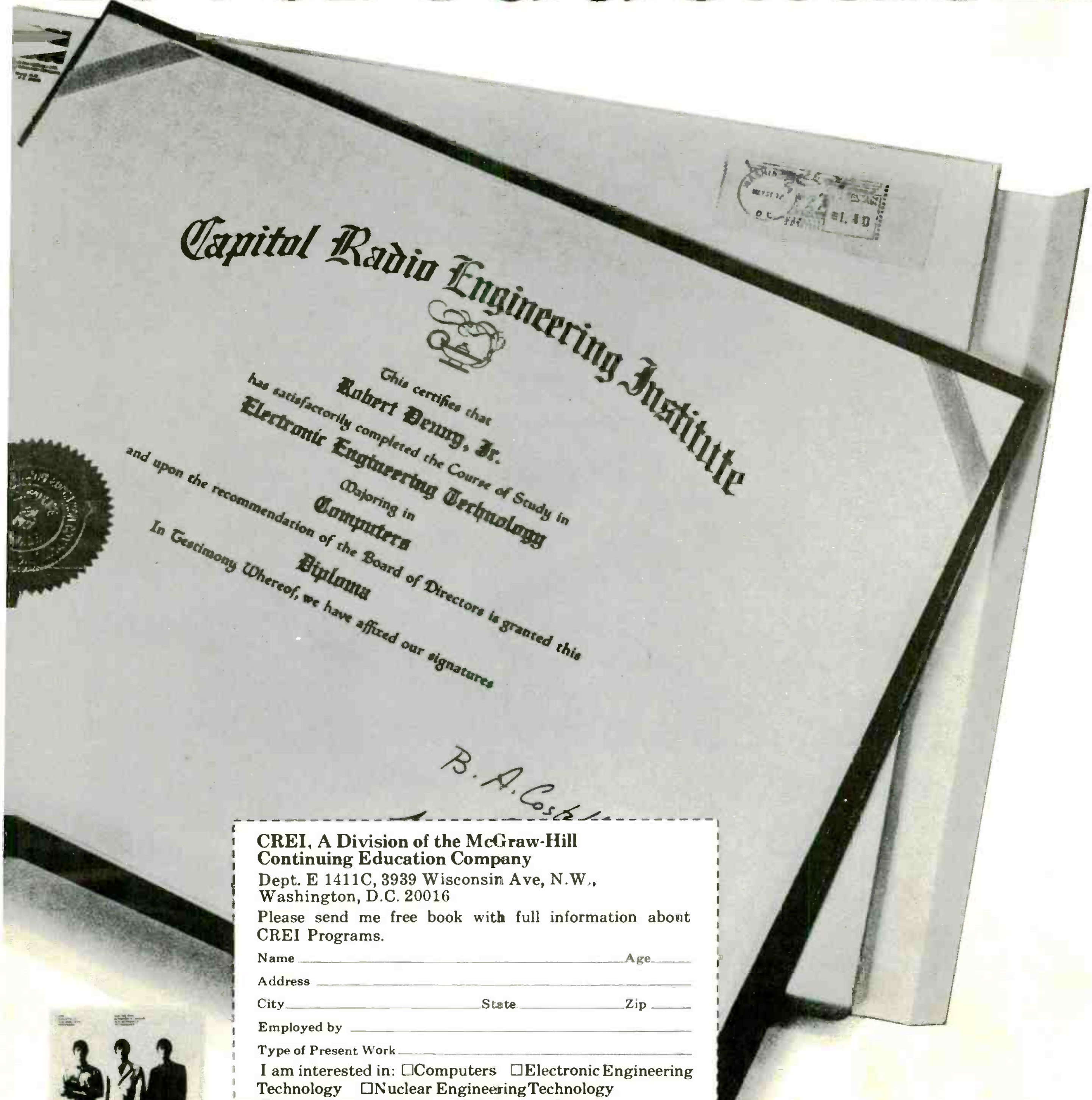

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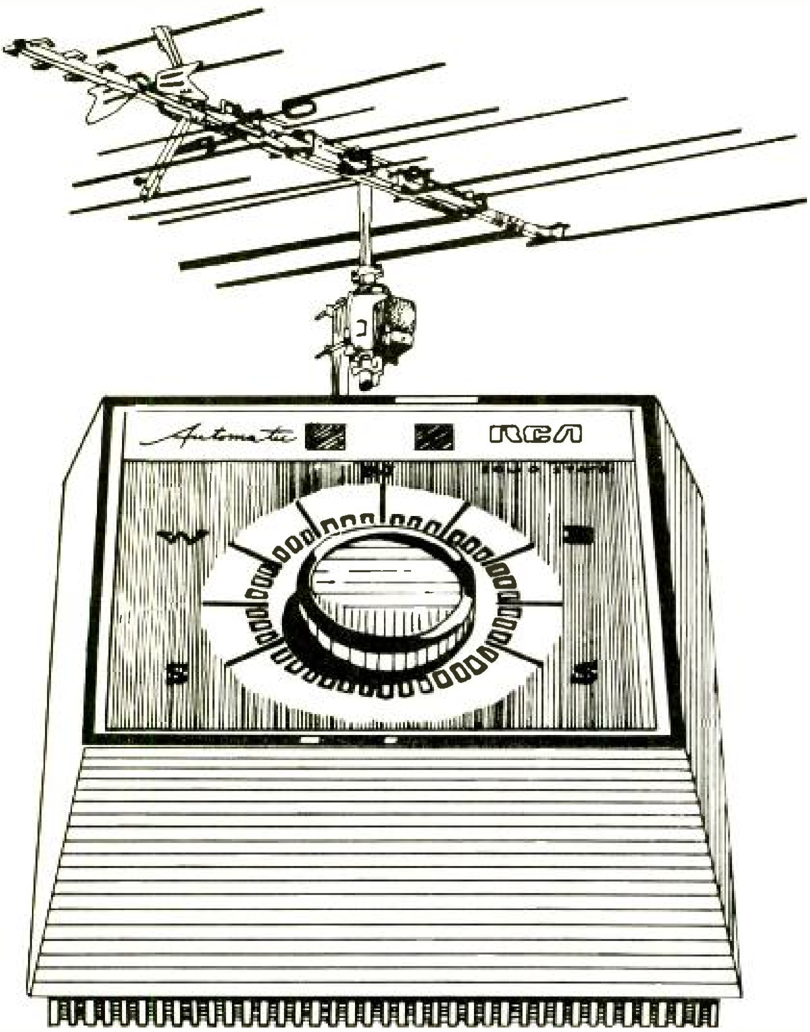


LETTERS

(continued from page 16)

"discrete" RCA-JVC record in practical playback situations. In SQ, the Lf and Rf signals are totally separated throughout the encode-decode process, while in the RCA-JVC, *demodulation* of the ultrasonic carriers followed by *dematrixing* must take place to separate Lf and Rf signals for 4-channel listening.

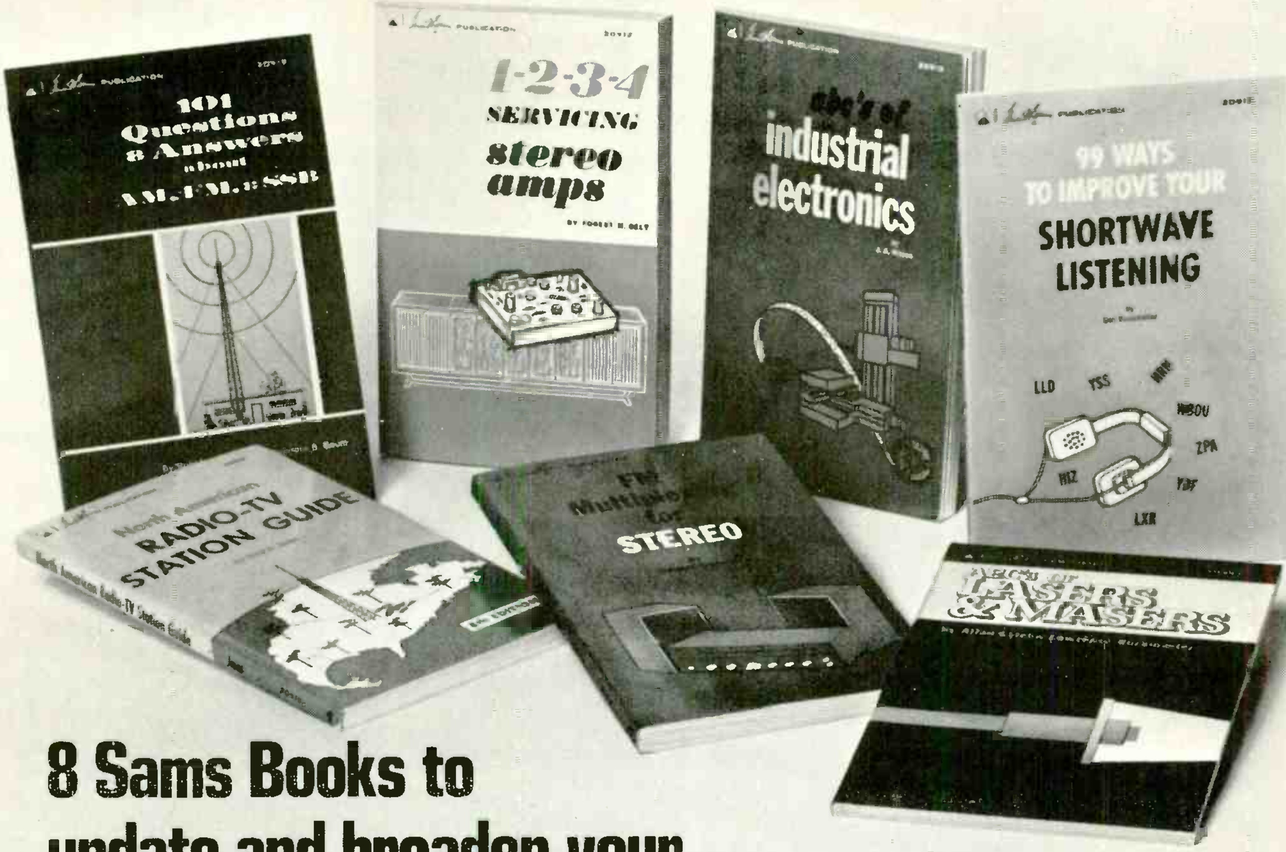
PETER SCHEIBER
New York, N.Y.

A "BETTER" IC OP-AMP

Referring to the article "Op-Amps At Work Using The 709" by B. R. Rogen in **Radio-Electronics,** September 1972.

It would be a disservice to your readers not to mention the "741" second generation op-amp (RCA, CA3741, Motorola MC1741). The 741 is a direct replacement for the 709 and requires no external frequency compensation, is output short circuit proof. It is also "latch-up" free and has a maximum of ±30 volts (with a power supply voltage of ±15 vdc) differential input signal range.

JAMES GUILBEAU
New Orleans, La. **R-E**



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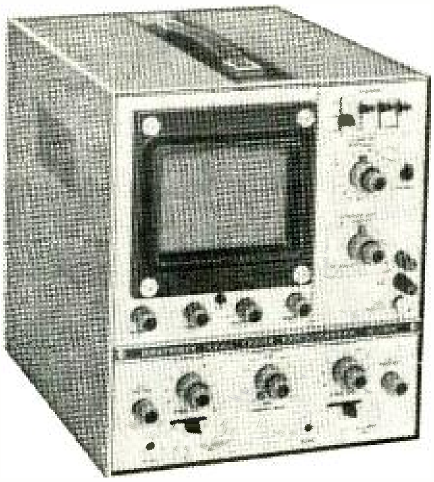
equipment report

Heathkit IO-105 triggered-sweep dual-trace scope



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OLDTIMERS WILL REMEMBER THAT ONE of the first Heathkits marketed some 25 years ago was a low-priced oscilloscope. The IO-105, Heath's latest, is a far cry from that instrument. It is probably the first oscilloscope kit to incorporate many features found only in laboratory instruments of considerably higher price. Like its lower priced cousin the IO-103 (**Radio-Electronics**, June, 1972), it is an all solid-state triggered-sweep instrument. However, as a study of its specifications will show, it is a good deal more sophisticated than the IO-103 and, therefore, can be used in many more applications, either in design work or on the service bench.

The dual-trace feature is a tremendous advantage in many kinds of design or service work since it permits the user to display two separate input signals side by side for direct comparison. Or one of the channels can be used to display an input signal while the other is displaying the same signal after it has passed through the piece of equipment being tested. A common time base is used for both the channel 1 and channel 2 amplifiers. When displaying two channels simultaneously, the user has a choice of two different modes of operations: *alternate* or *chopped*. In the alternate mode, the two signals are displayed alternately on successive sweeps. Of course, as the sweep speed is increased, the two signal traces seem to appear simultaneously. In the chopped mode, the two signals are sampled at a rate of 50 kHz.

A third mode: X-Y, displays channel 1 on the vertical (Y) axis and channel 2 on the horizontal (X) axis. This mode is useful when making input-output linearity comparisons, studying phase shifts and for displaying Lissajous patterns.

The channel 1 and 2 amplifier circuits contain identical wide-band amplifiers with a response from dc to 15 MHz with a variation of 3 dB. The rise time is 24 ns with an overshoot of less than 10%.

Both channels have 9-position attenuators in a 1, 2, 5 sequence providing a range from 50 mV/cm to 20 volts/cm. In addition, each channel has an uncalibrated variable gain control which can be used for vernier gain adjustments. The input impedance of each amplifier is 1 megohm shunted by 35 pF. Either ac or dc coupling is switch selectable.

Sweep circuits

The horizontal time base has 18 calibrated rates ranging from .2 μs/cm to 100 ms/cm in 1, 2, 5 sequence. Sweep accuracy is ± 3%. There is also a continuously variable uncalibrated sweep speed control. In addition, a panel push button provides a sweep magnification of 5 times.

The calibrated time base makes it possible to measure the frequency of any input signal within the frequency or voltage ranges of the instrument. This is one of the great advantages of a triggered sweep scope with a calibrated time base. Charts are provided in the instruction book for converting the TIME/CM selector switch settings to frequency. And the triggered sweep, of course, makes it easy to lock into a signal of any frequency for measurement or observation. Four triggering switches give great flexibility. The first selects either external, line or internal triggering: the second provides for ac or dc triggering. The third is for triggering either on

(continued on page 87)

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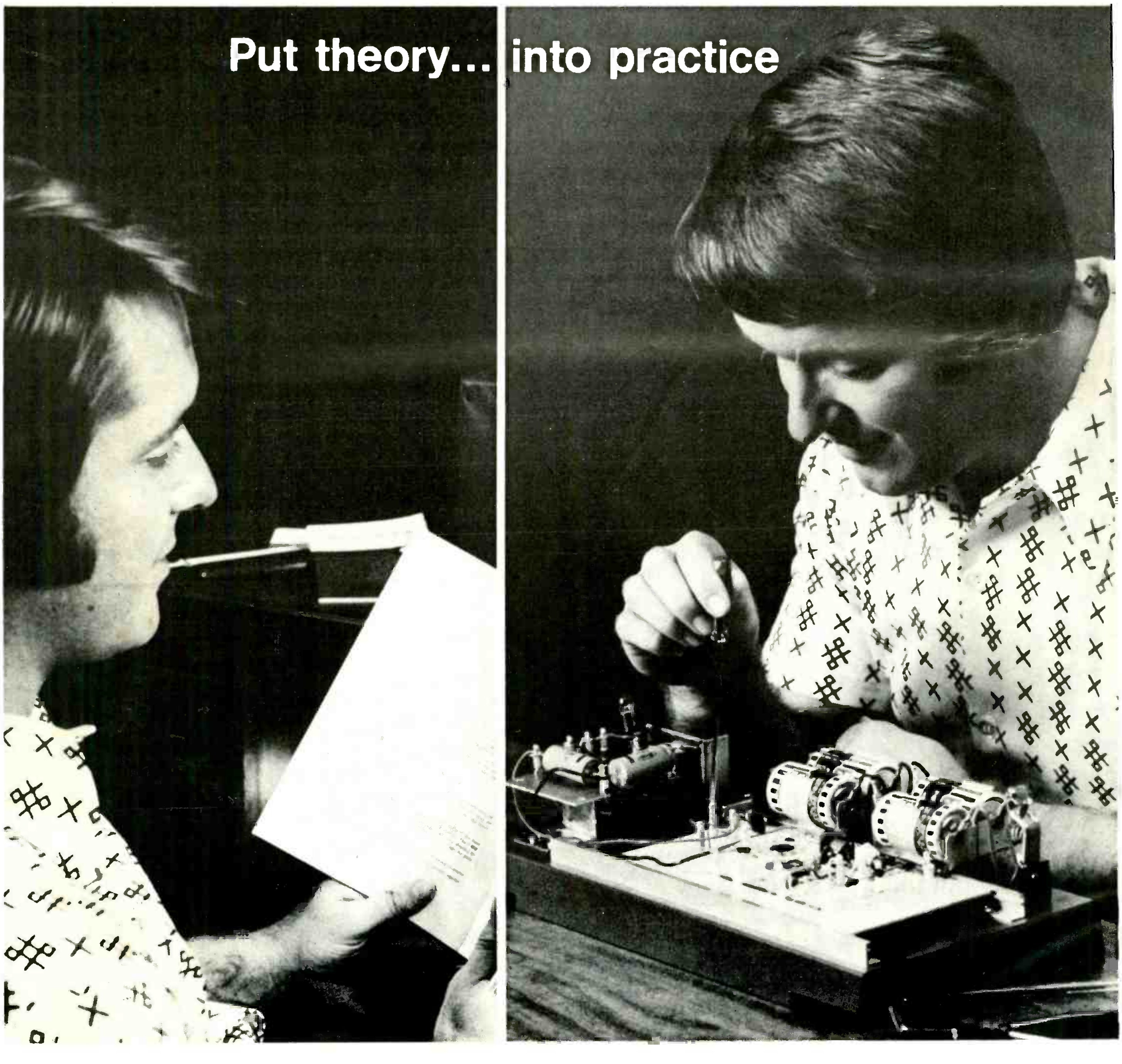

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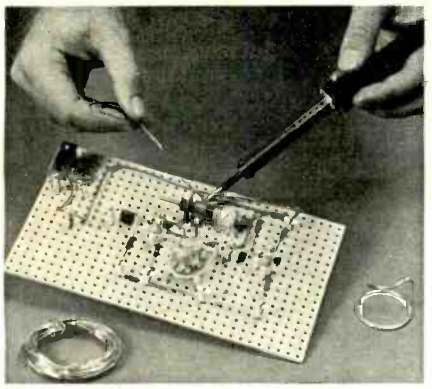

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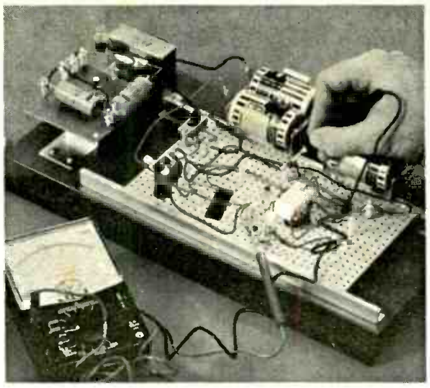

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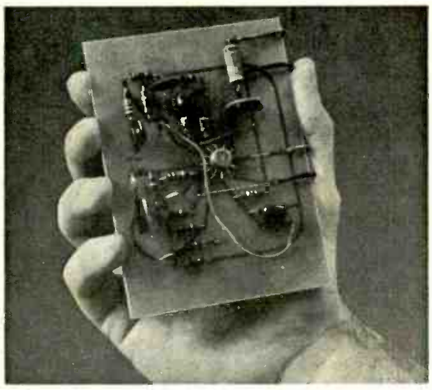

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Marvin Hutchens, Woodbridge, Virginia, says: "I was surprised at the relevancy of the CIE course to actual working conditions. I'm now servicing two-way radio systems in the Greater Washington area. My earnings have increased $3,000. I bought a new home for my family and I feel more financially secure than ever before."

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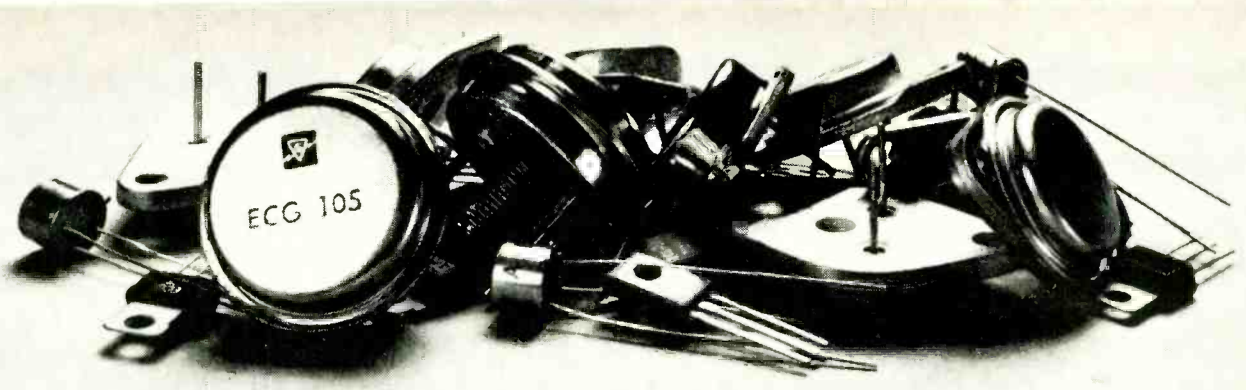

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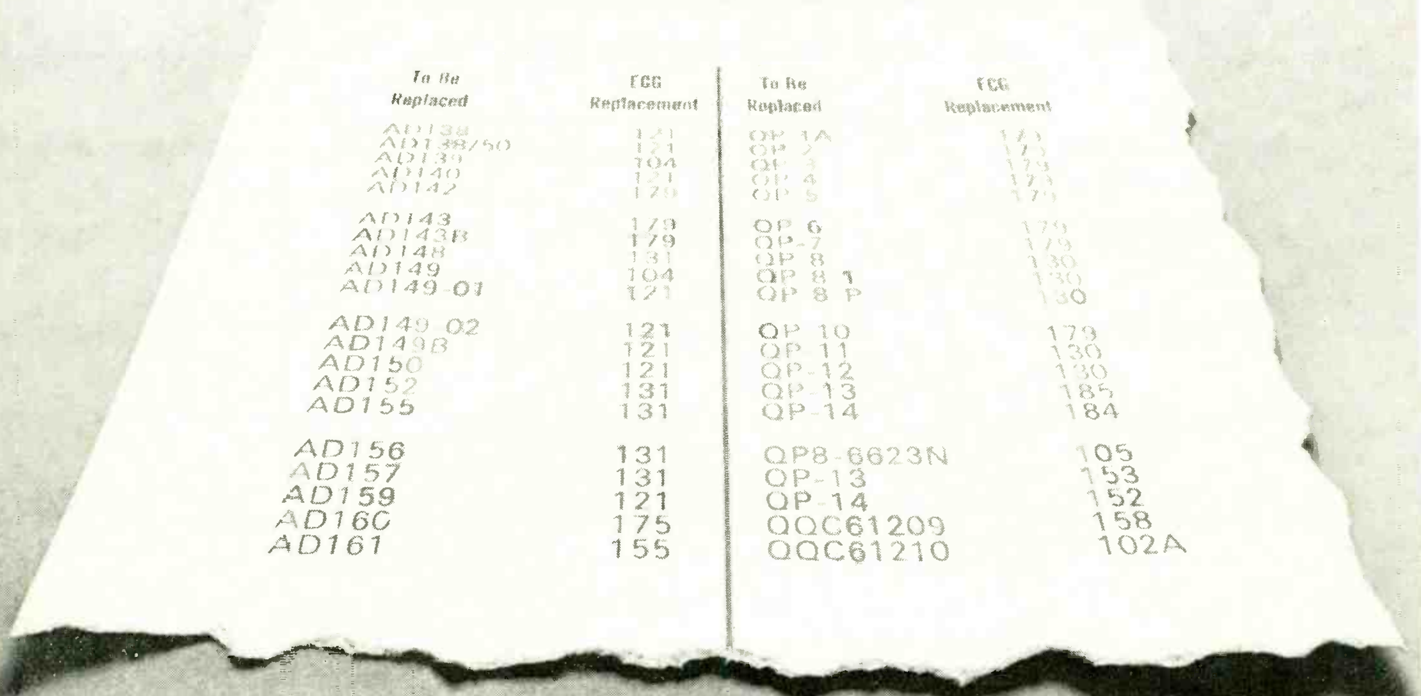

To Be Replaced	ECG Replacement	To Be Replaced	ECG Replacement
AD138	121	QP 1A	175
AD138/50	121	QP 2	175
AD139	104	QP 3	179
AD140	121	QP 4	179
AD142	179	QP 5	179
AD143	179	QP 6	179
AD143B	179	QP-7	179
AD148	131	QP 8	130
AD149	104	QP 8 1	130
AD149-01	121	QP 8 P	130
AD149-02	121	QP 10	179
AD149B	121	QP-11	130
AD150	121	QP-12	130
AD152	131	QP-13	185
AD155	131	QP-14	184
AD156	131	QP8-6623N	105
AD157	131	QP-13	153
AD159	121	QP-14	152
AD160	175	QQC61209	158
AD161	155	QQC61210	102A

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GTE SYLVANIA

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The foundation or mainframe of a group of useful and inexpensive digital test instruments for the lab, service shop and experimenters' workbench. Accessories plug into the readout.

BUILD R-E's GRINCHWAL DIGITAL TEST EQUIPMENT

by DON LANCASTER

VIRTUALLY EVERY DIGITAL INSTRUMENT needs an accurate internal time or frequency reference. For instance, an electronic digital counter needs 0.1-, 1-, and 10-second time gates, while an electronic stopwatch may need a source of 10-microsecond wide time period pulses, or a digital voltmeter may need a stable source of 100-kHz timing signals for *dual-slope integration,* used for accurate voltage to frequency conversion. This internal reference is usually called a *time base.*

One cheap time base is the power line, but it's hard to use in a battery-powered instrument and it doesn't have enough accuracy or stability to do justice to 4 decades of counting. So, traditionally, you had to go to a crystal oscillator and a bunch of current-hogging RTL or TTL decade dividers.

The digital grinchwal* does things differently. It starts with a crystal all right, but it uses a *single* integrated circuit that will give you any time or frequency reference you ask it to, from 1 MHz to 1 pulse per hour! To make things even nicer, the integrated circuit only draws 5 mA.

Figure 1 is a block diagram of the Mostek MK5009 time-base integrated circuit. You hang a 1-MHz crystal and some biasing and trimming components on its internal oscillator. You then send it a four-line code command that tells it how much to divide by, and out comes a reference frequency or time period that talks to the grinchwal counter or that can drive an ordinary RTL, DTL, or TTL integrated circuit. To program the IC to a desired division ratio, you use the code of Table 1. There are four input lines, called A, B, C, and D. A digital "0" is equal to ground, while a digital "1" is at or near the +6-volt supply. For instance, if you start with a 1-MHz crystal, and apply the code 0101, or A = 1, B = 0, C = 1 and D = 0, the IC divides by five decades, or 10^5, giving you either a 10-hertz output signal or a 100-millisecond period square wave. Accuracy to four decades can be obtained by trimming the crystal against WWV or another frequency reference, but even without any trimming you get a very stable and very accurate output.

You also get a *reset* input. Ground it and the IC runs normally. Make it 6 volts positive and the chip puts all its dividers in the 0 state. This is handy to *gate* your reference frequency for things like electronic stopwatches and sports timers. The reset and counters are synchronous. This means the first output cycle will be within a millionth of a second of the width of all the rest of the cycles.

There are several precautions in using this chip. Never apply reverse supply voltage or you will instantly zap it. Also, the unused inputs must be connected exactly as shown in Fig. 2, for the IC has some internal-test speedup modes it can get into if you, say, try to use −12 volts instead of ground for a logic "0". Note the 1-MHz direct output is too fast for the MK5005 counter and display plug-in, and thus can only be used on external circuits. With the addition of resistor R1, the two chips can talk to each other at any other reference time or frequency. And, like any other MOS device, an exceptionally unreasonable amount of mishandling can damage the chip, so leave it in its conductive foam carrier until after you have checked all the rest of your circuit out; then quickly and carefully solder it in place with a small soldering *IRON* (No guns please) and fine solder.

Building the mainframe

The schematic is in Fig. 2. Circuit boards, complete kits, and any and all parts are available from the source shown in the parts list. The grinchwal is

---

*grinchwal. *n,* (originated by author): gizmo, gadget, thingamajig. The digital readout and timebase of a multipurpose test instrument featuring plug-in modules for various functions or operations.

built in an unbreakable impact plastic case 5 × 6½ × 2½ inches deep. The power supply or the batteries mount in the upper bottom of the case, underneath a main PC board that contains the timebase and connector for the plug-ins and the counter module. A front panel covers the top half of the case, supporting a red filter for the display module, the CHECK and RESET pushbuttons and the OVERFLOW indicator. Besides the timebase and connectors, the PC board contains some supply filtering and reverse-polarity protection, a pulser for the reset line, a driver for the overflow indicator, and a "relay" (Q2, Q3) to control the -12-volt supply.

The PC board is shown in Fig. 3. You can get this commercially or etch and drill your own, using this pattern. All the components except IC1 may be mounted in place, watching the polarity on all the capacitors and diodes. A small four-wire flat cable makes the front panel connections neater, but plain old wire can be used. Note that the overflow indicator, being a light emitting *diode* is polarity sensitive. Be sure to connect it exactly as shown in the schematic with the narrow pin going to the IND terminal and the wide pin going to ground. Don't add IC1 till after the preliminary checkout.

You have a choice of batteries or a line-operated power supply. The battery supply—for maximum portability—consists of two 9-volt transistor radio batteries and four type C cells (alkaline for long life) connected as in Fig. 4-a. Note that the +terminal of the 18-volt battery goes to the +terminal of the 6-volt battery, *not* to ground! Use the line-operated supply in Fig. 4-b if you don't really need extreme portability and like to leave test instruments on for long periods of time. If you want to use *both* a power supply and larger batteries or rechargable batteries, you'll probably want to go to a somewhat larger case. A two-transistor and transformer inverter may be used to convert the +6 volts to -12 volts if you want to do away with the two 9-volt batteries.

Whatever route you pick, the power source mounts under the main PC board, leaving the bottom half of the case open for the plug-ins. Power needs are 6 volts at 125 mA and -12 at 5 mA.

Using the mainframe

We'll be showing you several plug-ins from time to time, but if you're designing your own modules, the following guidelines should be of some help.

The power ON-OFF switch goes between +6 volts and +6SW. With the Q2, Q3 relay it also controls -12 volts. The decimal-point selector goes between DP IN and the chosen DP1, DP10, DP100, or DP1K. If you don't connect it or else connect it to DP1, you'll get just a number displayed with all three left-hand zeros lopped off. If you can arrange things so you get a "0" reading between measurements, this will radically extend the battery life.

The timebase is activated by switching a "1" (+6 volts) and a "0" (ground) to inputs A, B, C, and D following the truth table of Table 1. The timebase OUT terminal may be connected directly to the COUNT terminal of the counter/display, or else it will drive one TTL or DTL input. You reset the timebase by putting +6 volts on the normally grounded RST line.

The COUNT input may be connected to a RTL, DTL, or TTL output in your plug-in, to the timebase output, or to +5 volts through a capacitor. It free runs (self-oscillates) with the capacitor and follows the counting with either the timebase or your external low-impedance logic source. UPDATE will follow the counting if grounded and keep the old count if at +6 volts. Reset for the count module forces the counter to zero if it is grounded. If you push the RESET button, you get a brief pulse going to ground on this terminal every time you hit the button. You can use this for a resetting signal for your plug in. Note that the resets of the counter and timebase are backwards in action. If you decide to reset both at once, you need an inverter to ground the counter while applying +6 volts to the timebase. RESET only resets the counter, not the display. To get a 0000 reading, you have to simultaneously reset and update the counter module.

The OVERFLOW output goes to ground on count 10,000 and stays there until reset. It may be directly connected to the IND input to light the overflow lamp, or it will drive one logic load in your plug-in. If you want to independently light the overflow indicator, you ground the IND input instead of connecting it to the OVERFLOW output on the counter module. A ground lights the lamp; +6 volts puts it out.

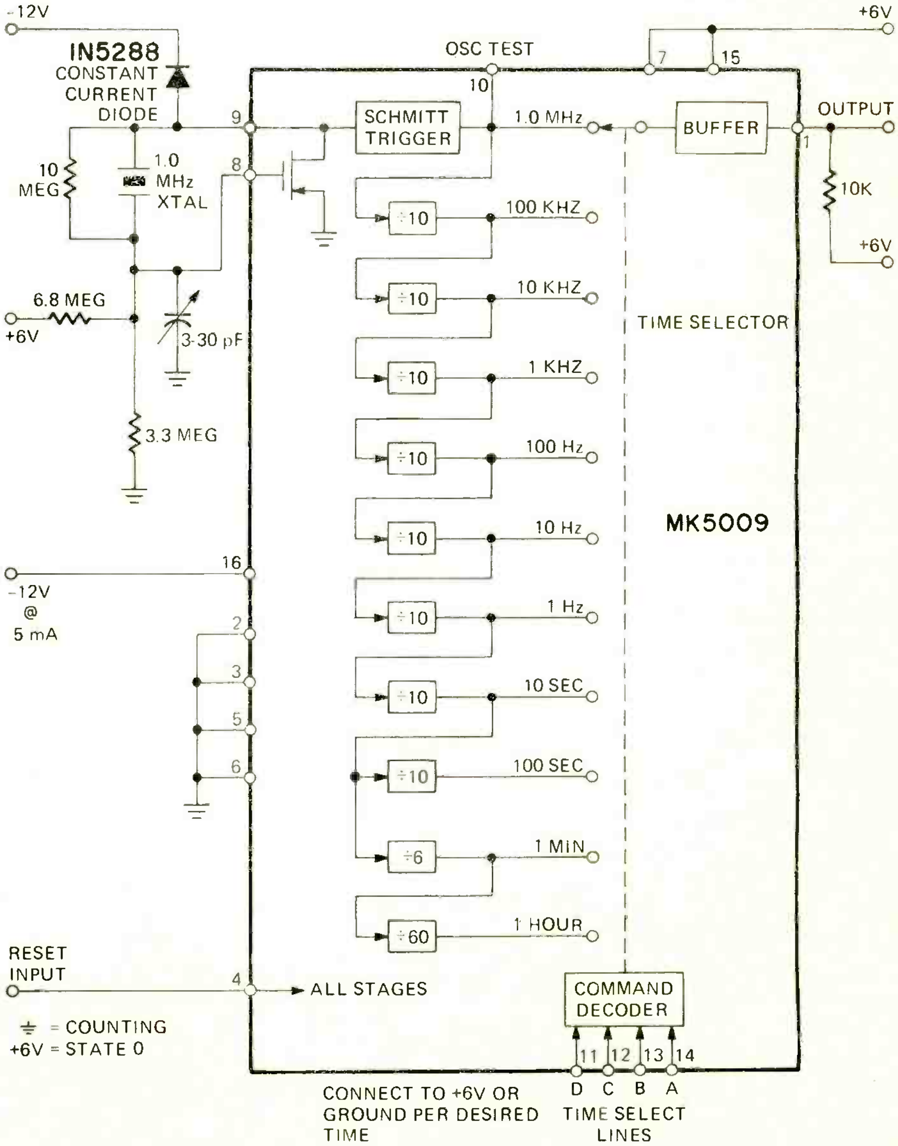


FIG. 1—BLOCK DIAGRAM of the time-base IC and the basic circuitry. This and the digital readout form the heart of several test instruments.

PARTS LIST

C1—3-30 pF trimmer capacitor
C2—5 pF mica capacitor—optional; needed only with certain cyrstals
C3, C5, C7—0.1 μF, 10-volts disc ceramic capacitor
C4—47 μF, 15-volt electrolytic
C6—220 μF, 6-volt electrolytic
D1, D2—1N914 diode
D3-D6—1N4001 diode
D7—1N5288 constant-current diode **DO NOT SUBSTITUTE**
IC1—MK5009P time base IC (Mostek), special design built for Don Lancaster projects.
LM1—MV5023 LED panel lamp or equivalent
S1,2—Spst momentary pushbutton
Q1,2—2N5139 transistor, silicon pmp
Q3—2N5129 transistor, silicon npn
R1,6,8—10K, ¼ watt carbon resistor
R2—2.2 megohm carbon resistor
R3—6.8 megohm, carbon resistor
R4—3.3 megohm carbon resistor
R5—1 megohm carbon resistor
R7—330 ohm carbon resistor
R9—4.7K, carbon resistor
SO1-4—10-pin chassis mounting socket, Molex 09-52-3103
XTAL 1—1.00 MHz crystal and mounting clip

MISC: PC Board per Fig. 3, plastic case; 9-volt battery clips (2); spacer foam for batteries; Dual C holders (2); front panel; red filter; mounting hardware; wire; solder.

NOTE: The following are available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas, 78216: PC Board, etched and drilled No. DGM-b, $4.85 postpaid. Circuit board for readouts, No. DGR-b, $3.85 postpaid. Kit of parts for readout, No. DR-C, $34.50. Kit of parts for mainframe and timebase plug-in, including case and front panel, No. DM-C, $26.75, less readouts and batteries, postpaid.

POWER SUPPLY PARTS LIST

C1—5000 μF, 10 V electrolytic
C2, 3—500 μF, 25 V electrolytic
D1, D2, D3, D4—1N5061 silicon power diode, 1 A to plv
D5—12-V Zener diode, 1N4742 or equivalent
F1—0.1 A fuse and fuseholder
IC1—6-V positive regulator, Fairchild 7806
R1—27 ohms, ¼ watt
T1—12.6 VCt, 100 mA transformer (Signal PC 12-100 or equal)

MISC: PC Board for power supply; line cord; PC terminals (Optional) (5); solder.

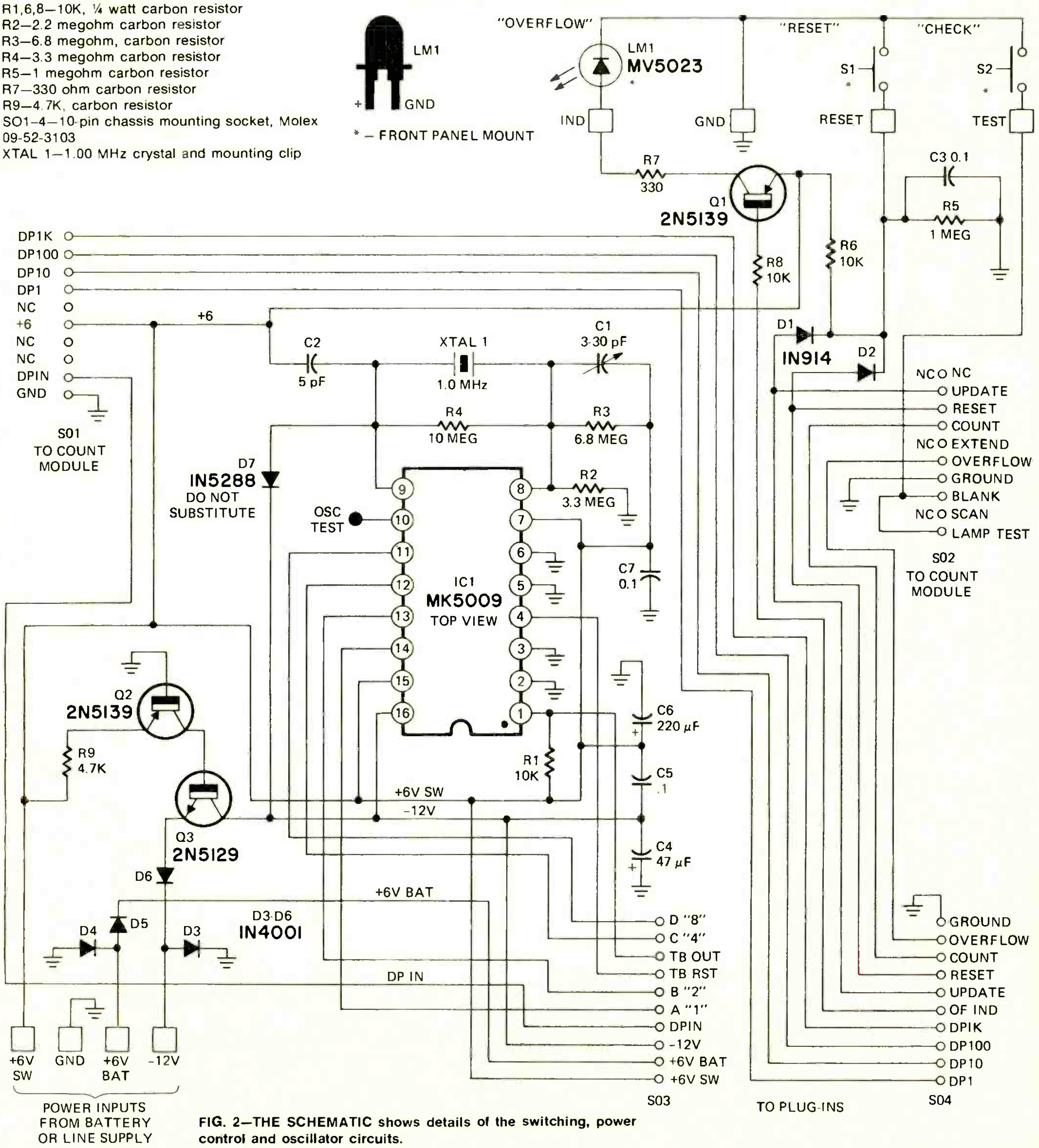


FIG. 2—THE SCHEMATIC shows details of the switching, power control and oscillator circuits.

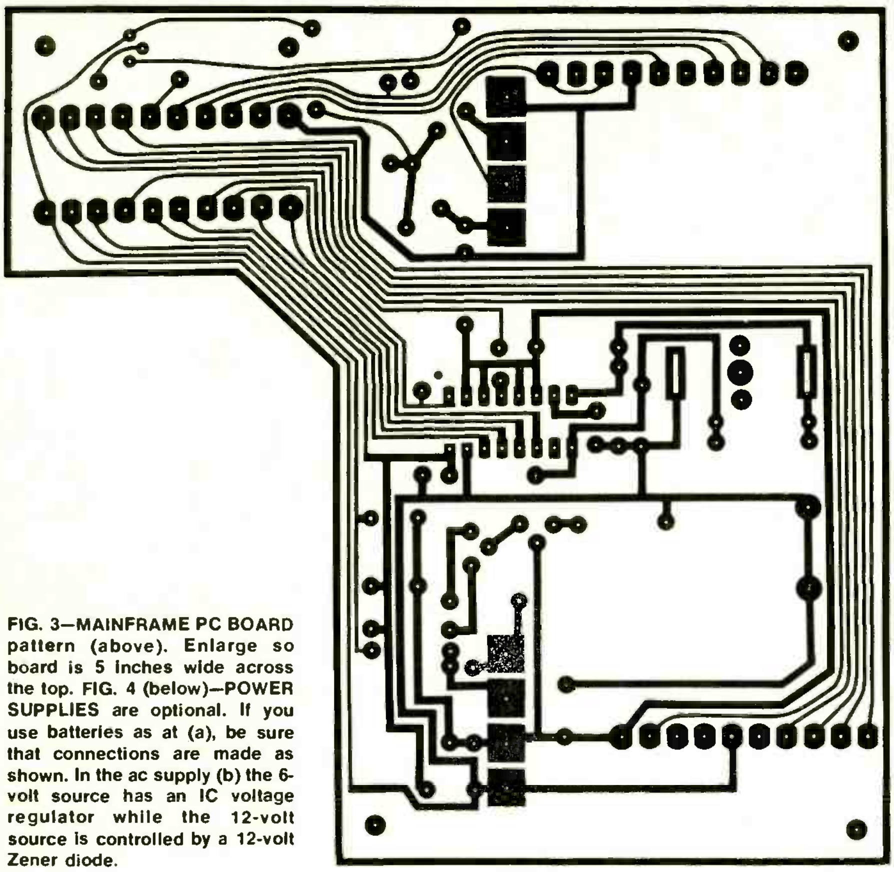
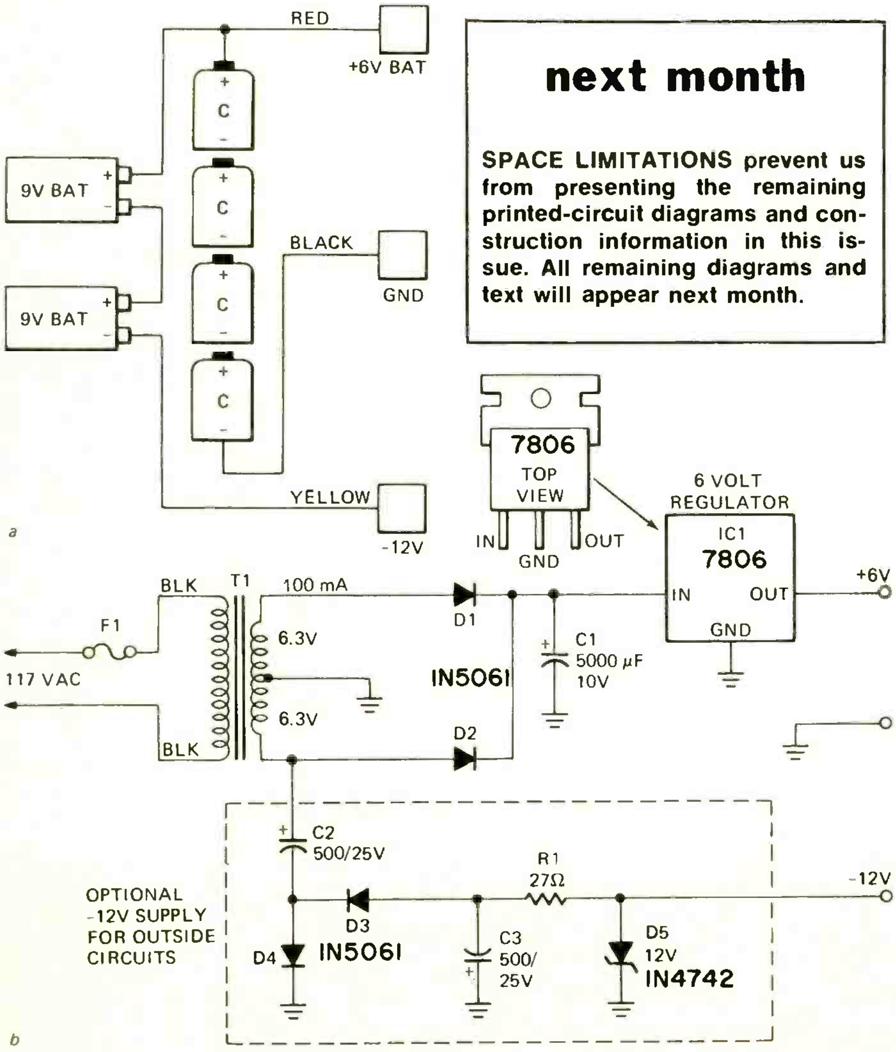


FIG. 3—MAINFRAME PC BOARD pattern (above). Enlarge so board is 5 inches wide across the top. FIG. 4 (below)—POWER SUPPLIES are optional. If you use batteries as at (a), be sure that connections are made as shown. In the ac supply (b) the 6-volt source has an IC voltage regulator while the 12-volt source is controlled by a 12-volt Zener diode.



next month

SPACE LIMITATIONS prevent us from presenting the remaining printed-circuit diagrams and construction information in this issue. All remaining diagrams and text will appear next month.

When you're using the grinchwal with your plug-ins, there are two additional design quirks you have to allow for that could cause you some headaches if you don't know about them. First, note that resetting the counter also resets the internal digit scanner. If you reset the counter too often, some of the numbers will not get displayed, or some of the digits may vary cyclically in brightness. To get around this, limit the number of *new* measurements you make to less than 30 per second. If you must go faster, the scanning capacitor (C1) on the counter plug-in could be reduced in value, but too small a C1 causes decimal-point ghosting and possible leading-edge blanking problems.

The second thing you have to allow for is to make sure that at least one count happens *after* you update if you want to keep the old answer and not reset immediately. This means you can't directly use the falling edge of an input gate as an update if it does away with the input at the same time. The input signal should continue at least one count after updating—making it nearly continuous is one obvious way around the problem.

Ideas for plug-ins

Timebase—Bring out the timing signals and you have a precision scope calibrator, source of timing signals, precision digital clock pulses, a source of timing clocks for lab experiments, an ultra-stable squarewave generator, etc.

Stopwatch—Simply gate the timebase with a set-reset flip-flop to get the time between events, or gate it directly to get the duration of a single event. You can measure any time interval from 10 microseconds to 9999 hours. Use it for a sports timer, a rally computer, photographic stopwatch for shutter testing, physics experiments, ballistic velocity checks, etc . . .

Frequency counter—Use the 0.1-, 1-, or 10-second output of the timebase to turn on and off a signal whose frequency you want to measure. The input frequency should be conditioned by going into a digital comparator. Maximum direct operation is around 200 kHz, but you can easily add scalers to count any frequency you want. With Schottky TTL, you can count beyond 100 Mhz, and by using more than one trip through the counter, you can get more than 4 decades of accuracy. For instance, a 10-second gate and scalers can give you a six-digit accuracy, for any input above 100 khz.

This list could go on and on. What can you do with a completely portable instrument that will measure or monitor anything you want to 0.01% accuracy? We'll show you how to do some of the common plug-ins. How about you showing us newer and better uses for the Grinchwal? **R-E**

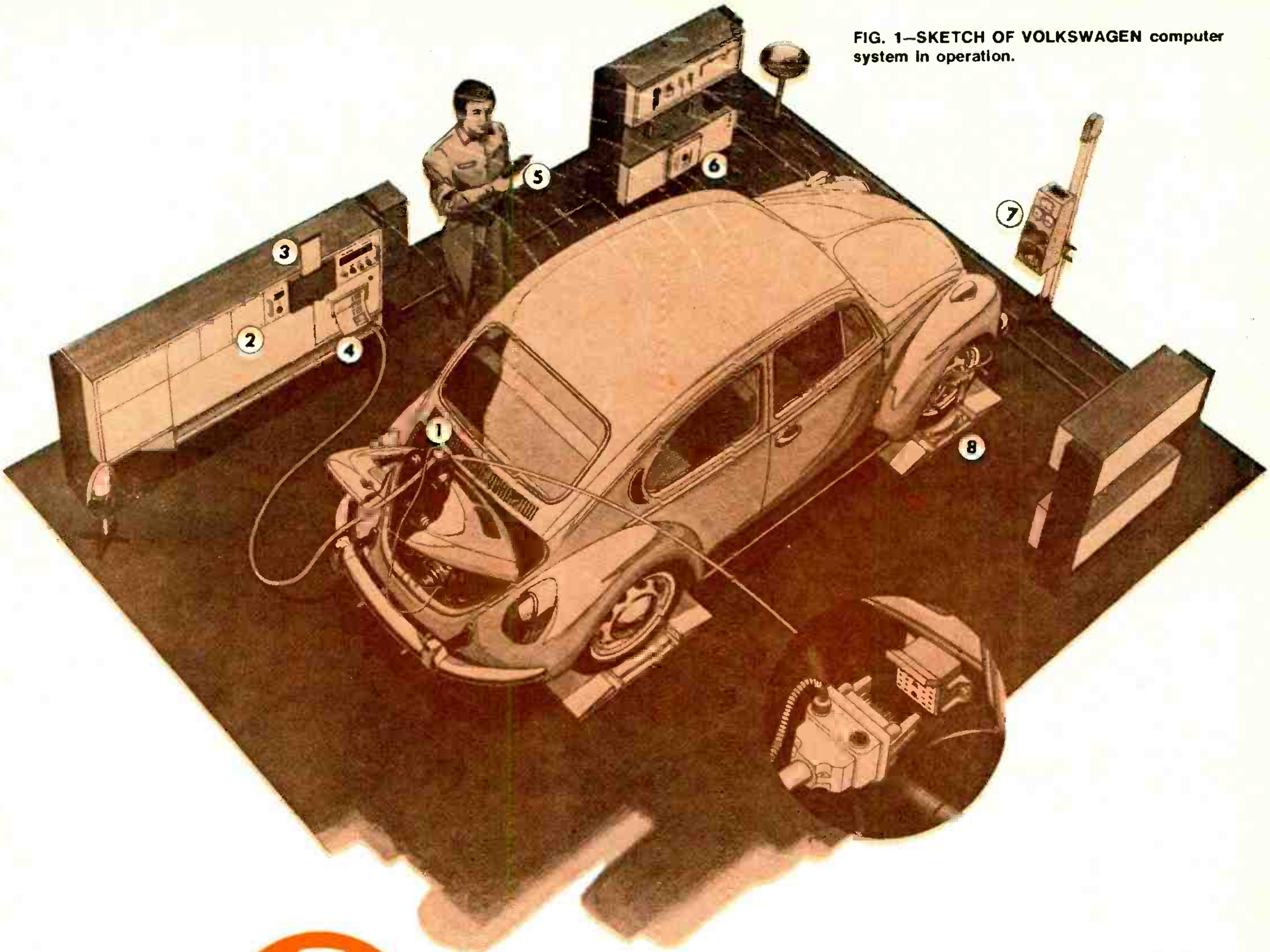


FIG. 1—SKETCH OF VOLKSWAGEN computer system in operation.

computer checks out your car

A fore-runner of things to come, Volkswagen's built-in self-analysis system slashes auto diagnosis time.

by FRED W. HOLDER

VOLKSWAGEN SCOOPED THE AUTO INDUSTRY IN 1968 WHEN IT introduced electronic fuel injection to avoid the use of power-consuming anti-smog devices. Another "first" is in the offing: computerized self analysis, a system designed to revolutionize automotive diagnosis. Volkswagen is introducing this new system at U.S. dealerships now. The system has been in use at European dealers for some time.

VW's Computerized Self-Analysis System is designed to checkout 1972 and later model Volkswagens, that have a built in central test socket and a network of sensors. It will, however, checkout any 12-volt VW (1965 and later models) through the use of an adapter cable. With a capability for 150 test operations, the system currently makes more than 60 separate checks on the VW Beetle in just 21 minutes. The current diagnosis method takes approximately 42 minutes to complete. The customer receives a printout showing exactly what work needs to be done to bring his car to standard specifications. With this check sheet as a guide, he may save on both parts and shop time.

The system uses space-age telemetry techniques to perform complicated checks of front-wheel alignment, ignition performance, engine compression, and battery condition in just seconds. The technician connects the system's digital computer to the car's sensor network with a single, multistrand cable which plugs into the car's central socket. He then inserts a program card into the computer card reader to provide specifications on the year and model of VW being tested. The program card is run through the computer as the technician signals the next test step with a hand-held input unit. The system produces both visual and printed results as the test progresses.

At certain points in the count-down, the system switches to automatic sequence and performs a variety of checks in rapid succession, comparing the readings against standard values and printing the results on a high-speed printer. For example, during one of the four automatic sequences, checks are made and the results printed for: battery voltage, voltage under load; parking, tail, and license plate lights; operation of stop lights; battery acid level; turn signals left; turn signals right; and rear window defogger.

System components

Figure 1 shows the principal components of the system. Item (1), and the insert, shows the central socket and the test cable used to connect the car to the computer (2). The thin armored cable leading off the top of the plug reads engine oil temperature. The computer console contains the program card reader (3). Each VW from Beetle to Bus has its own program card. Results of the more than 60 checks performed on the vehicle are recorded by the high-speed printer (4).

Many of the tests are performed by the technician using a hand-held input unit (5). The technician is told the "count down" sequence by a visual display in the hand-held unit. Buttons are provided to indicate GO and NO-GO conditions for visual checks.

Front wheel alignment is inspected using a photo-electric unit (6). The condition of the alignment is tested and recorded simply by turning the steering wheel. At a given position, camber and toe-in are recorded for each front wheel. Headlights are checked for both brightness and adjustment by the tester (7) mounted on tracks at the front of the car. Proper setting of the car for front wheel and headlight checks is ensured by positioning it on four pads (8). These pads also place the car correctly over a hoist that lifts the car for under-vehicle inspections.

Functional description

As shown on the block diagram of Fig. 2, test signals from the car's sensor network are routed through a 28-strand cable to the signal conditioning circuits. Here, the signals are conditioned, amplified, filtered, and brought into a system-compatible form. They are then available for multiplexing and further processing.

TECHNICIAN USES HAND-HELD INPUT UNIT to follow test countdown. Unit feeds the test findings into the computer at left.

Analog storage holds peak and temporary data until it is called for by the multiplexer. The multiplexer uses field-effect transistors and reed relays to select the desired test data channels, as instructed by the test step on the program card, and routes it to the analog-to-digital converter (ADC). The ADC converts the analog voltage signal to its equivalent as a three digit binary coded decimal (BCD) number for display and printing. The ADC is a voltage-to-frequency converter with a conversion rate of 100 Hz per volt.

With an input voltage of 10 volts, the total error is less than 0.5%. The output frequency is gated with a time-base signal and used to drive a three-digit BCD counter. The output of the counter is decoded and displayed. Also, the BCD data value is simultaneously checked in the dynamic comparator to determine whether it is within the tolerance limits specified by the program card.

Figure 3 shows the working principle for one BCD digit of the comparator. The lower tolerance range limit digit is gated with the BCD digit at gate group G1. At the start of the conversion time (when the time base signal enables the gate and allows the ADC signal to drive the BCD counter), the counter data content is zero and the flip-flop FF1 is in the NO-GO state. As the count increases and reaches the lower limit, a coincidence signal is generated by gate G2 and flip-flop FF1 is set to the GO state. If the BCD counter value exceeds the upper limit at gate group G3 before the time base signal stops the count, flip-flop FF1 is reset to the NO-GO state. The results of the comparator check are displayed on the computer console and printed as a plus or minus sign next to the actual data value. The printer is a version of the standard type used in small calculators. It has been adapted to meet the special application of this system.

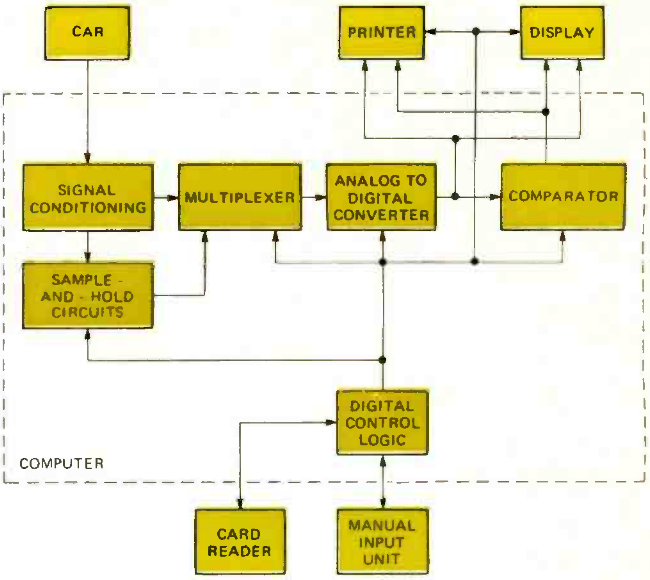


FIG. 2—BLOCK DIAGRAM of computerized self-analysis system shows the major functional areas and their interconnections.

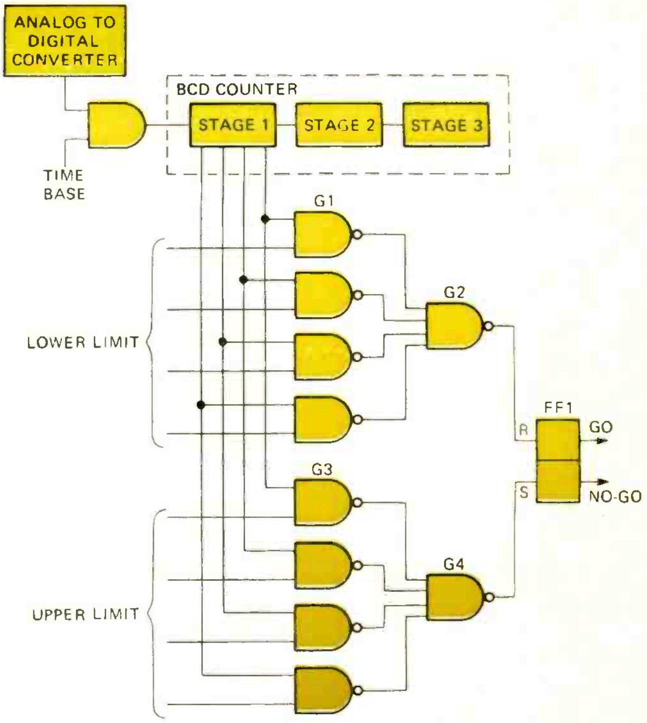


FIG. 3—SIMPLIFIED DIAGRAM OF COMPUTER CIRCUIT used to check test values from the automobile against specified limits.

Testing progresses automatically until a visual or manual test must be made. (Such tests include operation of the windshield wiper, windshield washer, condition of tire tread, oil leaks, etc.) At this point, a film strip in the hand-held manual input unit tells the technician what to check. If the item checks OK, he presses the plus-sign button; if it doesn't, he presses the minus-sign button. Either button advances the sequence to the next item to be checked. The technician continues to perform tests until another automatic sequence is reached. The film then advances automatically in synchronization with the test program as checks are completed until another manual check is indicated on the program card. This procedure continues until all of the more than 60 tests are completed.

All of these activities are supervised by the central control unit, which receives inputs from the program card, the manual input unit, and the car itself. It generates the control signals necessary to perform each test step and record the resulting data.

The program card has a capacity of 150 test steps although only about 60 are used at present. The card contains a 32-bit control word for each test step as shown in Fig. 4. Bits 1 through 6 designate the test subprogram to be used and bits 7 through 14 designate the multiplexer data channel to be sampled. Bits 15 through 22 contain the lower acceptable limit and bit 23 the sign for the lower limit. Bits 24 thorugh 32 contain the upper limit value and its sign.

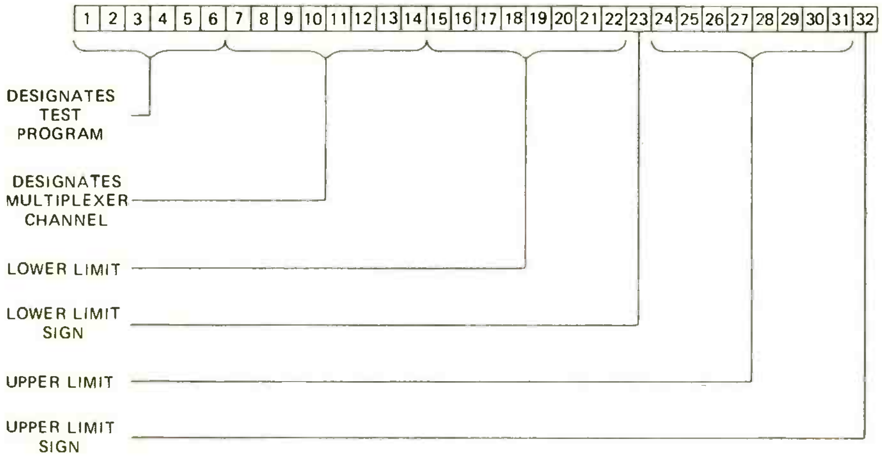
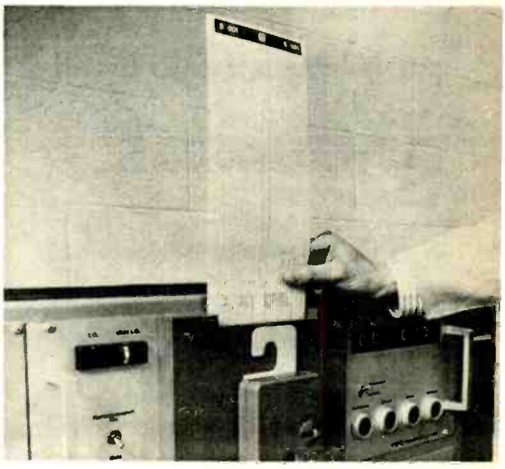


FIG. 4—MAKE-UP OF THE PROGRAM-CARD CONTROL WORD. A separate 32-bit control word is used for each of 60 different tests.



PROGRAM CARD is fed into card reader to ready the system to check out the next car.

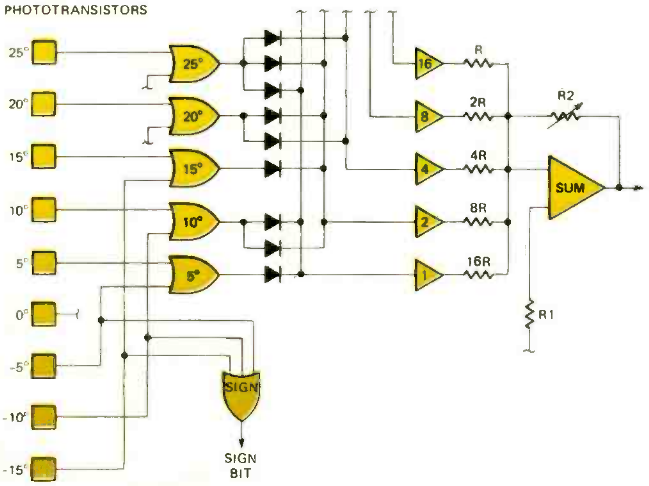


FIG. 5—SIMPLIFIED DIAGRAM OF DECODING CIRCUIT used to convert phototransistor signals into a scaled analog voltage.

Automatic tests

During automatic tests, the system monitors and records the status of the item being checked. These tests include items such as turn signals, parking, tail, and license plate lights, stop lights, defogger, battery, wheel alignment, starter performance, compression, dwell angle, generator and regulator, and headlights. All of these items except wheel alignment are checked by monitoring the internal test circuits wired to the central socket on the vehicle.

Current Consumer Tests: Includes items such as light bulbs and the defogger heating coils. Because the power consumption at a given voltage depends upon the resistance of the circuits, it is possible to learn a great deal from a resistance check. This is especially true when there are a limited number of consumers in a circuit; for example, the stop light circuit. In this case, if either of the two lamp filaments are shorted or open, a significant and measurable change from the standard reading will occur. Thus, the turn signal; parking, tail, and license plate lights; stop lights; and rear window defogger circuits are all checked by passing a current through the circuit, measuring the voltage drop, and comparing it against the limits specified on the program card.

Battery Checks: Three checks are made on the storage battery: (1) First, the battery voltage is read and recorded without any load. (2) Then, a resistor is switched into the circuit to provide a temporary test load for a specified length of time. Just before the load-time runs out, the battery voltage is recorded and compared to the tolerance limits specified for this test. (3) Finally, a built-in probe, normally immersed in the battery electrolyte, provides an electric potential reading to the computer. If the electrolyte drops to an unsafe level, the probe is no longer in contact with the electrolyte. The electric potential is missing from the probe, indicating a NO-GO condition to the computer.

Front-End Alignment: The front-end alignment is measured automatically by optical/electronic equipment using mirrors attached to the front wheels. A cross-configured light beam is directed from a projector to the mirror attached to the wheel. The mirror reflects the cross of light to the projector backing plate where it illuminates two rows of phototransistors, one row for vertical and one row for horizontal. The camber and toe data are indicated by the shift of the projected cross in relationship to the location of the zero coordinates of these rows. By turning the steering wheel, the technician triggers the sensors and obtains a measurement having an accuracy of five minutes of arc. The signals from the phototransistors are decoded and fed into the computer for evaluation.

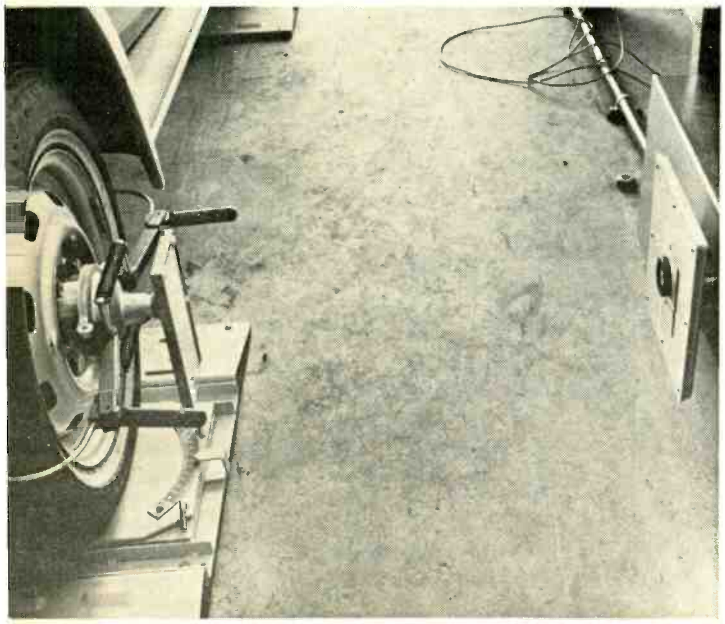
Figure 5 is a simplified diagram of the decoding scheme used to convert the phototransistor signals into scaled data for processing and printing. The circuit features an adjustment (R2) to compensate for different width workstalls in the various dealerships. Also, because the reflected light beam covers two adjacent phototransistors, it is necessary to use a one-step code to prevent inaccurate readings. The extended Gray code was selected for this system. The characteristics of this code is that a change of the code word by one step causes a change of only one bit. (Figure 6 shows sample bit configurations for this code.)

The same data value will be recorded whether the plus or minus phototransistor has been illuminated by the cross of light, because the outputs of phototransistors having like values are OR-gated before encoding into the Gray code. The output of all negative phototransistors are OR-gated to produce the sign bit.

STEPS	WEIGHT				
	1	2	4	8	16
1	1	0	0	0	0
2	1	1	0	0	0
3	0	1	0	0	0
4	0	1	1	0	0
5	1	1	1	0	0
6	1	0	1	0	0
7	0	0	1	0	0
8	0	0	1	1	0

FIG. 6—GRAY CODE is a cyclic code used to minimize errors when converting analog quantities into binary form. This is a sample.

The encoded signals are then converted to weightable binary code in a summing network. The resulting analog voltage is scaled to compensate for work stall width. The analog voltage output of the summing amplifier changes synchronously with the steering wheel motions made by the technician. As the steering wheel is rotated, this analog voltage is sampled and stored until called by the computer for processing.



LIGHT FROM PROJECTOR (right) is directed to mirror attached to front wheel to check the vehicle's front-end alignment.

Starter and Compression Test: When the starter motor is activated, an analog voltage drop is developed in the battery ground strap near the car body. This voltage drop is in the order of millivolts and must be amplified before it is processed; however, it contains the necessary data to evaluate starter motor performance and cylinder compression. This analog voltage contains two components: a dc-component depicting the power required to overcome the mechanical drag inherent in the entire starting system and a superimposed ac-component which depicts the variation in starter motor current caused by cylinder compression.

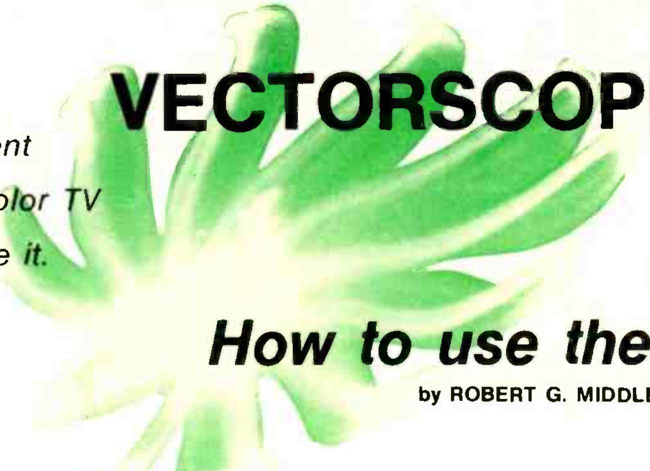
The ignition circuit is grounded through a resistor during this test to prevent the engine from starting. The starting procedure is long enough to allow good engine rotation before the starter current test is triggered. At this time, the starter current is read and four positive peaks of the ac-component are read and stored for evaluation. These peaks are related to their respective cylinders by correlating them with the trigger impulse sensor on the cylinder number one ignition cable. The lower limit of the peak values is automatically checked and compared with the nominal values given on the program card.

Dwell Angle Check: The dwell angle check is a measure of the equivalent time during which the breaker points are closed. During this test, the ignition coil terminal is monitored and the resulting voltage surge caused by the ignition points opening and closing is converted to a rectangular impulse. These rectangular impulses are integrated into a dc voltage level, which is an analog voltage representing dwell angle.

COMPUTER PRINT-OUT tells mechanic and VW owner what needs to be done to bring the automobile up to standard specifications.

Regulator and Generator Check: At 2000 rpm the generator voltage is reached and the voltage ripple resulting from the regulating process is smoothed out. Thus, when the engine rpm reaches 2000, the voltage is sampled. An external resistor is then switched into the generator output circuit to check it under load. After a defined period, the voltage is sampled, stored, displayed, and printed.

The Computerized Self-Analysis System marks a new trend in automotive servicing. It aids the mechanic in diagnosing complex systems and prevents him from inadvertently skipping items that should be checked. The result should be a savings in time and money for the VW owner, as well as greater confidence that his car is performing to standard specifications. **R-E**



VECTORSCOPES

This oft-ignored test instrument has no peer in some phases of color TV servicing. Get to know and use it.

How to use them

by ROBERT G. MIDDLETON

ALTHOUGH VECTORSCOPES HAVE BEEN around for some time, few of us know how they work, and how to use them in TV troubleshooting procedures. Therefore, let's start at the beginning and take it step by step.

There are several types of vectorscopes, and as would be anticipated, we can do more with the comparatively elaborate instruments. Fig. 1 shows the configuration of a basic vectorscope. It is simply a cathode-ray tube with supply voltages, operating controls, and capacitive coupling to the vertical and horizontal deflection plates. This arrangement has a deflection sensitivity of roughly 35 volts peak-to-peak per inch, depending on the screen size and type of crt.

Basic Lissajous patterns

All vectorgrams are based on Lissajous patterns. If we apply sinewave voltages of the same amplitude and frequency, but with a phase difference of 90° to the vertical and horizontal deflection plates respectively, we expect to obtain a circular pattern, as in Fig. 2. However, in practice, the sinewave voltage applied to the horizontal deflection plates (Fig. 1) must have somewhat greater amplitude to form a circular pattern, because the deflection plates nearest the screen have less sensitivity than the plates farthest from the screen. Aside from practical details, a circular Lissajous pattern corresponds to sinewave vertical and horizontal deflection voltages that have the same frequency, nominally the same amplitude, and a phase difference of 90°.

Most vectorgrams have an elliptical outline. Typical elliptical Lissajous patterns and their corresponding phase angles are shown in Fig. 3. We observe that if the vertical and horizontal deflection voltages have the same amplitude, any ellipse that is formed will lean 45° with respect to the vertical and horizontal axes. Next, let us consider the patterns that are obtained when the vertical deflection voltage is greater or less than the horizontal deflection voltage. These patterns are easily demonstrated with a slightly more elaborate vectorscope; one that has vertical and horizontal amplifiers, in addition to the basic arrangement shown in Fig. 1. These amplifiers are identical, and have a bandwidth of 1 MHz.

If we start with a circular pattern, and then advance the vertical gain of the vectorscope, we get an ellipse (Fig. 4-a). On the other hand, if we start with a circular pattern, and then advance the horizontal gain, we get the elliptical pattern shown in Fig. 4-b. Note that these ellipses are either vertical or horizontal—they do not lean with respect to the screen axes. Next, if we start with an ellipse such as the 120° ellipse in Fig. 3, and then advance the vertical gain of the vectorscope, the ellipse will have a greater height and will lean less than 45° with respect to the vertical axis. On the other hand, if we start with the 120° ellipse as before, but advance the horizontal gain, the ellipse will be displayed at less height, and will lean more than 45° with respect to the vertical axis.

There are two ways to determine the phase angle corresponding to an elliptical Lissajous pattern. A quick method consists of adjusting the vertical screen deflection to equal the horizontal screen deflection. As in Fig. 3, the vertical and horizontal tangents to the ellipse will then form a square. In turn, the indicated phase angle can be approximated by comparison with the examples given in the diagram. Although this is not a highly accurate method, it is generally adequate for troubleshooting chroma circuitry.

Sometimes we work with the basic vectorscope arrangement shown in Fig. 1. In this case, the vertical and horizontal screen deflections cannot be readily equalized. Therefore, the method of phase-angle determination in Fig. 5 is used. We center the pattern on the screen, and measure the distances *a* and *b*. In turn, the ratio *a*/*b* gives the sine of the phase angle, and the angle can be found from a table of sines. This is a general and comparatively accurate method. Note that the ratio a/b in Fig. 5 remains unchanged regardless of the

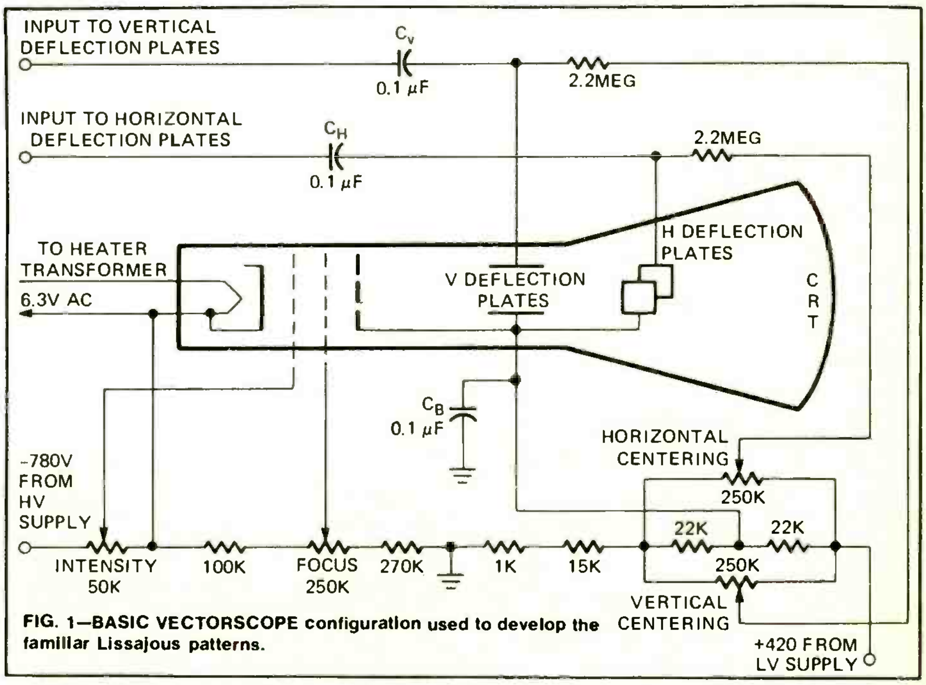


FIG. 1—BASIC VECTORSCOPE configuration used to develop the familiar Lissajous patterns.

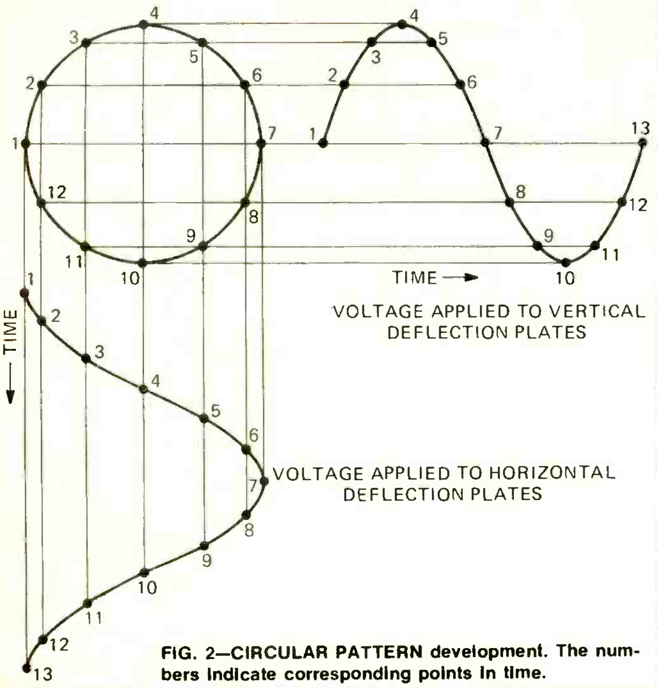


FIG. 2—CIRCULAR PATTERN development. The numbers indicate corresponding points in time.

FIG. 5 (at right)—MEASUREMENT of phase angle of deflection voltages indicated by an ellipse. The sine of a/b equals the sine of the phase angle.

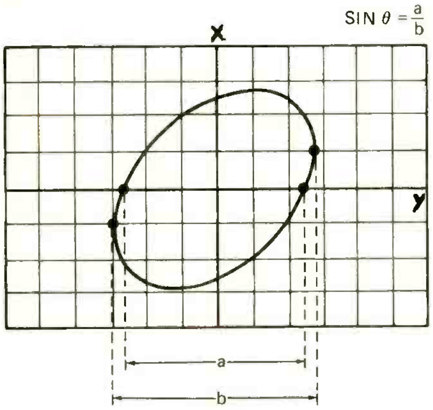
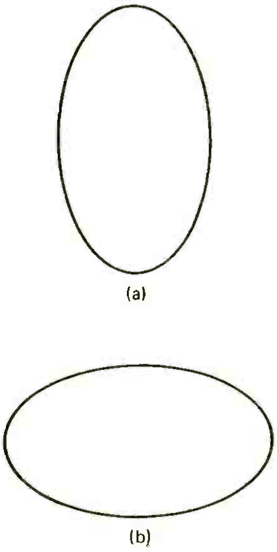


FIG. 4 (below)—PATTERNS formed by unequal deflection voltages with 90° or 270° phase difference. Vertical voltage greater at a, horizontal voltage greater at b.


(a)

(b)

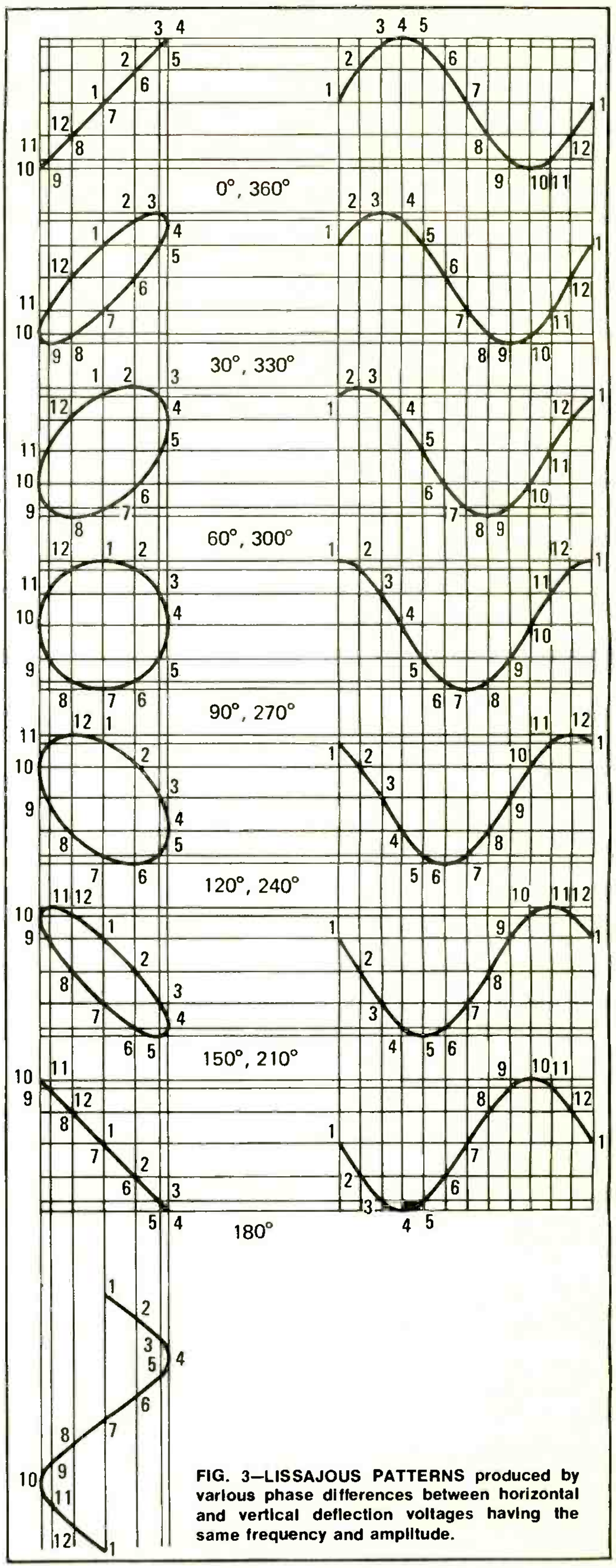


FIG. 3—LISSAJOUS PATTERNS produced by various phase differences between horizontal and vertical deflection voltages having the same frequency and amplitude.

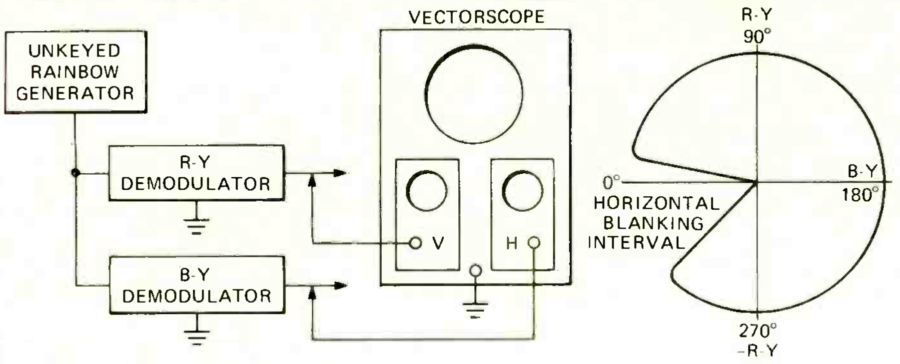
ratio of vertical and horizontal signal amplitudes.

Unkeyed rainbow signal

An unkeyed rainbow signal is the simplest type of chroma test signal. It is simply a 3.563795-MHz sine wave, which is 15,750 Hz less than the color-subcarrier frequency of 3.579545 MHz. In turn, an unkeyed rainbow signal shifts progressively out of phase with the receiver's color-subcarrier oscillator, and the two signals pass through an in-phase condition at the start of each forward-scanning interval. Fig. 6 shows the basic test setup, and the normal vectorgram that is obtained. In this example, chroma demodulation takes place on the R-Y and B-Y axes. A circular pattern is displayed normally, when the vertical and horizontal signal amplitudes are equalized. Note that the "pie cut" is produced by horizontal blanking action in the receiver.

It is helpful to note some typical trouble indications that may be observed. For example, a leaky capacitor in the subcarrier phase-shifting network causes demodulation angle to shift from its correct value of 90°. That is, if the hue control is adjusted to provide demodulation on the R-Y axis, then demodulation cannot occur on the B-Y axis, and vice versa. Approximately half of the hues are more or less distorted in the reproduced color picture. In this situation, a vectorgram such as depicted in Fig. 7 pinpoints the trouble. That is, an inclined ellipse is displayed, instead of a circular vectorgram.

Various forms of nonlinear distortion can occur, due to defects in chroma circuitry. For example, off-value resistors or leaky capacitors can cause incorrect bias voltages, with re-



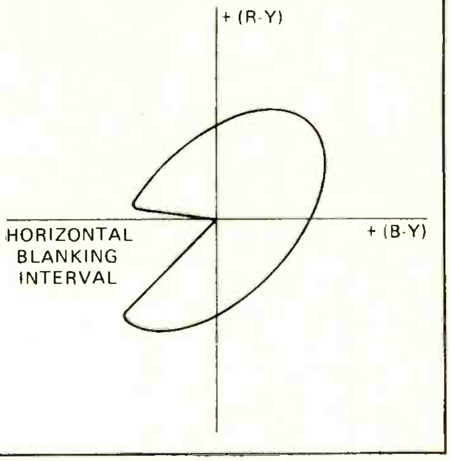


FIG. 6 (above)—BASIC VECTORSCOPE TEST SETUP. Using an unkeyed rainbow signal. Circular pattern results when vertical and horizontal signals are equal and receiver circuits are OK. **FIG. 7 (right)—A TILTED ELLIPSE** results when demodulation angle is not 90 degrees.

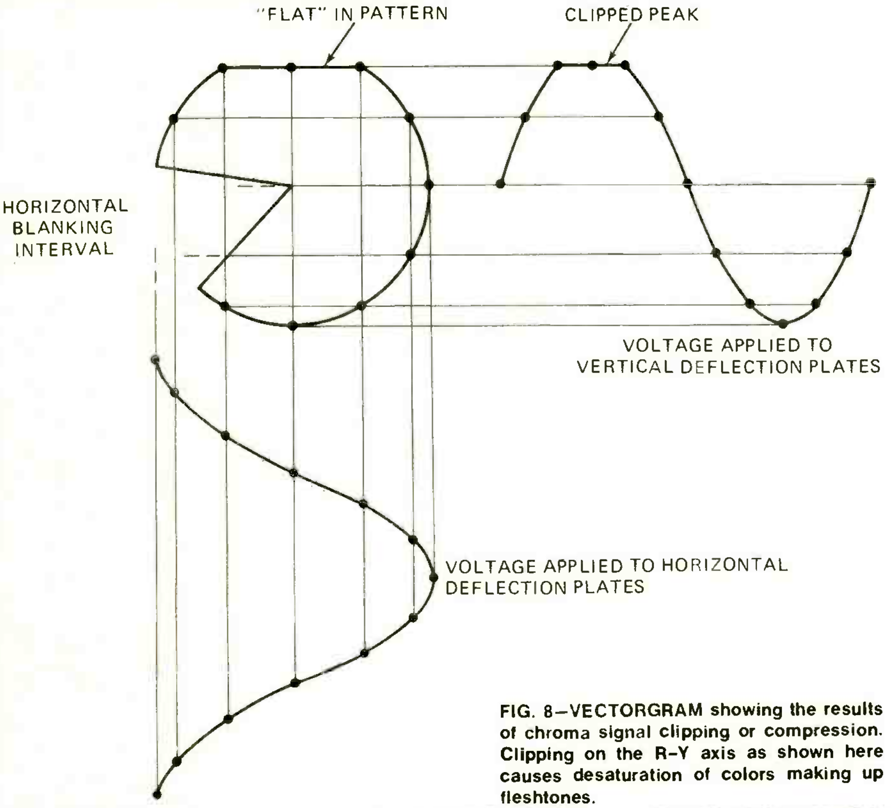


FIG. 8—VECTORGRAM showing the results of chroma signal clipping or compression. Clipping on the R-Y axis as shown here causes desaturation of colors making up fleshtones.

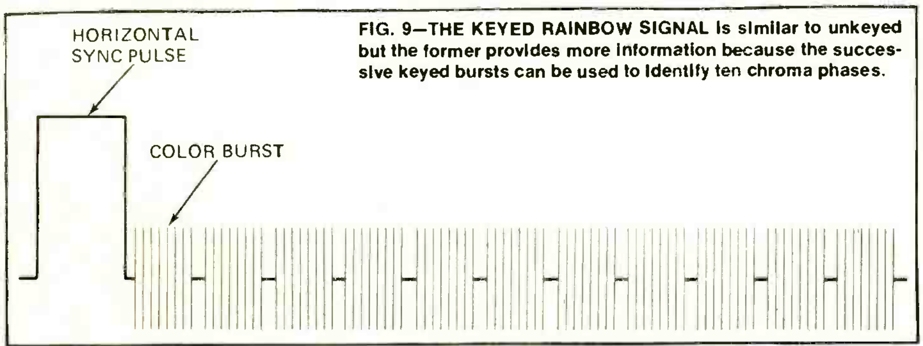


FIG. 9—THE KEYED RAINBOW SIGNAL is similar to unkeyed but the former provides more information because the successive keyed bursts can be used to identify ten chroma phases.

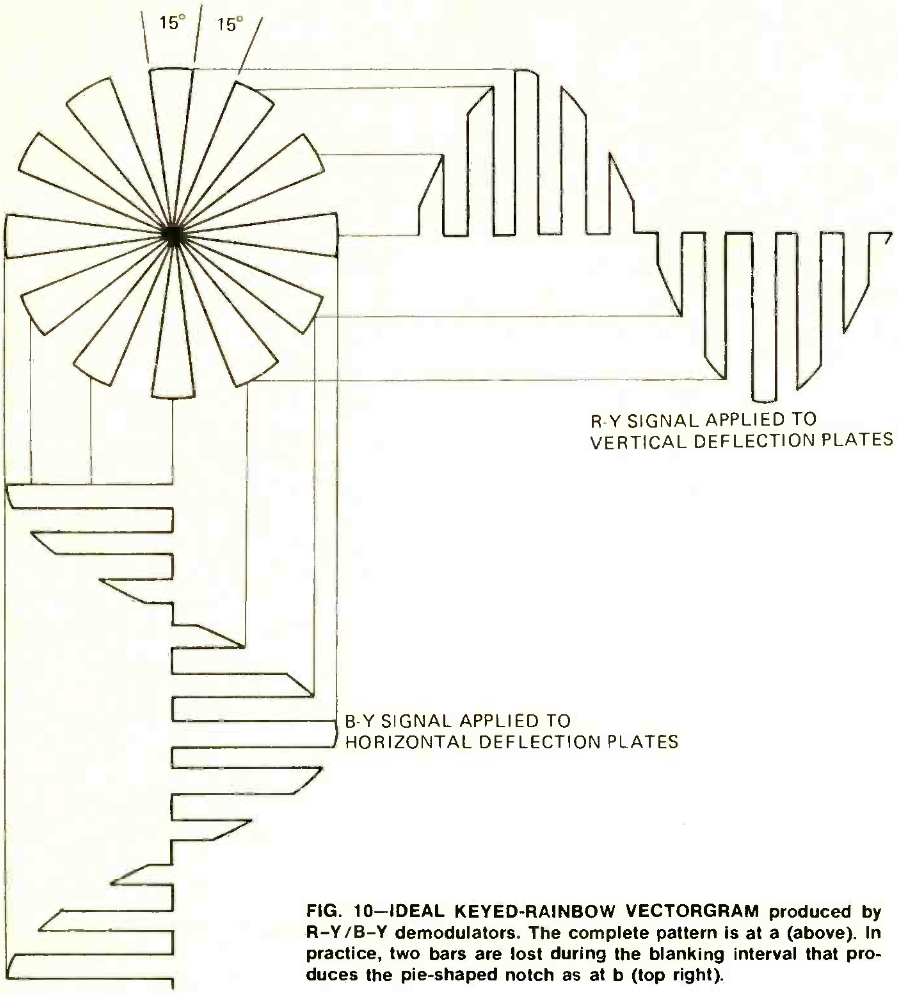
sulting compression or clipping of the chroma signal. Fig. 8 shows a vectorgram that results from positive-peak clipping of the R-Y signal. This type of distortion produces weakened or desaturated reproduction of the corresponding hues. In this example, the flesh tones would be affected. The distorted vectorgram identifies the fault, and helps to locate the defective component.

Keyed rainbow signal

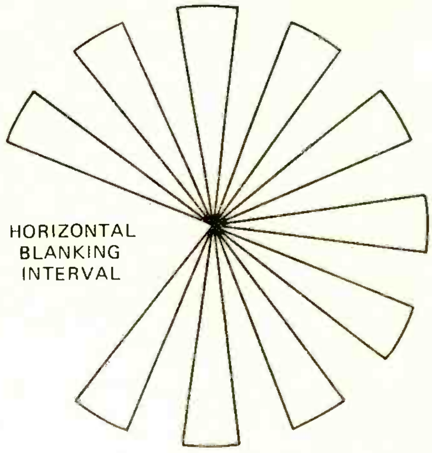
A keyed-rainbow signal, as depicted in Fig. 9, has the same basic characteristic as an unkeyed rainbow signal. In addition, the keyed signal provides more information, because the successive bursts identify 10 chroma phases. It is helpful to start with consideration of the same test setup as depicted in Fig. 6, but employing a keyed-rainbow generator. In such case, the ideal vectorgram that results is developed as shown in Fig. 10. Note that the tops of the R-Y and B-Y bar signals fall along a 15,750-Hz sine wave in the ideal case, and the tops of the vectorgram petals fall along the circumference of a circle.

In actual practice, the tops of the R-Y and B-Y bar signals do not have sharp corners, but are rounded as depicted in Fig. 11. This corner rounding results in rounding of the tops in the vectorgram petals. As in square-wave or pulse test work, corner rounding of chroma-bar waveforms results from limited high-frequency response. The R-Y and B-Y bar signals in Fig. 11 are idealized in that the pulse waveforms have zero rise time. In practice, of course, the rise time is slowed down to an extent that is determined by the bandwidth of the chroma circuits. It is instructive to consider the situation in which the bar signals have half-sine waveforms. As shown in Fig. 12, the vectorgram petals are formed of single straight lines in the ideal situation.

This ideal situation may be partially realized in practice, as illustrated in Fig. 13. Note that three of the vectorgram petals approximate straight lines, although the remaining petals have appreciable widths. There are some other practical points to be observed in Fig. 13. First, only nine petals appear in the vectorgram, while the ideal pattern in Fig. 10-b has 10 petals. The "lost petal" is due to a comparatively long horizontal blanking interval (slow horizontal flyback). Observe also that the horizontal blanking interval appears in the upper right-hand part of the vectorgram in Fig. 13. This is due to the fact that the cathodes of the color picture tube are driven by the chroma signal in this example.



(a)



(b)

FIG. 10—IDEAL KEYED-RAINBOW VECTORGRAM produced by R–Y/B–Y demodulators. The complete pattern is at a (above). In practice, two bars are lost during the blanking interval that produces the pie-shaped notch as at b (top right).

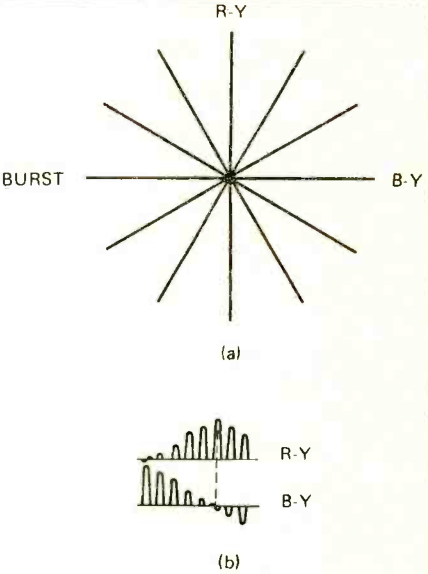


FIG. 12—PETALS ARE STARIGHT LINES (a) when bar-signal phase is as shown at b.

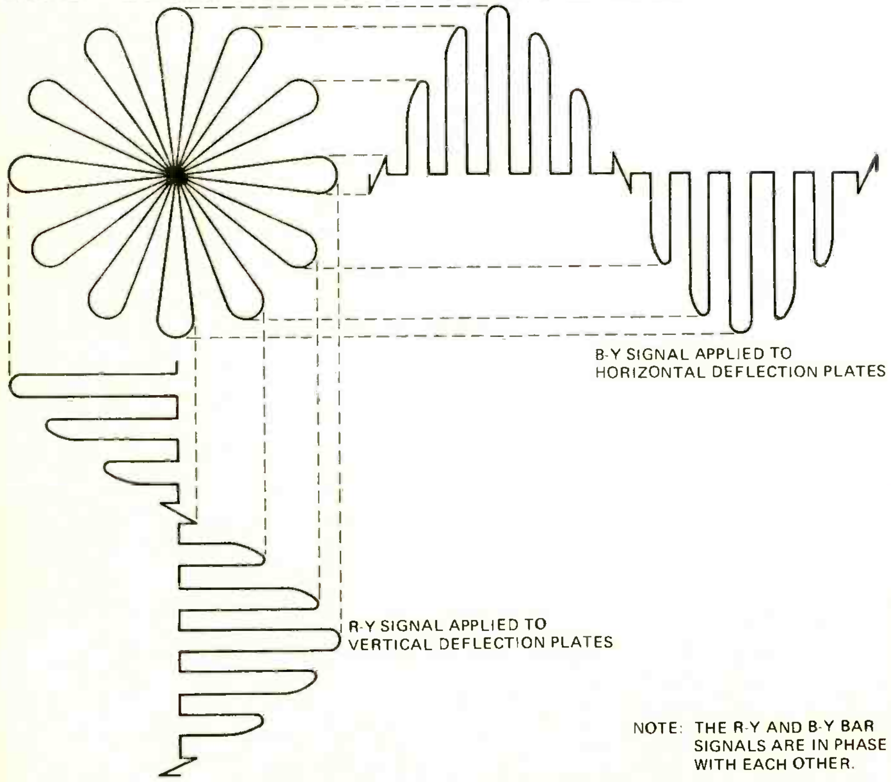


FIG. 11—HOW R–Y AND B–Y SIGNALS FORM PETALS ON THE VECTORGRAM. Signals on the deflection plates are in phase. The petals have rounded tops if the bar signals are rounded.

Next, let us consider the case in which one bar signal leads or lags the corresponding bar signal slightly. For example, we will suppose that the B-Y waveform is moved slightly to the right in Fig. 12-b, so that the peaks of the R-Y and B-Y pulses no longer occur at exactly the same instant. The result of this shift is the formation of elliptical petals in the corresponding vectorgram, as depicted in Fig. 14. Again, let us suppose that the R-Y and B-Y pulses are in exact time coincidence, but that the R-Y pulses are slightly wider than the B-Y pulses. The result is to change the straight-line petals in Fig. 12 into widened petals, somewhat similar to those seen in Fig. 13.

Another fact that we observe in Fig. 13 is that the petals extend down to the center of the vectorgram, where they form a bright spot. This means that the chroma circuits have adequate bandwidth. On the other hand, if the chroma coupling circuits have insufficient bandwidth, the center of the resulting vectorgram is an "open circle".

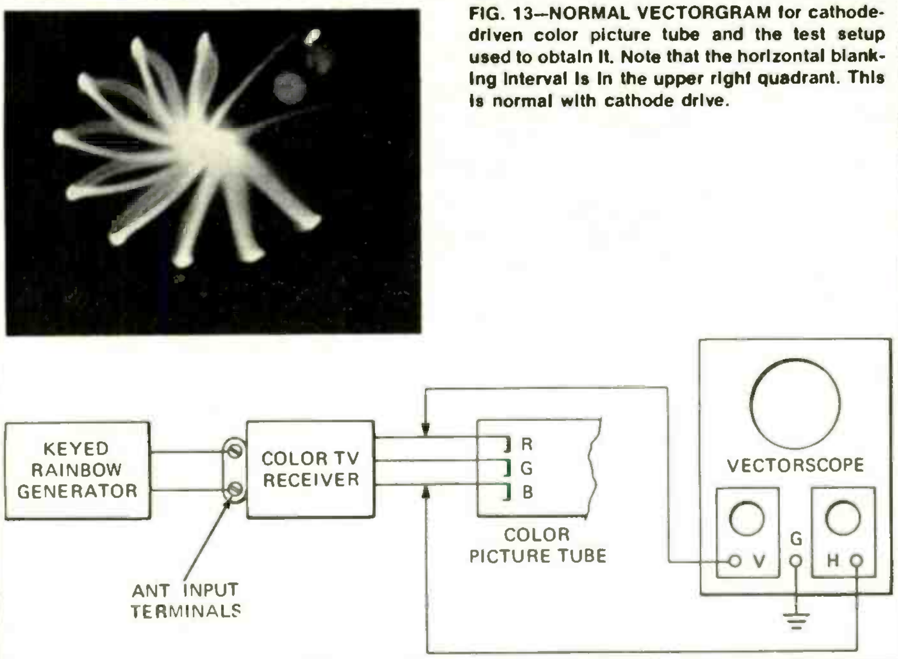


FIG. 13—NORMAL VECTORGRAM for cathode-driven color picture tube and the test setup used to obtain it. Note that the horizontal blanking interval is in the upper right quadrant. This is normal with cathode drive.

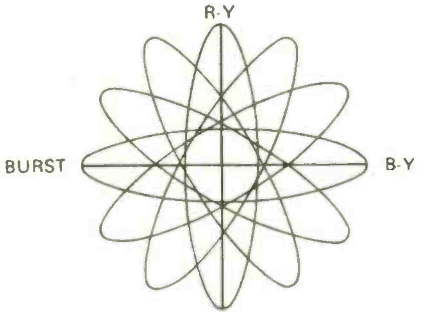


FIG. 14—PETALS ARE FORMED BY ELLIPSES when the R-Y or B-Y bars are delayed.

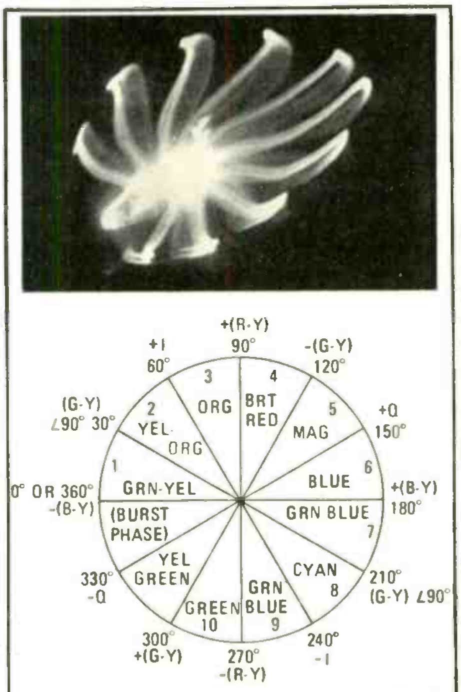


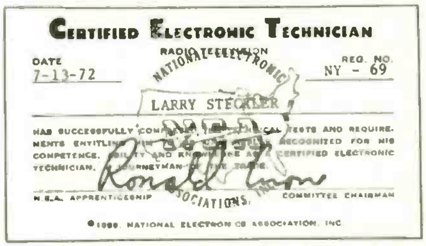
FIG. 15—NONLINEAR DISTORTION is evident in the vectorgram at top. This is indicated by the fact that some bars are much longer than others. Overloading is indicated by the squaring-off of the tops of some of the petals—particularly those developing between 240 and 300 degrees. The drawing illustrates chroma hue and phase reference.

This results from baseline curvature introduced into the R-Y and B-Y waveforms. In case the R-Y and B-Y channels have insufficient and unequal bandwidths, the center of the vectorgram is an "open ellipse".

Finally, let us consider the chief distortions that appear in the vectorgram in Fig. 15. Nonlinear distortion is immediately apparent. For example, the +Q petal is considerably longer than the +I petal. Overload distortion is evident in the tops of the -I, -(R-Y), and +(G-Y) petals, in particular. By way of comparison, the +(B-Y) petal shows little or no overload distortion. Nonlinear distortion is usually caused by incorrect grid or base bias. Leaky coupling capacitors are the most likely culprits. To close in on the defective stage, vectorgram patterns can be checked back step-by-step from the picture tube to the chroma demodulators.

Vectorgrams are very informative in chroma troubleshooting procedures, provided that we know how to interpret the patterns. There is more information in a vectorgram than in a conventional waveform, because a vectorgram is produced by sweeping one signal against another. The most useful type of vectorscope provides vertical and horizontal amplifiers so that tests can be made in low-level chroma circuits. Although only the most basic points can be covered in the available space, the foregoing discussion should get the apprentice technician off to a good start. As he gains experience in troubleshooting with the vectorscope, many other test techniques and pattern interpretations will unfold. **R-E**

R-E editors now CET's



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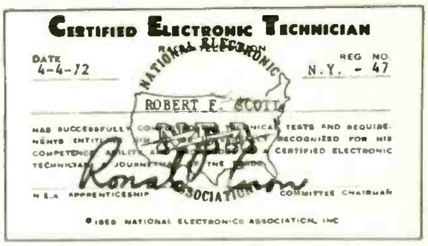
Editor Larry Steckler is now the proud holder of his CET certificate, N.Y. #69. His comments on the CET test—"It was more difficult than I expected it to be. I'd like to see every technician take the test and earn his certificate."



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Ronald [illegible]

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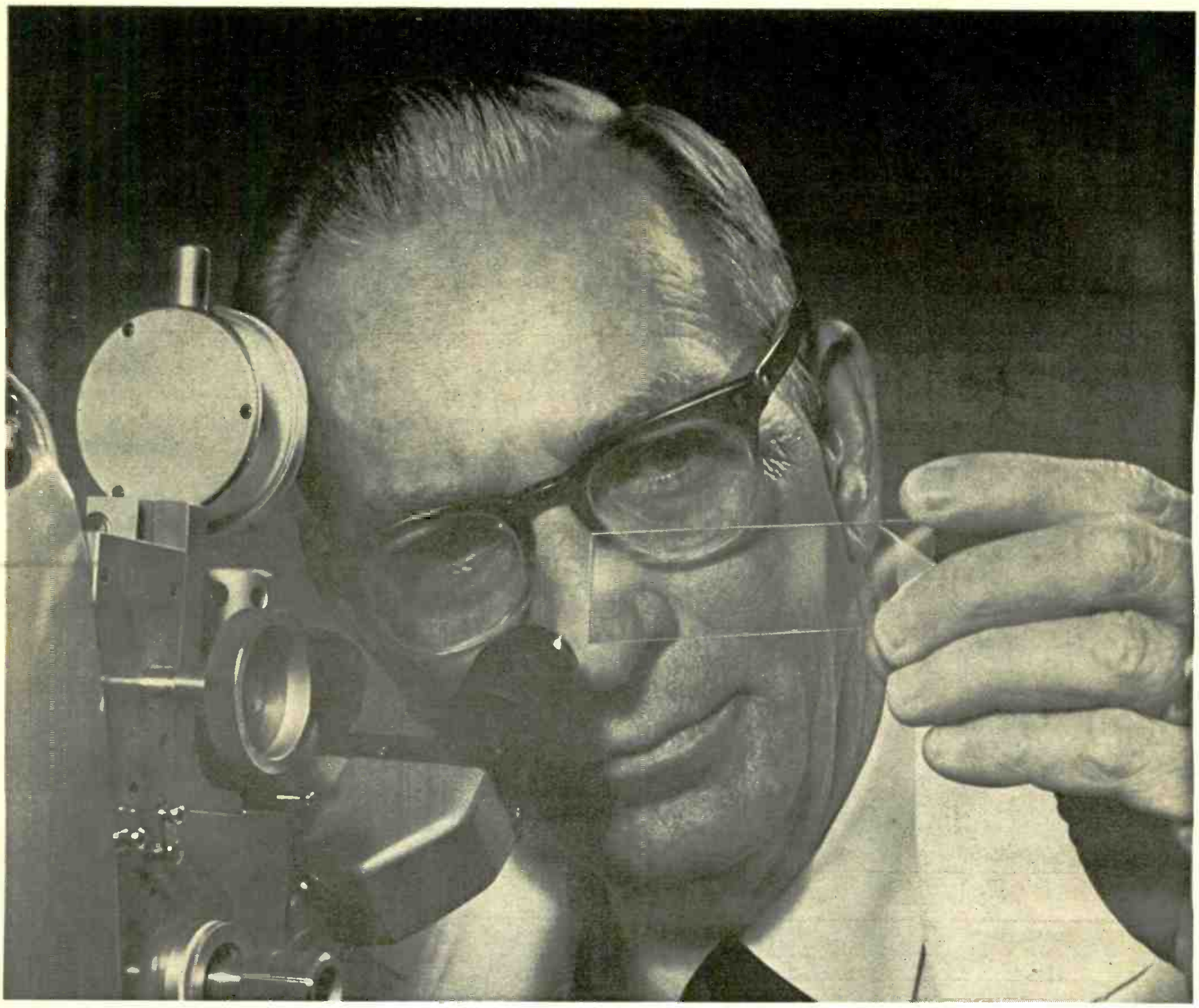
Technical Editor Robert F. Scott and his CET certificate, N.Y. #47. Bob and Larry both conduct CET tests in the metropolitan New York area regularly.



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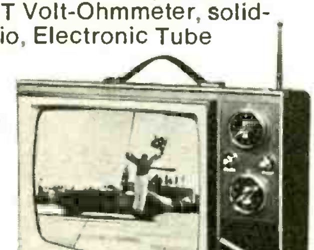

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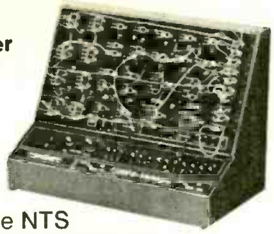

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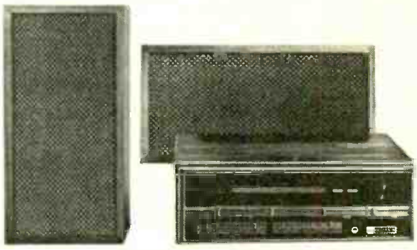

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step-by-step TV TROUBLE

The sound module in a IC and associated

by **ART MARGOLIS**

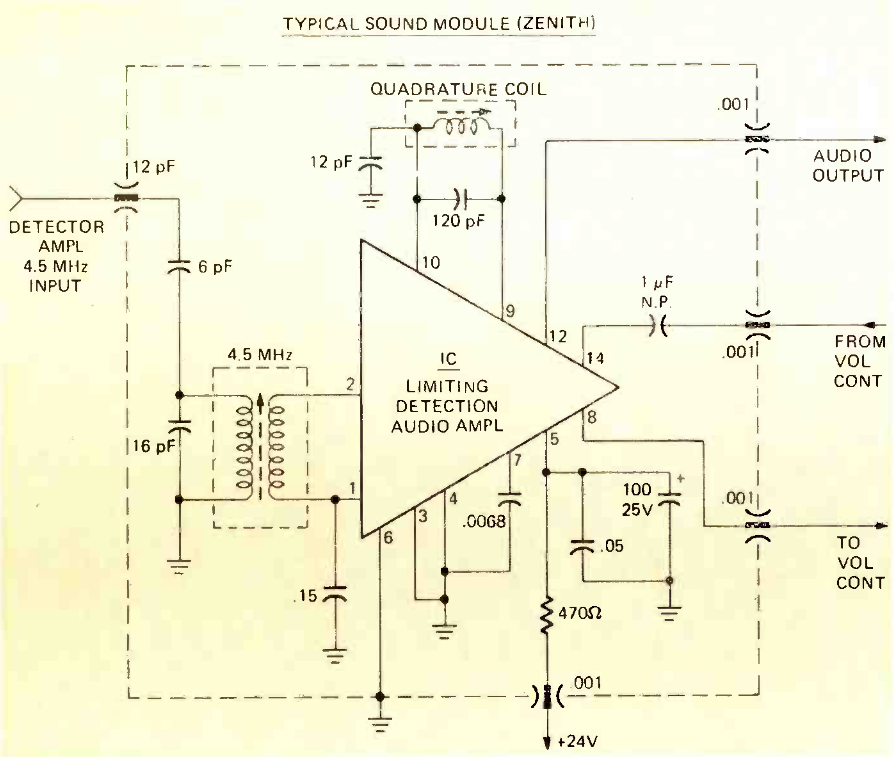
THE SOUND CARRIER IN THE COMPOSITE TV signal is troublesome. It is positioned only 920 kHz away from the color subcarrier. When it mixes with the color it produces a beat that can drive right through the video amplifiers into the color display. Just a tiny amount of sound can do this. As a result TV engineers do everything possible to get rid of the sound carrier before and after the video detection. There is little or no problem with the beat between the video carrier and color subcarrier which are 3.58 MHz apart.

Inside the sound module

In a typical solid-state color TV, the sound pickoff can be in the output second i.f. This permits placing a 41.25-MHz sound trap into the third i.f. input. Taking the sound off at the second i.f. presents a problem. The sound is quite weak and has to be beefed up before it can be fed to the sound-detector. This is done in the sound-detector amplifier. It mixes the 41.25-MHz sound carrier and 45.75-MHz video carrier, producing an amplified 4.5-MHz sound output for the detector. The sound-detector amplifier acts like a third i.f. stage for the sound only.

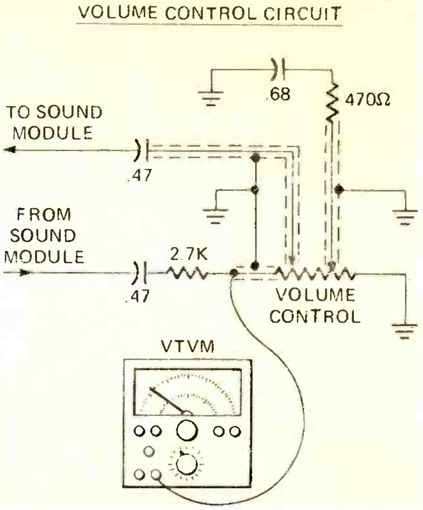
Next in line, in some sets, is a sound module. In the Zenith it has five terminals and a ground strap. Its heart is an IC chip. Also in the module are inductive devices that cannot be installed in an IC.

The chip is a "black box" type of thing containing the detector and audio amplifier. The 4.5-MHz output from the sound-detector amplifier enters one terminal of the module and passes through a 4.5-MHz transformer.



COMPLETE SCHEMATIC OF A TYPICAL SOUND MODULE. This one comes from a Zenith TV receiver. Note that there's a lot more than just an IC to go wrong.

Transformers or coils cannot be formed inside a chip so they are discrete components on the module. The 4.5-MHz sound-pickoff transformer is conventional and picks the 4.5-MHz intercarrier frequency out of the mess of frequencies heterodyned inside the detector amplifier circuit. The 4.5-MHz signal is applied directly into the chip. A limiter and an FM sound-detector are inside the chip. The 4.5-MHz and quadrature transformers and all other parts shown outside the outlines of the IC and discrete components on the sound module.



CHECK THE SIGNAL leaving the module to find out if it is operating.

The B-plus (24 volts) is applied through a series resistor and is bypassed with a couple of capacitors, a routine .05 and a 100-μF 25-volt electrolytic. The volume control and audio output are hooked conventionally onto the chip. Audio comes out of the chip.

Distorted or weak audio makes the sound module a suspect. It has to be tested, but how?

The first step is to eliminate the audio output stage and speaker by feeding

SHOOTER'S GUIDE

solid-state TV set may consist of only a single components. Here's how to troubleshoot it fast

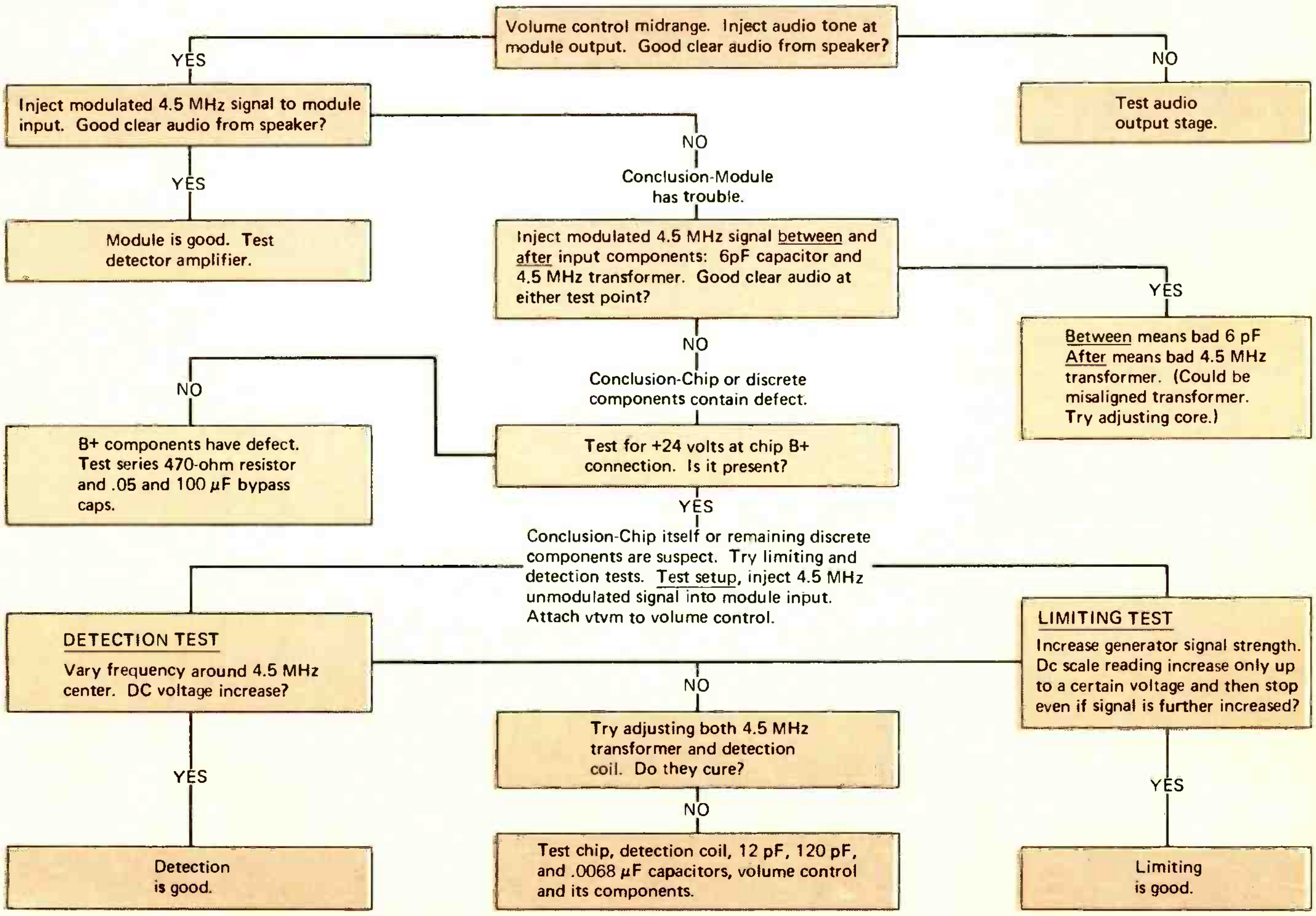
an audio signal into the output stage and listening for distortion. If all is well, the trouble may be in the audio module. The IC cannot be investigated on its own. It must be tested with input and output tests. You must apply signals and by observing what happens to the signal as it leaves the chip decide what to do about trouble. The chip is tested primarily for its ability to limit and detect the incoming FM signal.

Take a 4.5-MHz signal and apply it to the sound-module input. Attach a vtvm (on a low scale) to the module output at the volume control. The unmodulated 4.5-MHz input should produce little or no dc output voltage since there is nothing to detect. Then vary the 4.5-MHz generator frequency slightly to either side of center. That sets up an imbalance in the FM detector, some dc voltage is developed as if it was modulation. The dc scale will read some voltage either side of the center frequency. If it does, the chip is detecting.

To test the limiting action, turn up the output on the generator. Set the generator frequency on one side of the center frequency to produce a reading. As the generator output is turned up, the dc voltage will rise until it reaches the limiting point of the chip. From there on in, turning up the output will produce no more dc voltage. If this occurs, the chip passes its limiting test.

When you cannot cause detection, limiting or both, the sound module is the source of the trouble. Adjust the cores in the sound i.f. and quadrature transformers to peak performance. Quite often the cores will be out of adjustment and by aligning the two cores for good detection and limiting the repair will be made. Otherwise the problem boils down to, is the chip defective or is a discrete component bad? The trouble chart procedure leads to the suspects. **R-E**

SYMPTOM – DISTORTED OR WEAK AUDIO, PIX OKAY



technical topics

Four off-beat circuit applications you can use. Most unusual is the multivibrator-type i.f. sweep gen.

by **ROBERT F. SCOTT**
TECHNICAL EDITOR

SELECTING MATERIAL FOR THIS COLUMN can be frustrating. We never know whether the material selected will interest most of you. Some months back, you indicated that you like *Technical Topics* and want to see it more often. I have a constant fear of saturating you with material that turns you off. This is your column so why make me play guessing games? Drop me a line and tell me just what subjects interest you and what type of material you'd like to see.

We gather our material from application notes and limited-circulation and foreign magazines so it may take a while to work up material on *your* pet subject. If enough of you tell me what you want, we'll be able to get it and even tell you when it will appear. Meanwhile, here are a few circuits that you may want to adapt for your own needs.

Unusual i.f. sweep generator

The response of i.f. strips, bandpass filters and various forms of FM detectors can be checked and corrected, if necessary, by using a sweep generator and a scope. Most sweep generators consist of an rf *sinewave* oscillator whose frequency is swept about a center point by a reactance tube, an Increductor (voltage-variable inductor) or a variable-capacitance diode.

In a recent issue of *Radio Communication*, G8CGA points out that a sinewave source is not necessary when checking the response of high-Q tuned circuits. The prime requisite is a signal whose amplitude is constant over the swept range. Fig. 1 is the circuit of a sweep generator using a saturating-type multivibrator oscillator. The frequency is varied about the center point by applying a sawtooth voltage as bias to the base of Q2. The sawtooth excitation voltage is tapped off the scope's sweep oscillator and fed to the common base circuit through the DEVIATION control. The value of resistor R1 is determined by the magnitude of the sawtooth from the scope. It should be about 40,000 ohms for each 10 volts peak-to-peak of sweep voltage. The output signal level is controlled by a 3-step attenuator and a 1000-ohm pot for smooth control.

With the values shown, the multivibrator can be tuned from about 440 to 550 kHz. Frequencies as high as 20-30 MHz can be covered using adequate transistors and adjustments in circuit constants.

When using the sweep generator, set the scope sweep-speed control for the lowest rate that can be used without objectionable flicker on the trace. In any event, the response curve will be distorted if the sweep rate is too high. Start with a very slow sweep and increase it to the point where the trace starts to distort and then back off a hair.

Micropower on-off indicator

The absence of a power on-off indicator has long been a major disadvantage of solid-state battery-powered devices. Although the power drain is so low that it has negligible affect on battery life, it is still disturbing to find that a battery-powered device has been left on for days, or even weeks. The light-emitting diode, or LED, is a miniature low-voltage, low-power device that makes an ideal pilot light.

The circuit in Fig. 2 is a novel pilot indicator recommended for installation in a solid-stage vom described in *Electronics Australia.* It runs off a 9-volt battery and draws an average of somewhat less than 2 mA.

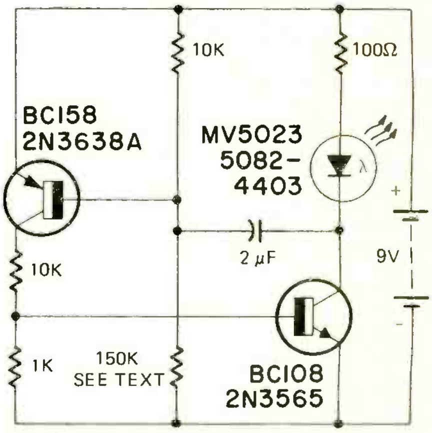
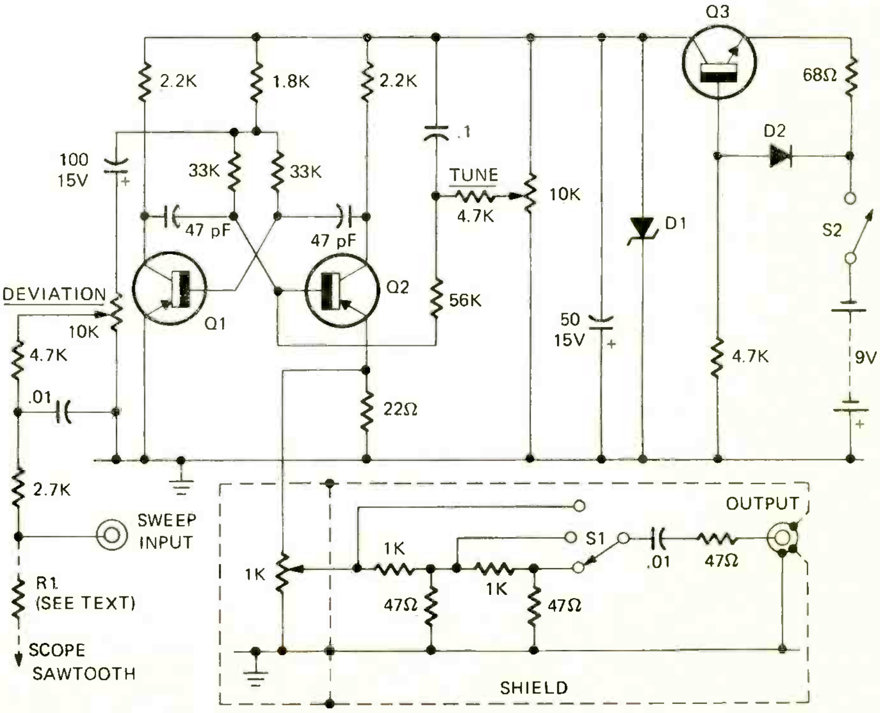


FIG. 2—LED IS PILOT LAMP for battery-powered test instrument. Transistor multivibrator pulses LED for more brightness.



Q1, Q2 = BFX12, GE-12, HEP-52, ETC.
Q3 = GE-7, HEP-641, ETC.
D1 = 6.1V ZENER
D2 = GE-504A, HEP-156, ETC.

FIG. 1—MULTIVIBRATOR SIGNAL GENERATOR delivers sweep signal for i.f. circuit alignment.

The LED, Monsanto MV5023 or Hewlett-Packard 5082-4403, is in the collector load circuit of a multivibrator that pulses the light on and off approximately 10 times per second. (LED's provide higher light output when pulsed and the eye is more sensative to flashing light so the pulsed LED makes an ideal power-on indicator.)

The critical components in the circuit are the capacitor and the 150,000-ohm resistor. The capacitor must be a low-leakage type such as a polyester or metallized polyester. The 150,000-ohm resistor may have to be adjusted for proper operation. If it is too low the circuit will not oscillate and the LED won't light. Too high; both transistors remain conducting and the LED lights continuously.

Versatile lab power supply

A good wide-range power supply is essential to every experimenter and service technician's workbench. One of the most versatile we've seen was described in *Radio Elektronik Schau.* It consists of two identical 0–25-volt, 1-ampere supplies that can be used alone or switched in series to deliver up to 50 volts dc.

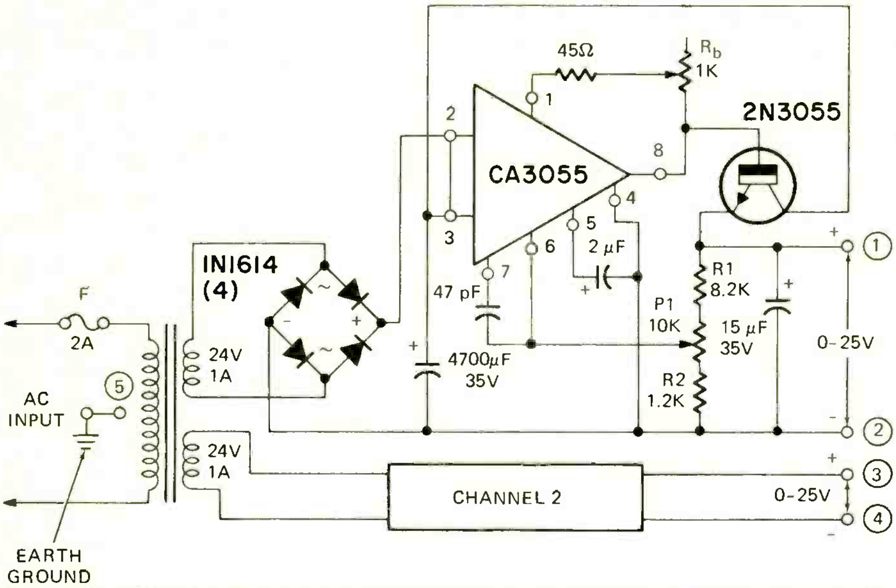


FIG. 3—BASIC DUAL POWER SUPPLY FOR LAB OR BENCH feeds two separate 25-volt loads or one load at 50 volts. Metering and switching circuits are illustrated in the next figure.

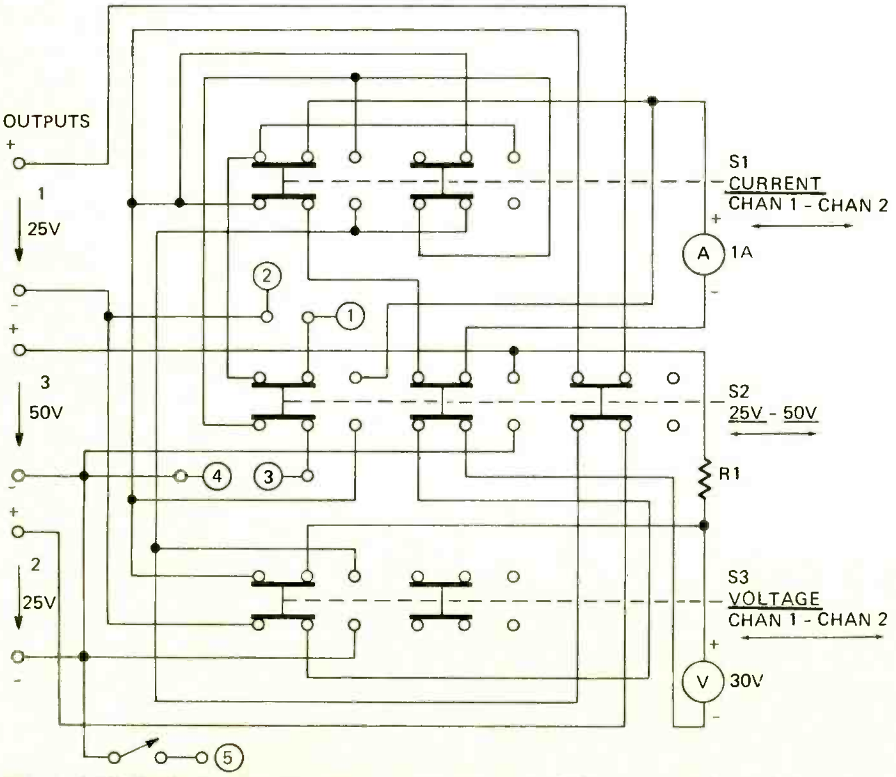


FIG. 4—HOW SUPPLIES AND METERS ARE SWITCHED. Terminals indicated by circled numbers correspond to those on the dual supply in Fig. 3. Switches may be slide, rotary or pushbutton types.

The active circuits in the supply are shown in Fig. 3. One of the supplies is represented by the schematic, the other by the block diagram. Voltage control and adjustment is provided by the CA3055 IC and 2N3055 transistor. Current and voltage can be read on built-in 1-ampere and 30-volt dc meters. Figure 4 shows the switching that accounts for much of the versatility of this instrument. S1 switches the ammeter to either supply when used separately while S3 switches the voltmeter similarly. Slide switch S2 is used to connect the two supplies in series for up to 50 volts output. A multiplier resistor (R1) is switched with the meter to double its range to 60 volts dc. The resistance of the multiplier should equal the meter's internal resistance.

Solid-state ratchet relay

A ratchet relay is normally specified when we need a sequential on-off operation from a simple pushbutton switch, as when operating a light or similar device from several remote points or for the send-receive circuits of a two-way radio setup.

The circuit in Fig. 5 is an electronic ratchet relay described in *The Radio Constructor.* The device consists of a SCR and a 500-ohm relay with a pair of spdt contacts and a normally open spst contact to handle the load. The relay contacts are shown as they are when the SCR is turned off and the relay coil is not energized.

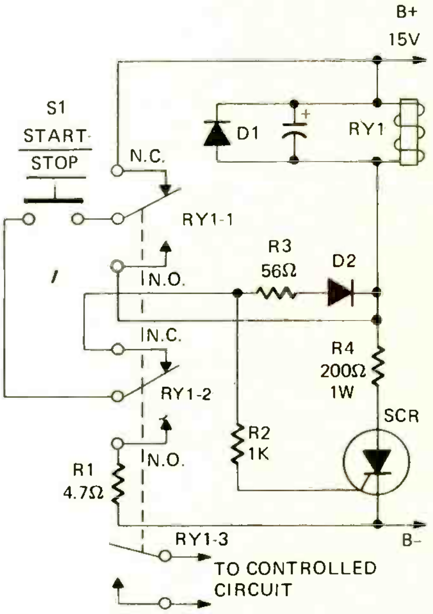


FIG. 5—HYBRID SEQUENCING CIRCUIT. The SCR latches on and off on consecutive closures of momentary switch S1.

When the pushbutton is first pressed, a triggering pulse is fed to the gate through relay contacts RY1-1 and RY1-2 and the SCR fires. The bottom end of the relay coil connects to B+ through D1, R3, S1 and relay contacts

RY1-1 and RY1-2 so only a small portion of the SCR's anode current flows through the relay coil and most of the voltage is dropped across R4. Current through the coil is too low to actuate the relay.

As the pushbutton is released, gate voltage is removed from the SCR and the low end of the relay coil is no longer tied to B+. The voltage across the coil now rises high enough to actuate the relay, switching contacts RY1-1 and RY1-2 and closing load contacts RY1-3.

The next time the switch is pressed, the bottom end of the relay coil is shunted to ground through the normally open contacts of RY1-1 and RY1-2 and a major portion of the SCR supply voltage is shunted to ground through R1. The SCR anode current drops below the holding-current level and conduction stops. The relay is held in because the bottom end of its coil is now connected to B– through the normally open contacts and R1.

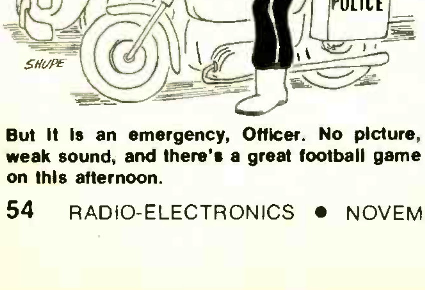
Releasing the pushbutton breaks the circuit through the coil, releasing the relay, opening the load contacts and readying the circuit for the next operation.

The circuit can be checked for correct operation by metering the voltage across the relay coil. It rises from zero to 4 volts when S1 is pressed for START or ON and rises to 11 volts when the button is released. Voltage rises to 15 when the button is pressed for STOP or OFF and drops to zero when the switch is released.

A maximum current of about 50 mA is drawn when S1 is pressed to START and then drops to 22 mA for as long as the controlled device is on. Current drain is zero when the controlled device is off.

Diodes D1 and D2 are small silicon rectifiers. We do not have any technical data on the type CRS1/05 SCR but it is a small plastic device in a TO-5 can. Any low-current SCR should work nicely.

Well, thats about it for now. Don't forget to let me know what you'd like to see in future columns. **R-E**



But it is an emergency, Officer. No picture, weak sound, and there's a great football game on this afternoon.

equipment report

International Crystal's FM-2400-CH frequency meter

Circle 23 on reader service card

THE FIRST REQUIREMENT FOR A FREquency meter is accuracy. The second is ease of operation. The International Crystal FM-2400-CH frequency meter meets both of these with ease. Twenty-four different crystals can be used, covering all bands from 25 to 1,000 MHz.

For accuracy, each crystal meets or exceeds FCC standards with a *minimum* accuracy of ±0.001%. (The typical crystal is checked to an accuracy of ±0.0005%.) Stability is ±0.0005% between 32 and 122°F. The 25 to 54-MHz vhf band, and high-band crystals are calibrated to these standards. The uhf band crystals (450 MHz band) are calibrated to ±0.000125%.

A special chart is provided for each crystal. The FREQUENCY-ADJUST dial is set to a correction factor determined by the ambient temperature. An accurate thermometer is provided, in the knob of the FREQUENCY ADJUST dial. A vernier on this scale allows setting to very close tolerances.

For ease of operation, this is a dandy. It's the simplest instrument of its type that I've ever used. Measurements can be taken with ease, on any kind of transmitter. Coupling to the transmitter isn't critical; the FM-2400-CH has ample sensitivity to make usable readings without a lot of trouble.

All you have to do is place the instrument near the transmitter, check the temperature and the chart for the desired crystal, and make the setting. While you're doing this, the transmitter is warming up. Push the key and note the reading, with the frequency meter set to RF; this is just to assure you that there is a signal present. Only a small amount of signal is needed to get an accurate reading. On the other hand, this instrument will read fairly high signal levels without trouble.

To read the actual frequency of the transmitter, the dial is set for FREQUENCY DEVIATION, and both the transmitter and frequency meter are turned on. The amount of frequency error is read directly on the meter dial in kHz. If the transmitter is right on the button, the needle won't move.

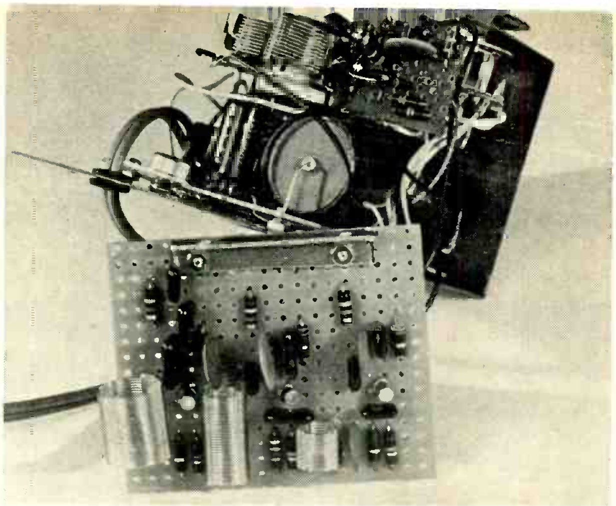
Three different sensitivity ranges are provided; X3, X1 and X0.3. The meter reading is multiplied by the factor indicated, X0.3 being the most sensitive. You can find the exact frequency of the transmitter, if it is off, by turning the FREQUENCY ADJUST dial, and noting which way you have to go to get the zero-beat.

The FM-2400-CH can also be used to check and align the receivers in any system. Since the same crystal is used for both transmitter and receiver testing, this makes accurate "netting" of any system fast and accurate. (*Netting*—adjusting all receivers and transmitters in a radio system to precisely the same frequency.)

Since the FM-2400's 24 crystals can each be used for a single system, this allows the testing of 24 different radio systems without the need for more crystals. Modulation of the transmitter can be checked by noting the increase in meter reading, in the RF position, when the transmitter is modulated. An earphone jack is provided on the panel for listening to it, or for checking zero-beat, etc.

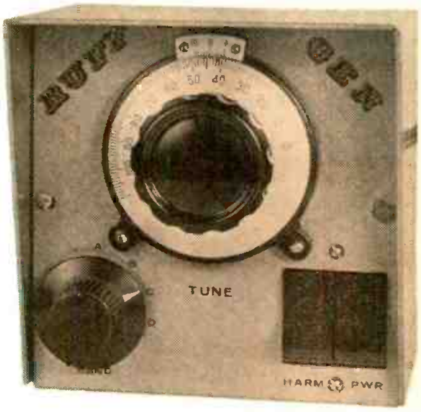
The FM-2400-CH is powered by two 6-volt NiCad batteries. A charger is part of the "package." It is installed on the bench, and the instrument can be left plugged into it at all times. The charging rate is regulated and the con-

(continued on page 102)



INSIDE THE RUFF GEN, a handy test oscillator that you can build to meet your needs. Parts are inexpensive and most are not critical.

SIGNAL GENERATOR APPLICATIONS



An rf signal generator is much more than a mere alignment tool. Here are some uses that'll lead you to develop others.

By JIM HUFFMAN

THE SIGNAL GENERATOR IS ONE OF those everyday instruments that has literally thousands of applications. Thirteen interesting uses are described in detail in this article. In addition, we will show you how to build a basic signal generator of your own.

The first group of eight generator applications will primarily interest the experimenter. Here we go:

1. Heterodyne Frequency Meter Although the signal generator is a reliable source of known frequencies, it has little value when checking the output frequency of a frequency generating device such as an oscillator. By adding the circuit shown in Fig. 1, you can convert the signal generator to a heterodyne frequency meter. The unknown signal is applied to the input of the frequency meter and the signal generator is tuned until the two signals zero beat. At zero beat, you simply read the unknown frequency from the signal generator. Note: when an rf heterodyne meter arrangement is being used, make sure you are not reading a harmonic of the generator. It is a good idea to know the approximate frequency range for the unknown signal to insure a harmonic is not being used. (Using the "Ruff Gen" here eliminates the worry when using the sinusoidal output.)

2. Grid Dip Meter The circuit shown in Fig. 2 doesn't make the generator into an actual "grid" dipper, but it does function in the same way. When the loop is brought near a resonant circuit and the signal frequency is tuned to the resonant frequency of the network, the meter indicates a dip showing the tuned circuit loading the output of the signal generator. You can also connect the generator output leads directly across a tuned circuit and look for a rise on a suitable ac voltmeter.

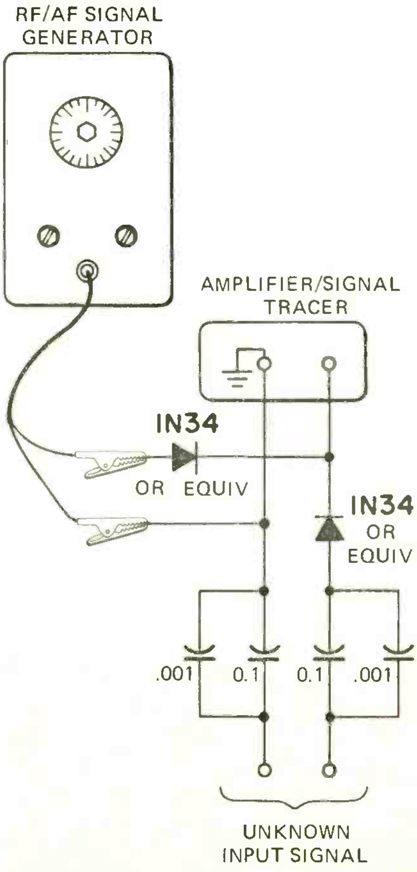


FIG. 1—HETERODYNE FREQUENCY METER. The signal generator can be used as a heterodyne frequency meter with this circuit. The .001-μF capacitors work at rf, while the .1-μFs couple audio. Make sure the unknown input signal is about the same level as the rf generator output. Both should be somewhere between 0.5 and 1.0 volt.

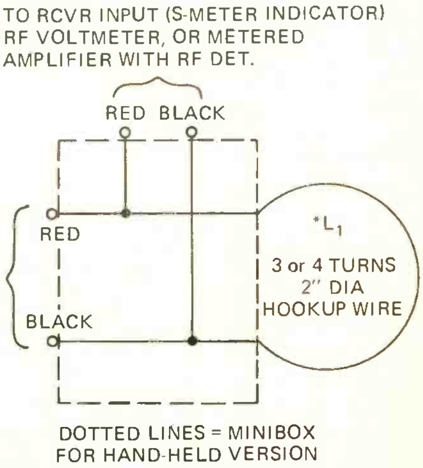


FIG. 2—GRID DIPPER. You can find resonant frequencies, unknown C and L, and many other values when you add this circuit to a signal generator. Optimize L1 for your generator and top frequency you wish to use.

3. Input/Output Impedance Measurements By using the arrangement shown in Fig. 3, you can use the signal generator to measure the input and output impedances of amplifiers. Fig. 3 shows how to measure input impedance. Variable resistor R_Z is adjusted until the output voltage reads one-half the maximum value. The value of the variable resistor is measured at this point and this value is approximately the same as the input impedance. Of course, this method does not give the imaginary components of the impedance.

Fig. 3-b shows how the output impedance is measured. Again, adjust for one half the maximum reading. This time the resistor reads the output impedance. This method will work for any amplifier whether one-stage or multistage.

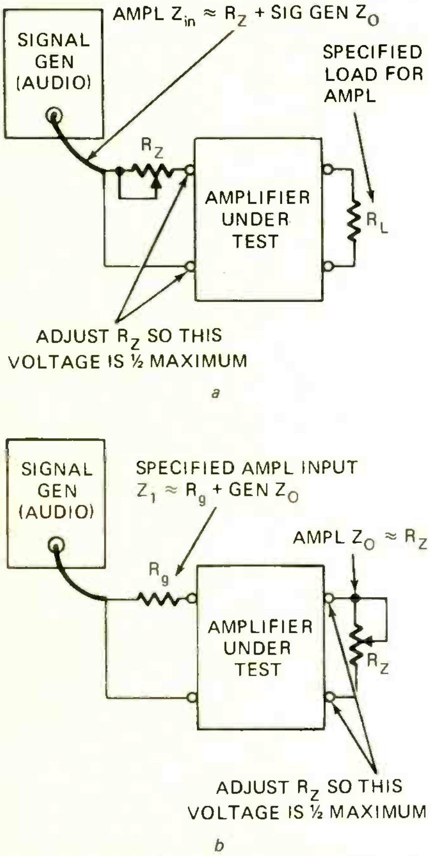


FIG. 3—INPUT/OUTPUT IMPEDANCE MEASURING. (a) above setup used to measure Z_{in} (for any 4-terminal network). (b) is the Z_{out} setup. In either arrangement, the signal generator must have adequate output to drive the amplifier under test.

4. Frequency Response The signal generator can be used to measure the frequency response of an amplifier or network. Merely find the two points at which the output voltage is 0.707 times the maximum value. In other words if an amplifier's maximum output voltage is 1 volt and the generator frequency is 50 Hz and 100 kHz before the signal drops to 0.707 volt, then the response is -3 dB from 50 Hz to 100 kHz. If the meter reading varies little between these ranges, then the amplifier is essentially flat between the upper and lower cutoff frequencies. On the other hand, there may be points within the 50–100 kHz at which the voltage drops to or below the 0.707 volts and the output is not flat between these ranges. Make sure the output of the signal generator is constant, this may mean occasional readjustment of the output level of the generator.

5. Transformers Signal generators let you determine the transformer turns ratio at the frequency for which the transformer is designed. Merely insert the proper frequency at a given input level to the transformer, say, 1 volt. Measure the output voltage and set up a ratio of input volts to output volts. In the example: 1 volt to X volts. The transformer turns ratio is then 1:X. If the output voltage (X) is 2 volts, the ratio is 1:2. If the transformer is a power type, 60 Hz: in operation with 110 Vac in, the output voltage would be 220 Vac.

You can also check transformer efficiency by connecting the signal generator to the primary, with the prescribed load on the secondary. Now calculate the power in the primary and secondary ($P = E^2/Z$). Where Z primary is equal to the load resistance times the turns ratio squared. Transformer efficiency is given from $\%(P_{out}/P_{in})$.

6. VFO Connect a buffer between the rf signal generator and the input of the transmitter (Fig. 4). The coil and capacitor LC are there to filter out spurious outputs from your generator. Coil and capacitor data are given in the table. (Note. The Ruff Gen may be used directly in this application because it is extremely stable and has no harmonic output.)

BAND	L1	C1	C2	C3
80	5 µH	500 pF	.01	.1
40	3 µH	250 pF	.01	.01
20	5 µH	25 pF	.001	.005
15	.8 µH	80 pF	.001	.001
10	.5 µH	50 pF	.001	.001
8 MHz*	2.5 µH	250 pF	.01	.01

* (6 & 2 METERS)

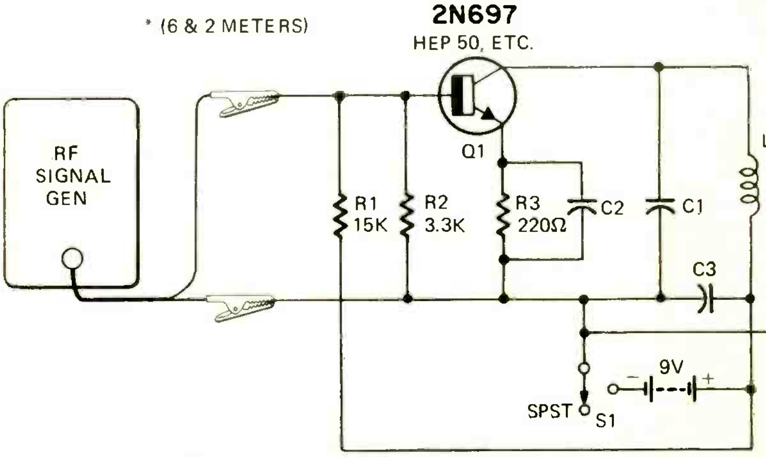


FIG. 4—SIGNAL GENERATOR VFO. The signal generator makes a decent VFO with the addition of a buffer. Q1 can be almost any npn transistor that will work at the highest output frequency you plan to use. You can even use a pnp transistor if you reverse the battery polarity.

7. Transmitter To the rf generator with modulated output, you can add the vfo circuit shown in Fig. 4 and modulate for an AM transmitter. This is a milliwatt input job. The input to the buffer stage can be held at less than 100 mW by adjusting the drive. This means the generator can be used legally with no license on the AM broadcast band, Citizens band, or television audio. If you hold a proper ham ticket, you can use the outfit on the amateur bands for a QRP (low power) rig. QRP operation is fun in these days of 2 kW linears.

8. Strobe Light Driver The audio generator can be used as sort of a visual tachometer in that it can be used to drive a strobe light. When the generator frequency coincides with the mechanical frequency, motion freezes. Don't figure on stopping the motion completely, as the phase of the light and motor drift somewhat. And don't forget to convert revolutions-per-minute to cycles-per-second. Just multiply the audio frequency by 60.

Technician applications

1. Check The Condition Of Capacitors Just connect the capacitor in series with generator output and your meter. Now sweeping the generator from low to high frequencies should produce low to high output voltage variations. But if the output is constant, the capacitor is open. If you have trouble reading the outputs or cannot detect changes too well, try connecting a 1000-ohm resistor across the meter terminals.

2. Inductor Checker Inductors can be checked in the same manner as capacitors. As the frequency goes up, the impedance of the coil goes up, and the voltage at the meter goes down. Use the 1000 ohm resistor if you do not obtain very substantial readings at first.

3. Sweep It If you don't mind going inside your rf generator, add a Varicap sweeper. This changes the frequency when a unijunction supplies a variable sweep voltage. Fig. 5 shows the schematic of such a sweeper. If you cannot gain enough sweep range, use a 1N5148 varactor.

4. FM Source With the circuit of Fig. 5 and your rf signal generator you have a source of FM that can be used to check out FM receivers. The circuit works on the same principle as the electronic sweep generator except consider the input as audio and not sweep signals. The audio will be adjustable from about 1 to 2 kHz (ignore the sweep output to the scope).

5. Horizontal Bar Generator The standard rf generator with 400 Hz signal modulation will produce horizontal bars on a television receiver. This signal simplifies vertical linearity and height

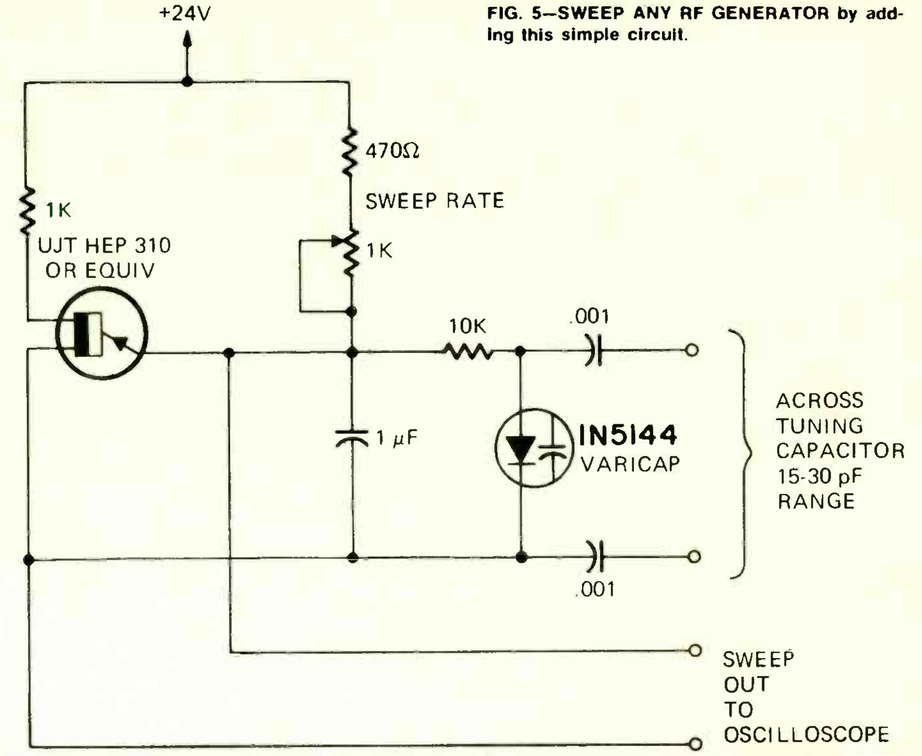


FIG. 5—SWEEP ANY RF GENERATOR by adding this simple circuit.

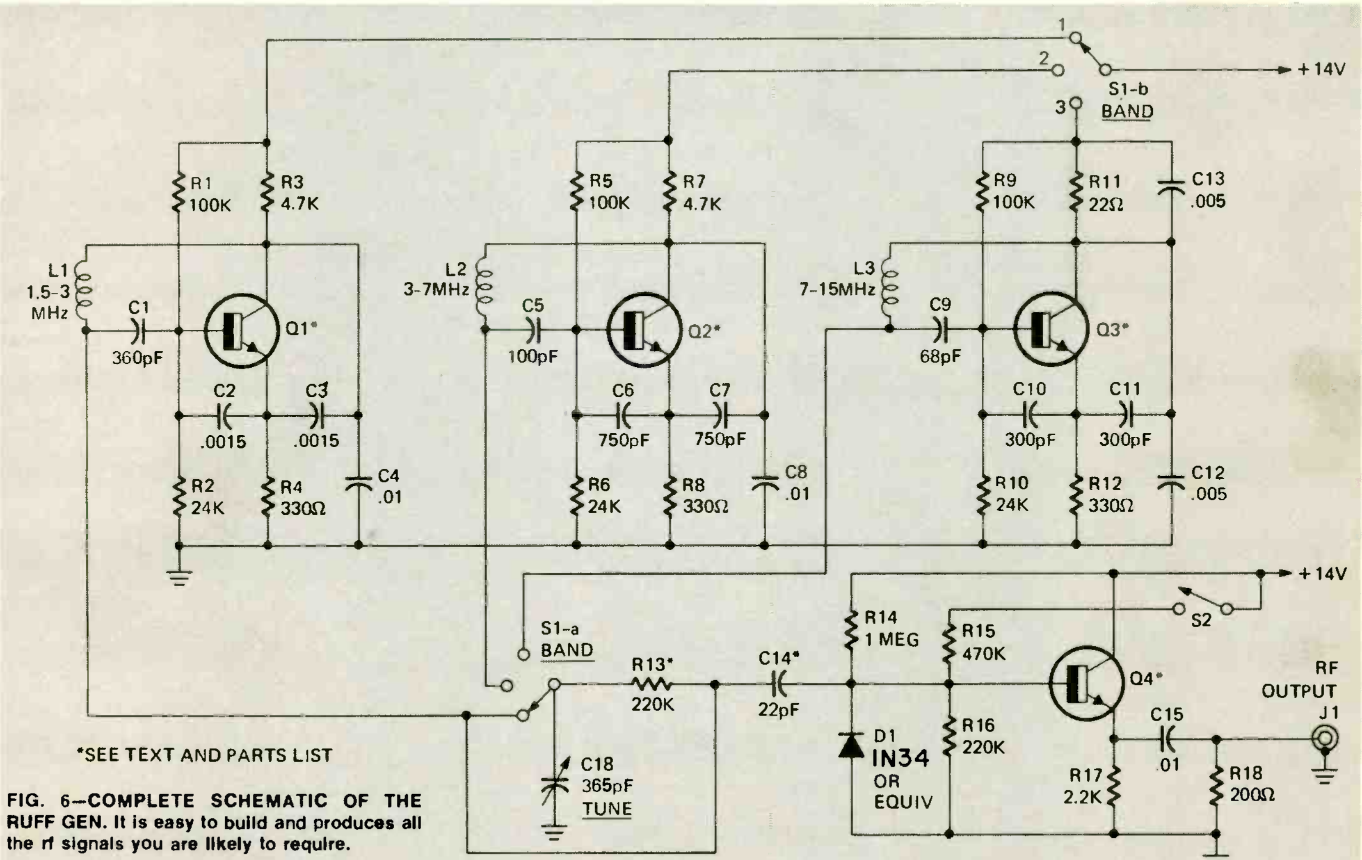


FIG. 6—COMPLETE SCHEMATIC OF THE RUFF GEN. It is easy to build and produces all the rf signals you are likely to require.

PARTS LIST

All resistors ½-watt 10% unless noted

R1, R5, R9—100,000 ohms
R2, R6, R10—24,000 ohms
R3, R7—4700 ohms
R4, R8, R12—330 ohms
R11—22 ohms
R13, R16—220,000 ohms
R14—1 megohm
R15—470,000 ohms
R17—2200 ohms
R18—200 ohms (5%)
R19—1000 ohms

All capacitors silver mica unless noted

C1—360 pF
C2, C3—.0015 μF, at least 50V, ceramic
C4, C8, C15—0.01 μF ceramic
C5—100 pF
C6, C7—750 pF
C9—68 pF
C10, C11—300 pF
C12, C13—.005 μF ceramic
C14—22 pF
C16—2000 —F, 50 V, electrolytic
C17—1000 μF, 15 V, electrolytic
C18—365 pF variable (1 5/16H x 1 ⅜W x 113/16D). See text

D1—1N34 or equal
D2—50 V, 1A, full-wave bridge
D3—400 mW, 12 - 13 volt Zener
L1—27 turns B&W 3012 (¾" dia x 32 tpi)
L2—34 turns B&W 3004 (½" dia x 32 tpi)
L3—14 turns B&W 3004 (½" dia x 32 tpi)
Q1, Q2, Q3, Q4—2N914 or equal
Q5—15W silicon npn power transistor
S1—2 pole, 3 position rotary (see text)
S2—double rocker switch (spst/spst)
T1—24 V 500 mA transformer (sec), 117 Vac (pri)
MISC—perf board, hardware, knob, 5 x 5 x 5 box, 3" dial, BNC jack, grommets, line cord

adjustment. Connect the rf generator output directly across the TV's antenna terminals. Then adjust the frequency until the bars appear. Now adjust the vertical linearity (and height) controls till the bars are evenly spaced up and down on the screen.

Building the Ruff Gen

Now that you have been introduced to some uses for the signal generator, it's time to get one. If you don't already have an rf signal generator, the Ruff Gen would be ideal. In fact, some of the features of the Ruff Gen might make you want to supplement your existing signal generator with this one. The circuit was originally designed when a source of nearly sinusoidal rf energy was needed. If you have ever used a commercial signal generator, you know that the output is anything but sinusoidal. Also, stability is somewhat wanting in the cheaper commercial units so this rf generator also fills this gap. Speaking of cheaper, we have the third reason for building this unit. It is less expensive than many units.

Since the rf generator only operates on fundamentals to about 15 MHz and it is sometimes desirable to use it above this range, harmonic generation capability is included. The normal sine-wave output of the generator is distorted at the flick of switch S2, harmonics can be added when needed. This unit is not modulated, but modulation may be added if desired.

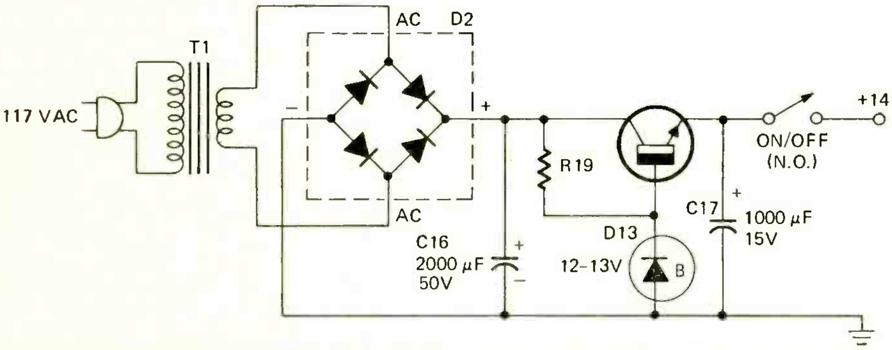


FIG. 7—POWER SUPPLY for the Ruff Gen. It is a simple, yet regulated supply. Note the unconventional position of the on-off switch. See text for explanation.

Three separate oscillators are used in the unit for optimum performance. The oscillators are basically Colpitts types. Somewhere a trade-off had to occur because of the multiband feature, and this was in the tuning capacitor. The same 365-pF capacitor tunes all three bands. Figure 6 shows the scehmatic diagram for the generator. Fig. 7 is the power supply.

Power for the unit is regulated by an emitter follower voltage source; one of the simplest regulators. Actually, the greatest advantage is in the fact that power supply ripple is held to a minimum (around 15 mV). There is no power on/off switch, the power supply is "on" as long as the unit is plugged in. The only real advantage here is the creation of the heat from the regulator which tends to stabilize the temperature inside the generator. The heat also prevents moisture buildups when the case temperature undergoes one of the rapid excursions sometimes associated with a garage workshop.

Since one of the primary considerations is that the unit be inexpensive, the entire unit was designed around the bargain pages of a mail-order catalog. Almost everything needed can be found there, excluding the case, etc.

Construction hints

Perf-board is used throughout, but a printed circuit could easily be fabricated since the wiring has no crossovers.

Three boards make up the unit. They are the power supply, oscillator, and amplifier boards. Each board is mounted within the case on angle brackets fabricated from a defunct utility box. Note the transformer mounting method. The transformer was the cheapest/best unit available, but there appeared to be no way to mount it on a board. Mounting was finally solved by pushing some no. 22 solid hookup wire through the holes at the four corners of the transformer. The wires are simply looped around and then soldered for a very stable mounting method. No heat sink is used for the power transistor, since the power dissipated is no where near the available 15 watts the unit can dissipate at room temperature. On the oscillator board the coils are merely glued in place.

Then there is the issue of the switches. In the interest of money; you can order an assortment of rotary switches, in hopes that you find one that would work and restock the junkbox with the rest. I had to remove an spst on/off switch from the switch I used. For only 99 cents, it was a worthwhile experience and it paid off in the form of 9 additional rotary switches (and the spst, too). Should you want to go the more conservative route, you can merely order the 2-pole 3-position switch specified in the parts list.

The variable capacitor will have to be raised in the air on a strip of aluminum 1 inch wide and 7 5/16 inches long. Bend the strip ⅝ in either side of center down to a 90 degree angle. You should now have a U-shaped bracket. Now put mounting ears on the bracket by bending ¾ inch of the ends away from the center. Drill for the capacitor and mount. There is actually three way support for the capacitor. Two directions from the mounting ears on the bracket and one way from the vernier dial and capacitor shaft. This capacitor is a common type. Radio Shack's No. 272-1344 looks good. Others can be used with minor alterations in the mechanical layout of the generator.

The rocker switches should be mounted on spacers to recess them in the panel. I got the spacers from the rotary switch that was modified to make a band switch. Letter the front, mount the switches, and vernier, glue some grommets on the bottom for feet and you are in business.

Calibration steps

Calibration is really no problem. Just use the procedure for using the signal generator as a heterodyne frequency meter (Fig. 1), borrow an rf generator from someone and you are all set. Since the ranges should have a slight overlap any way, no attempt was made to add a calibrate control. You can adjust the value of R13 to achieve a more distorted output (more harmonics) if desired. In fact, there may be some merit in making R13 a potentiometer to allow a degree of harmonic distortion to be controlled at the generator. For more distortion of the lowest frequency oscillator, you would have to increase coupling capacitor C14 which is optimized at 22 pF.

The signal generator in one of its many forms is a helpful addition to the lab workbench. It can check the bandpass of an amplifier, tuned circuit, mechanical filter, etc. It will do any of the other things mentioned in this article and many more that you might think of.

Certainly, constructing your own rf generator is not as challenging as building a receiver, but the versatility of the Ruff Gen should merit the little time and effort that it takes to build it. The Ruff Gen's output is nearly a sinusoid so that it is extremely helpful in determining network response since there are no harmonics to confuse what you see. Harmonics may be added at will when needed merely by switching the output amplifier to a different amplifier mode and thus increasing harmonic distortion.

At any rate, whether you build, buy, or just apply; you will find the extremely handy signal generator a welcome device on your bench. **R-E**

the state of SOLID STATE

Telephone answering devices, low-power consumption semiconductors, COS/MOS price reductions, power hybrid Darlington, and more

by LOU GARNER
SEMICONDUCTOR EDITOR

THANKS TO SOLID STATE CIRCUITRY, electronic equipment is invading industrial areas which, before, were the exclusive province of electromechanical or mechanical devices and, moreover, expanding into commercial businesses where, previously, it had only a precarious toehold. According to economic forecasts at an EIA (Electronic Industries Association, 2001 Eye St., N.W., Washington, D.C. 20006) conference held earlier this year, the total U.S. market for electronic equipment should nearly double between 1975 and 1985, reaching a total of over *80 billion dollars* by 1985. In contrast, total 1970 U.S. sales were under 29 billion dollars.

One area where tremendous inroads are being made by electronic equipment is in business offices. A few years back, about the only electronic equipment one would find in such offices—other than a personal radio—was an intercom system. Some offices boasted, in addition, electronic dictating equipment. Today, however, even a relatively small office might have electronic data processing equipment, the familiar intercom system, dictating and transcribing equipment, an electronic calculator, and an electronic automatic telephone answering system. Where part of the office staff may be assigned to field work, the office might be equipped with a two-way radio system to maintain constant contact for information and reassignment purposes.

Currently, electronic telephone answering systems are enjoying a fair-sized boom. More and more businesses are installing these systems, including professionals, such as physicians, attorneys, architects, accountants and engineers, real estate, insurance, stockbroker and construction offices, and even retail and service establishments, such as stores and repair shops. An automatic telephone answering system can be worth its weight in gold to the radio-TV service technician operating a one-man enterprise. In addition to business applications, quite a few systems are being installed in private homes.

Retail prices range from about $150 to over $700, plus installation, depending on the quality of the instrument and the operating features offered. Generally, the more expensive the system, the greater the number of operational options. All currently available systems feature solid-state circuitry and all will answer a telephone automatically with a prerecorded message, afterwards recording an incoming message for later playback. Most provide for monitoring an incoming call while recording.

The more expensive systems may have an automatic counter for incoming calls, two-way recording facilities for outgoing calls, and even a remote query option, permitting the owner to check his accumulated calls from a remote telephone.

Despite the seemingly simple functions provided by automatic telephone answering equipment, their circuitry can be quite complex, even rivalling that of a color TV set.

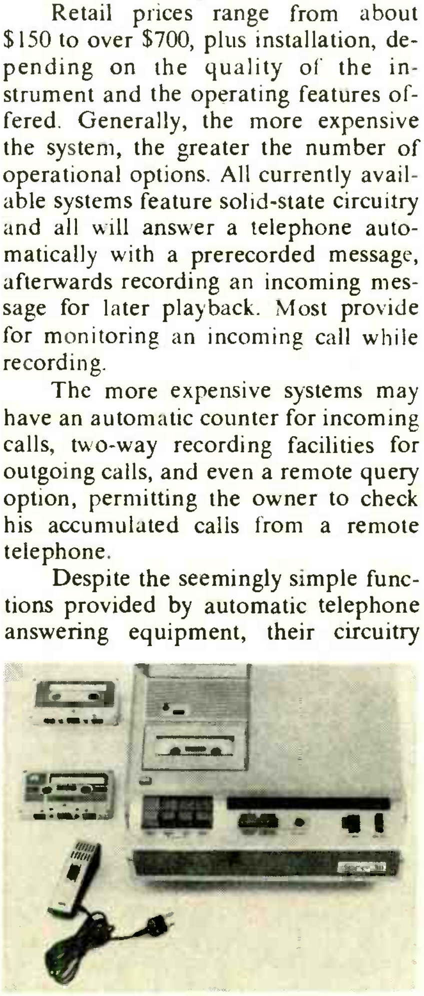


FIG. 1—AUTOMATIC TELEPHONE answering system; the Doro 311.

By way of illustration, the unit shown in Fig. 1, is a moderately priced instrument that includes many of the features found in more expensive systems. Unfortunately, space limitations prohibit the publication of the instrument's complete schematic, but some idea of its complexity can be gleaned from its simplified block diagram, given in Fig. 2. The instrument's power supply, alone, uses four diodes in a bridge rectifier, a medium-power pass transistor, and an IC operational amplifier to provide regulation. Altogether, this device uses over 40 diodes, 35 transistors, 2 SCRs, and 4 ICs.

Various recording systems are used by different manufacturers of automatic telephone answering equipment. Some use standard cassettes, others reel-to-reel tapes, and still others special cartridges.

If you find automatic telephone answering equipment intriguing, have a knack for solid-state circuits plus mechanical skill, and are an experienced technician looking for other pastures or even a hobbyist with an eye towards a professional future, you may find it worthwhile to investigate the rapidly expanding field of office electronic equipment installation and maintenance. *It's a comer!*

The merry MISER

An interesting semiconductor device being offered by Lithic Systems, Inc. (10010 Imperial Ave., Cupertino, Calif. 95014) is a real miser when it comes to its power requirements. Suitable for use in light flashers, relaxation oscilators, tone generators and timing circuits, the unit can operate with source power drains measured at microwatt

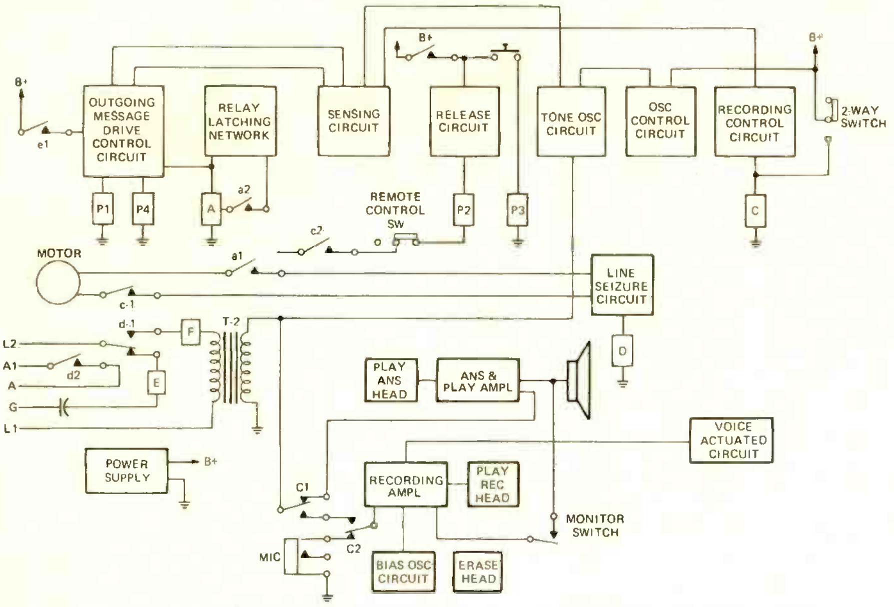


FIG. 2—SIMPLIFIED BLOCK DIAGRAM of Doro 311 automatic telephone answering system.

levels. In fact, it's actually called a MISER, for *M*onolithic *I*ntegrated *S*tored *E*nergy *R*egulator. If teamed with a standard LED, the unit can provide performance characteristics comparable to those of a low-voltage neon lamp. Some of its possible applications are truly fascinating—*would you believe a light-powered light?*

The MISER's functional block diagram is in Fig. 3. It consists of a dc-comparator, high and low threshold voltage limiters, and a power gate capable of furnishing output currents of up to 50 mA. In most applications, the device is used with an external capacitor connected between its source (S) and ground (G) terminals; the load, be it a LED, loudspeaker voice coil, relay, or transformer primary, is connected between the load (L) and source (S) terminals. Only one version is currently available, the LP1000, supplied in a standard 3-lead metal TO-18 package.

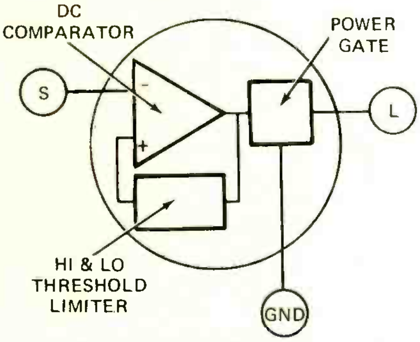


FIG. 3—MISER FUNCTIONAL block diagram.

In operation, the capacitor between the source and ground terminals is charged slowly by an external dc power source. During the charge period, the capacitor's instantaneous voltage is constantly compared to an internal threshold voltage. At the same time, the dc-comparator holds the power gate in a high-resistance (non-conducting) state, supplying a peak threshold voltage to its own non-inverting input. As the capacitor's charge voltage reaches the peak threshold, the dc-comparator switches suddenly, biasing the power gate to a low-resistance state and, at the same time, changing the voltage at its own non-inverting input to a lower "valley" threshold. With the power gate conducting, the capacitor discharges through the external load until its instantaneous voltage drops to the new valley threshold, whereupon the dc comparator reverses its mode, turning the power gate off and returning to its original peak threshold voltage, permitting the entire cycle to repeat.

When a low resistance is connected between the source (S) and load (L) electrodes, the combination of MISER and load have an overall characteristic which is generally similar to that of a Unijunction transistor (UJT), but at considerably lower voltage values. As with a UJT, there is the customary positive resistance slope, peak point, negative resistance slope, valley, and upward positive slope in the combination's performance curve.

Several of the MISER's interesting circuit applications are shown in Fig. 4—a LED flasher at (a), tone generator at (b), and low power dc/dc inverter at (c). In each, the MISER is type LP1000, the power source B1, a 3-volt battery, and the resistors half-watt units.

With the parts values given, the LED flasher, Fig. 4-a, delivers a single flash every few seconds. The total battery drain is less than 200 μW. Almost any standard LED may be used, including Monsanto's popular MV50. If desired, the flashing rate may be raised, but at the expense of increased power drain. Simply reduce the value of series resistor R1 or raise the supply voltage. If B1 is replaced with a photovoltaic cell (such as International Rectifier's type S7M) and R1's value reduced to 5,000 ohms, the circuit operates as a *light-powered light.*

You can use the tone generator circuit illustrated in Fig. 4-b as either a low power code-practice oscillator or as a metronome, simply by changing C1's value. A high-impedance loudspeaker (20-ohm voice coil) is preferred for best performance. If used as a code-practice oscillator, C1's value may be from 0.05 to 0.5 μF, while up to 100 μF, or more, is needed for metronome rates.

In laboratory tests, the dc/dc inverter circuit shown in Fig. 4-c has supplied as much as 90 volts at microwatt levels when powered by a small 3-volt battery. Step-up transformer T1 is chosen for the output voltage needed, while D1 is a standard rectifier diode and C2 a suitable filter capacitor.

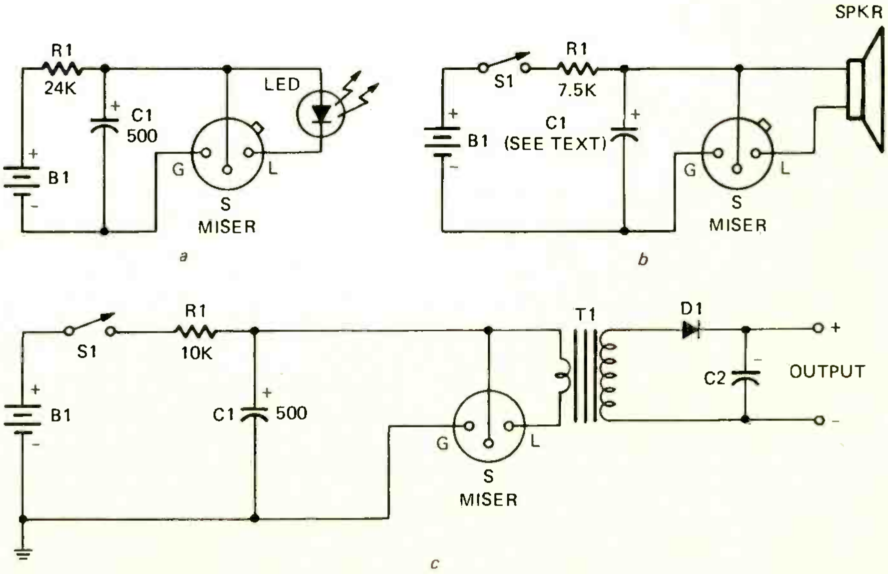


FIG. 4—TYPICAL MISER APPLICATIONS a—LED flasher; b—Tone generator or code practice oscillator; c—power inverter.

Commercially, the MISER may be used in telemetry, biomedical, communications, alarm, and automotive applications.

Device/product news

Designated type TIS125, a new npn planar transistor designed for use as a common-base amplifier in TV vhf rf applications has been introduced by Texas Instruments, Inc. (P.O. Box 5012, M/S 308, Dallas, Tex. 75222). Illustrated in Fig. 5, the TIS125 features a high power gain of 19 dB and a noise figure of only 3.5 dB at 200 MHz. Offered in a TO-18 pin-circle plastic package, the new unit has a low feedback capacitance of 0.3 pF maximum.

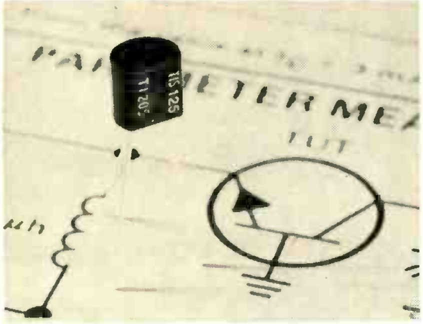


FIG. 5—TI's NEW TIS125 VHF transistor.

Good news from RCA's Solid State Division (Route 202, Somerville, N.J. 08876)—general base price reductions on its entire line of commercial COS/MOS integrated circuits! The new base prices apply to more than 180 standard types, including dual in-line plastic, dual in-line ceramic, flatpack and chip configurations. Price reductions average 25 percent for plastic packages, 20 percent for dual in-line and flatpack ceramic types, and a whopping 50 percent for chips.

RCA also has announced a variety of exciting new devices, including a high-current array, two new vhf/uhf transistors, a high-power switching transistor, a hybrid dual Darlington amplifier, heavy-duty triacs, and three new COS/MOS IC's.

Illustrated in Fig. 6, the new high-current device, type TA8624, consists of an array of six 50-ampere, hometaxialbase silicon *npn* transistors mounted in a compact plastic package with a common collector connection to the mounting flange. External leads attached to either side of the package provide one common lead for six transistor bases and another for the six emitters, but the external leads can be sheared apart to separate individual base or emitter leads to form multi-parallel or single-circuit combinations; if desired, external crossover links may be added to form single- or dual-Darlington configurations. With the six transistors connected in parallel, the TA8624 has a switching capability of 300 amperes and a dissipation of 1000 watts. It can be used in such applications as dc motor controls, converters, inverters, low-frequency high-power amplifiers, and switching, series, and shunt regulators.

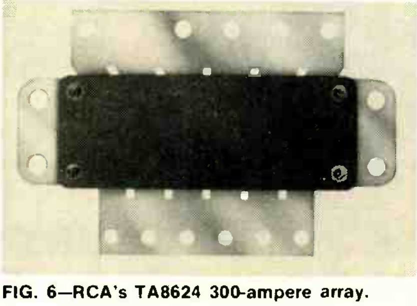


FIG. 6—RCA's TA8624 300-ampere array.

Designed for Class C vhf/uhf applications, RCA's new high frequency transistors are silicon *npn* overlay devices. Designated types 40964 and 40965, the units feature high power gain: 6 dB minimum tripling up to a frequency of 470 MHz for the 40964, and 7 dB min. at 470 MHz for the 40965. Both units are intended for use in mobile and portable transmitters in which intermediate power output is required at low supply voltages. They are supplied in JEDEC TO-39 hermetic packages.

Identified as type 2N6354, RCA's new switching device is a 120-volt, 10-ampere silicon *npn* transistor intended for such applications as switching-control amplifiers operated from 48-volt power supplies, power gates, switching regulators, dc/dc converters, and power oscillators. It is furnished in the popular TO-3 package, and features an exceptionally fast switching time.

Supplied in a compact 14-lead dual in-line package, as shown in Fig. 7, RCA's new power hybrid device consists of two Darlington amplifiers, each of which can deliver 5 amperes with a current gain of 500, or 3 amperes with a current gain of 600. The amplifiers include integral diodes for load-current commutation and, therefore, are suitable for driving inductive loads. Typical applications for the new hybrid, type TA8590, are hammer driver, solenoid driver, stepper-motor driver, and regulator service.

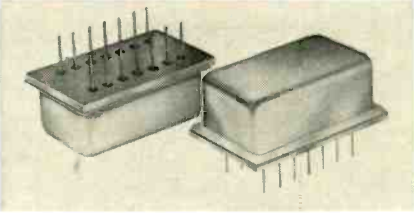


FIG. 7—RCA's TA8590 dual Darlington.

Intended for the control of ac loads in applications such as heating controls, motor controls, arc-welding equipment, light dimmers, power switching systems, and in air conditioning and photocopying equipment, RCA's new triacs are rated at 40 amperes, 800 volts. Designated types 40925, 40926, and 40927, the devices are supplied in press-fit, stud, and isolated-stud packages, respectively.

RCA's new COS/MOS devices are the CD4048A, CD4057A, and CD4058A. Of these, the CD4048A is an expandable 8-input multifunction gate featuring medium power TTL drive capability, three-state outputs, low-power dissipation, high noise immunity, and good temperature stability. Three binary control inputs select 1-of-8 output functions of eight input variables. The eight output functions are OR, NOR, AND, NAND, OR/AND, OR/NAND, AND/OR, and AND/NOR. Through the use of multiplexing techniques it is possible to obtain all eight functions during a given clock time. With an "expand" input permitting cascade operation to obtain functions of 16, 24, or more variables, the CD4048A is supplied in a 16-lead dual in-line ceramic package.

The CD4057A is a flexible arithmetic array for use in LSI computers. It provides 4-bit arithmetic operations, time sharing of data terminals, and full functional decoding for all control lines. The device, furnished in a 28-lead dual in-line ceramic package, can be used in parallel arithmetic units, process controllers, remote data sets, and graphic display terminals.

Finally, the CD4058A is an MSI 8-stage fully static bidirectional shift register having parallel inputs and outputs as well as serial JK inputs. Intended for applications in code converters, up/down Johnson or ring counters, pseudo-random code generators (sequence generators), sample-and-hold registers (storage counting and display), and frequency and phase comparators, the CD4058A is available in a 24-lead dual in-line ceramic package.

Silicon General, Inc. (7382 Bolsa Ave., Westminster, Calif. 92683) has introduced an upgraded industrial version of its SG1501 dual-tracking voltage regulator. Identified as type SG4501, the new device will accept inputs of up to ±30 volts, supplying ±15 volts within ±5%. Output voltage balance is within 2% and line and load regulation to 0.1%. The device is offered in both TO-100 10-lead metal cans and 14-pin dual in-line plastic packages. Its specified temperature range is 0°C to 70°C, and it has a maximum load current rating of 100 mA. The device alone can power up to 25 op amps. External transistors can extend load currents to above 2 amperes.

That concludes our look at solid state for this month, my friends . . . have a happy Thanksgiving and *don't eat the whooole thing!* **R-E**

Using a Solid State Curve Tracer

Many important time-saving tests can be made using a scope-curve tracer combination. Here are some tests you will want to try

by MANNIE HOROWITZ

FIG. 1—TRANSISTOR-DIODE CURVE TRACER plugged directly into a scope. The output of this tracer can be displayed on any general-purpose scope.

THE TV OR HI-FI SERVICE TECHNICIAN uses a curve tracer to check the quality of semiconductors when they are wired in the circuit or as individual components. The hobbyist uses the instrument to select devices sold in a bulk package that he may have purchased at some "bargain" counter. The engineer uses a curve tracer to note and check characteristics of transistors and diodes when he designs them into equipment. Test and quality control technicians use curve tracers to evaluate the grade and type of device supplied by a vendor.

It is not presumptuous to state that a curve tracer is so versatile, that it serves some function to everyone involved directly in modern electronics. It may be used in a different manner by each individual, but the applications overlap.

Some skeptic might stop here and say, "I can do anything with my transistor tester that can be done with a curve tracer." While it is true that there are excellent transistor testers on the market, they will measure only a limited number of characteristics of some devices, and these only at a specific collector current or voltage level. Using a transistor tester, will in many cases, enable you to separate good devices from bad ones. Yet you can know much more about a device with but one glance at the crt of a curve tracer.

It is easier to perform the tests and measurements on the curve tracer if your scope uses direct coupling (no input or coupling capacitors in the amplifier circuits) in both the vertical and horizontal amplifier chains. A typical arrangement of scope and curve tracer is shown in Fig. 1.

Transistor curves

The collector characteristics of a transistor can be displayed on the screen of a curve tracer. Briefly, the collector current flowing through a bipolar transistor is dependent upon two factors—the collector to emitter voltage and the base current. The traces on the screen of a curve tracer display this information. Much can be learned about the transistor from this display. A typical set of curves for an npn transistor is in Fig. 2. The pnp transistor characteristics are very similar—only the polarity of the voltages and currents are reversed.

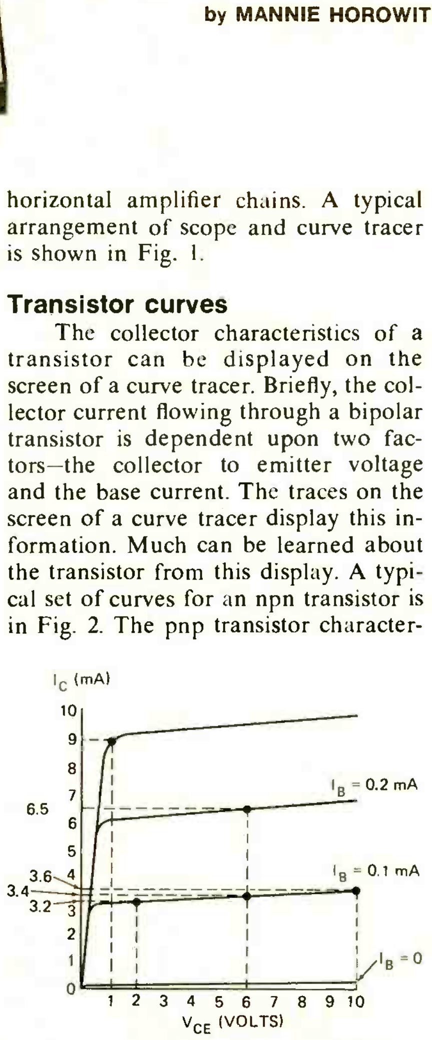


FIG. 2—TYPICAL NPN collector display and construction to determine characteristics of bipolar device.

Each relatively horizontal line describes how the collector current, I_C, varies with the collector-to-emitter voltage, V_{CE}. The different horizontal lines define this relationship for the various values of base current. For example, draw a vertical line from the 6-volt point on the V_{CE} axis up to the I_B = 0.2 mA curve, and a horizontal line from the intersection to the I_C axis. It crosses the I_C axis at 6.5 mA. For this particular transistor, when there is 6 volts between the collector and emitter, and 0.2 mA flows into the base, the collector current is 6.5 mA.

The construction may be repeated to determine the collector current at any point on the characteristic curves. You can determine bias requirements from the display on the crt and make the necessary calculations to establish the desired idling current for the particular transistor under test.

Beta can be determined from the curves. Although it is not drawn as such, the curves do not have to be evenly spaced and the horizontal lines are not always parallel to each other. Because of this, beta will vary with I_C and V_{CE}.

Beta is the short-circuit current gain of the transistor. As you recall, two types of beta are encountered—the dc and the ac. Dc beta (B_{dc}) is the ratio of collector current flowing to the base current causing this collector current, at a specific collector-to-emitter voltage. In the figure, at V_{CE} = 6 volts, there is 6.5 mA of collector current when the base current is 0.2 mA. B_{dc} is 6.5 mA/o.2mA = 32.5.

When ac signal is applied to the base of a transistor, it forces the base current to vary with the size of the input. In turn, the collector current will vary with the base current. The ac beta, B_{ac}, is the ratio of these two variations at specific collector to emitter voltages. As an example, let us assume that the signal causes the base current to change from 0.1 mA to 0.2 mA and that V_{CE} is 6 volts. The collector current will, in turn, swing from 3.4 mA to 6.5 mA. B_{ac} is (6.5 mA -3.4 mA)/(0.2 mA - 0.1 mA) = 31.

Alpha is the ratio of the collector current to the emitter current. It is used primarily when dealing with common-base circuits. The ac alpha, α_{ac}, and dc alpha, α_{dc}, can both be calculated from the respective betas using the equation

$$\alpha = \frac{\beta}{\beta + 1}$$

Another important characteristic of the transistor is the saturation voltage. At the extreme left of the display in Fig. 2, note the curve at low collector voltages. The relatively vertical curve is inclined at a slight angle. The transistor cannot operate to the left of the vertical line. At the maximum collector current of interest to you, draw a horizontal line from the vertical axis to the highest base current curve. Next draw a vertical line from the point of intersection to the V_{CE} axis. The voltage on the V_{CE} axis is a good approximation to the saturation voltage of the transistor.

From Ohm's law, resistance of any device is a voltage divided by a current. The ac collector resistance, r_d, is the ratio of the peak-to-peak voltage to the peak-to-peak current. The ratio is the slope of a particular display. For the transistor, the ac resistance varies with the base and collector currents. On the I_B = 0.1 mA curve, the collector resistance around the I_C = 3.4 mA point is (10 volts - 2 volts)/(3.6 mA -3.2 mA) = 20,000 ohms. This resistance is valid for the common emitter circuit. For the common base mode of operation, the collector resistance is approximated by beta multiplied by r_d.

The ac collector resistance of the vertical portion of the characteristic is radically different from the rest of the curve. It has been assigned the special name of saturation resistance. Ideally, it should be zero ohms so as not to limit the minimum value of collector voltage. In the figure, it is 1 volt/9 mA, or 111 ohms.

Leakage current and breakdown voltage are important characteristics of the transistor. Although they can be estimated from displays similar to those in Fig. 2, they are diode characteristics and can be determined by testing the transistor as a diode.

FET curves are similar in form to those of the bipolar transistor, except that while the current steps are fed to the base of the latter, voltage steps are impressed between the gate and source of the FET. A typical set of n-channel curves are shown in Fig. 3.

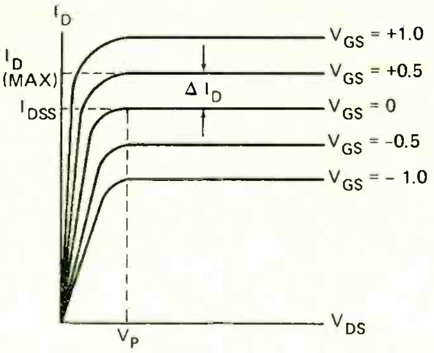


FIG. 3—TYPICAL N-CHANNEL DISPLAY and construction to determine characteristics from the display.

The I_{DSS} is the current flowing when the gate-to-source voltage, V_{GS}, is zero. V_P is the pinch-off voltage and is equal to the V_{DS} (drain-to-source voltage) at the point where the V_{GS} = 0 curve becomes horizontal. The zero gate voltage transconductance, g_{mo} is approximately equal to the ratio of the difference in drain current, ΔI_D, to the difference in gate voltage, ΔV_{GS}, causing the change in drain current. In the drawing, the two V_{GS}'s are chosen at 0 and +0.5 volts. To avoid misleading answers, do not choose values of V_{GS} greater than 0.5 volts for the calculation.

For p-channel devices, only the polarity of the voltages and currents are changed. In either case, the transistor is treated as a diode to test for breakdown voltage and leakage current, I_{GSS}.

Diode breakdown curves

As you know, diodes conduct readily when a voltage is applied making the anode positive with respect to the cathode. Should the voltage be applied in the opposite direction, only a small leakage current, I_L, will flow. The current will be large when the reverse voltage is increased beyond the breakdown voltage, V_B, of the diode. A curve showing this is drawn in Fig. 4.

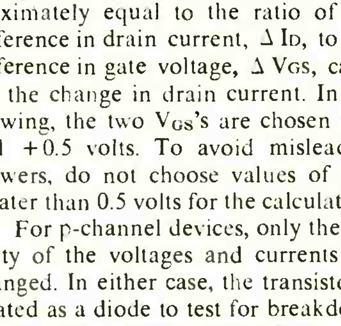


FIG. 4—REVERSE BREAKDOWN CURVE of solid-state rectifier.

Much can be learned from the curve. The diode breakdown voltage is at V_B, the voltage that causes the curve to turn from the horizontal. (This is also the regulating or rated voltage of a zener diode.) The leakage current is I_L, the distance in microamperes from the zero axis to the essentially horizontal portion of the curve at the breakdown voltage.

An extremely important characteristic can only be seen on a curve tracer. Diodes which can best withstand transient voltage pulses (and these pulses can be extremely high), exhibit low resistance in the breakdown region. It is desirable that the vertical portion of the display be as near vertical as possible.

A good diode will be capable of dissipating as much power in the reverse direction as it is permitted to dissipate in the forward direction. As a rule of thumb, I_R(max) = $0.7I_F/V_B$, where I_F is the forward current rating of the diode. When making tests, limit the curve tracer so that the current through the diode will not exceed the calculated I_R(max). The diode should, however, be capable of conducting this current.

A bad junction can only be seen on a curve tracer. The V_B voltage should be stable and not jump, however minutely, from one value to another. Any jumping indicates a poor diode that should be disposed of.

Leakage current and breakdown voltages of a transistor can be determined using diode measuring techniques.

For the bipolar transistor, I_{CBO} is the reverse current that will flow between the base and collector when the emitter lead is left disconnected. The npn device can be checked by connecting the base to the anode terminal of the diode jacks and the collector to the cathode terminal. The leakage current at any particular voltage is I_{CBO}. If you increase the voltage up to V_B, you can find the BV_{CBO} or collector-to-base breakdown voltage of the transistor.

To determine the I_{CEO} of the npn transistor, the base rather than the emitter is left open. The collector remains connected to the terminal where you would ordinarily connect the cathode of a diode, and the emitter is connected to the anode terminal. Leakage and breakdown voltage, BV_{CEO}, are measured as before.

In each case, the pnp transistor is measured by reversing the connections indicated for the npn device, on the curve tracer.

The I_{GSS} or leakage of an n-channel JFET is measured by connecting the gate to the anode terminal on the instrument and the remaining two leads to the cathode terminal. The leakage and gate-to-source breakdown voltage are measured in the same manner as the equivalent factors of the bipolar devices. The drain-to-source breakdown voltage can be checked on the curve tracer by connecting the drain to the cathode terminal and gate and source to the anode terminal. Increase the voltage until V_B is reached. Of course, the connections must be reversed should a p-channel JFET be tested

Diode breakdown measurements also apply to the SCR. Just connect the

(continued on page 68)

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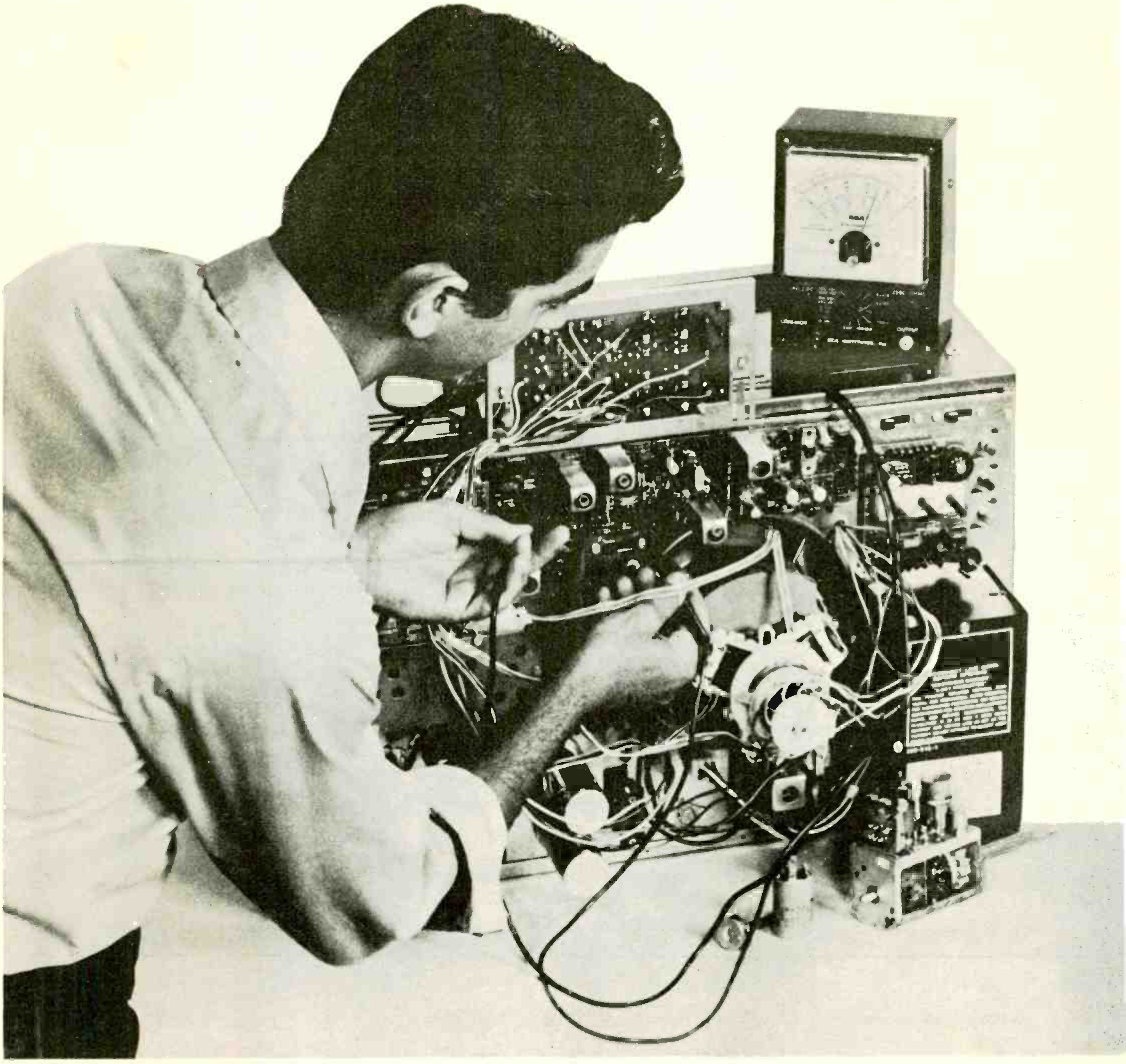

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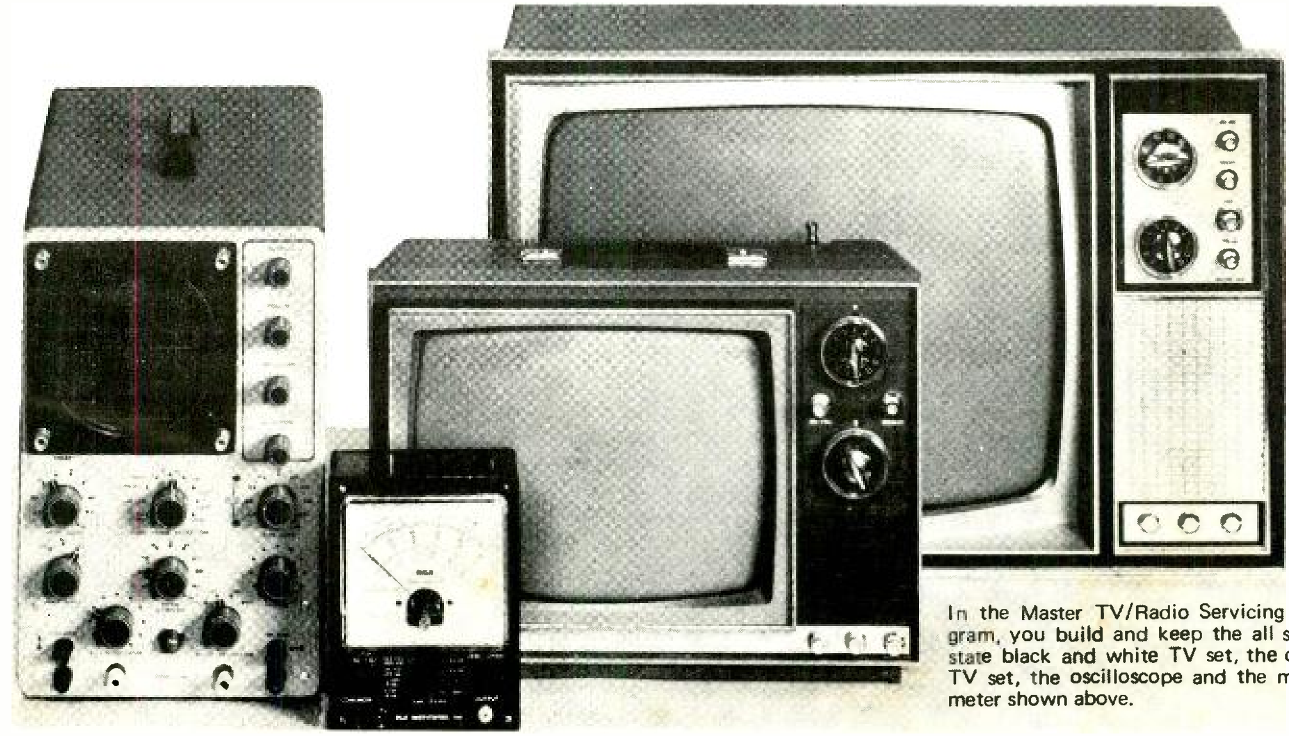


In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

SOLID-STATE CURVE TRACER

(continued from page 63)

gate on the device to the cathode on the device thorugh a 1000-ohm resistor. Then check the anode-to-cathode breakdown voltage in both directions by simply reversing the connections of the SCR to the curve tracer.

Forward diode characteristic

All diodes have a distinct relationship between the applied forward voltage and the forward current. These curves tell much about the particular rectifier or diode. A typical curve is shown in Fig. 5.

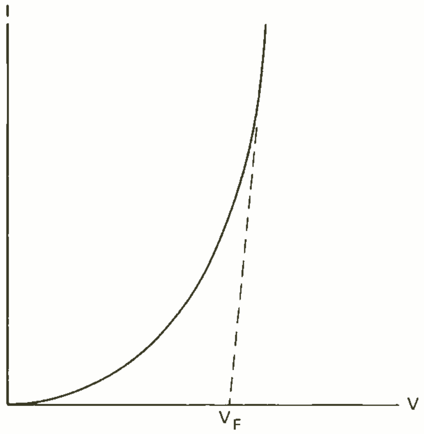


FIG. 5—FORWARD CHARACTERISTIC curve of solid state diode.

The broken line is an extension of the relatively straight portion of the diode characteristic to the voltage axis. It crosses the axis at V_F. V_F is between 0.3 and 0.5 volts for junction germanium diodes and between 0.6 and 0.8 volts for silicon devices.

The resistance of a germanium junction diode is lower than that of a point contact signal device. You can then separate the two devices by noting that the slope of a junction diode is more nearly vertical than that of a point contact diode.

The relative size of a rectifier chip determines its current carrying capacity. The capacity may be estimated from the type of curve shown in Fig. 5. At any one current level, large devices will have lower voltage drops than will power rectifiers constructed with smaller chips.

The EICO model 443 curve tracer

The EICO 443 curve tracer is shown in Fig. 6. It can produce the curves shown in Figs. 2, 3, 4 and 5, and then some, when measuring semiconductor devices. The functional panel layout allows the operator to readily use the instrument. The technician just calibrates his scope using the calibration voltages from the 443, and starts making measurements using a few of the simple controls on the panel. A circuit designer will undoubtedly use his ingenuity to accumulate a great deal more information about a device under test than is readily available at a glance.

Using the FUNCTION switch, you can select the required one of the four groups of displays that can be generated by this instrument. Let's select and discuss one function at a time.

Transistors—signal types

Four current steps produced in this instrument feed the base of the transistor under test. The steps are synchronized to the 60 Hz power supply frequency. Thus four steps are generated during each cycle. Half-cycle pulses are fed to the horizontal input of the scope sweeping the trace four times each cycle—once on the rise and once on the decay of each half cycle. These half cycles serve two other functions as well. First they are applied across the transistor to serve as the collector supply voltages. Second, they are fed to the step generator so that the steps fed to the base of the transistor under test, will be in time with the swept quarter cycles.

The emitter current of the transistor being tested flows through a resistor. In bipolar devices, the emitter current is just about equal to the collector current. This current, a product of the base current and beta, flows each time one of the four different steps is supplied to the base. The voltage across the resistor in

(continued on page 96)

FIG. 6—EICO MODEL 443 is a typical solid-state semiconductor curve tracer.

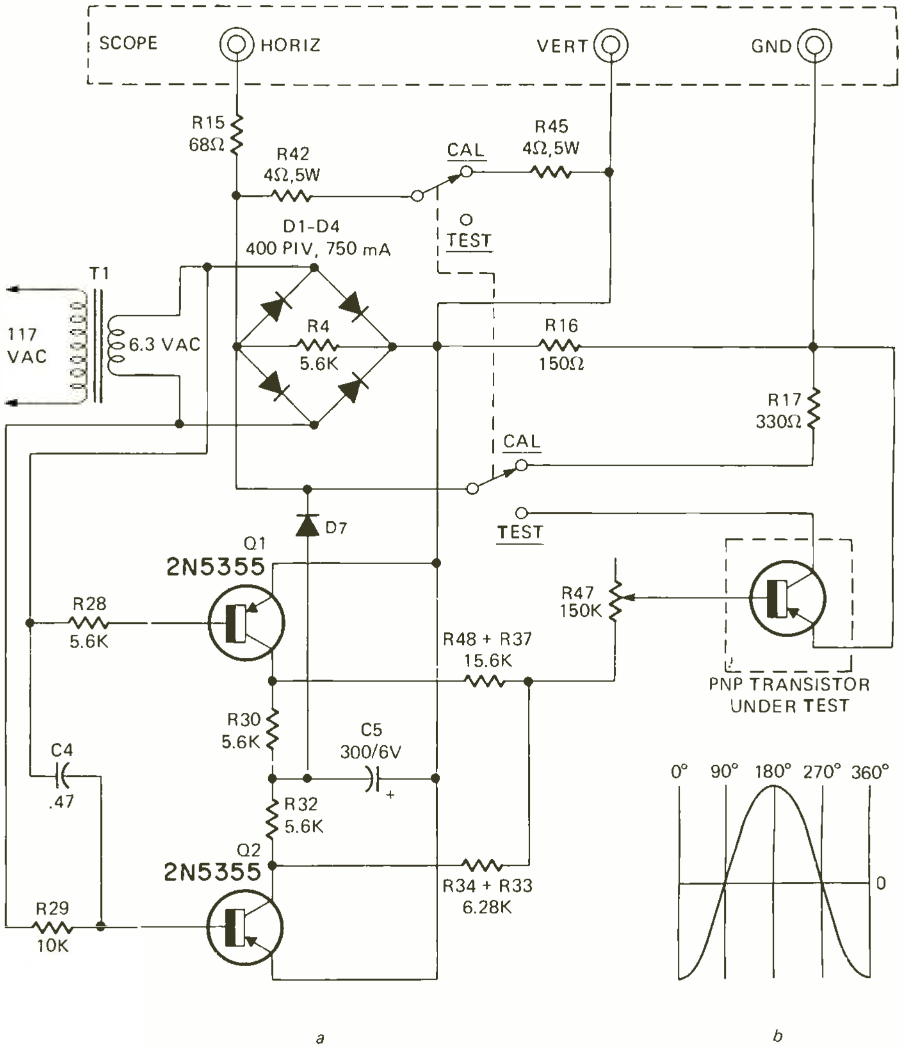


FIG. 7—CIRCUIT TO TEST SIGNAL TRANSISTORS is in (a). The negative cosine wave in (b) is used to explain the formation of the four steps fed to the base of the transistor under test.

R-E's Service Clinic

Troubleshooting—a novel approach

Imagination aids troubleshooting by eliminating the mental rut

by JACK DARR
SERVICE EDITOR

THIS MAY SEEM ODD, IN A TECHNICAL column, but I'd like to go from technology to psychology for a while. Don't worry; it has a real, practical application. It's about the use of *imagination* in our work. The best diagnosticians have a very vivid imagination, plus a thorough knowledge of the circuit they're working on. With *both* of these, they are able to make up a list of the many, many things that could be causing the symptoms they find. After this, all they have to do is check out the list, one item at a time, to find the cause.

Try it yourself, when you get a spare moment. Get a defective set; any kind. Also get a scratch-pad. Open the set up, turn it on, and see what the main symptom is. No picture, no high voltage, no sound, etc. Write this at the top of the sheet. Now, sit there and make up a list of everything you can think of that could possibly cause it. Number each item. You might start with the one you consider the most likely and go on from there.

Now start making tests. Check off each item as you go. If your imagination is active enough, you *will* have all of the possible causes on your list. However, I think you'll be surprised to find, in many cases, that there were after all, one or more things you forgot to put down on your list.

I speak from a lot of experience. I have used this method for a long time; my shop is full of clipboards with notes on 'em. You may be a bit embarrassed the first few times. You'll find that you forgot to put down what turned out to be a very obvious cause, and this was the one. After a little practice with this method, I think you'll find your diagnostic skills sharpening up perceptibly. By back-tracking, you will be able to see where you got off the correct line.

Above all else, this will help you to develop the most valuable attribute in all diagnostic work—*a completely open mind.* The cardinal sin, of course, is the "fixed diagnosis," made on the basis of no evidence whatsoever; just what you *think* it should be. If you commit this error, you'll find yourself testing, not to find out what the real trouble is, but solely to verify your first *opinion*. (For that's what this is; not a valid diagnosis, but just a personal opinion, until you have some hard facts and test results to back it up.)

For a good horrible example of this, you're sure that the loss of high voltage and the high current in the horizontal output tube is due to a shorted flyback. So, you change the flyback; now, you still have high current and no high voltage. Checking further, you find that the focus transformer was shorted, causing the whole trouble.

To use your imagination properly you'll have to reverse the tradition of the U.S legal system. Everything must be considered guilty until proven innocent, by test. No matter how unlikely a certain part may seem, suspect it until you've proven definitely that it is good. When you get this result, check that one off your list and go on to the next one.

For another example, no high voltage, cathode current very low, screen voltage on output tube very low. Tube good, by replacement. Open flyback? No, by ohmmeter test. B+ supply at bottom of winding normal, so the damper is conducting. Imagination says "This tube is acting as if it had no plate voltage, but it's there on the flyback." Final result: check plate lead; insulated cap, looking good; wire not damaged. Look *inside* the plate-cap, and find that the wire has corroded and opened up. No plate voltage.

For a final example, during WW II I was servicing a B-25 bomber which was ferrying through our field. It was parked on a taxi-strip about half a mile from the tower. I pulled the SCR-522 vhf radio, took it to the shop, changed a tube, tuned it up, and called the tower. Fine. Time, 12:00 midnight. At 3:00 AM, after two trips back to the shop, and a perfect response, the radio still would not work in the aircraft.

My test instruments showed that the transmitter had ample rf output, good modulation, and everything else, but I could not get the tower. Mikes and every other part of the ship's wiring, checked. Since I had already tried cussing, I did the only thing left. I sat down

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

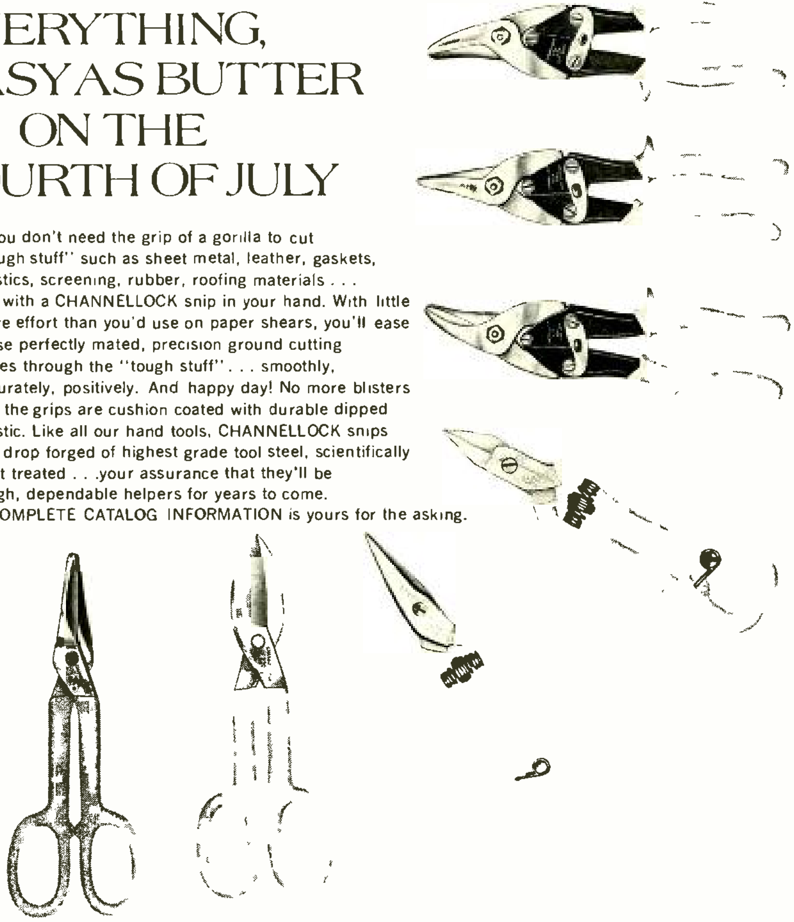
If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

on the runway and cried.

Sitting there in the cold Texas moonlight, Imagination finally came to the rescue. From where I sat, I could see the "ax-handle" vhf antenna on the bottom of the fuselage. Looking past it, I could see that the antenna, the right landing-gear strut and the tower were perfectly lined up. I said, "Imagination, shut up! That strut *couldn't* be splitting the signal. It couldn't be!" Imagination says "Try it. What have you got to lose except more sleep?"

I untied the tail tie-down, fastened the rope to my jeep, and dragged the tail of the aircraft about 5 feet to one side. Crawling wearily back up into the cockpit, I picked up the mike. "Rosy Tower, this is Army 359. Radio check, please." Back came a roar "Army 359, 5 by 5! Loud and clear!" "Thank you, Rosy Tower! Army 359 over and out! Goodnight!"

The moral of this is, of course, that after you've exhausted all of the reasonable, normal alternatives, sit back and let your imagination take it from there. There must be something you haven't thought of *yet.* Wind it up and let it fly, and sooner or later you'll get it. If all other ways have been exhausted, try a vivid imagination. Remember, no idea is too far-fetched to be worth investigating if all else has failed. **R-E**



reader questions

FLOATING BLUR

I've got an odd floating blur in a Philco 19KT51 chassis. It's about 6 inches high, and floats slowly up the picture. When the blur is at the bottom of the screen, I can see video that should be at the top of the picture, and vice versa.—A.M. Philadelphia, Pa.

Whatever it is, it is a "60-Hz" pulse (only one bar visible). Suggestion; put a scope on the dc supply lines around the video stage, and look for anything like a 60-Hz ripple or hash, pulse, etc. A heater-cathode short in the video output tube will cause the same kind of symptoms. In fact, any tube in the signal-path, with a cathode resistor, and a heater-cathode short can do it. I've seen an rf amplifier tube cause similar symptoms.

WHITE FLASHES

I've got an old RCA CTC-9 color chassis on the bench. Works like a charm, with a few new tubes and a resistor or two, and realignment. But the set has an intermittent white flashing in the picture. The whole picture will go very bright, and out of focus a little, then go back to a good color picture. Long-term intermittent. I'm afraid to take it back until I find this.—L.H., Honobra, Okla.

This is caused by something that is affecting the video(Y) signal, or, you could say, the brightness level. The pix tube cathode voltages are going negative (which makes the picture tube go to higher brightness) then falling back, to normal.

The most likely cause for this is an intermittently-leaky or shorted 12BY7 last video output tube. Try a new one here. While you're there, clean the socket contacts and check all of the PC board conductors for breaks.

VERTICAL BLINK

I've got an Airline color TV in for service. The raster will collapse to a very thin line, then slowly fill up again. Action is pretty fast. This is a GEM-17148B chassis, and I can't find a listing in the Sams file. The vertical tube (13GF7) is OK, and the dc voltage supply is OK.—R.D., Vinita, Okla.

For a schematic, check the "Sharp CN-52T", Sams Set 1076-2. This is practically the same, especially in the vertical circuit. (Airline made by Sharp, in this one)

Check the cathode voltage on the vertical output; pin 3 of the 13GF7. If it is jumping up and down, turn it off, and check for continuity to ground. Should read 1470 ohms; a 470-ohm resistor on

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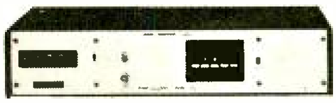

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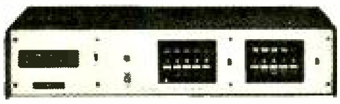

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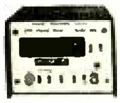

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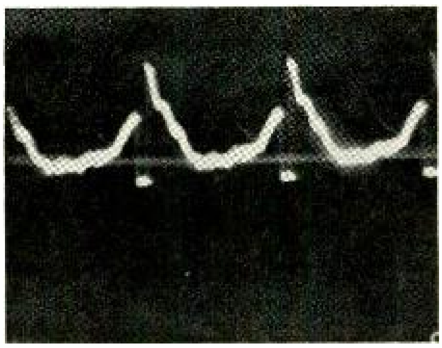
the PC board near the socket, and a 1000-ohm resistor (a 2-watt film type). The last one is probably opening intermittently.

By the way; this 1000-ohm resistor is completely inaccessible unless you pull the chassis. It's in a group of similar resistors to the left and below the opening you see by taking off the bottom plate. Trace the circuit from the 13GF7 socket to the 23JS6 (horizontal output tube) socket. You'll find a thin green wire going to pin 4 (suppressor) and then going on over to the 1000-ohm resistor. Quick-repair, just clip the wire to the original resistor, and solder a 5-watt wirewound 1000-ohm resistor from the lance on the PC board (bottom of the 470-ohm resistor) to ground. There is plenty of room for this in here. Use spaghetti on the leads.

POOR HORIZONTAL SYNC

I've got a Zenith 14N22 chassis with very poor horizontal hold action. From the solder joints, it looks as if there has been some "work" done around that circuit. I've checked all of the capacitors, and so on, with no results. Where do I go from here?—F.S., Acorn, Ark.

Check the apc diodes. If they have been replaced, it could be that someone used a poor grade of diode, or that one of them is leaking. The scope photo shows you what the sawtooth will look like when this happens. (or it did on the last one of these that I found.)



This waveform reads about 4 volts peak-to-peak, and it ought to be about 17 volts. Note the distortion: it also shimmered so badly that it was hard to photograph. Try a new pair of diodes, and check them for balance and reverse leakage before you put them in!

HORIZONTAL OSCILLATOR FREQUENCY PROBLEMS

In a recent Service Clinic, you had a question about a horizontal oscillator running too high. I found the same kind of trouble in a Zenith 14M23. It whined, with no picture on the screen. Tracing the B+ lead back from pin 1 on the horizontal control tube, a 6GH8, I found that C44B, an 80 μF electrolytic capacitor in the B+ supply was open. Replacing this cured the trouble.—Gerald Oium, Towner, N.D.

Duly noted and filed! Thanks, Gerald. Found a lot of hash on the B+ when you scoped it, didn't you?

COLOR PROBLEMS?

In a practically new Motorola Quasar II TS-929 color set, I had what looked like agc problems. On weak stations I got a picture. On a strong signal the raster went out. Left small "sparkles" of light, so I knew it wasn't the high voltage. I adjusted the i.f. agc control, and now I have a good monochrome picture.

However, I have a weird color problem. When I turn the color (intensity) control up, I get big horizontal bands of oversaturated color. However, in between these are bands where the colors are locked in the right places on moving objects. I scoped the color demodulator (IC) and color amps, etc., with a color-bar signal, and I got the right patterns—jittery, but OK. All keying pulses are OK, agc and all. I think this is agc, but what?—R.G., Baltimore, Md.

Right! This is an agc problem, but one of adjustment. The i.f. agc control on these sets is pretty sharp, and hard to hit, unless you're very careful. This condition can be caused by the agc control being set too far toward the "blackout" end. Move the control back to a "white-

(continued on page 78)

[redacted] [redacted]

Universal tap simplifies MATV design

by Bert Wolf

Manager Jerrold DSD/ECSD Division

Until now, MATV system design has been somewhat complex. You had to calculate losses in decibels and specify a fixed tap-off isolation value at each receiver location.

The new Jerrold OMNI-TAPs have changed all this. OMNI-TAPs are universal. That is, *any* OMNI-TAP can be used *anywhere* in *any* MATV system. The secret is adjustable isolation, which you can vary simply by turning a screwdriver after the system has been installed.

Aside from simplifying system design, OMNI-TAPs also reduce your inventory problems. Since OMNI-TAPs can be varied continuously over a 12 to 25 dB range, one type of OMNI-TAP replaces three types of conventional tap-offs.

Figure 1, for example, shows a typical 8 story apartment house, older school or hotel, with eight TV outlets per floor. OMNI-TAPs are used for every TV outlet. Because tap insertion loss is very low (average about 0.6 dB per tap at VHF), isolation is adjustable, and Jerrold CAC-6 cable loss is minimal, (3.2 dB/100' at VHF), your system calculations are greatly simplified. Just use a Jerrold Gibralter 3550 amplifier, fed by a Paralog Plus antenna. A new motel or school would be similar, except that trunklines would be run horizontally.

If your particular system is smaller, reduce the number of trunklines and tapoffs, but nothing else. The 3550 is economical enough even for small systems. If the system is bigger, add trunklines and tap-offs, but nothing else. The 3550 can easily handle up to 100 OMNI-TAPs. (For systems over 100 tap-offs, use the 3661 or 3880.)

Choose the antenna as you would an ordinary home TV antenna, except that it usually pays to choose the next larger model. If signals are weak, simply add a Powermate preamplifier.

Figure 1 is a VHF-only system. But adding UHF channels is no problem. Simply use a VU-FINDER PLUS antenna instead of the PARALOG PLUS, and a 4400 82 channel amplifier in place of the 3550. No other changes are required because the OMNI-TAPs, the splitters and the cable can handle UHF frequencies with no difficulty.

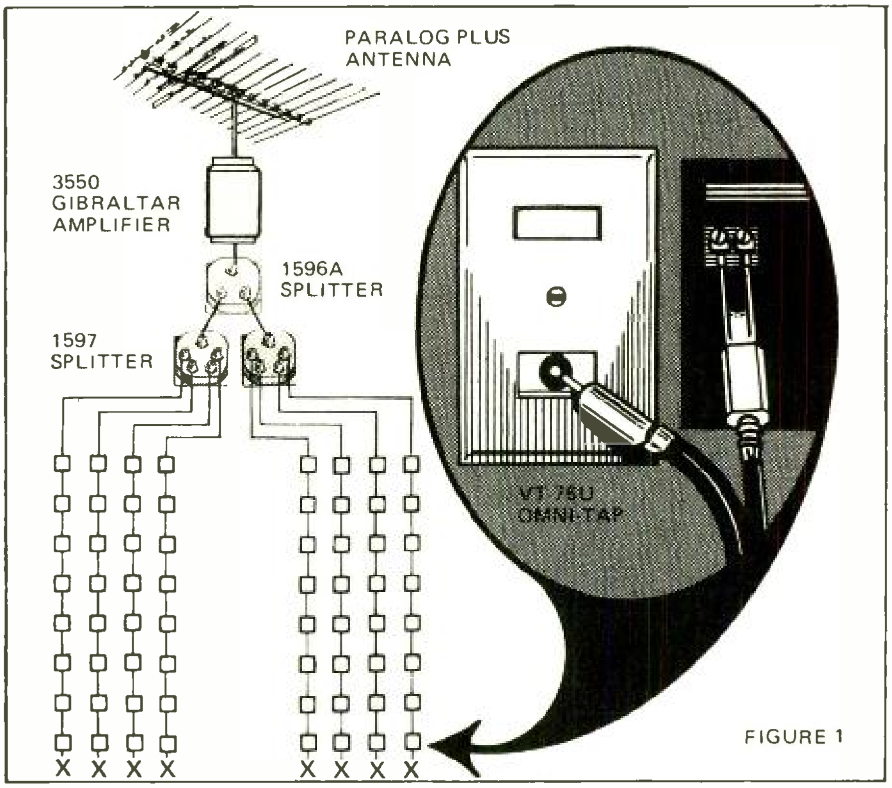


FIGURE 1

Adjusting Omni-Tap Isolation

Once the system is installed, you have to make sure it works properly. In many cases, no adjustments will be necessary. The OMNI-TAPs will work fine in the system just as you receive them.

In large systems, however, you will have to adjust the OMNI-TAPs so that they provide more isolation near the Head End amplifier than they do at the ends of the trunklines.

There are two ways to adjust OMNI-TAP isolation:

1. With a Field Strength Meter, such as the Jerrold 747. You should have a Field Strength Meter for MATV work anyhow, and this is the easiest way to adjust OMNI-TAP isolation.

Start by turning all of the OMNI-TAPs fully clockwise, for maximum attenuation. Then, go to a tap in the middle of the trunkline and make sure you can read at least 1000 microvolts of picture carrier signal on the highest channel the system carries. If the reading is less than 1000 microvolts, turn the OMNI-TAP counterclockwise until you get 1000 microvolts. Repeat for each tap until you get to the end of the line.

2. With an Ohmmeter. Connect the Ohmmeter between the arm of the OMNI-TAP potentiometer and the center conductor of the tap output. Set the first four OMNI-TAPs in each trunkline (nearest the Head End) to 700 ohms. Set the next two OMNI-TAPs in each trunkline to 500 ohms. Then, reduce each tap-off in the line by 100 ohms until you get to the end of the line.

For help in laying out a system or solving specific system problems, contact Jerrold via your local Jerrold distributor.

Or, for more information on MATV systems, write Jerrold Electronics, P.O. Box A, Philadelphia, Pa.

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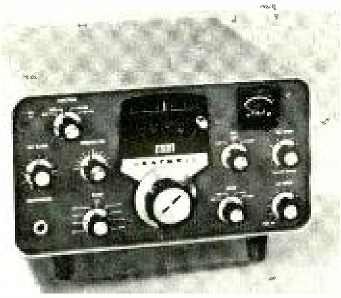

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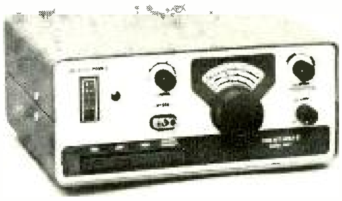

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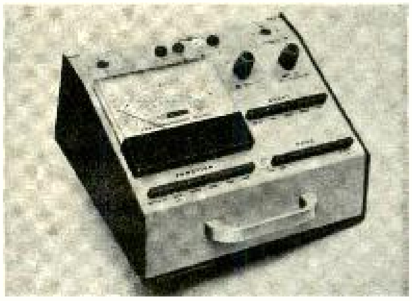

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Circle 100 on reader service card

READER QUESTIONS

(continued from page 72)

out." Then, very slowly, bring it back until you see a good color picture. Going just a little too far will cause this color condition, before you black out the whole picture. Get it set exactly right, and it will hold.

S-BENDING

I have a very bad case of bends in the picture, with sync instability, etc., in a GE AA chassis. I have checked all of the filter capacitors, with no results. What is causing this?—C.L.E., Malacanang, Philippines

This chassis has two main PC boards, mounted to a sheet-metal frame with self-tapping screws. If either of these boards develops a high-resistance ground connection, you'll get symptoms exactly like this.

Suggestion: loosen and retighten all of the grounding screws. If this doesn't help, then run extra grounding wires, or shield-braid, between the ground foils and the chassis. Most likely suspect, the one with the video i.f., agc and so on.

INTERMITTENT FLARE, RASTER COLLAPSE

In a Clairtone C11 color TV chassis, the picture bloomed, brightened, showed retrace lines, then faded and went out, at intervals. I replaced the 3A3, and it cleared up for about 10 minutes, then went out again. Pulled chassis, took to shop. As expected, it played for hours!—S.J., Scarborough, Ont.

(I started to answer this, then got another letter! In this, the reader said "Never overlook the too-simple and obvious things! While waiting for the thing to cut out, I pushed down on one corner of the PC board, and the raster flared and went out. So did the *heater* of the G-Y amplifier, the R-Y/B-Y amplifier and the X demodulator. Common ground point for these heaters is an eyelet on the corner of the PC board. Now everything is fine.)

That's what I like; self-answering questions! Thanks to Steve Jordan, Scarborough, Ontario, Canada.

HOT POWER TRANSFORMER

One of my customers replaced the EZ81 rectifier tube in his Eico HF-12 amplifier with a 6CA4. He said it played well for about an hour, then the power transformer burned out! I replaced the power transformer with an exact duplicate, but it runs hot!

I have checked the current drain, and it runs only about 60 mA instead of the 90 mA specified. Dc voltage is +360 V, as shown, but the transformer still runs very hot. What do you think?—B.A. Houston, Tex.

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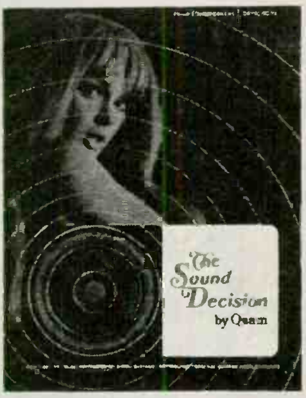

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power. Power is "EI" which is voltage multiplied by current. So if your transformer has normal voltage and slightly less than normal current, your *load circuits* are not taking too much! If the transformer overheats, it may be the wrong transformer for this amplifier or it may even have a shorted turn in one of the windings. Check the transformer by pulling the rectifier tube, and disconnecting the hot wire to the heaters. In other words, take off *all* loads.

Now plug it into a wattmeter. Normal reading should be almost zero. All you should see is the iron-loss which will be below 5 watts. If the transformer *has* an internal short, you will read 25-35 watts or more. If it shows no internal short, but still gets too hot, it may be that it doesn't have the right current-rating.

No wattmeter? Hook a 1-ohm wirewound resistor in the primary; read ac voltage across it. 1.0 volt equals 1.0 ac ampere.

A transformer is "too hot" when it melts the wax, smells, etc. It may run too hot to hold your hand on, but if it doesn't stink or smoke—it may be OK!

INTERMITTENT TRANSISTOR

In one of your articles, you said that transistors will not become intermittent. Not too long ago, I got a call on a Sylvania D-14 color chassis. After a lot of trouble, I found that the video output transistor was intermittent! I could move the collector lead and make it cut out, either in the circuit or on my transistor checker. Replaced it, and the set worked. Any comment?—G.W., Ipswich Mass.

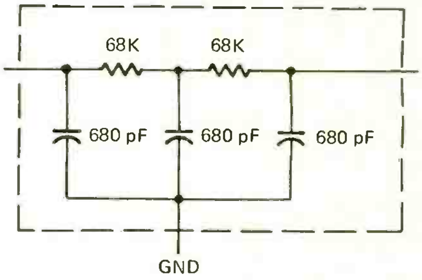
Nope! Not too long after I did that article, I, too, found one! Same type as this, but used in an audio amplifier. Collector lead intermittent there, too. So I quit saying that you can't find intermittent transistors! Since then, I've heard of others.

Seems to be mostly this type of transistor; the little flat ones with 3 legs, bolted to the chassis, heat-sink etc. These are in "case-77" type cases. So far, none of the other cases have shown intermittents, but I'm waiting; and not sticking my neck out.

VERTICAL PROBLEMS

I've got all kinds of vertical problems in a Zenith 14N22 chassis. Can't get enough height with the proper linearity, the sync is bad, and you name it I've got it. I've checked all of the coupling capacitors for leakage, and the resistors read within tolerance.—L.C., Ink, Ark.

Y'missed one! Check the little PC integrator unit in the feedback loop, from output plate to "input grid"; PC-2 on the Sams schematic. You'll probably find that this thing is open. You should be able to read about 150,000 ohms from end to end, and about .001-μF of capacitance from either end lead to the center (ground) lead.



Zenith part number is 87-7, and I think it can be replaced by a Centralab PC-90, etc. The diagram shows the equivalent circuit; if you have to, you can make up one of these from separate parts.

VERTICAL LINEARITY PROBLEMS

I had an Admiral H1A1 chassis, with a "no high voltage problem." Bad horizontal yoke coil. Since I happened to have a universal-type yoke that I picked up somewhere on hand, I tried it. Now I get high voltage, but the vertical linearity is pretty bad. Can't correct it with the controls.

This yoke, by the way had a label "DY-57AT" on it. Do you think this is a mismatch problem?—C.P., Stow, Mass.

I'm afraid I do! If your universal yoke is a Stancor DY-57, as it seems to be, it'll have a vertical winding of about 70 mH. The correct replacement yoke for this Admiral chassis should be about 13 mH. You can get by with about a 20% mismatch in a lot of sets, but this is completely out of the ball-park.

Evidently your horizontal winding is close enough, but I'm afraid that you'll have to get a yoke that will be closer on the vertical.

HORIZONTAL OUTPUT TRANSISTORS?

The horizontal output transistors and the flyback have burned out on a Sony 9-304UW TV set. They use two 2SC41 transistors in parallel. Can't find a replacement for these. Any ideas?—W.J. McL., Phoenix, Ariz.

You *might* be able to replace these two with a single transistor with the proper ratings. For example, a Sylvania ECG-163, which is an npn, silicon, with a 700-volt breakdown voltage, and a rating of a whooping 100 watts peak. There are other similar types available.

For luck, run the ac line voltage up slowly with a Variac, watching the collector current, and output, etc. as you go. Normal current here is given as 520 mA per transistor. If the thing doesn't get too hot, fine.

(Note: we got some "field feedback" from the reader on this. He tried the single transistor, and it worked. Got pretty warm, but worked. Just for luck, he replaced the surviving 2SC41 in parallel with it (one of them turned out to be good!) whereupon both transistors cooled off, drew about 360 mA. apiece, and everything worked very nicely! Thanks to W.J. McLain, of Phoenix, for this one.)

BAND OF RIPPLES

I've got some of the most weird symptoms I've ever seen in this Motorola Quasar II TS-929 chassis. With a picture, there's a vertical "band of ripples" right in the middle of the screen, flickering with all colors! If I take the antenna off, I get very thick black vertical bars, odd shaped, like Barkhausen, but definitely not; they're all over the screen! I scoped the horizontal sync, and the sync-pulse goes all to pieces when the antenna is disconnected.—R.T., Hatfield, Ark.

I've seen this before. Uncommon, but it happens. Look for a very small rf choke, encapsulated, mounted on the plate-cap of the 6LF6 horizontal output tube. Take a piece of wire and short this choke! This will clear it up.

Apparently, this choke causes the horizontal output stage to ring heavily at some high frequency, and generate parasitic oscillations. Shunt it, and they quit! (Usually, the rf choke in the horizontal output plate lead suppresses spurious oscillations. However, in this case, it appears that the choke can cause hf or vhf oscillations.) **R-E**

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

LAB SCOPE, *model KC-6060A* combines a 1-kHz sinewave oscillator (with variable output level from zero to 1 V rms, regulated by front panel volume control) and a 3-inch oscilloscope (for waveform displays up to 200 kHz). Has 5-position selector to test 0.1 V peak-to-peak to compare voltage measurement of an input signal against a 1 kHz sine waveform; waveform left for left channel audio signal; waveform right for right channel audio signal; stereo display with left channel signal applyed to vertical section, right channel signal to horizontal section; FM multipath to check performance of a tuner or adjust antenna. Can be used to check an amplifier for linearity, frequency response and phase characteristics; measure phase difference between two signals; test phono cartridges and more. $224.95.—**Kenwood,** Dept. P, 15777 So. Broadway, Gardena, Calif. 90248.

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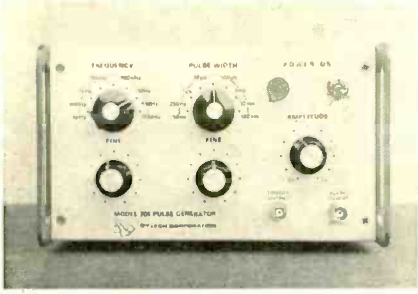
PULSE GENERATOR KIT, *model 701.* A professional type instrument with all-integrated design, sockets for all integrated circuits and protected outputs. Pulse repetition rate: 10 Hz to 10 MHz in seven overlapping ranges; output pulse amplitude 0 to 5 volts across 50 ohms—0 to 10 volts unterminated. Pulse width: 50 nsec to 100 msec, in seven overlapping ranges. Duty factor: 90% at all frequencies. Rise and fall time is less than 5 nsec, jitter less than 0.1%, baseline offset 0 volts for both trigger and pulse outputs. Oscilloscope trigger output, 1.2-volt, 50 nsec width, 10 nsec rise and fall time. Output 50 ohms; instrument is short-circuit proof. $159. (assembled $220).—**Dytech Corp.,** 391 Mathew St., Santa Clara, Calif. 95050.



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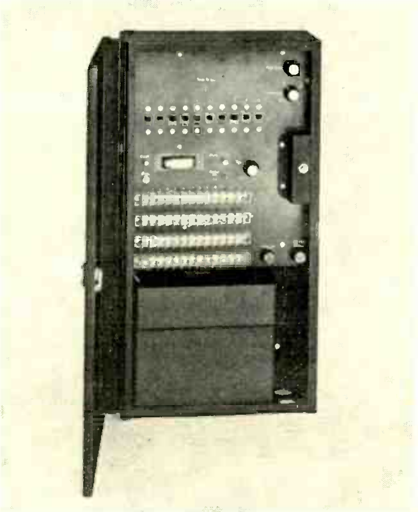
INTRUSION DETECTOR, *Sound Discriminator.* A series of intrustion alarms that operate with ordinary paging speakers as microphones. Can also be used with other sensors or switches. Discriminates against and rejects sounds for which a response is not desired. Model SD400AG, illustrated, has manual adjustment of reference ambient level and manual selection of number of events (2 to 5) to be received in an accumulation time period, to reject occasional and non-repetitive loud sounds. Units are available for 10 inputs up to 120 inputs.—**Scientific Security Systems, Inc.,** Jackson, Miss. 39216.



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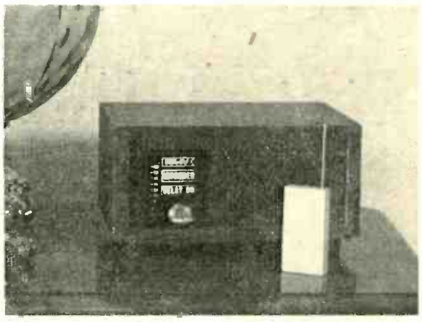
NOISE POLLUTION MONITOR, *RCA WE-130.* A hand-held, battery-operated unit for measuring sound levels in factories, airports, urban traffic areas and other high-noise areas.

The WE-130 uses solid-state circuitry and is powered by four penlight cells. Weight is a little over 11 ounces. Dimensions are 6⅞ x 3 x 1 15/16 inches. The meter scale is divided into three parts. The green portion is the safe area; the yellow indicates levels bordering on the unsafe. Readings in the red indicate noise that can be dangerous to hearing if maintained for long periods.

A 32-page booklet—almost a simplified course in sound measurement—accompanies each instrument. $75.—**RCA/Electronic Components,** 415 South Fifth St., Harrison, NJ 07029

Circle 34 on reader service card

BURGLAR ALARM SYSTEM, *RA-IV.* Completely self-contained wireless system operates on 117-volt ac or on its own dc supply should power fail. One central receiving station receives from any number of small wireless transmitters within 250-foot range. Transmitters use rechargeable batteries that are good for six months normal operation, and can be recharged with unit that forms part of receiver. Alarm is a loud pulsating siren. $159. (for receiver and one transmitter).—**Lumik,** P.O. Box 1312, Douglas, Ariz. 85607.



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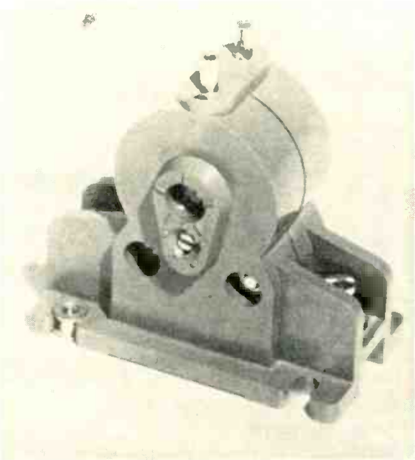
AIR ACTUATED SWITCH, *T4 Air Wave Switch.* Performs many alarm, detection or control functions cheaply where relatively expensive floor mats, motion detectors or light beams are often used. Typical application uses 100 feet of ⅛-inch inside diameter plastic tubing, which can be zigzagged under a carpet or mat or run through grass near a fence. A footfall on the tubing generates an air wave that actuates the switch. Contacts rated at 1A, 330V (ac). Switches cost less than $15.—**Mountain West Alarm Supply Co.,** 4215 North 16th St., Phoenix, Ariz. 85016.



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SCANNING MONITOR, *SCAN 308*. A programmable 3-band scanning monitor receiver covering 25-50 MHz, 140-174 MHz and 450-470 MHz simultaneously. Can be programmed easily to monitor any combination of eight channels in the high-band vhf, low-band vhf or uhf ranges. Visual readout. Rear panel programming switches select the desired combination from the units total capacity of 16 channels. Built for both ac and mobile 12-volt use. $189.95.—**Pace,** Box 306, Harbor City, Calif. 90710.

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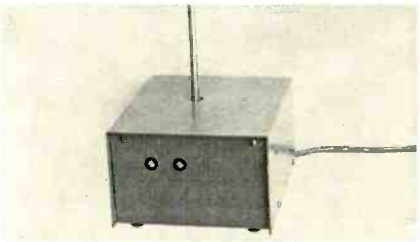
MICROWAVE INTRUSION DETECTOR, *model A5-001 Space Switch,* provides total premise protection by giving an alarm triggered by forced entry through roof, wall, door or window. Unit is all solid-state microwave uhf Doppler radar system. Protection is provided over as much as 3500 square feet or a 30-foot radius. Microwave transmissions penetrate most non-metallic structures and are reflected by metal. Movements from an intruder set off the alarm circuits, while a digital filter rejects movements of small animals and other false alarms. Powered by 117 Vac or optional 12 Vdc battery. Measures 3¾" x 6" x 7", weighs 4 lbs. $185.—**Mountain West Alarm,** 4215 N. 16th St., Phoenix, Ariz. 85016.



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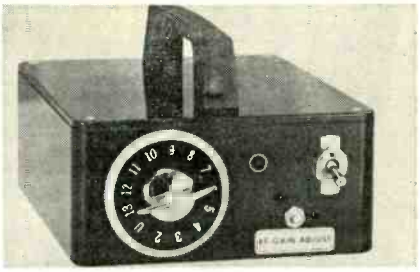
TV TUNER SUBBER *Mark II.* Improved version has higher gain and longer battery life. Uses LED indicator. Substitutes the vhf tuner in defective TV receiver to prove if original tuner is good or bad. Simplifies analyzing i.f. and agc system defects and tests the uhf tuner. Only two connections must be made, antenna and i.f. cable. Set of i.f. extension cables is furnished. Solid-state tester is battery powered. The portable unit uses a transistor vhf tuner with external gain control affording a gain reduction range of more than 40 dB independent of receiver agc. $31.95.—**Castle TV Tuner Service, Inc.,** 5710 N. Western Ave., Chicago, Ill. 60645.



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LOW-COST CITIZENS BAND RADIO *Pace 223.* An all U.S. made two-way unit that provides all 23 channels of operation through a crystal synthesizing technique that compensates for temperature drift. Reliable in sub-zero temperatures as well as hot desert climates. Full squelch control with 0.3 μV threshold. Agc circuit holds volume essentially constant over a signal range of 0.5 μV to 100,000 μV (0.1 volt). Input power of 5 watts, with modulation boost circuit for maximum talk level performance within the class-D Citizens Band Radio regulations. U.S. made design includes use of U.S. made transistors and components, facilitating in-field servicing.

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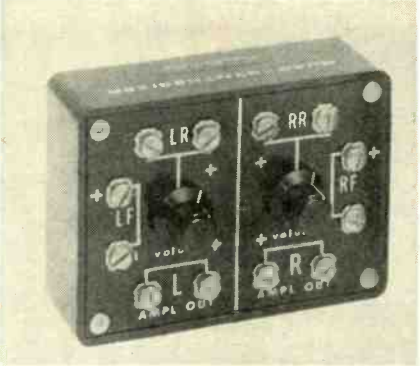

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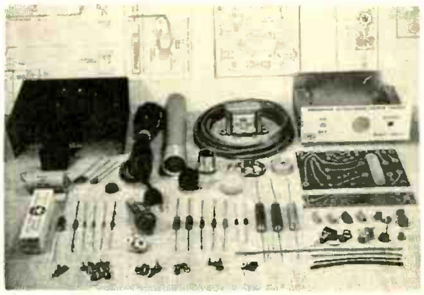

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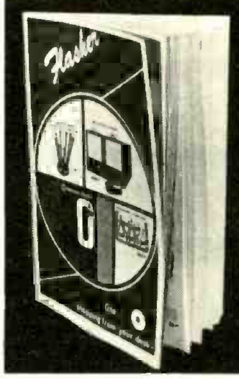

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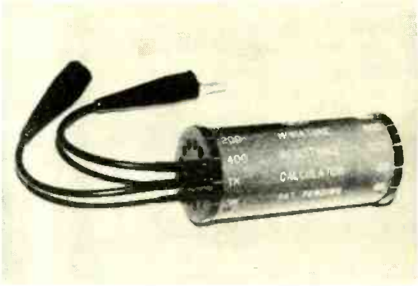

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ELECTRONIC IGNITION SYSTEM, Capacitive-discharge kit, claimed to develop 50% more spark energy for complete combustion and increase spark magnitude to 3-5 times normal for faster acceleration and quicker starts, even in sub-zero weather. Unit can be used with any 4, 6, or 8-cylinder engine having a 12V negative-

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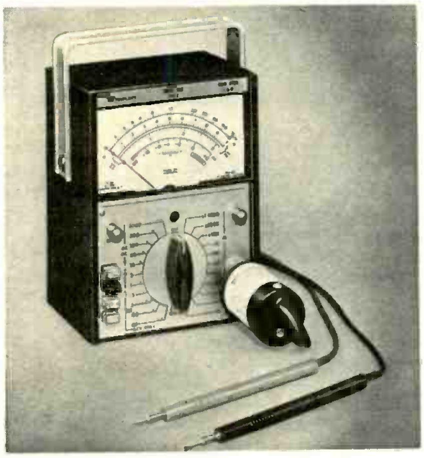

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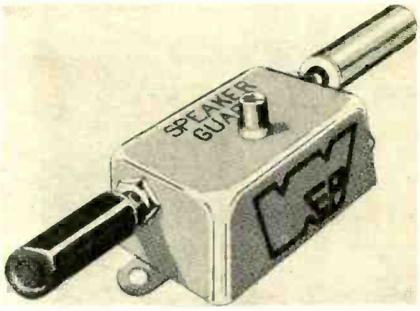
SPEAKER GUARD, consists of a resistor and circuit breaker that can be easily connected in series with the speaker. A wattage overload from the amplifier output activates the circuit breaker and prevents damage to the speaker. Resetting the circuit breaker resets the unit. *Speaker Guard* is available in 18 different models with varying combinations of wattage and resistance—**Workman Electronic Products Inc.,** Box 3828, Sarasota, Fla. 33578. **R-E**



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new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.

ELECTRONIC PARTS & EQUIPMENT CATALOG, 48 pages packed with all kinds of useful electronic devices. Included are such things as picture tubes, vacuum tubes, hi-fi components, tools, rectifiers, books and test equipment—**Cornell Electronics Company,** 4217 University Ave., San Diego, CA 92105.
Circle 49 on reader service card

TV/FM ANTENNA INSTALLATION GUIDE, 10 page booklet covers antenna selection, masts, mounts, lead-in wire, lightning protection and multi-set systems. Illustrated with a series of complete pictures and diagrams, the guide gives the reader step-by-step instructions on various types of home antenna installations. The guide also gives a clear explanation on how to protect the installation from wind and weather, how to prevent damage to the roof and the house and how to make the installation as solid as possible.—**Jerrold Electronics Corp.,** 401 Walnut St., Philadelphia, PA 19105.
Circle 50 on reader service card

PHYSICS & ELECTRONICS CATALOG, 10 pages of classroom demonstrators and potential science fair projects. Includes such things as a parametric ac motor, oscillating magnet, motion detector demonstrator, perpetuum Mobile and many other items of interest.—**Sercolab,** P.O. Box 78, Arlington, MA 02174.
Circle 51 on reader service card

Write direct to the manufacturers for information on items listed below:

SILICON RECTIFIER CATALOG, six pages detailing this manufacturer's entire line of standard and fast-recovery silicon rectifiers. The new catalog devotes individual pages to ratings and electrical characteristics as well as dimensional drawings of case styles for EDI bridges, high voltage axial lead rectifier cartridges, high voltage rectifier assemblies and miniature axial lead rectifiers—**EDI,** 21 Gray Oaks Avenue, Yonkers, NY 10710. **R-E**

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(continued from page 26)

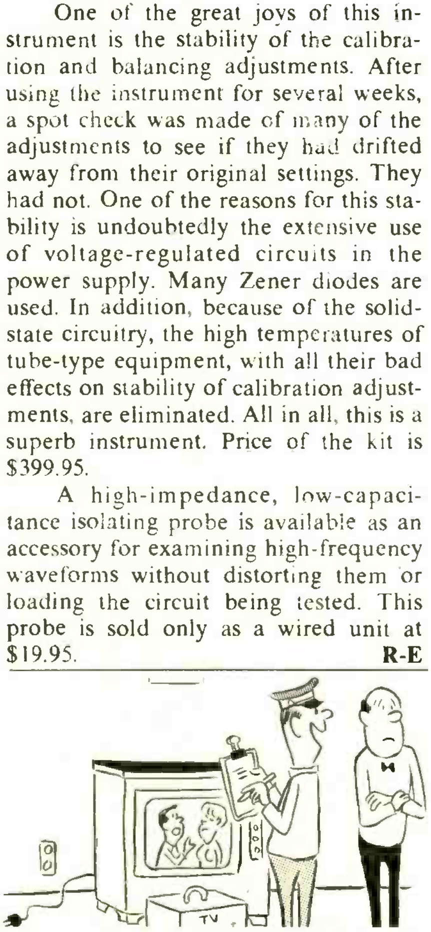
the positive (upward) or negative (downward) slope of a waveform. The fourth is the triggering AUTO-NORM switch. In the AUTO position, the ac/dc triggering switch and the trigger level control are disabled. This position is useful for signals which are too weak to trigger the sweep circuits in the normal fashion or for triggering simple waveforms. The NORM position of the switch is used for other signals and, particularly, for low-frequency signals.

Construction of this oscilloscope is not a simple project. The IO-105 packs an awful lot of circuitry into a compact case. Six printed circuit boards are used (the two vertical amplifier boards are identical). Instructions are straightforward and, in the usual Heath fashion, assembly follows a logical sequence.

Because of the complexity of the instrument's circuitry, calibration is necessarily much more time-consuming than with a simple scope. However, the calibration instructions are straightforward and easy to follow. Two procedures are given, one for calibration without a calibrated generator and the other with generator.

One of the great joys of this instrument is the stability of the calibration and balancing adjustments. After using the instrument for several weeks, a spot check was made of many of the adjustments to see if they had drifted away from their original settings. They had not. One of the reasons for this stability is undoubtedly the extensive use of voltage-regulated circuits in the power supply. Many Zener diodes are used. In addition, because of the solid-state circuitry, the high temperatures of tube-type equipment, with all their bad effects on stability of calibration adjustments, are eliminated. All in all, this is a superb instrument. Price of the kit is $399.95.

A high-impedance, low-capacitance isolating probe is available as an accessory for examining high-frequency waveforms without distorting them or loading the circuit being tested. This probe is sold only as a wired unit at $19.95. **R-E**



Your little joke with the fake cord really startled me, Mr. Conrad—almost as much as this bill for the service call is going to startle you.

appliance clinic

INSIDE THE CLOTHES DRYER

by **JACK DARR**
SERVICE EDITOR

CLOTHES-DRYERS, LIKE MOST MAJOR appliances, aren't really too complex. They all have the same parts; a large perforated drum, turned at a low-speed by a motor; a heater and fan, to blow hot air through the drum; a thermostat to control the air temperature; and an electrical driven timer to control the entire process.

In the electrically heated dryers, large heating elements are mounted in the air duct, with a fan to force the hot air through the drum. The majority of these use 240-volt heaters. Elements run from 2,000 to 5,000 watts. The heating elements have three controls; the switch contacts in the timer, which will probably operate a relay to switch the high currents, and a thermostat acting as a limit switch. This breaks the heater circuit when the temperature rises above the desired point.

So if the problem is "The drum turns but the clothes stay cold." you have one of four possibilities. Open switch contacts in one of the three controls just mentioned, or an open heating element. Many of the later model dryers have multiple-section heaters, for different heats. So, the chances of all of these opening at once would be small. A complete loss of heat would be most likely to be in the three switches.

To check for this, pull the machine out from the wall, pull the line plug and take the back off. Usually this will be fastened with self-tapping screws around the edges. In a great many units, you'll find a complete wiring diagram pasted to the back or inside the cabinet. With this, it isn't too hard to find the wires going to the heaters and trace them out. With a continuity meter, the various switch contacts can be checked by turning the timer knob manually to the right position.

In the flat-top types, with controls mounted on a splash-board (vertical surface at the back of the top) many of the controls will be quite accessible. In several models, the whole top can be slid back and lifted up, exposing all heater wiring, controls, etc. A lot of the wiring, including the timer, will use push-on connectors, which makes it very handy to check.

The thermostat can be hard to get to in some, especially if it is mounted inside the air-ducts. However, you can trace the wiring from the timer and controls, and locate the leads to it. Pull these loose and you can check the contacts for continuity. If the dryer is cold, the contacts should be closed, of course. If you get an open-circuit reading across the thermostat leads, its contacts aren't making. Take it off and check the contact surfaces for burning or pitting. If they are badly burnt, it would be best to replace the thermostat. Filing down the points would change the spacing, and probably make the thermostat lose calibration. Be careful while handling them, since calibration can also be upset by bending the blade. Some units use a "snap-action" thermostat, making use of what is called the "oil-can effect"; these are not easily upset.

If the drum won't turn, but you can hear the motor running, you've got a belt problem. This is accessible as soon as you take the back off. If the belt has jumped off, check the alignment of the driving and drum-pulleys, and the motor mounts. Failure or breakage of one of the motor mounts can throw the motor out of line and the belt will jump as soon as it's started the next time.

If the belt is broken, take the old one to an appliance supply house to be sure you get the right length and size replacement belt.

Some units use a spring-loaded idler arm. It moves to tighten the belt and make the drum turn. Check the control linkage, springs, and bearings on this. The whole thing is usually easy to get at, and adjustments are simple, mechanical. If the idler arm doesn't hold the belt against the pulleys tightly enough, it will slip, causing rapid wear and short belt life. With the arm engaged, the belt should have only a small amount of slack.

The timers are driven by a small electric motor, similar to electric clock motors, mounted on the back of the switching unit. In many makes, this motor can be replaced without changing the whole timer. Two screws hold them in place, on a bracket.

If the whole timer must be replaced, the push-on connectors make this job a lot easier. Color-coding of wires is used extensively, and the whole thing should be shown on the wiring diagram. If this isn't clear enough, or if it doesn't show color-coding, make up your own drawing of the wires.

The best way, if a timer must be replaced, is to leave the old one in place until you have the replacement. Then, unbolt the old one, and pull it away from the panel, leaving the wires connected. Mount the new unit, and then transfer the wires to it, one at a time. Much less chance of confusion.

Fan/blower problems are usually fairly obvious. If the fan doesn't run, check the belt. Many of these are driven from the drum motor; others have their own small motor. Most of these are mounted on some kind of shock-mount—rubber pads, etc., to prevent excessive noise and vibration. If these mounts have gone bad, from old age or heat, the fan-blades can hit the sides of the duct, making a terrible uproar. It's a good idea to check all rubber mountings like this, whenever you have the back off the dryer.

All in all, you shouldn't find any really complex problems in modern clothes dryers. Simple electrical equipment, such as a vom for checking continuity and ac voltage, will tell you what's going on (or not going on, as the case may be). **R-E**

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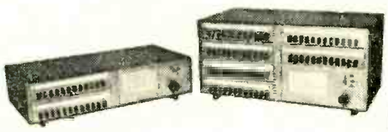

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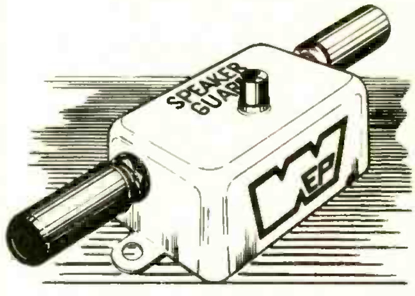

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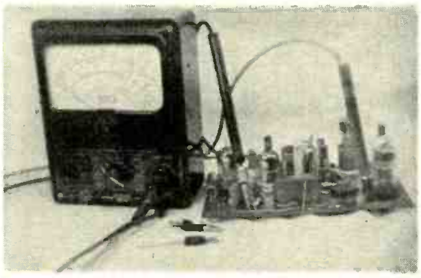
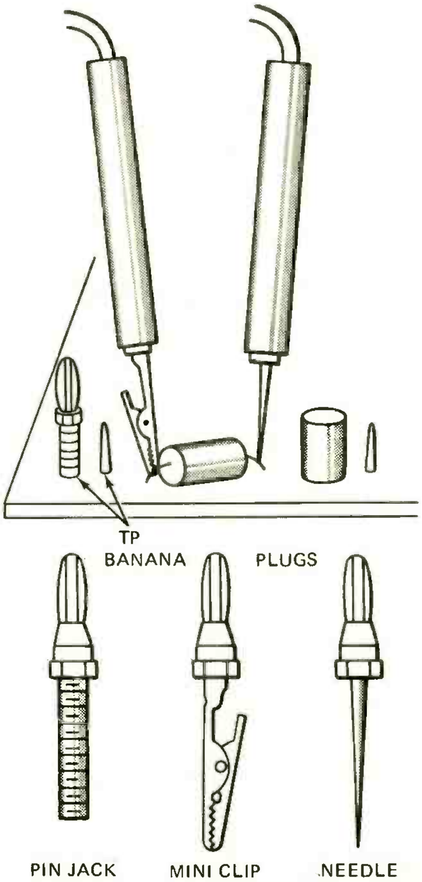
INTERCHANGEABLE PROBE TIPS

In a very short time, you can make up a set of test probes with interchangeable tips that can save time when servicing printed circuits and wiring in miniature electronic assemblies. The basic test prods are leads with banana jacks.





The first test tip consists of a pin jack back-to-back with a banana plug. The jack end of this tip fits snugly over test points and terminals in many receivers. The second and third tips consist of banana plugs backed-up by a miniature alligator clip and a press-fit needle-point.—*Peter Legon* **R-E**

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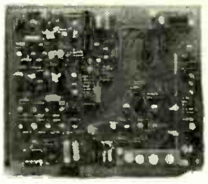
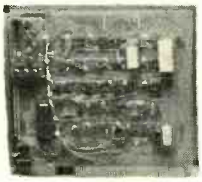

J9404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new books

ABC'S OF ELECTRONICS, by Earl J. Waters. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN. 46268. 8½ x 5½ in. 160 pp. Softcover, $3.95.

This latest edition is an easy to grasp, but comprehensive introduction to the broad field of electronics. The author avoids complicated technical concepts and mathematical terms as much as possible and relies on simple language and on analogies familiar to everyone. The text presents a detailed anlaysis of the principles of the principles of electricity, functions of atoms and electrons, magnetism and solid-state physics. Individual chapters are devoted to electrical resistance, capacitance and inductance. The remainder of the book deals with alternating currents, circuit impedances, electro-magnetic radiation, vacuum tubes, transistors, integrated circuits, radio wave production and propagations and the various electro-mechanical devices.

ENCYCLOPEDIA OF INSTRUMENTATION AND CONTROL, by Douglas M. Considine, Editor-in-Chief. McGraw-Hill Book Co., 330 W. 42nd St., New York, NY 10036. 9½ x 7¾ in. 788 pp. Hardcover, $29.50.

Bringing together the many facets of scientific information which can be termed instrumentation and control technology, this comprehensive Encyclopedia provides a bridge between the underlying principles and the techniques of applying instruments and controls to whatever work there is to be done. Of great importance to the user, the Encyclopedia is a convenient desk reference, designed for rapid and easy use. Fully cross-referenced, with in text cross references as well, it contains an extensive alphabetical index, a classified index and a contents wheel to permit the user to locate desired information rapidly.

1972 POPULAR TUBE/TRANSISTOR SUBSTITUTION GUIDE, by TAB Editorial Staff. TAB Books, Blue Ridge Summit, PA 17214. 8½ x 5½ in. 256 pp. Vinyl Cover, $4.95. Papercover, $2.95.

New up-dated and expanded edition of the only substitution guide available that lists best substitutes for all popular tubes and transistors. The new volume contains eight sections, four devoted to tubes and four to transistors. Section I provides a cross-reference of popular American receiving tubes. Section II lists substitutes for popular tube types found in commercial and industrial equipment. Section III provides a cross-reference of popular foreign/American tube types and Section IV shows the base diagrams for all tubes. Section V is a complete listing of popular American transistors. Section VI lists American substitutes for the most often encountered foreign transistors. Section VII lists general-purpose replacements. Section VIII presents base diagrams of transistors.

HOW TO REPAIR ELECTRICAL APPLIANCES, by Gershon J. Wheeler. Reston Publishing Co., Inc., Reston, VA. 9¼ x 6¼ in. 224 pp. Hardcover, $10.00

Using this book, it is possible to fix anything from a faulty lamp switch to a washing machine by following the easy step-by-step instructions. The basic methods described are clear, safe and useful to any man or woman who owns an appliance. Some of the many items covered in the text include heating pads, waffle irons, electric irons, vaporizers, three-way lamps, solenoids, blenders, can openers, garbage disposals, dish washers.

COMMERCIAL RADIO OPERATOR THEORY COURSE, by Martin Schwartz. Ameco Publishing Corp., 314 Hillside Ave., Williston Park, NY 11596. 9 x 6 in. 448 pp. Softcover edition, $5.95.

An ideal book for anyone studying for his first or second class commercial radio operator's license. It is complete in its coverage of radio theory and it covers all the information needed to pass the FCC exams. In addition, over six hundred FCC-type multiple choice questions are given. No previous technical experience is required since the course starts with basic electricity.

PULSE & SWITCHING CIRCUITS, by Harvey F. Swearer. TAB Books, Blue Ridge Summit, PA 17214. 5¾ x 8¾ in. 254 pp. Hardcover, $7.95.

For anyone interested in the science of electronics, particularly those involved in its practical day-to-day aspects, the use of pulse and switching circuits is a vital concern. There is hardly a phase or field of electronics untouched by some form of pulse and switching applications. This book is not an engineering text; it is a practical examination of pulses, the circuits that shape them and the variety of ways they can be put to work. It begins with an examination of pulses, basic definitions and pulse parameters. From there it continues to progress to pulse generators and circuit response characteristics. The remainder of the book is devoted to a variety of practical, everyday applications, including remote control, computers, radar, telemetry and various automation devices. R-E

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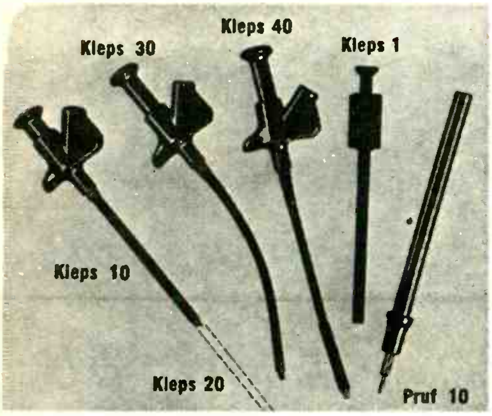

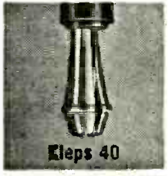

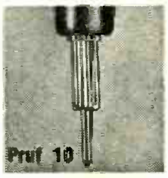

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next month

DECEMBER 1972

- **Now The Transistor Is 25**
  December 23 marks the 25th anniversary of the transistor. Here's a look at its short yet long, and very exciting history.

- **Build An IC Breadboard**
  More than just an easy way to interconnect components, this unit has a built-in power supply and clock generator to speed circuit development.

- **Evolution Of The Calculator**
  Calculators, it seems, have been around for quite some time. Here's an in-depth look at how man has progressed from counting on his fingers to electronic marvels that solve complex problems in fractions of a second.

- **Keyed Rainbow For Faster Troubleshooting**
  The lowdown on how to use a color-bar signal generator effectively inside a color TV chassis.

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Service Clinic
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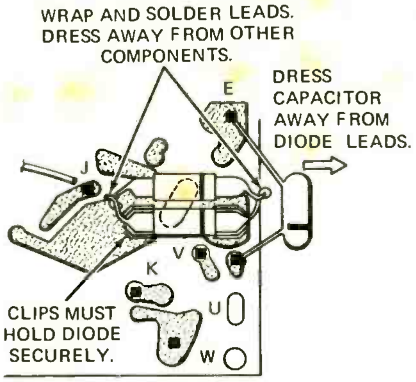
technotes

DAMPER DIODES—RCA CTC22, 41, 42 AND 43

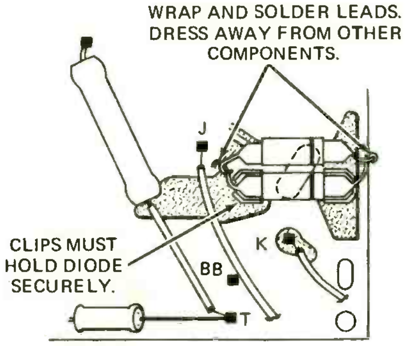
It is advisable to use two diodes in parallel when replacing the solid-state damper diodes in these chassis. (Note: The damper diodes are supplied by two sources. The black plastic barrel portion of one is slightly larger than the other. Always use two of the same configuration.)



CTC 22

Two diodes, similar to those previously supplied except that they will have leads attached to each end, are available under stock number 135320. The single diodes without leads will not be available.

To install, wrap the diode leads together and solder. Make a good electrical and mechanical bond. Keep leads as short as possible, clip off excess. Space diodes approximately ⅛ inch apart for easier installation. Install the diodes as shown in the appropriate drawing.



CTC 41, 42, 43

Caution: Relatively high voltages exist between the damper diode terminals and other components in the adjacent area. These components include capacitors, the metal chassis, board terminal stakes and associated leads and the printed circuitry on board PW400. Be sure the diode leads are dressed well away from these components. Make certain the mounting clips hold the diodes securely in position after dressing leads properly.—*RCA Television Service Tips*

MAGNAVOX T936 AND T956

Reduced vertical sweep may be a complaint on early production runs of these chassis. The +140-volt supply for the screen grid of the vertical output tube (V106) is developed from a voltage divider in the screen-grid circuit of the horizontal output tube (V103). In these chassis, leakage in diode D102 (in the high-voltage regulator circuit) can cause increased screen current in the horizontal output stage, resulting in lower screen voltage and reduced vertical sweep.—*Magnavox Service News Letter*

MAGNAVOX T946

A condition of horizontal jitter in this chassis can be caused by leakage in capacitor C66—the .001-μF, 1000-volt unit connected between terminal 4 on the flyback transformer and low end of the horizontal oscillator coil. The degree of jitter depends on the amount of leakage. Severe leakage through this capacitor can disable the horizontal oscillator and result in no high voltage.—*Magnavox Service News Letter*

SOUND DISTORTION ON CATV SYSTEMS

This complaint refers to G-E C2/L2 color chassis. The set performs normally on an outside antenna. On CATV, careful fine tuning will usually produce clear sound but use of afc will result in one or more stations with distorted sound.

The problem is caused by the cable sound-carrier levels being more than 17 dB below the video carrier (broadcast ratio is 10 dB). Sound sensitivity can be increased with a EP50X6 sound kit. Receivers beginning with serial numbers 5G40. . . . have the new circuit.—*G-E Service Hints* **R-E**

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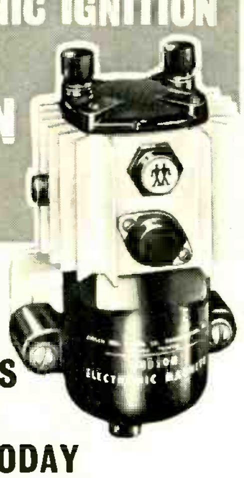

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Circle 82 on reader service card

USING THE CURVE TRACER

(continued from page 68)

the emitter circuit is proportional to the current flowing through it. This voltage is applied between the vertical input of the scope and ground. Hence the vertical deflection is proportional to the collector (and emitter) current.

On the 443, different circuits are used to accommodate pnp and npn transistors. The circuit in Fig. 7-a is used for a pnp device. Q1 and Q2, along with the associated circuitry, establish the steps for the base circuit in an interesting manner. Assuming the negative cosine wave of Fig. 7-b appears across the secondary of power transformer T1, the base of Q1 is negative with respect to the emitter for the first quarter cycle up to 90°. The transistor conducts and is in saturation. The collector of Q1 approaches the emitter voltage of the transistor. Meanwhile, the base of Q2 is negative with respect to its emitter, so that it does not conduct and its collector remains at the supply voltage potential. Resistors R48+R37 and R34+R33, connected to the collectors of Q1 and Q2 respectively are the components of a voltage divider. The voltage resulting from the divider action and from the relative voltages at the collectors of the transistors, forms one step at the SIGNAL beta control. R47.

FIG. 8—CIRCUIT USED TO TEST POWER TRANSISTORS. The base current steps of Fig. 7 are amplified by transistors Q3 and Q4.

In passing, it should be noted that some JFET and IGFET characteristics can be tested on the 443. Once you know the current in milliamperes per step fed to the base, you can change the input steps into volts per step by merely adding a 1000-ohm resistor from the base to emitter terminal. The steps fed to the transistor are normal for the enhancement mode of operation and is quite satisfactory for most IGFET's. For JFET's, the bias should be in the reverse direction. However, it may be used in the direction supplied on the 443 for gate to source values up to 0.5 volts, if there is to be no conduction between the gate and source. The I_{DSS} will, of course, be the lowest step established when $V_{GS} = 0$. V_P can be determined from this curve. The ratio of the difference in drain current between the I_{DSS} step and the next step, to the difference in gate voltages establishing these steps, is the g_{mo}.

Extended use and imaginative applications are not limited to the engineers. Technicians can use any ac transistor tester to check transistors in

(continued on page 98)

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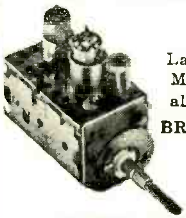

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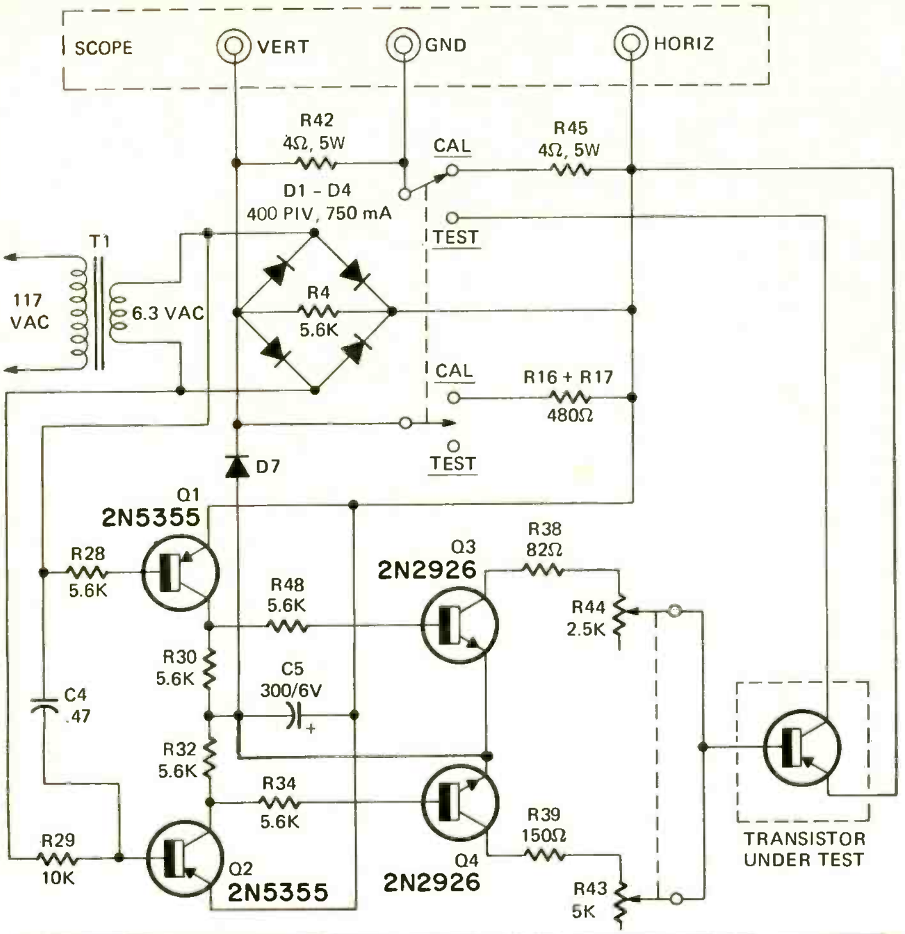


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USING THE CURVE TRACER

(continued from page 97)

circuit. The curve tracer is an ac transistor tester. To be sure, the curves will not be as logical nor as valuable as when the transistor is tested out of circuit, but, in some distorted manner, these tests will show four steps and indicate that there is gain if the transistor is not defective. A shorted transistor will appear as a single vertical line on the 'scope while an open transistor will appear as a single horizontal line.

The circuit in Fig. 7-a does not supply enough base drive to accommodate a power transistor. A position on the FUNCTION switch is provided for this type of device. In the 443, two transistors are added to the collector circuits or Q1 and Q2. They increase the current at the collectors enough to drive the base of a power transistor. The circuit is shown in Fig. 8. The performance is exactly as discussed above for the signal device, except that now, the POWER dial must be used for beta measurements. It is accurately calibrated in beta when the maximum collector current step is at 1 ampere. All suggestions listed for diverse tests in the signal transistor discussion can be applied here as well. I am certain you will find a few more!

Only a curve tracer will provide reverse characteristic information about a diode economically. The 443 will test the breakdown of rectifiers up to 2000 volts and show leakage current down to 1 mA per division. A protection switch and flashing warning light are provided on the front panel to alert the user that high voltages are present.

The forward and reverse breakdown voltages of SCR's can likewise be tested. Connect a 1000-ohm resistor from the gate to the cathode and connect the cathode and anode to the tester as you would an ordinary diode. Advance the VOLTAGE ADJUST control and note the reverse breakdown voltage of the SCR. The forward breakdown voltage can be measured by simply reversing the connections of the SCR to the tester. The holding current can likewise be observed in this test.

The 443 must be connected to a scope to observe the various displays. Inexpensive scopes using ac amplifiers are perfectly satisfactory. However, due to capacitive coupling, you will find it necessary to reset the vertical and horizontal controls for many of the measurements. In addition there will not be a true dc level so that you will be unable to note leakage current on the set of collector curves. You will, however, be able to measure it quite accurately using the reverse diode test position.

The best solution is obvious. Use a scope with horizontal and vertical dc amplifiers. **R-E**

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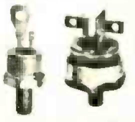

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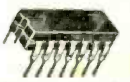

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SANKEN HIGH POWER, HIGH PERFORMANCE HYBRID VOLTAGE REGULATORS

These hybrid regulators are easy to use, requiring no external components. Excellent for operational amplifier supplies, logic supplies and other high performance applications. All regulators have less than 50 millivolts ripple and better than 1% line and load regulation, some models far exceeding this specification.

☐ SI3120E 12 Volts, 1 Ampere	$2.25
☐ SI3150E 15 Volts, 1 Ampere	$2.25
☐ SI3240E 24 Volts, 1 Ampere	$2.25
☐ SI3050E 5 Volts, 1 Ampere	$2.25
☐ SI3554M 5 Volts, 3 Amperes	$7.00

SANKEN HYBRID AUDIO AMPLIFIER MODULES

We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: - 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

☐ SI1010Y	10 watt RMS amplifier, industrial grade	$4.75
☐ SI1025A	25 watt RMS amplifier, industrial grade	$14.75
☐ SI1050A	50 watt RMS amplifier, industrial grade	$22.50
☐ SI1025E	25 watt RMS amplifier, entertainment grade	$14.00
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- ☐ Transformer for stereo 10 watt amplifiers (2 lbs.) $3.95
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- ☐ Complete kit for 100 watt RMS stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00
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SGS TAA 621 AUDIO AMPLIFIER

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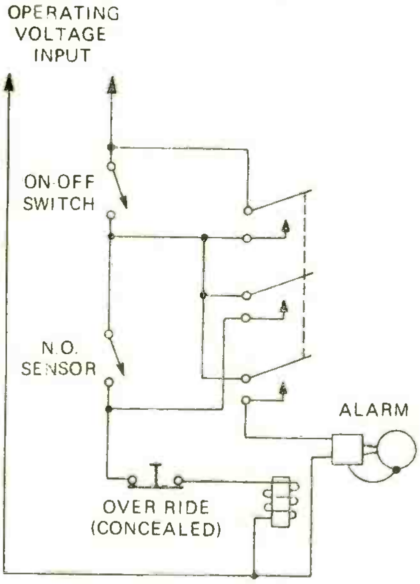
A SIMPLE ALARM

Need a simple alarm? A 3pst relay with normal open contacts will solve the problem. From the schematic, once triggered the alarm sensor and on/off switch are bypassed. The on/off switch is a toggle switch, thus saving the extra cost of a key operated switch. For optimum protection, it is suggested that the power source be wired direct to line, thereby eliminating an obvious line cord. For the same reason, the alarm should be attached to the same box as the relay. With this scheme, the only visible wire would be the alarm sensor and by the time an intruder noticed this wire, the alarm would be on and an attempt to cut this wire would end in negative results. The concealed over-ride switch is a major feature of this system. The ingenuity of the constructor will dictate type and access to this switch.



A form of self test can be performed by operating the alarm sensor, a test for power as well as component failure. In addition, relay life should be optimum.—*Herbert C. Olney* **R-E**

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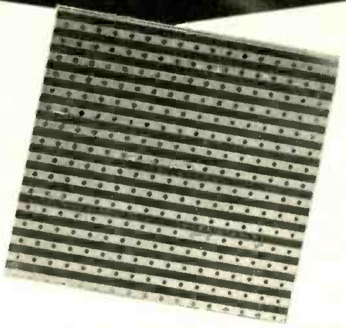

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Fits into a standard 2-1/4" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e. replacing battery in car). The clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligable power drain. The low price is only possible because of a new one chip MOS clock circuit, developed for quartz crystal wristwatches.

Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit to 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

☐ Quartz Chronometer, Kit Form	$59.50
☐ Quartz Chronometer, Wired	$99.50
☐ 24 Volt Adapter	$10.00

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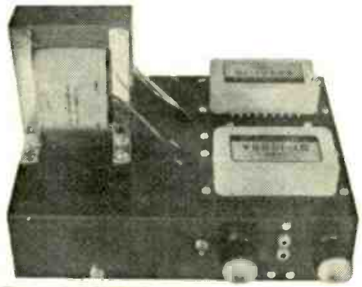
Because we have made an extremely good purchase of over 20,000 nixies, we can sell a complete digital clock kit for less than the usual cost of the display tubes alone. We provide a complete etched and thruplated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes and seconds.

☐ Clock Kit, complete less outside cover . . .	$57.50
☐ Aluminum blue or black anodized cover . .	$4.50



AUDIO AMPLIFIER KIT

This is not our prettiest kit, but it sure does perform. Hybrid Sanken audio modules make wiring easy. Output ratings are maximum continuous at 1000 Hz with a distortion less than 0.5% into a load of 8 ohms. Response is ± 0.5 db 20-20KHz @1 watt. Chassis supplied is heavy guage anodized aluminum. Capacitors are all computer grade. Level controls on both inputs.

☐ 100 Watt (RMS) Stereo Kit	$88.00
☐ 50 Watt (RMS) Stereo Kit	$58.00
☐ 20 Watt (RMS) Stereo Kit	$30.00

50 MHz DIGITAL COUNTER LABORATORY SPECIFICATIONS AT A BUDGET PRICE!

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Assembly time for the kit is approx. 10 hours. The semiconductor complement is (1) 7400, (1) 7408, (1) 7442, (10) 7490, (2) 74122, (6) 74141, (1) 74193, (1) 74196, (1) 74S11, (1) CD 4007AE, (1) LM309, (6) Diodes, and (1) Transistor. If you always wanted a laboratory quality counter, but could never justify the price, here is your chance.

☐ 50 MHz Counter Kit, Complete with Crystal Time Base and Case – Postpaid in USA	$125.50

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We expected a favorable reaction to our calculator, however, we were overwhelmed when we received orders for hundreds at a time. The reaction of our customers was that they felt this was the most advanced pocket calculator on the market, and priced so low, they could assemble and market it at a profit. The features that make this so exciting are:

- So compact it fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4).
- Performs every function you would expect in a desk calculator, and then some, multiplies, divides, adds, subtracts and gives true credit balance. Includes constant and chain operation, full floating decimal, suppressed trailing zeroes, and automatic single entry squaring.
- Powered by self contained AA batteries with up to six hours operation (Nicad batteries with charger option, up to five hours per charge).
- Calculations performed by a single 40 pin LSI (large scale integration) chip. Displays are 8 digit LED's (light emitting diodes) and overflow and minus signs are also LED's.

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☐ Pocket Calculator Kit	$75.00
☐ Pocket Calculator Completed	$99.00
☐ NiCad Batteries & Charger	$17.50
☐ Batteries & Charger Completed	$25.00

16 DIGIT ELECTRONIC DESK TOP CALCULATOR KIT

Just one evening puts it together. Even if you have never assembled a kit before, our comprehensive step-by-step manual makes it easy. This calculator adds, subtracts, multiplies, divides - multiplies & divides by a constant. Has full 16 digit capacity with 8 decades of display and zero suppression. Entries and answers with greater than 8 digits can be displayed in their entirety in two alternate sections: the last eight digits and those digits exceeding eight. Negative results are correctly displayed, and an error symbol indicates an overflow beyond the 16 digit capability. Sequential operations can be performed using the answer to the previous operation as one of the entries for the next. The decimal point can be positioned following any of the eight least significant digits and will be carried automatically during subsequent operations. An additional good feature, concerning the beginner, is that all major components are in sockets, making troubleshooting easy. And if all else fails, (an unlikely occurance) you can send it back to Aries and we will fix it for a maximum of $10.00, no matter what is wrong, baring gross negligence.

☐ Kit - with Power Supply & Case	$99.00

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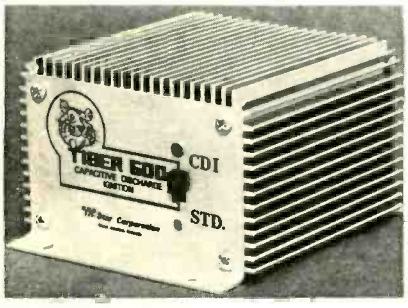

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EQUIPMENT REPORT

(continued from page 54)

dition of each battery can be read by turning the meter selector switch to BATT TEST. To save battery power, the on-off switch is a spring-return type. Power is drawn only when readings are actually being taken.

For receiver alignment, a double PIN-diode attenuator is used. This provides accurate control of the rf output over the entire range from 25 to 1000 MHz. This is a special voltage-controlled device. The control voltage applied can be monitored by placing the selector switch in the A position.

Receiver i.f. stages can be accurately aligned by installing the proper crystals. Any frequency between 5 and 20 MHz can be generated on fundamentals, and up to 40 MHz using harmonics. A lot of dual-conversion receivers use a 5.0 MHz "High i.f.," so this one could be very useful.

Internal construction of the instrument is rugged. A heavy PC board holds two IC's, used in the counter circuits, 5 transistors, plus the other parts. The whole thing is housed in a rugged steel case, with storage space in the lid for calibration charts, cables, the pickup antenna, earphones, etc.

For the operating tests, we took it out to the local airport. We checked several of our friend's aircraft (and some found wanting!) and tuned up. Even in the crowded quarters of the "offices" of some of these Bamboo Bombers, we had no trouble using this convenient little instrument. All in all, a very compact, accurate and useful instrument, and one that will make some difficult jobs a lot easier. **R-E**

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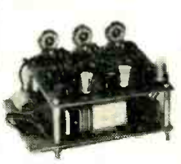

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D7	135	GE Diode 1N60 Subst.	DO-7	.16
D8	165	Sel Dual Diode Com. Cathode	8	.38
R2	153	Si Pwr Rect 200V 15A	DO-4	1.32
R7	159	Si Rect Ax lead 800V 2.5A	DO-41	.40
R9	161	Si Rect Ax lead 50V 3A	20	.66
R11	170	Si Rect Ax lead 1000V 2.5A	DO-15	.55
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GT7	232	GE Pwr Tr PNP 7A	TO-3	1.65
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GT29	632	GE Audio Ampl. PNP	TO-5	1.10
GT36	639	GE Drift-Field PNP	TO-18	.99
GT38	641	GE RF Ampl. NPN	TO-5	.88
GT40	643	GE Audio Pwr Ampl. PNP	TO-66	1.15
ST2	51	Si RF Tr PNP 150 MHZ	TO-5	.77
ST5	54	Si RF Tr NPN 30 MHZ	TO-5	.66
ST6	55	Si RF Tr NPN 200 MHZ	TO-92	.70
ST7	56	Si VHF Osc. NPN 750 MHZ	TO-92	.88
ST11	240	Si Pwr Tr NPN 300V 10W	TO-66	1.20
ST14	243	Si Med Pwr Tr NPN 60V 3A	TO-5	1.10
ST17	246	Si Med Pwr Tr PNP 60V 3A	TO-220	1.32
ST18	247	Si Pwr Tr NPN 70V 10A	TO-3	1.70
ST20	310	Si Unijunction Tr 300mW	TO-92	.99
ST25	703	Si Audio Pwr Ampl. NPN	TO-66	1.76
ST26	704	Si Audio Pwr Ampl NPN	TO-3	1.43
ST42	721	Si Audio Ampl. NPN 260 MHZ	TO-92	1.50
ST69	3001	Si RF Pwr Tr NPN 65V 5W	TO-5	2.30
FET1	801	Fet Audio N Channel	TO-46	.99
FET2	802	Fet RF N Channel	TO-46	.99
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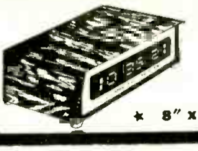

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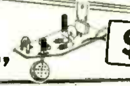

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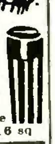

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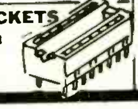

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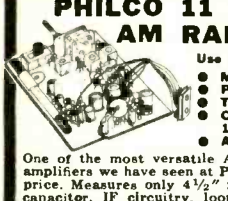

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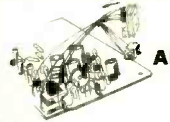

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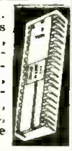
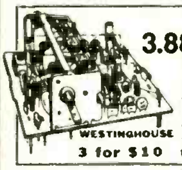


Sorry, can't name U.S. maker! Type SD5001. Similar to Mostek 5012. Outperforms Texas 8-digit TMS-1802. Features: 40-pin DIP; not 5, not 3, but only single "calculator chip". 12-digit capacity; adds, subtracts, multiplies, divides, fixed point (0, 2, 3 or 4 decimal places), chain operations, leading zero blanking, 7-segment decoded display output, overflow lockout, and negative sign output. Drives incandescent, fluorescent, Nixies, and LED readouts, complete with instruction booklet.



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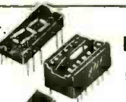

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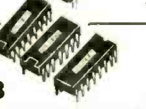

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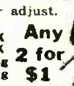

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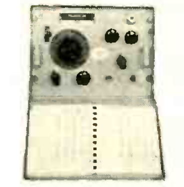

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Circle 104 on reader service card

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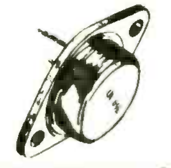

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*Trade Mark

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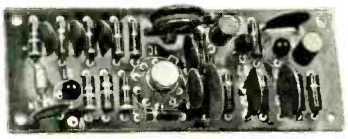

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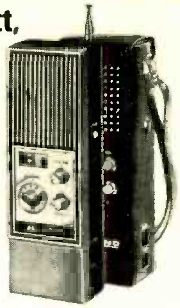

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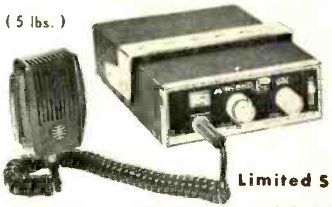

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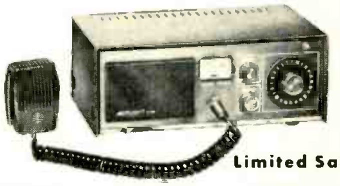

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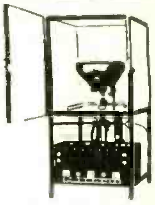

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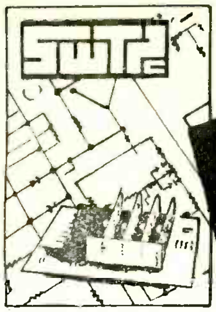

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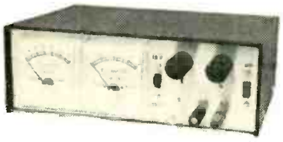

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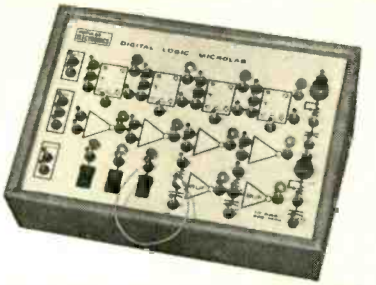

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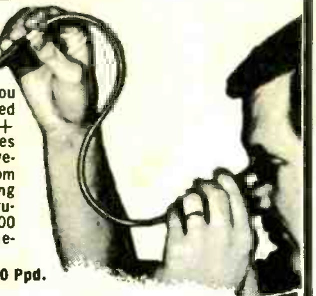

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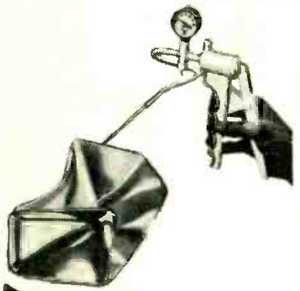

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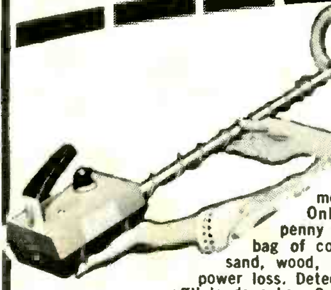

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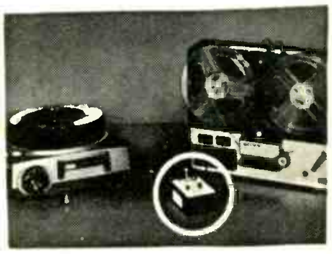

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