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Electronic Servicing

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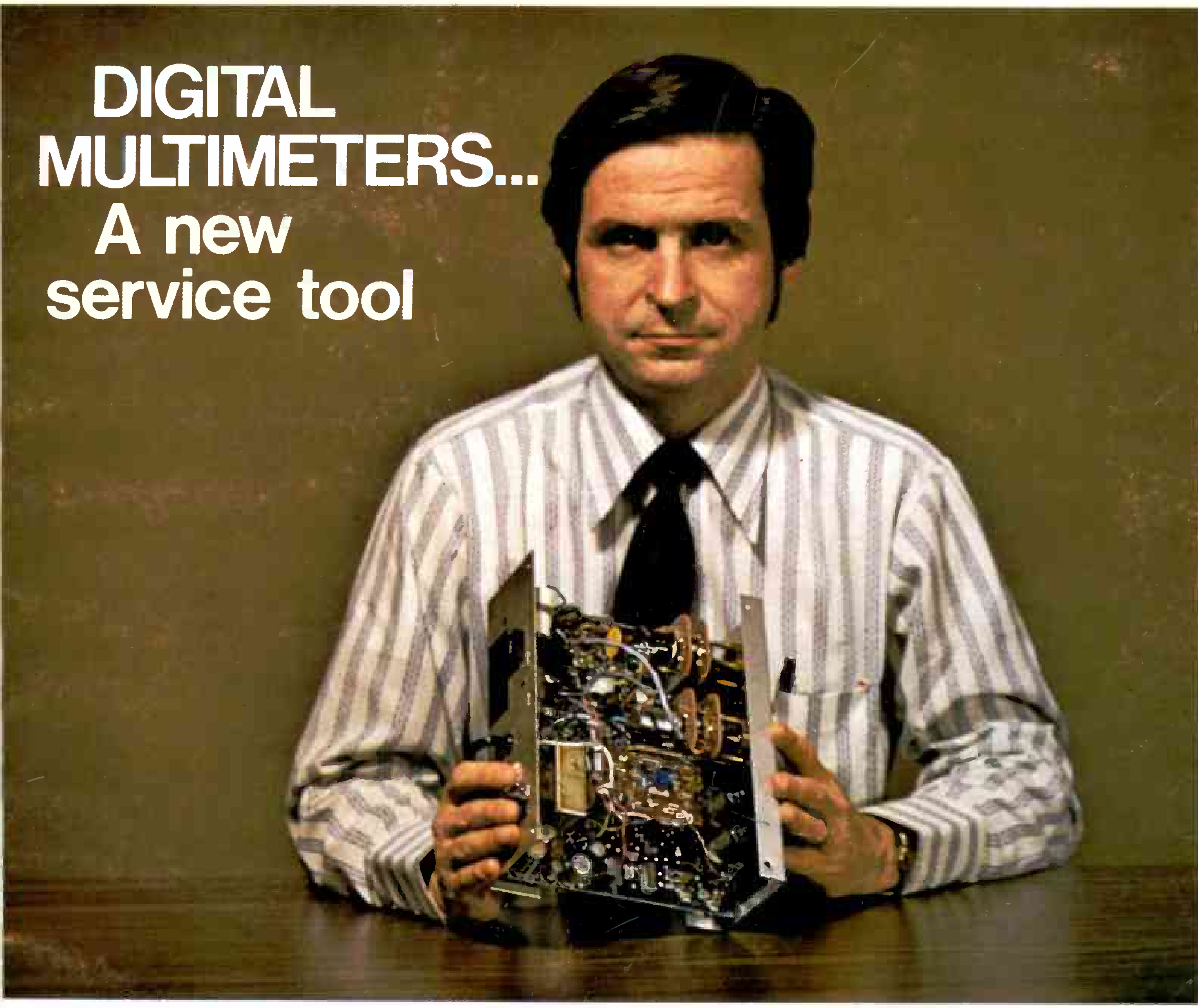

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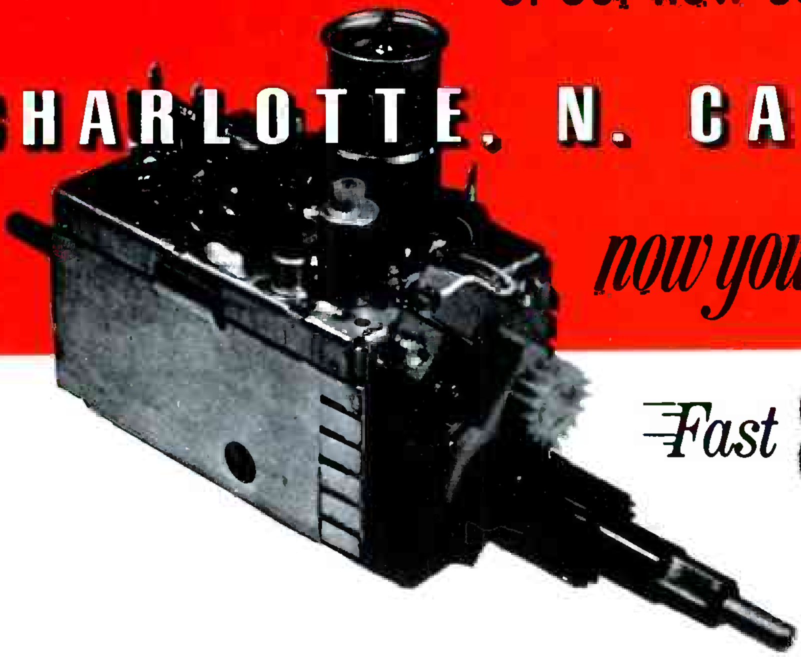

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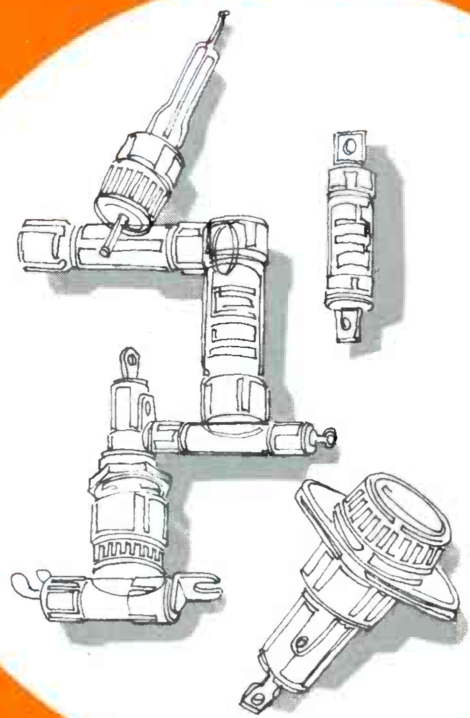

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March, 1974 | | Volume 24, No. 3

Electronic Servicing®

in this issue...

ABOUT THE COVER

Editorial Director Ron Merrell examines the inside of a B&K Precision Model 281 digital multimeter.

DEPARTMENTS

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ABP

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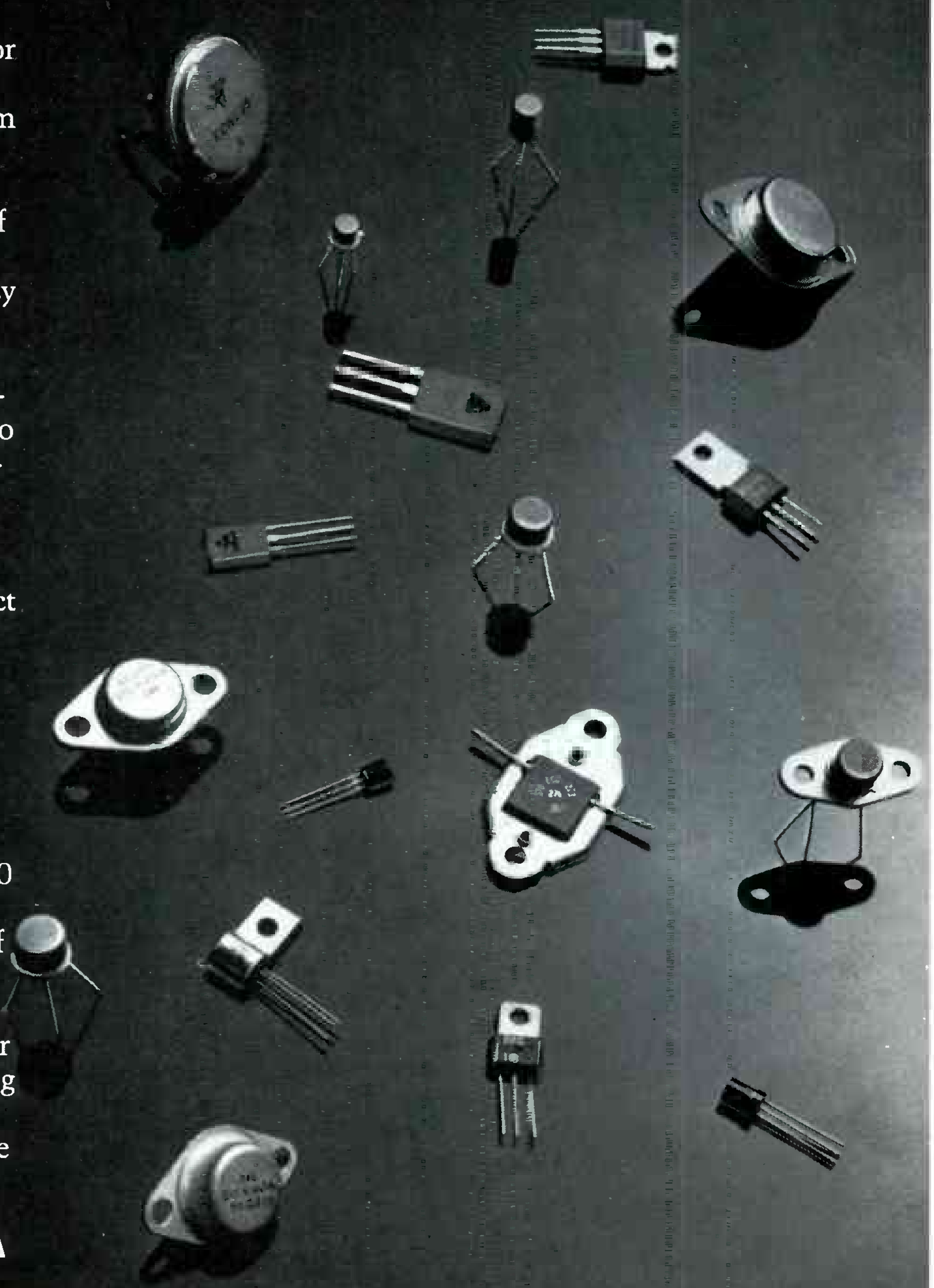

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news of the industry

A color picture tube that lights with full brilliance approximately five seconds after turn-on has been developed by GTE-Sylvania. This makes possible instant-on operation without the necessity of applying partial heater voltage when the set is turned off. Sylvania estimates the possible saving of energy for each receiver over present types of instant-on sets might be as much as 20 kilowatt hours per year.

Sansui's QS four-channel matrix system has been adopted by the Recording Industry Association of America (RIAA) as Type II standard for disc encoding, according to an announcement by the Sansui Electronics Corporation of Japan.

Courses covering repairs of Sony video tape recorders have been scheduled for 1974. Now available at Sony's resident school are courses for monochrome AV-series VTR's, and U-Matic videocassette equipment (five days and three days, respectively). Three-day courses for color VTR's might be added, if the demand is sufficient. Classes will be limited to ten students, and instruction will include balanced amounts of theory and workbench methods. For further information, write to Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

A new video-disc system offering potentially lower prices has been developed by Eric Rabe, a German inventor, according to **Home Furnishings Daily.** At current exchange rates, the playback machine might sell for $150. Innovations include a special grooving and magnetic coating of the standard 12-inch-sized record, and refinements of the recording and playback head. Although the short playing time of about 10 minutes per side is still a limitation of the discs, Rabe believes the time can be increased to 24 minutes.

A 5% allowance for handling of in-warranty parts has been initiated by the Philco-Ford Corporation. John W. Miller, Philco general parts and service manager, is quoted by **Home Furnishings Daily** as saying: "These are legitimate expenses, normally passed along to the consumer for in-warranty work, and the industry simply cannot ignore them any longer." In addition, Philco is increasing some in-warranty labor payments.

Controversial Intro 109, the bill calling for the licensing of all TV, radio, and audio repair shops in New York City, **was signed by Mayor John Lindsay,** and becomes effective on April 1. Technicians now are required to obtain a $100-per-year license for each shop, and $15 permits for service managers, reports **Home Furnishings Daily.** Although the bill was bitterly opposed by many technicians, only a few people showed up for the last public hearing, according to Henry Stern, the Deputy Commissioner of Consumer Affairs. No major representatives of service organizations attended, perhaps because the hearing was held on the afternoon of a holiday weekend.

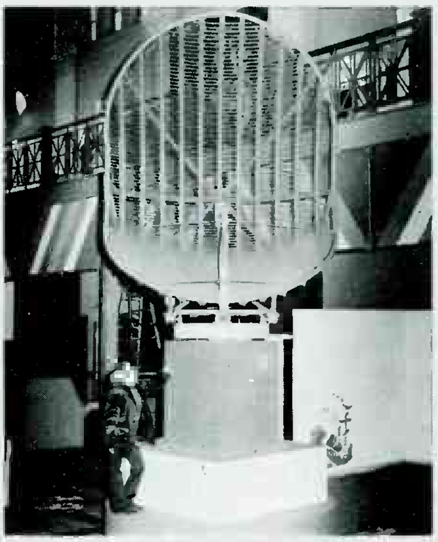
(Continued on page 6)

A new line of b-w television cameras is the first offering of the RCA Corporation upon entering the closed-circuit video market. These cameras feature integrated-circuit construction, automatic-light compensation (ALC), easy-to-use controls and 2/3-inch RCA vidicon camera tubes. They are backed by service at the manufacturing location, and are said to be competitively priced.

An ultra-sonic dishwasher planned to retail for $485 might be imported by a Swiss manufacturer. Dishwashers of this type have been sold in Europe for several years, according to **Home Furnishings Daily.** Electronic circuits supply ultra-sonic power to a transducer immersed in water where the dishes are located. Vibrations of the water loosen the dirt which is floated away. Advantages are less power used compared to conventional dishwashers, and a short cycle time of only 10 to 15 minutes. On the other hand, more water is used and the machines are expensive to manufacture.

Fifty years ago, the Electronic Industries Association (EIA) began operations as the Radio Manufacturers Association (RMA). A charter was issued by the state of Illinois on April 16, 1924 to a group of Chicago radio and parts manufacturers, who had been meeting informally for about a year to discuss mutual problems. From that small beginning has grown a large organization providing guidance and help to many segments of our industry. Changes of names reflect the enlarged scope of the organization. In 1950, the name became Radio-Television Manufacturers Association. Later it was changed to Radio-Electronics-Television Manufacturers Association, and finally, in 1957, to Electronic Industries Association. One of the most valuable contributions to television was the introduction of proposed standards for both b-w and color television. EIA now sponsors the Consumer Electronics Show twice each year. Profits from the show are used for educational programs for technicians.

The first airport-surveillance radar made especially for civilian use has now been enshrined in the Air Science Museum at the Smithsonian in Washington, D.C. This radar gave a continuous view of all aircraft in a 40-mile-wide area, and was built by the ITT Gilfillan Division of International Telephone and Telegraph Corporation.


(Courtesy of ITT)

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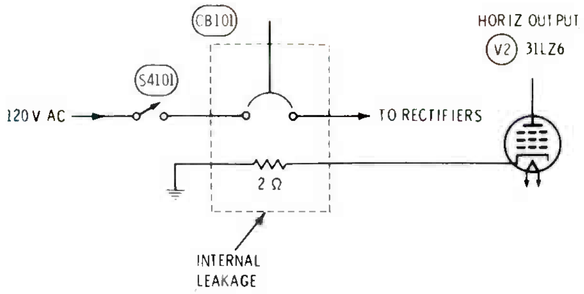
symcure

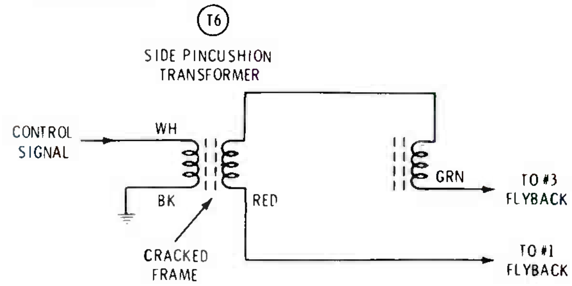
Symptoms and cures compiled from field reports of recurring troubles

Chassis—RCA CTC52
PHOTOFACT—1211-3



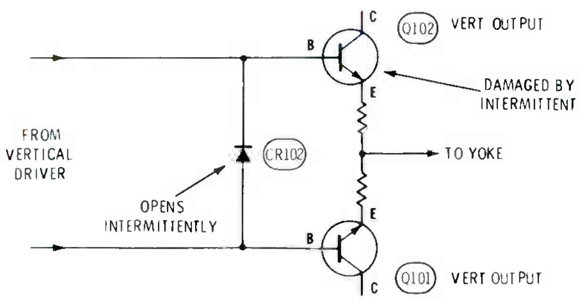
Symptom—Width in an "hourglass" shape
Cure—Check for leakage inside circuit breaker, and replace breaker if defective

Chassis—RCA CTC39
PHOTOFACT—1246-2



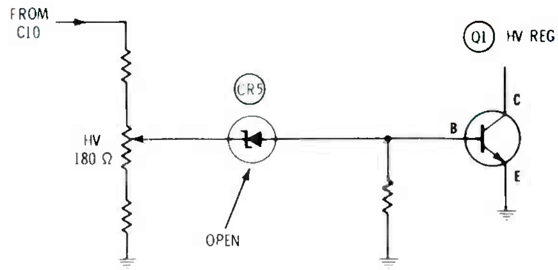
Symptom—High-frequency squeal
Cure—Check side pincushion transformer T6 for a cracked frame, and replace transformer if defective

Chassis—RCA CTC46
PHOTOFACT—1243-2



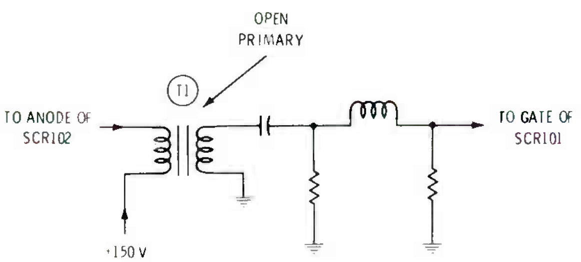
Symptom—Repeated failures of vertical output transistor Q102
Cure—Check for an intermittent open in CR102, or replace on suspicion

Chassis—RCA CTC46
PHOTOFACT—1243-2



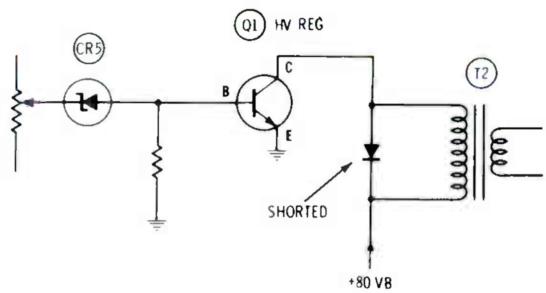
Symptom—No HV regulation and unstable horizontal locking
Cure—Check zener diode CR5, and replace if open

Chassis—RCA CTC46
PHOTOFACT—1243-2



Symptom—Low HV, horizontal foldover and no HV regulation
Cure—Check T1, and replace if it is open

Chassis—RCA CTC48
PHOTOFACT—1300-2



Symptom—Video has "S" bend vertically
Cure—Check CR4, and replace if it is shorted

reader's exchange

Need a not-available schematic? Need an obsolete part? Have an unusual service problem and want help? Send information and full mailing address to ELECTRONIC SERVICING. Other ES readers should send replies with their offer of help direct to the writer. We reserve the right to edit and print all letters sent to this column. **Let us help one another.**

Needed: *Four WD-11 tubes, eight WD-99 tubes and Volume 1 of Perpetual Troubleshooter's Manual by John F. Rider. Also, any other manuals or schematics on radios older than 1930.*

Douglas L. White
1767 Campbellton Road S.W.
Atlanta, Georgia 30311

Needed: *Address of Superior Instruments Company, a copy of operating instructions for a Sico model 450 tube tester, and tube charts or updated charts. Also need updated rollcharts for Sico Superior TW11 tube tester.*

W. W. Blackwell
521 Gold Street
Toms River, New Jersey 08753

Needed: *Dial glass for a Viscount stereo model 205.*

Earl White
West Adams TV Service
4486 West Adams Blvd.
Los Angeles, California 90016

Needed: *Roll chart or booklet with latest tube listings for a Precision tube-and-battery tester model 10-12. State price.*

Edward Schoener
P.O. Box 44
New Ringfield, Pa. 17960

Needed: *Schematic and service information for a Beyside 990 portable aircraft VHF transceiver. Also need schematic and instruction book for an Engine Ignition Analyzer model AR-1 (REIC 310.000) manufactured by Republic Electronic Industries of Farmingdale, New York.*

Hoang Trung Sac
82 Ngo Tung Chau
Saigon, South Vietnam

(Continued on page 10)

(Continued from previous page)

Needed: *Name and address of any company that services Precision Test Instruments.*
Leon Arends
Arends Radio & T.V. Service Center
102 N. Webster
Shenandoah, Iowa 51601

Needed: *RCA radio service manuals Volume 1 for 1923-1928, and Volume 2 for 1929-1930. Also, pre-1931 Atwater Kent radio manuals.*
E. T. Montgomery
1092 Willowbranch Avenue
Jacksonville, Florida 32205

Needed: *Playback/record head for Sony reel-to-reel model TC-530.*
R. Richardson
P. O. Box 93
Thomson, Illinois 61285

Needed: *Recording head part number 11X380 for model 288 Webster-Chicago wire recorder. Or would like to know where it can be repaired; coils are okay, core is worn.*
M. F. Elliott
1252 Winston Road
Cleveland, Ohio 44121

Needed: *Schematic for Ansafone model KH85. Will pay handling and cost of schematic.*
John Hluchy
286 Garrett Road
Mountainside, New Jersey 07092

Needed: *Schematic for a "Checkmate 66" guitar amplifier.*
Stanley Pindjak
10907 W. 49th Terrace
Shawnee Mission, Kansas 66203

Needed: *Service data for AGS model 7TVP2 combination TV and radio.*
Leon Tebis
434 4th Street
Brooklyn, New York 11215

Needed: *Meter for an NRI model W VTVM.*
Cyrus V. Todd
1320 N. W. 116th Street
Miami, Florida 33167

Needed: *Schematic for a model 37 Atwater Kent radio.*
David Badt
2377 Beechwood Drive
Westlake, Ohio 44145

Needed: *Operating manuals and schematics for a B&K Dynamatic 375 vacuum-tube voltmeter.*
Lewis TV & Radio
1004 South 6th Street
Brownfield, Texas 79316 □

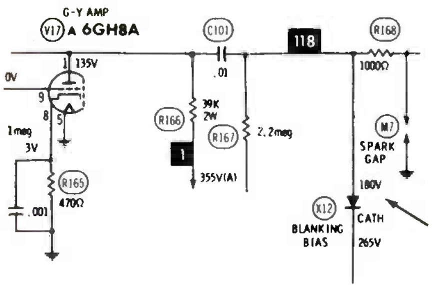
troubleshooting tips

Send in your helpful tips—we pay!

No color, brightness was excessive RCA CTC31A color chassis
(Photofact 928-3)

In this case, the trouble was very hard to locate because the symptoms were misleading.

There was no color on the screen; with the service/normal switch in the service position it was impossible to extinguish the horizontal line; contrast and brightness controls had little effect; the screen was slightly darker on the left; but removing any -Y tube changed the screen to white.



When the color bar generator was connected, the scope showed color present at the grids of the picture tube, although visibly the color was very weak.

After trying many tests that led into blind alleys, I found diode X12 (used for DC restoration of the CRT grid) to be shorted. After I replaced the diode, the contrast control operated okay and there was some color. But the picture was still too bright and no red could be seen in the picture.

Replacement of the other two DC-restoration diodes (X13 and X14) plus adjustment of the gray scale corrected all the troubles.

Charles Spurgeon
Duncanville, Texas

Editor's Note: In all cases of excessive brightness, it's advisable to measure the DC voltages at all grids and cathodes of the picture tube. In this chassis leakage of the DC-restoration diodes makes the affected picture-tube grid more positive. If the three grids are not within ten volts of the same reading, suspect the diodes.

(Continued on page 12)

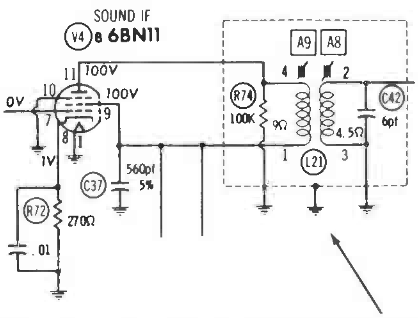
troubleshootingtips

(Continued from previous page)

Intermittent buzz in sound Admiral G13 color chassis

(Photofact 844-1)

The buzz in the sound was intermittent, and sounded the same as a misadjusted AGC control, but the buzz did not change with the program (which argued against it being an AGC problem).



I sprayed all the components with freeze spray, but without any clues. Also, there was no pattern to the buzz; it might happen with the set hot or cold, rapidly or after a long period of time.

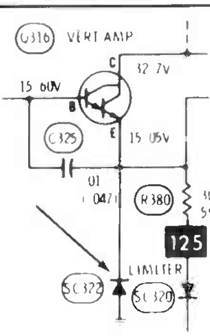
Finally, during ohmmeter tests of the sound circuit, I found an intermittently-open secondary winding in L21, the sound IF transformer. Replacement of the transformer and peaking the adjustments stopped the buzz.

R. J. Horsley
Buffalo, New York

Insufficient height Sylvania D18 color chassis

(Photofact 1322-3)

Waveform measurements showed insufficient AC voltage from the



emitter of the driver transistor, Q316.

Many of the components in this area were tested, but without success. Finally on suspicion (for it had checked okay), I replaced limiting diode SC322 and obtained full height. Evidently the diode leaked when the AC and DC voltages of the receiver were applied, but not from the lower ohmmeter voltage.

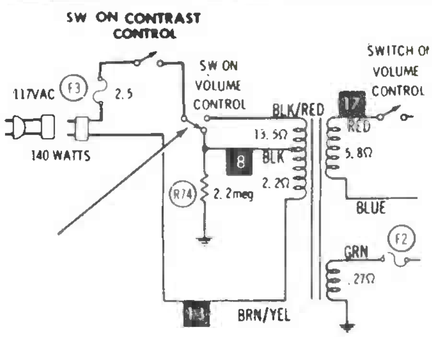
Thomas O. Ward
Lutz, Florida

Small picture General Electric A-2 b-w chassis

(Photofact 1196-1)

The picture was small, having a two- or three-inch margin on all sides. Everything else was reasonably normal.

The obvious conclusion is an open filter capacitor. Or at least, a power supply problem. All the filters were bridged with new ones; no change. Sometimes a bad damper tube causes this symptom; but a new damper made no change. And the power-supply diodes checked okay.



Then I noticed that the heaters of all the tubes were not very bright. Different taps of the power transformer primary winding are used in the instant-on circuit; these components now were tested. Apparently the section of the switch connecting to the primary winding was stuck in one position, allowing the heaters to operate from reduced instant-on voltage at all times. And of course, sweep tubes which are operated with insufficient heater voltages act as though they are weak. Installation of a new volume control with switches cured the small size.

Roger D. Redden
Beaver, West Virginia □

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DIGITAL MULTIMETERS ...A New Service Tool

Here's practical information about digital multimeters (DMM's) that all technicians need to know.

By John E. Cunningham

Digital multimeters for years have had the good reputation of providing convenience and extreme accuracy of readings, but high prices limited their use to research and engineering laboratories.

During the past year or two, however, rapid developments in the fields of integrated circuits and optoelectronics have permitted significant price reductions. In fact, some models of digital multimeters (DMM's) now sell for less than $200, and others are priced only slightly higher.

Two important questions arise with the introduction of any new item of test equipment: "How does it work?", and "What are the advantages to me?" We will answer those questions about digital meters.

How DMM's Operate

Other types of meters read in the analog mode. That is, the reading is continuous and changes smoothly from one value to the other. Whether the instrument is a simple VOM, or a more-complex VTVM or FET meter, the readout is made visually according to the position of a meter pointer relative to the printed scale. The reading must be interpreted from one of several scales, and parallax errors occur if the meter face is viewed from an angle.

The word "digital" originally came from fingers, and the way they could be manipulated to count up to ten. Digital meters sample the voltage that is being tested, change this analog (amplitude) signal to a digital one (time), and display the result on several readout devices, each capable of showing any of the ten numbers from zero to nine. In other words, a voltage shows as two or more lighted numbers; no interpretation or scales are necessary.

Although the circuit details of the various brands and types of digital meters differ widely, they can all be illustrated by one basic block diagram (Figure 2).

The heart of each DMM is the analog-to-digital (A/D) converter stage. This stage accepts some continuous input signal (such as a DC voltage between zero and one volt) and produces a digital (pulsed) output signal that is directly related in some way to the input. Several different circuits are used for this purpose, each having unique advantages and limitations. In fact, it is in this stage that DMM's differ most from each other.

Linear-ramp converter

One method of converting the analog signal to digital is by use of a single linear ramp. In the converter, a DC ramp is generated starting with a maximum positive value and continuing on to an equal negative value (Figure 3). In this example, the voltage changes at a rate of one volt-per-second. It is imperative that the ramp voltage change at a perfectly-constant rate at all times.

Suppose the converter applies the

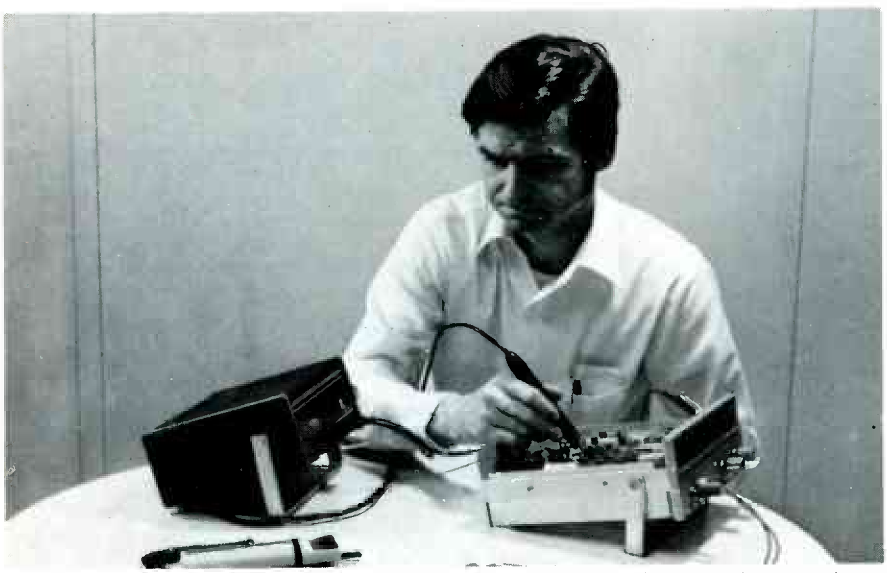


Fig. 1 Digital multimeters come in all sizes. One of our editors is shown using a B&K Model 281 to measure voltages in a Heathkit IM-102 which he built. On the table is a Model 970A Hewlett-Packard DMM, probably the smallest available.

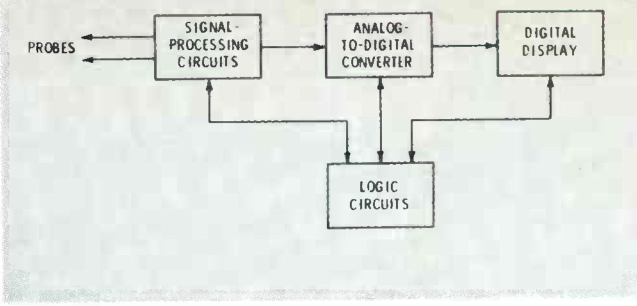


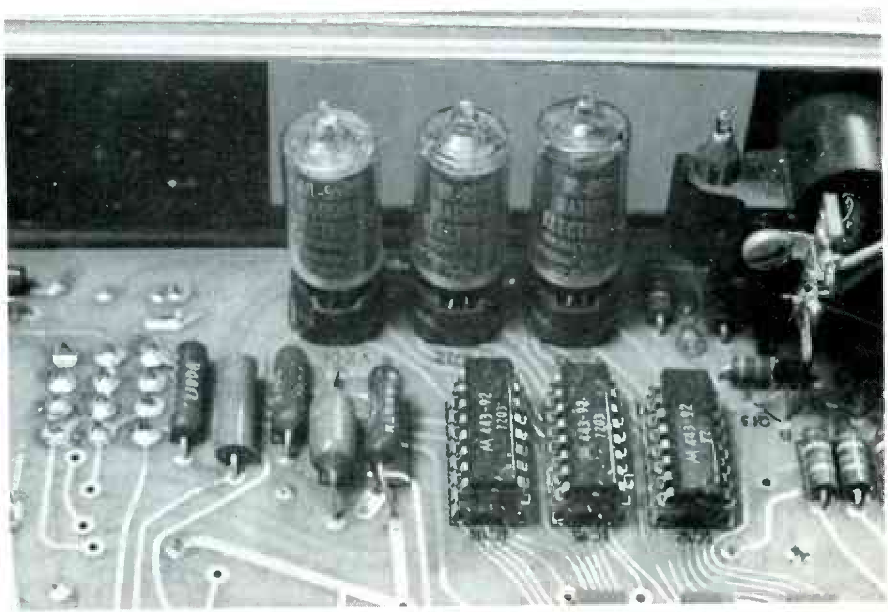
Fig. 2 All digital multimeters conform to this block diagram.

ramp voltage and the unknown voltage to be measured to a pair of comparator circuits as shown in Figure 4. When the ramp voltage equals the voltage being measured, a pulse is produced by the comparator. The ramp voltage continues to decrease at a constant rate, and when it reaches zero, another pulse is produced by the ground comparator. To find the unknown voltage, it's necessary only to measure the time interval between the two pulses. If the unknown voltage was .5 volt, the time between start and stop pulses would be exactly .5 second. A block diagram of the complete meter (Figure 4) shows that the time is measured by counting the number of cycles from the oscillator (clock) between the start and stop pulses. The display is merely a frequency counter.

Although this explanation is greatly simplified, it serves to illustrate several features of DMM's. From the values given in this hypothetical example, a second of time would be required to measure the voltage once (a meter continues to measure until turned off). Most DMM's are not that slow; about one millisecond is more typical. However, all A/D converters require some time to make each measurement.

One drawback of the simple single-ramp circuit is that noise or hum mixed with the signal can cause faulty readings. Depending on polarity and waveshape, these undesired signals can trigger the start pulse too soon or too late.

Conventional meters are not affected excessively by noise riding on the signal. VTVM's have low-pass integrating filters, and VOM's have mechanical inertia of the meter's moving-coil and pointer system. Digital multimeters respond instantly during each count. Also, DMM's have greater sensitivity which permits measurement of lower voltages, those most susceptible to noise.



This partial view inside a Heathkit IM-102 shows the Nixie tubes and a few of the IC's.

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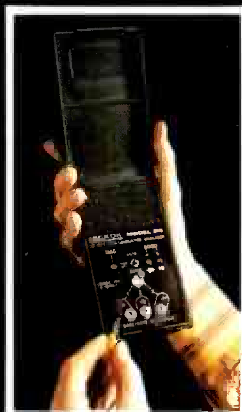

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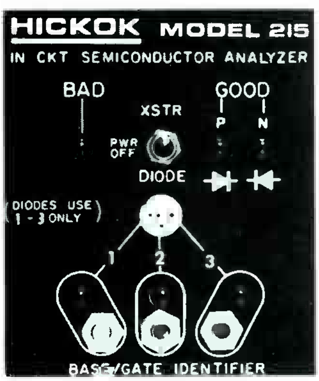

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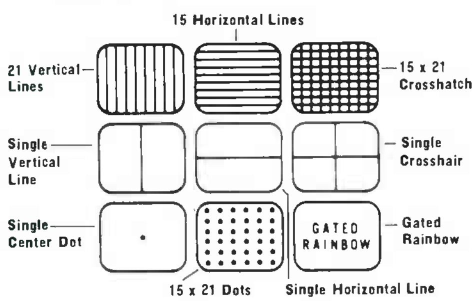

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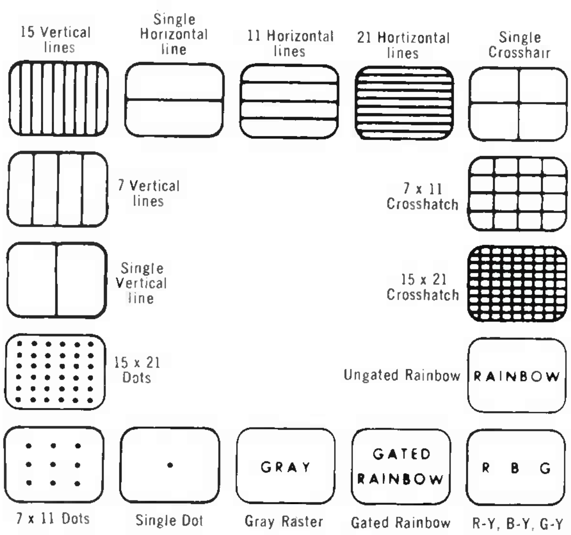

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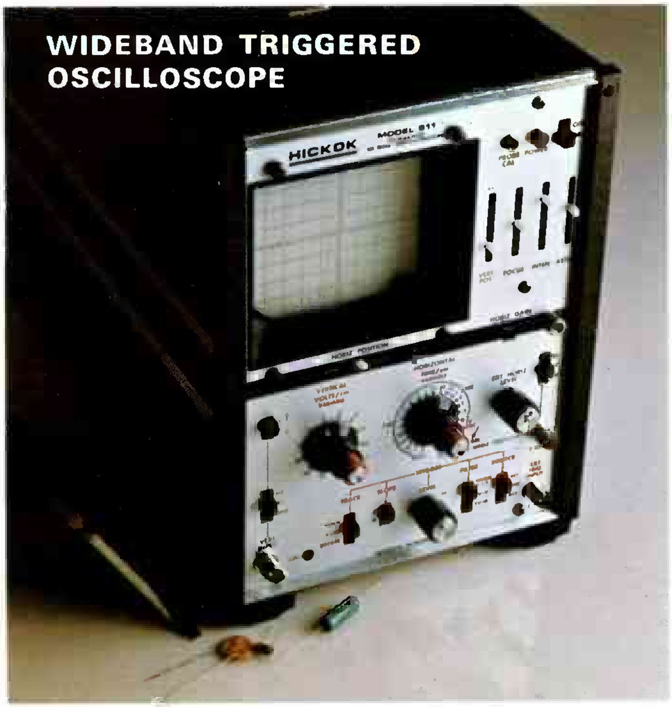

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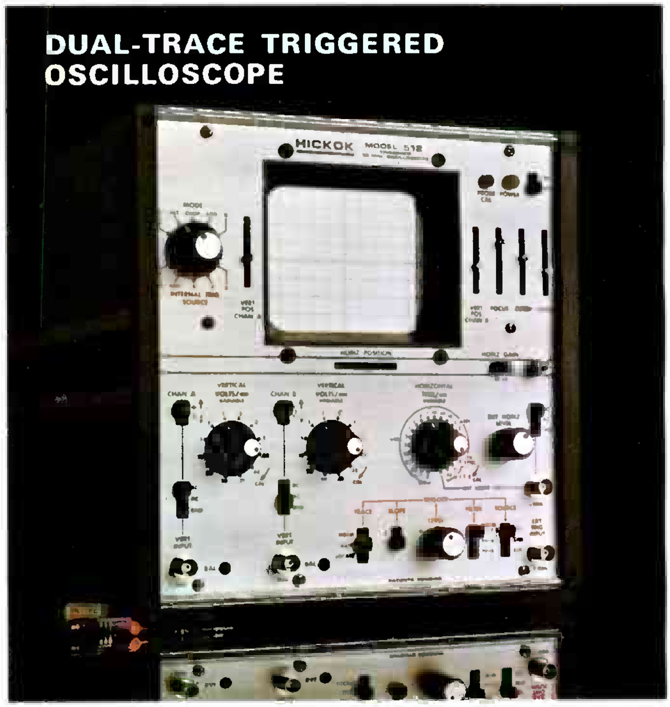

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Dual-slope integration

A popular circuit that minimizes the errors caused by noise mixed with the signal is dual-slope integration. Figure 5 shows two linear ramps, back to back. The first ramp always has the same duration (timed by a certain number of clock pulses), but the amplitude is proportional to the **average** of the incoming voltage. This minimizes errors from noise and hum riding on the signal voltage.

Next the ramp voltage is reduced to zero by applying a fixed standard voltage of opposite polarity. The higher the ramp voltage at the start of the discharge time, the more time is required to reduce it to zero. A start-counting pulse is generated at the end of the charge period, and then when the ramp voltage reaches zero, the stop-counting pulse is generated. Time between these two pulses is proportional to the reference voltage versus the voltage being tested.

In other words, a capacitor is charged slowly by the voltage under test for a fixed period of time. The higher the voltage, the larger is the capacitor voltage at the end of the charge period. The capacitor voltage is discharged by a fixed voltage; therefore, the time required to reach zero depends on the initial charge in the capacitor. The time required for the capacitor voltage to reach zero is measured by starting and stopping the counting of the clock pulses.

Accuracy of the reading depends on the linearity of the ramps, and on the voltage stability of the reference voltage, which might be from a battery cell or a zener diode.

Surprisingly, long-term frequency of the oscillator need not be very stable. Both the charging and discharging ramps are timed by the same oscillator, so it is necessary only that the frequency remain the same during the two ramps of each individual voltage measurement.

Frequency counting

Pulses from the A/D converter during the discharge time are measured by a frequency counter. This digital device counts pulses up to ten, overflows to the next-higher digit and resets to zero. The next-higher digit does the same, and so on for as many digits as required. The count of each digit is displayed in numbers from zero to nine.

Types of displays

Different arrangements of segmented elements are used to form all numbers of the readout.

Perhaps the first type used was a small vacuum tube having the numbers zero through nine stacked from front to back. DC voltage applied between the desired number and a common anode caused the number to glow orange. These glorified neon bulbs often are called "Nixie" tubes, and one is used for each separate digit.

Two popular arrangements of segmented number displays are shown in Figure 6. Any number can be shown by lighting the proper segments.

The seven-segment type of Figure 6A is most often used with "liquid-crystal" displays. Liquid-crystal displays consist of two clear glass plates having conductive coatings

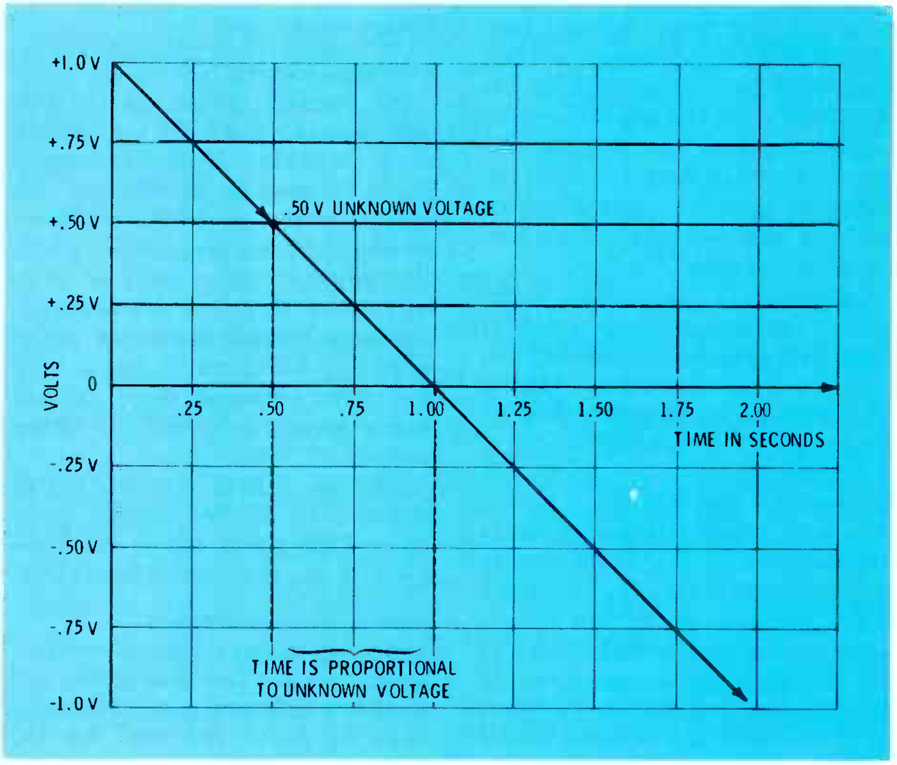


Fig. 3 A single-slope converter compares the DC input voltage against a linear ramp having a known amplitude. The input voltage is tested by measuring the time required for the ramp to move from a point which equals the input voltage to the zero-voltage point.

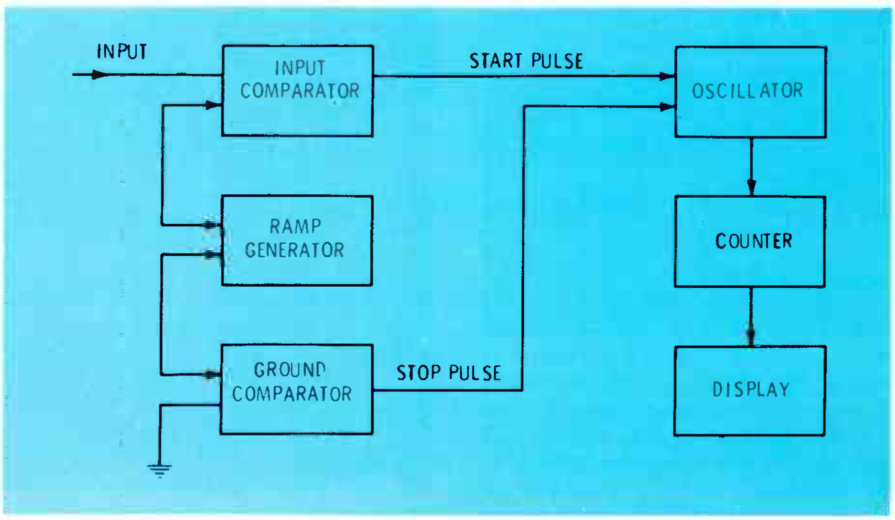


Fig. 4 Block diagram of a DMM using a single-slope ramp.

(for connection to the energizing voltage) separated by a thin layer of liquid-crystal material. These displays require less power than any other. However, external light (either from behind or from room light) is required to generate the necessary brightness. Perhaps they are best for operation under bright ambient lighting.

A 5X7 matrix of dots using light-emitting diodes (LED's) is shown in Figure 6B. Each dot represents an LED.

Because they require more power, Nixies usually are limited to equipment operated from the AC line. Both LED's and liquid crystals need very little power, and are employed in battery-operated meters. Liquid-crystal displays dissipate less power than any other, so they are used in wristwatches, clocks or displays where long battery life is essential.

Regardless of the display, a decoder is required to accept the A/D signal and energize the display devices. In many modern DMM's, this function is accomplished by one integrated circuit (IC).

Signal-conditioning circuits

As mentioned before, the A/D converter of a DMM can only accept a limited range of input signals, such as a DC voltage between zero and one volt. In order to use the DMM for measuring other voltages, the quantity to be measured first must be converted into a DC voltage between zero and one volt. That's called signal conditioning.

If the full-scale range is less than one volt, amplification is required. Or if it is greater than one volt, attenuation is needed.

Figure 7 shows a typical signal-conditioning arrangement used for DC-voltage measurements. Gain of the operational amplifier (op amp) is determined by the negative feedback through resistors R3 and R4, which are switched as the ranges are selected. Resistors R1 and R2 form a voltage divider to prevent overload when higher-voltage ranges are selected.

AC measurements

AC voltages always are rectified and measured as DC. A single diode, doubler, or bridge circuit might be used for rectification. All are calibrated for RMS, but some rectifier circuits respond to RMS, and others to either peak or average values. Peak- or average-reading meter circuits introduce errors when the waveform is not a pure sine wave (although these are the same errors inherent in other meters).

Not all DMM's provide flat response to AC frequencies above about 5,000 Hertz. Better check the specs, if you need wider bandwidth.

Resistance measurements

Analog meters have ohmmeter scales that are very non-linear, and require a different scale calibration than the linear one used for DC volts. Also, accuracy of reading is not very good, especially at certain areas of the dial.

Ohmmeter circuits in DMM's must be linear in order to match the readouts, and they are capable of greater accuracy. The theory is simple: generate a constant current; then the voltage drop across an unknown resistance is in direct proportion to the value of resistance. It is only necessary to measure the voltage drop with an appropriate DC scale (Figure 8).

Logic Operations

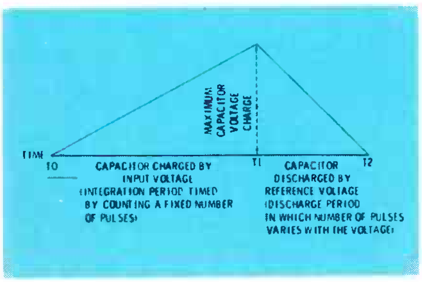
Logic circuits in a DMM control its operation. They determine when each measurement is started and completed, constantly repeat the measurement, position the decimal point in the readout, and indicate the polarity of the DC voltages.

Basic functions, such as DC volts, AC volts and ohms, are selected by the operator using a function switch. Individual voltage voltage and resistance ranges might be selected by another switch, or they might be determined automatically by the logic circuits. This latter function is called autoranging.

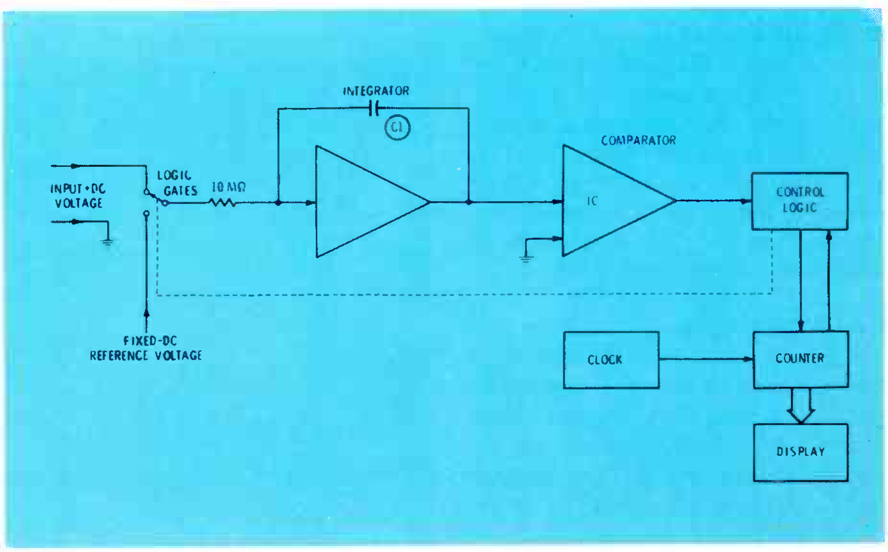
Digital Ranges

The ranges of a DMM are quite different from those of a conventional VOM. With a VOM, the full-scale value can be anything determined by scale calibration and the multiplier resistances. Digital displays have no scale to mark. Also, the full-scale range can't be

Fig. 5 Dual-slope integration eliminates many errors caused by noise and hum, also drifting of component values and clock frequency.



(A) Length of the rising ramp is always the same, but the amplitude depends on the input voltage. Time required for the ramp to fall to zero depends on the maximum charge of the capacitor, and it's measured by counting the number of clock pulses during that period.



(B) Simplified block diagram of a commercial DMM using dual-slope integration in the A/D converter.

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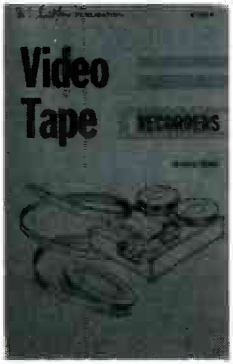

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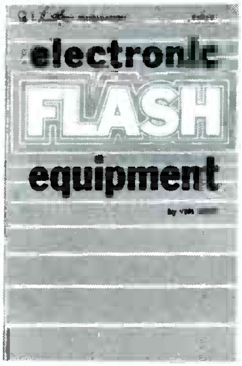

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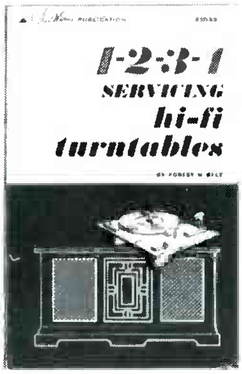

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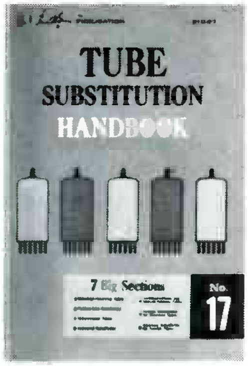

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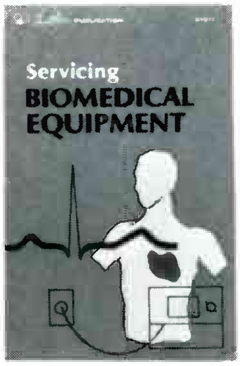

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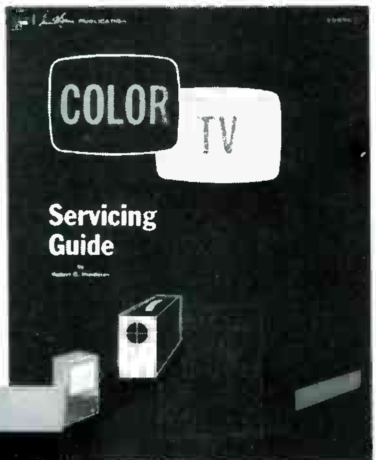

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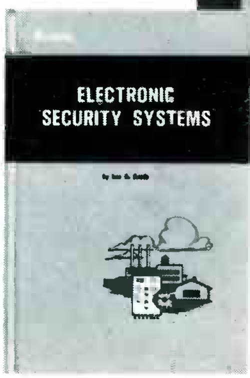

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more than the largest number formed by the digits in the display.

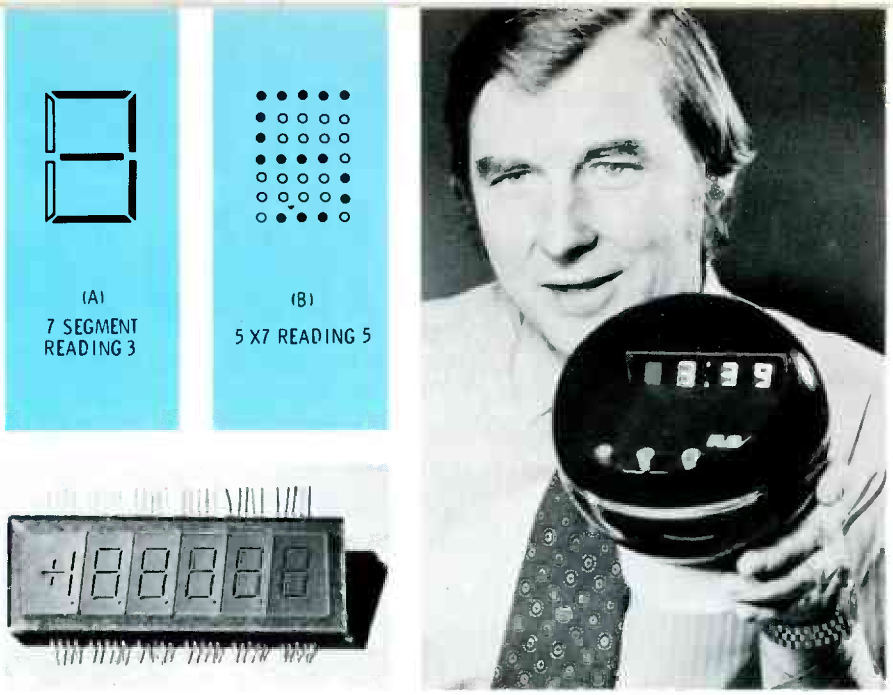
Figure 9 shows a digital display using four digits. Although it isn't always true, we assume that each digit can display any number from zero through nine. Now, the largest voltage possible to display with four digits is 9999 volts. On this range, the decimal point would be to the right of all four digits. The smallest voltage that can be displayed is 100 microvolts, or .0001 volt. Here the decimal point must be to the left of all digits. The full-scale voltage of the range in use depends only on the position of the decimal point. In other words, all ranges are decimally related.

In specifying the digits of a DMM, many manufacturers use expressions such as 4-1/2 digit capability. Generally, the whole number of digits are the ones capable of assuming any value from zero to nine. If another digit of the display cannot assume all values, it is referred to as a 1/2 digit. In most cases, it either is not lit or it shows a 1. Therefore, a 3-1/2 digit display can read up to 1999.

When such a display switches to over 1000 volts, it is said to be **overranging.** Chart 1 shows the nominal, overrange, and the value of the least-significant digit for the four usual DC ranges.

Nominal Range up to:	Overrange up to:	Least-significant digit:
1.000 volt	1.999 volts	10 mV
10.00 volts	10.99 volts	1 mV
100.0 volts	199.9 volts	.1 volt
1000 volts	1999 volts	1 volt

Chart 1 Limits of overrange, and the minimum values of the least-significant digit for four voltage ranges.



(C) (D)

Fig. 6 Displays are segmented so all numbers from zero to nine can be formed by lighting the proper segments. (A) A 7-segment display looks this way when showing number 3. (B) A 5X7 35-segment display forms number 5. (C) A 5-1/2 digit gas-discharge display. (*Courtesy of Diacon, Inc.*) (D) An experimental electronic clock using liquid-crystal readout. (*Courtesy of RCA*)

Most readouts also show a plus or a minus sign at the left of the digits to indicate polarity.

It's easy to see when the voltage applied to a conventional meter is excessive; the pointer swings off scale on the high side. Digital meters have no pointers, so some provision must be made to show when the applied voltage is greater than the scale can measure. For example, suppose a 3-1/2 digit display indicated 1999 volts. How do we know that the actual voltage isn't larger than this? Some DMM's have a separate overload indicator, or all the digits may blink at once. Consult the operating manual for each instrument to be certain.

Specifications of DMM's

Many specifications of DMM's (such as the number of functions, its ranges, and the input impedance) have the same meaning as those for any other type of multimeter. Other specifications might be unfamiliar to you, because they apply only to digital meters.

Some unique digital specifications are sensitivity, resolution, accuracy, common-mode rejection, and normal-mode rejection.

Sensitivity and resolution

Sensitivity describes the ability of

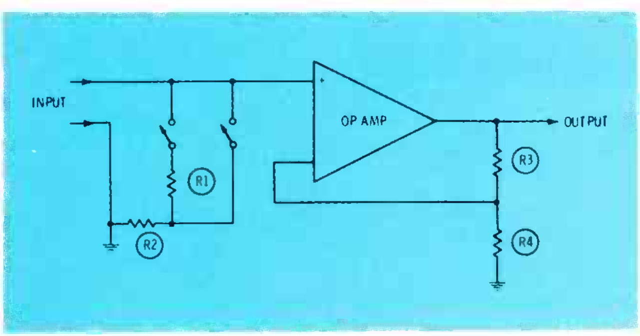


Fig. 7 Changing the value of negative-feedback resistors determines gain of the op-amp, and input voltage dividers prevent overload. Both together determine the full-scale range.

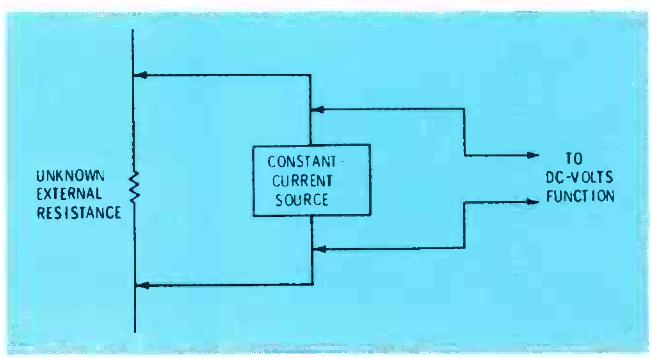


Fig. 8 Resistances are measured by applying constant current, then reading the voltage drop across the resistance.

a DMM to respond to small changes of voltage. It's usually equal to the value of the least-significant digit on the range in use.

Resolution is related to sensitivity, but stated as a percentage. For example, a 4-digit DMM can resolve one digit in 10,000, so the resolution is stated as one part in 10,000, or as .01 per cent.

Accuracy

Different ratings must be given to DMM's to describe accuracy. For years, we have worked with multimeters whose accuracy was expressed simply as a percentage of the full-scale rating of the scale in use. A 3% multimeter on the 100-volt range could have an error of up to ±3 volts at full scale. Little thought was ever given about what percentage of error this represented at low-scale readings.

Accuracy of a DMM is given in two figures. The first is a percentage of the indication. If a DMM indicated 120 volts and the accuracy was rated at ±2%, the error could be up to 2.4 volts.

The other specification might be either a percentage of the full-scale range or a certain number of digits. As an example, assume a 3-1/2 digit DMM on the 1000-volt-DC range, and an accuracy specification of ±2% of indication ±1 digit. At 120 volts DC, the possible error due to the first specification would be ±2.4 volts. Because the least-significant digit represents 1 volt, the error represented by ±1 digit would be ±1 volt. Therefore, the total error might be as much as 3.4 volts maximum.

One reason for the question about the least-significant digit is found in the basic nature of frequency counters. Sometimes there is a fraction of a pulse at either the beginning or ending of the counting time. Therefore, accuracy of counting can never exceed ±1 digit.

Common-Mode Rejection

As shown in Figure 10, normal-mode signals enter the instrument through the two usual input terminals, just as the desired signal does. Common-mode signals (usually undesired) enter between the normal inputs (when not grounded) and case ground.

Any 60 Hz signal riding along with the DC voltage that is being measured is the main cause of normal-mode errors. A low-pass resistance/capacitance filter (or a bridged-T filter tuned to 60 Hz) can be added to the input terminals to minimize the AC. Of course, dual- or triple-slope integration in the A/D converter also reduces the error from noise or 60-Hz signals.

Some DMM's have both input terminals isolated from the case, which permits measurement of voltages in a circuit where neither side of the meter is grounded. This increases the possibility of stray signals entering the meter through the common mode and causing errors.

When listed, the manufacturer's specifications usually state the ability of the instrument to reject stray signals in both common and normal modes. This rejection is usually listed in decibels.

Advantages of DMM's

The most obvious advantage of digital multimeters is the convenient readout, which is displayed in easy-to-read figures with the decimal point in the right place. There is no need to estimate how far a pointer is from a mark on a scale, and it's not necessary to notice multiplying factors.

Parallax is the change of apparent position from different angles. With conventional meters, parallax errors are introduced unless you look at the meter scale from a point perpendicular to the pivot of the meter. Mirrored scales offer one solution for the error, but require additional time for each measurement. Digital displays have **no parallax errors.**

Accuracy of readings with freedom from drift are other major advantages of DMM's. Some models are rated on DC volts with accuracy as excellent as .2% ±1 digit, and this is obtainable without zero adjusts or any need to interpret a scale! □

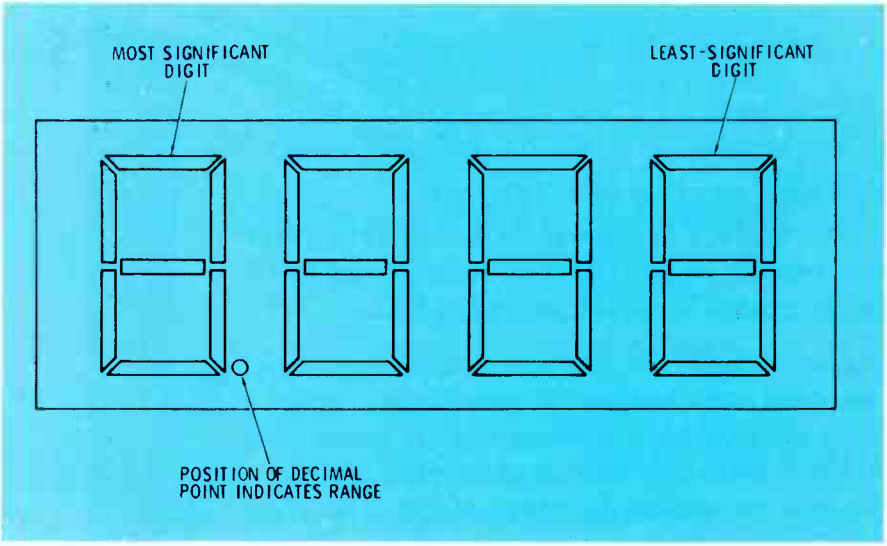


Fig. 9 Appearance of a 4-digit display with a decimal point.

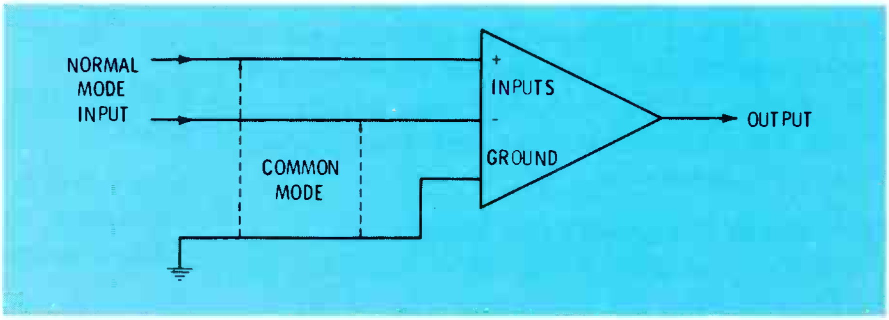


Fig. 10 Normal-mode undesired signals enter a DMM in the same way as the desired voltages. Common-mode undesired signals enter between the input terminals and the metal cabinet.

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The new exclusive Winegard Cablemate TV Signal Selector lets your customers enjoy the advantages of both cable and TV antenna reception.

If there's cable TV in your area, a lot of your customers already have, or someday will have, a cable hookup. Most of them sign up to get long distance stations or local programming not possible with an outdoor antenna. At the same time, cable people claim that every subscriber will get better reception all the way around.

But the cable subscriber usually gets short-changed. He soon finds out that the channels he regularly watched with an outdoor antenna **don't** come in as clear on cable. And these are almost always the network stations, the ones people watch 90% of the time.

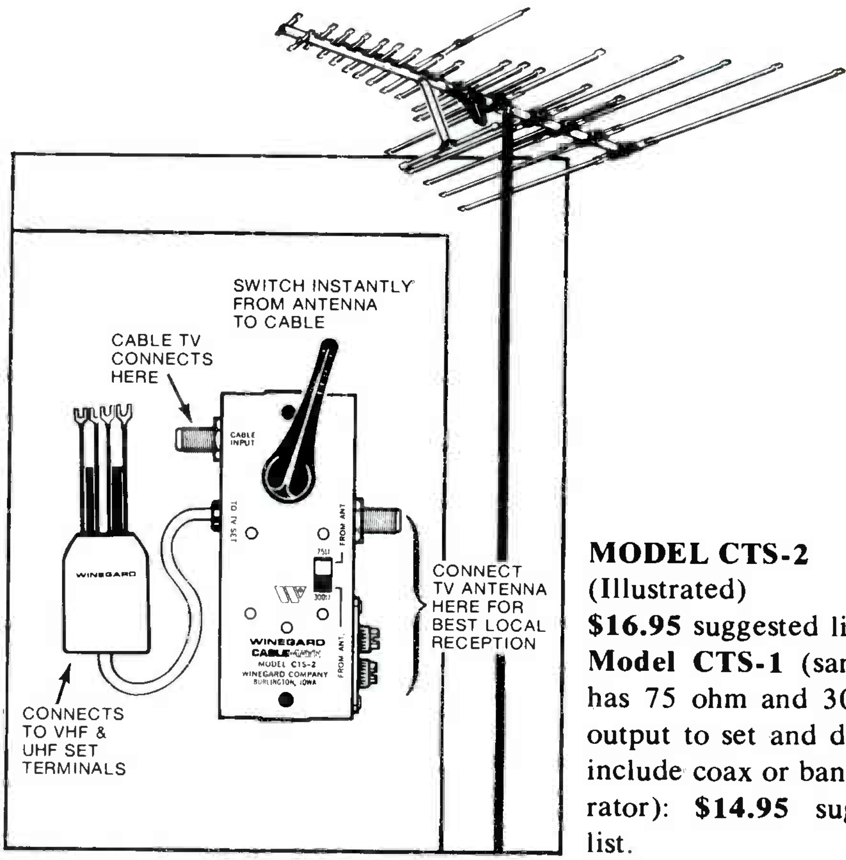
Technicians Frequently Get Blame

The problem of poor quality cable reception on one or more channels is a common one in city after city. Too often the TV technician is called for TV set repair when the cable is really at fault. Cable outages, too, are a frequent customer complaint.

That's where you come in. With a Winegard Cablemate TV Signal Selector and a Winegard outdoor antenna.

Cablemate lets you connect cable signal **and** the antenna signal to the TV receiver. The viewer simply flips a switch to select antenna or cable.

can turn a new TV antenna



Not "Just Another Switch"
Cablemate, of course, is not an ordinary switch. <u>It has specially designed circuitry with 58db isolation to prevent interference between cable and antenna signals.</u> And it gives you a choice of coax or twinlead antenna input.

MODEL CTS-2 (Illustrated) **$16.95** suggested list. **Model CTS-1** (same, but has 75 ohm and 300 ohm output to set and does not include coax or band separator): **$14.95** suggested list.

Customers Are Waiting For You
If your cable TV customer already has a good antenna on the roof, then all he needs is Cablemate. But if he has an inadequate antenna or none at all, then he's a hot prospect for **both** an antenna and Cablemate. That's profitable business . . . and the easiest way yet to sell a TV antenna to a cable subscriber.

As you can tell, you stand to gain a lot from one switch! But then remember it comes from Winegard, the folks who consistently originate new and better products for the TV service industry.

For more information, circle the reader's service card or write to: Winegard Company, 3000 Kirkwood Street, Burlington, Iowa 52601

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SAFETY...
The ignored subject

By Wayne Lemons

It's only human nature to become complacent about hazards that are not visible. However, the dangers from television receivers are so important they should be kept in mind at all times.

Have you given any serious thought to the potential dangers inherent in your job of repairing television receivers, and how to minimize those hazards? Before buying replacement parts, do you consider what future dangers your choice of wrong specifications might bring your customers? I fear we ignore these questions all too often.

Television receivers can expose people to four different dangers:
- electrical shock,
- fire,
- X-radiation, and
- picture-tube implosion.

Most new receivers have been carefully designed and manufactured to minimize those hazards. So it is the responsibility of TV technicians to maintain those relatively-safe conditions by proper repairs.

Dangers To TV Users

The one condition most dangerous to the operators of TV sets are any shorts that bring a "hot" 120-volt connection to the outside where a person could touch it accidentally. Such an accident might cause only an annoying tingle if the floor were dry. But if a lower resistance ground return is possible, the result could be serious.

"Hot-Chassis" Receivers

Any receiver having one side of the line voltage intentionally connected to the main part of the chassis is called a hot-chassis type. Now, it might or might not have some kind of a power transformer, so the term "transformerless" is not sufficiently accurate. Don't be fooled by heater transformers; many chassis have them, but ground the power line, too.

"Hot" chassis, when correctly mounted in their cabinets, are made safe by insulation. Front-panel knobs usually are made of plastic, and the shafts of the tuner and controls are insulated from the chassis, either individually or as a cluster of controls. Rear-chassis controls which can be reached from outside the back have plastic shafts. And around any holes through the cabinet back are shields of insulating paper to prevent people from inserting metal objects which might touch the chassis or wiring.

Metal cabinet parts and escutcheons also are insulated by mounting the chassis to the cabinet by screws driven into plastic blocks. Capacitors in series between the antenna connectors and the wires of the twin lead going to the tuner isolate antenna circuits from the chassis.

Needless to say, none of these safeguards should ever be defeated. It's an excellent idea to examine every machine, just before you replace the back, to make certain all the insulators are in the proper place, and that none of the mounting screws ploughed a wrong path down the outside of a plastic block so it's shorting cabinet and chassis together.

Static charges

Annoying, but not dangerous to life, are the tingles or small shocks caused by discharge through the body of high-voltage low-current static charges. These static shocks originate from two different sources.

One kind of static shock has no direct connection to the TV set, but happens from contact with any metallic object. Usually this is caused by walking across a rug, then touching anything made of metal. Friction from the walking builds up static electricity on the body, and it discharges with a visible spark and a tingle to the person when he touches anything made of metal.

Customers have been known to be afraid of a TV or stereo because they suffered a shock when they turned it on or off. They thought the machine was defective and dangerous. In such cases, you should explain (then demonstrate with a lamp or doorknob) that touching other metallic objects also produces the same shock.

Other mild shocks are caused by external static charges built up

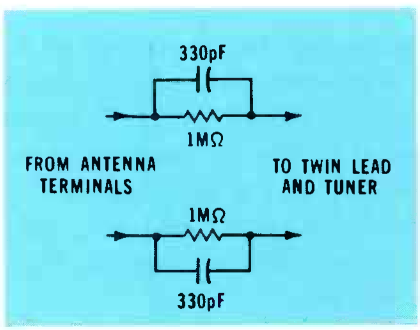

Fig. 1 "Hot"-chassis TV receivers have this type of protective circuit. The desired RF passes through the capacitors, but DC and 60-Hz voltages are blocked. Static charges leak away through the resistors.

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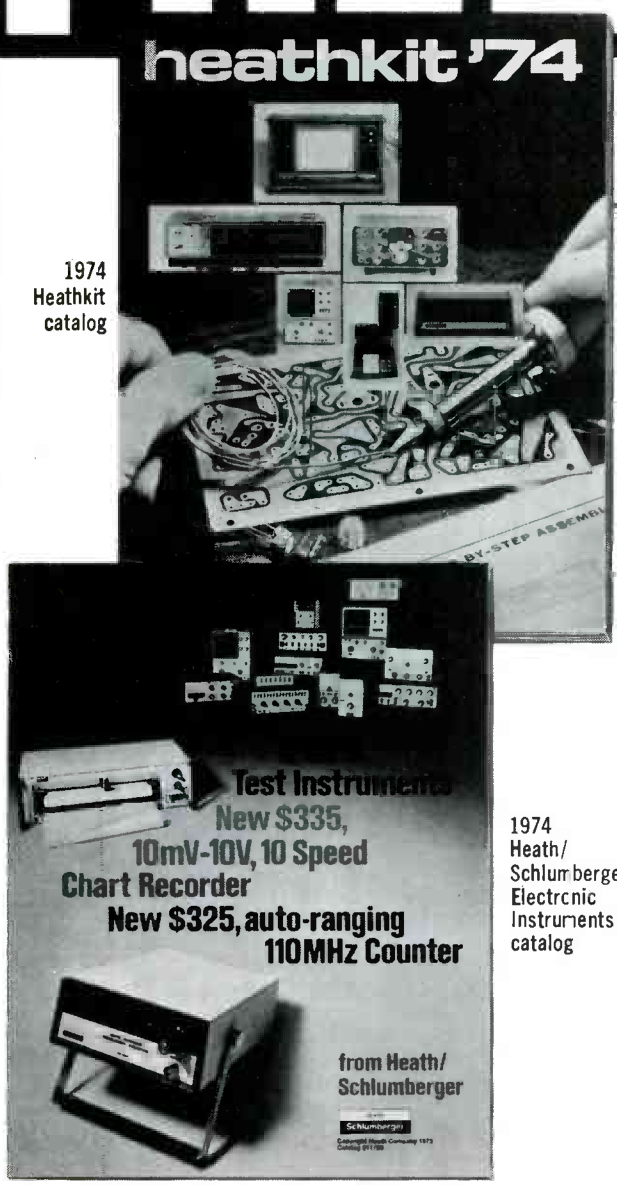

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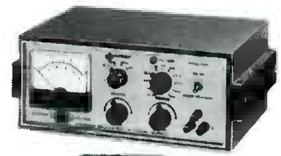

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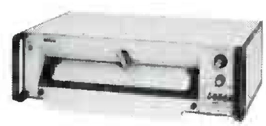

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*Mail order prices; F.O.B. factory. AI-103 from voltages inside the TV receiver. It seems logical to believe that merely insulating a piece of metal, or by connecting it to ground through a capacitor, would protect against shocks from 60-Hz voltage and from static charges alike. Well, the capacitor idea works fine for 60-Hz problems, but not for static charges.

Here's the reason. An undergrounded piece of metal near another which has a DC voltage will receive part of the voltage by capacitance-charging action. When the voltage source is the high voltage inside a picture tube, any **ungrounded** metal object nearby charges up enough to produce a small arc to ground, if given the chance. The solution, then, is to ground all exposed pieces of metal on "cold" sets, or connect them to ground through a resistance, if the chassis is "hot".

That's the reason for connecting a resistor and a capacitor in parallel from escutcheons, metal cabinet, or control brackets to the chassis. Resistors of values between 470K and 2.2M are used for this purpose. The capacitor grounds RF, and the resistor bleeds away any static charges so they can't build up to troublesome levels.

A similar need is fulfilled by the resistance/capacitance filters (see Figure 1) between both antenna connectors and the antenna coil in the tuner. The desired RF signal goes through the capacitors with very little loss, while the resistors bleed away static charges, which might otherwise build up enough to arc across and ruin the capacitors.

Watch tuner replacements

Tuners intended for use in "hot"-chassis receivers are different in two ways from transformer-operated "cold" sets. As shown in Figure 2, most "hot" tuners have RC filters at the antenna terminals on the tuner, and the tuner shaft includes a plastic insulator. Although a tuner intended for a "hot" set can be used with a "cold" chassis, **don't ever install a "cold" tuner with a "hot" chassis.**

Polarized wiring

One conductor of house wiring is connected to earth ground. If this wire always was the one going to the chassis of a "hot" receiver, there could not be a shock hazard. Many sets have polarized "cheater" power cables and input power sockets so the cable can be plugged into the set only one way. In addition, each male plug of the cable has one wide prong. In a correctly-wired house, this is the one connected to ground.

The danger is that the house wiring might be wrong, or that some misguided technician or customer might cut off the extra width of the prong, allowing the mutilated plug to fit any AC outlet regardless of polarity.

Another safety feature is house wiring that has a third conductor which is grounded. Unfortunately, this desirable feature can be defeated all too easily by use of a dime-store adapter.

Measuring Leakage

Visual checks of the various insulating safeguards are not enough. I can't forget the refrigerator motor I checked once long ago. It looked okay, but between the refrigerator cabinet and a nearby sink was the full 120 volts. Someone had replaced the fuse socket (a screw-in type) with one not having any insulation. One wire of the fuse was solidly grounded to the frame of the motor! It was just a miracle nobody was electrocuted by that example of appliance "servicing".

The only way to be certain any individual TV is safe from 120-volt shocks is to measure the leakage voltage. Two popular ways are used.

VOM measurements of leakage

Because many technicians use 20,000-ohms-per-volt VOM's during service calls, one method of measuring voltage leakage is based on that type of meter. The sensitivity for AC measurements usually is 5,000-ohms-per-volt, and this meter resistance determines the voltage reading obtained. Other resistances produce different voltages for the same amount of leakage.

After the repairs are all done, and the back of the receiver is in place, string a temporary connection from the nearest earth ground (water pipe, sink, lavatory faucet, etc.) and measure the AC voltage

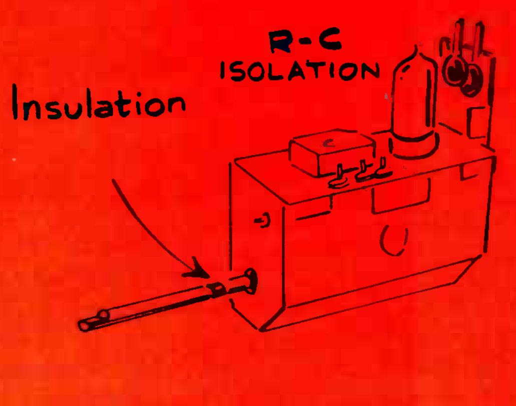
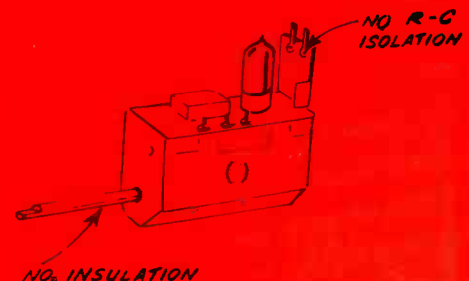


Fig. 2 Tuners built for use with "hot" chassis have resistance/capacitance filters in the antenna leads, and insulators in the tuner shaft (left). Tuners for "cold" chassis (right) don't have these two safeguards against shock and damage. Don't use such tuners with "hot" sets.
(Courtesy of EIA)



Have Time For An Injury?

By Ted Youngman, CET

From the time it was new, my scope had a tilted base line. One day I decided to correct the tilt, and removed the scope case to expose the works. Sure enough, the clamp around the base of the CRT was loose. I plugged in the power cable, adjusted for a sharp horizontal line of full width, and turned the CRT until the line was level with the graticule.

Because I was a thoughtful, safety-conscious person, I carefully avoided the high-voltage anode on the CRT as I tightened the screw in the clamp. I stood back and admired my accomplishment. Perfect!

Now, I never had looked inside my scope before, and this seemed a good chance to admire it. After examining the topside, I decided to look underneath. My eyes scanned the plug firmly inserted in the power outlet, and I briefly thought about removing it. But, for reasons too unclear to be explained, I didn't pull the plug.

I grabbed the chassis with both hands to turn it over, and in a flash knew something was wrong. Smoke poured from the chassis, as I heard an erratic buzz, smelled something burning, and felt a piercing pain in my right hand. I was doing a 60-Hertz handshake with my scope and couldn't let go! Finally, with my left hand, I unplugged the power cable, and examined the results of that long, dangerous second.

One finger of my right hand had a half-inch jagged wound with white edges. Under the break in the skin was a hole large enough to contain a small transistor. Don't believe it? Well, this time I don't recommend "hands-on" training as a means of finding out!

What about the scope? It hadn't escaped unscathed. The solder connection I had touched was barren of solder; evidently vaporized in the arc along with part of my finger. It seems I had made contact with the terminal carrying high voltage from the power transformer.

Now the moral: It takes only a second either to pull out the line plug, or to get seriously shocked. What will you do with ***your*** *second?*

between this ground and each exposed metal part of the receiver. Select the 2.5-volts AC scale of the meter, and have the receiver plugged in and turned on. After you make that first voltage test, reverse the polarity of the AC cable, and repeat the measurement. If necessary to defeat any safety wiring, use a non-polarized extension cable.

Under these conditions, a full-scale reading of 2.5-volts AC is considered to be the **maximum** safe amount of leakage. This is a current of .2 milliampere, or about 600K of leakage resistance.

Measurements by SS meter

Another more scientific test, not so dependent on meter resistance for accuracy, is shown in Figure 3. A capacitor and resistor in parallel are connected between the test point and earth ground. Then the voltage drop of AC and both polarities of DC across the RC circuit are measured by a battery-operated solid-state multimeter or FET meter. (AC-operated meters might have some internal leakage and thus give wrong readings.) Value of the capacitor is such that RF and high-frequency noise are bypassed to prevent false readings, but the value is small so accuracy at 60 Hz is not degraded. Maximum safe current is stated usually as .5 milliampere. That's .75 volts across the 1.5K resistor, or the equivalent to leakage of 240K ohms.

Test for antennas

Leakage of voltages in antenna or MATV systems should be checked by one of the methods given previously. Technicians have been known to receive dangerous shocks from underground antennas made "hot" by receiver shorts, or from shorted MATV amplifiers.

No receiver can be above suspicion. For example, the power transformers in "cold" chassis receivers seldom develop internal leakage. However, I remember one in a color set that had a short circuit between the primary and the power-supply secondary. Performance of the receiver was not affected. Because the secondary winding was not grounded directly, ohmmeter tests were not conclusive. But the chassis measured about 80 volts to earth ground for one polarity of the power cable, and about 40 volts the other way. When used with rabbit-ear antenna, this set was very dangerous to anyone operating it.

Because it was a "cold" chassis, no RC filters were supplied to isolate the antenna leads. If this receiver had been connected to an outside antenna that was **not** grounded, the antenna and the lead-in wires would have been an extreme shock hazard to anyone touching them. All the more dangerous, because it's a condition we don't expect.

If this particular receiver had been attached to a grounded outside antenna, the overload when the set was plugged in would have ruined the antenna coil and possibly blown the house fuse.

Beware of extra wiring

Investigate carefully, if you find wires other than power cable and antenna leads coming out of a TV set. The customer might have attached an extension speaker, phonograph, or other gadget, in such a way as to make the television a shock hazard.

Several years ago, a case was written up in magazines about a death attributed to an AC-DC "hot"-chassis radio used as an extension speaker. Don't let that happen to you.

Normal leakage

Every television receiver operated

from AC power has **some** leakage. Perhaps the smallest possible amount is that produced by stray capacitance between the primary winding and other windings plus the case in the power transformer used in a "cold" receiver. However, even this tiny (and safe) amount of capacitance is sufficient to cause the sensation of being shocked, if a person is grounded and then touches the chassis or some conductor attached to it.

That's the reason for using meter readings to determine the exact amount of current in the leakage path. This way, you know for certain; and you can show the customer the reading, if he doubts your diagnosis.

Implosion Dangers

Original-equipment picture tubes normally mounted in the cabinet present virtually no implosion hazards. Each face plate is protected by a safety glass, tension band, or some other device. And the neck is protected from damage by the cabinet and back, which also restrain the flying glass should an implosion take place.

But with the back removed, or with the tube out of the cabinet, **each picture tube is a potential bomb.** It speaks well for the quality of the tubes plus the caution of the technicians that so few injuries have resulted from the handling of picture tubes.

Nevertheless, it's still recommended that a technician wear goggles and gloves when handling or installing picture tubes, especially color tubes. Don't bump, scratch or apply undue pressure against any part of a picture tube. **Don't** pick up a tube by the neck. Order all spectators to leave the room (for their own safety) when you install a picture tube.

Radiation Dangers

Although the radiation scare is long gone, it's not forgotten; and the possibility of excessive X-radiation still exists. In older color receivers, the danger multiplies with high voltages above about 25KV. Radiation can be generated in the picture tube, or in other tubes, such as HV rectifier, or shunt-DC HV regulator.

No technician accurately can judge the amount of high voltage without a meter (although some believe they can). We recommend you **measure the high voltage** in each color set you service. In addition to being the first step of protecting the viewers from possible radiation, this simple measurement often indicates borderline troubles before they become more serious. The high voltage should not rise above the rated amount even with the brightness control turned down for a black screen.

Have you heard that several models of the new 1974 color sets are designed for safe operation using high voltages up to 30KV? Solid-state HV rectifiers are used, and there are no regulator tubes with high voltage applied to them. In addition, the glass used in those picture tubes is a special type giving more filtering of X-rays.

Observe these two important precautions about sets which have the extra-high anode voltage. Replace the picture tube **only** with one having this new kind of glass. And don't operate one of these chassis on your test jig before you install a new test tube which has the new type of glass.

When you are working with any model of color set, keep radiation down to a minimum by always replacing all access panels and high-voltage shields.

Fire Hazards

Have you ever examined a room after a fire originated in a TV receiver? Well, I have. They were sights I would rather forget.

At least one governmental agency is investigating the reasons for fires started by TV's, so it's time to speak frankly about a subject usually swept under the rug.

I don't believe either the manu-

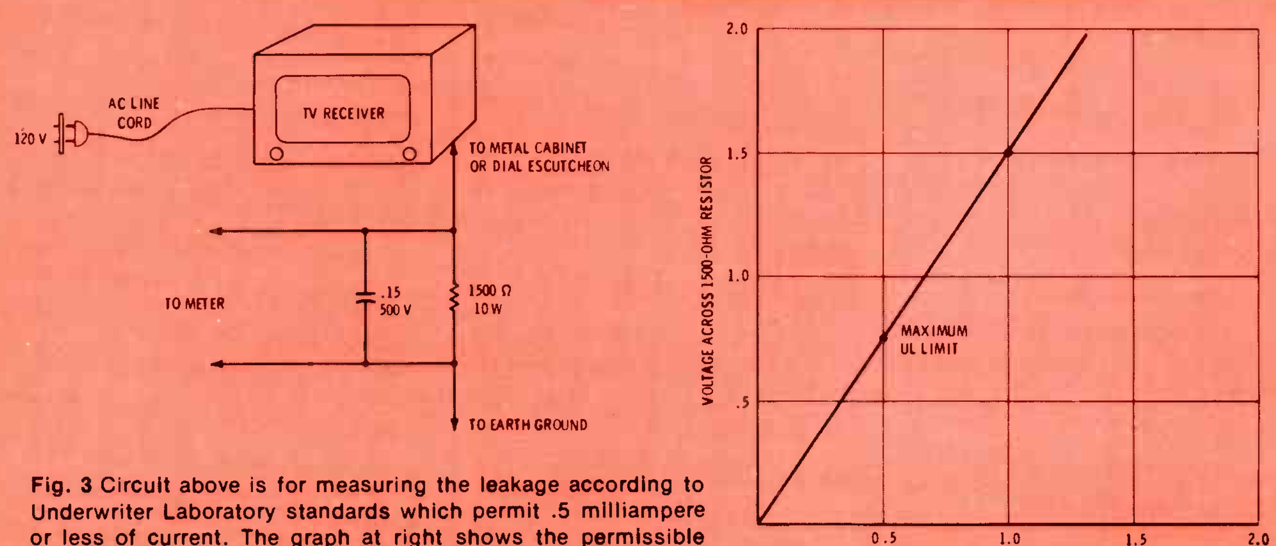


Fig. 3 Circuit above is for measuring the leakage according to Underwriter Laboratory standards which permit .5 milliampere or less of current. The graph at right shows the permissible voltage drop across the 1.5K resistor to be .75 volt or less.

Dust and dirt act as tinder, making fires easier to start. Clean all chassis as one step toward safety.

facturers or the technicians are often to blame for fires. Any electrically-operated device has the potential for causing damage. However, any reduction of this waste of lives and property certainly would be welcome. It's not a simple problem, because fires can originate in several different ways.

Fires From Arcs

Most arcs don't generate enough heat to start a fire; there's not enough current. However, a mixture of dust, cobwebs and oil (either from lubrication and cleaning, or from cooking grease borne by the air) becomes incendiary, and might be ignited by large hot arcs. As prevention, it's best to dust and clean dirty chassis during repairs, and to instruct the customer to shut off the receiver if arcing begins.

Replace any defective spark-gap capacitors with ones of the same rating; don't use normal capacitors of the same value.

Fires From Resistors And Capacitors

Resistors hot from overload and capacitors with burned spots from leakage have been identified as the sources of some fires. Their heat can ignite combustible materials nearby, which then smolder or burn. For example, a ceramic capacitor inside a yoke might short or arc and cause heat which would start a fire on the insulation of a wire lying against the capacitor. Then the fire follows the yoke wires to the chassis.

TV manufacturers who are conscientious use components of certain strict specifications in an effort to minimize the risks of fire. For example, glass-insulated film-type resistors usually are employed for wattages above 1 watt. Carbon resistors tend to change value with heat. And of course, carbon itself will burn (consider the way charcoal is used for cooking).

Low-value low-wattage carbon resistors which are used as decouplers should **not** be replaced with ones of higher ratings. Normal wattage dissipation is far below the rating of the resistor, so no more reserve is needed. But more important, a low-wattage type is more likely to burn in two when overloaded, and thus, open the circuit, as a fuse would do.

Regarding capacitors, the situation is different. It's perfectly okay to use capacitors of the same capacitance but **higher** voltage rating. In fact, it's an excellent idea to do so.

At least one manufacturer is printing gray blocks on schematics over the symbol of any components whose specifications are important to safety. That's a good idea; it reminds the technicians to use more care in selecting replacements.

On/off switches have caused more than their proper share of problems. Voltage transients on the power line (perhaps lightning) can arc across such a switch, even though it's "off", and short out other components in the chassis. Now, in addition to the chassis overload (which might or might not be protected by fuses or circuit breaker), the switch either heats or feeds through the power until the power cable is unplugged from the wall outlet. Either way it is a danger.

Capacitors bypassing each side of the 120-volt line to chassis (or a single capacitor across the line) should be of special designs which fail in ways that are not dangerous. Replace these only with ones intended for such use.

You should do two general things to maintain the original safety from fires. First, know which parts are of critical specifications so safe ones can be ordered. And second, move wires or components to locations that minimize the hazards. For example, insulated wires should never touch any component which dissipates more than .5 watt. In fact, it's better if wires touch none of the active parts, because a capacitor can short and burn, or a resistor can become overloaded and heat up. Also, wires and components should be kept away from voltages which are high enough to arc. This is particularly important with horizontal sweep and high voltage circuits.

Good Advice

One form of electronic "Russian Roulette" is permitting a TV receiver to operate without anyone watching who can shut it off in case of trouble. Children and adults alike should be instructed to shut off the TV if the picture is lost. That minor defect in the horizontal sweep circuit might turn into a fire (or at least a major repair) if allowed to continue.

Technician Safety

The preceding information largely was for the protection of the paying customers. And you also should be concerned about your own safety. Some things are self evident, such as not touching circuit wiring, and not getting too close to high voltage, knowing it can jump an inch or more.

Bare concrete floors which are laid over the ground are a shock hazard to anyone working on live chassis. Moisture from the earth constantly seeps upward to the surface. It evaporates so the floor doesn't appear wet, but the moisture is sufficient to conduct plenty of electricity to any technician who touches B+ or a hot line-voltage connection. Cover such floors with insulating material, such as asphalt tile or rubber mats.

Benches should be of wood, not metal. Or they should be covered with pressed wood. Imagine the fireworks if two "hot" chassis sets were on a metal bench at the same time and one of the power cables got plugged in backwards!

Don't use rug material to pad benches. Hot tubes can scorch them, and some rug material is flammable.

Danger from shop antennas

Every TV-repair shop should have a good master-antenna system. To avoid damage to both the antenna system and the TV's, we advise you to use couplers that

(Continued on page 54)

STRANGE SYMPTOMS FROM "FAIL-SAFE" CIRCUITS, *part 1*

Following the big radiation scare a few years ago, our government tightened the specifications so that, even under the worst-possible conditions, X-radiation could not be excessive. One answer for these requirements is found in "fail-safe", "hold-down", or "redundant" circuits which appear to "do" nothing. However, protective circuits can fail, so all technicians should understand which peculiar symptoms point to a defective "fail-safe" circuit.

By Lawrence Bowen

Fail-safe circuits are designed to prevent X-radiation because of excessive high voltage resulting from failure of the primary HV regulation. Some models replace the HV-adjustment control with precision resistors to prevent wrong adjustments. In others, any loss of HV regulation is sensed, and the circuit automatically reduces the high voltage and width. Another method forces the picture out of lock when the high voltage becomes excessive.

Four things need to be considered:

- How does each circuit operate when the high voltage is normal?
- How does each circuit operate when the high voltage is excessive?
- What are the symptoms when the protective circuit fails?
- How can each circuit be tested easily and accurately?

Fixed Shunt Regulation

Several typical protective circuits can be found in the RCA CTC38 chassis. This model appeared in three model years, with slightly different variations. First-year sets (prefixed FL for table models, and GL for consoles) used the HV circuits of Figure 1.

The usual variable HV control was replaced by R182, a 1% precision resistor, and the tolerance of R183 was tightened to 1%. HV controls in earlier models caused few problems, but they were subject to a lot of misadjustment by "phantom screwdrivers". Fixed resistors, of course, eliminate that problem, but they prevent any tailoring of the values to compensate for long-term changes in the high-voltage system or to match individual regulator tubes. R181 is added to provide some variation of regulator current. It can be jumpered to increase the high voltage (less regulator current).

Resistance measurements of R182 and R183 using an ohmmeter of the usual 3% accuracy won't show if they are slightly off tolerance. If you can't find any other reason for excessive high voltage

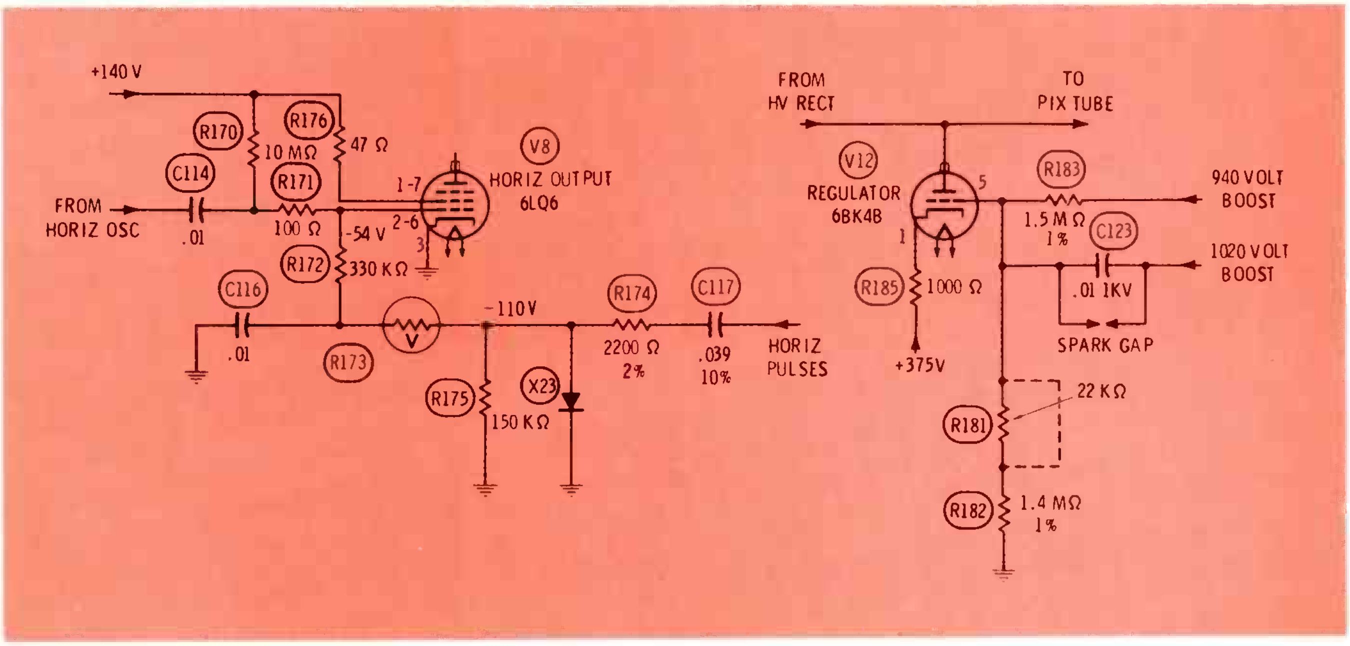


Fig. 1 Partial schematic of the RCA CTC38 early-production chassis shows the DC-shunt regulator, and the back-up circuit that places a ceiling on the high voltage by changing the bias of the horizontal-output tube.

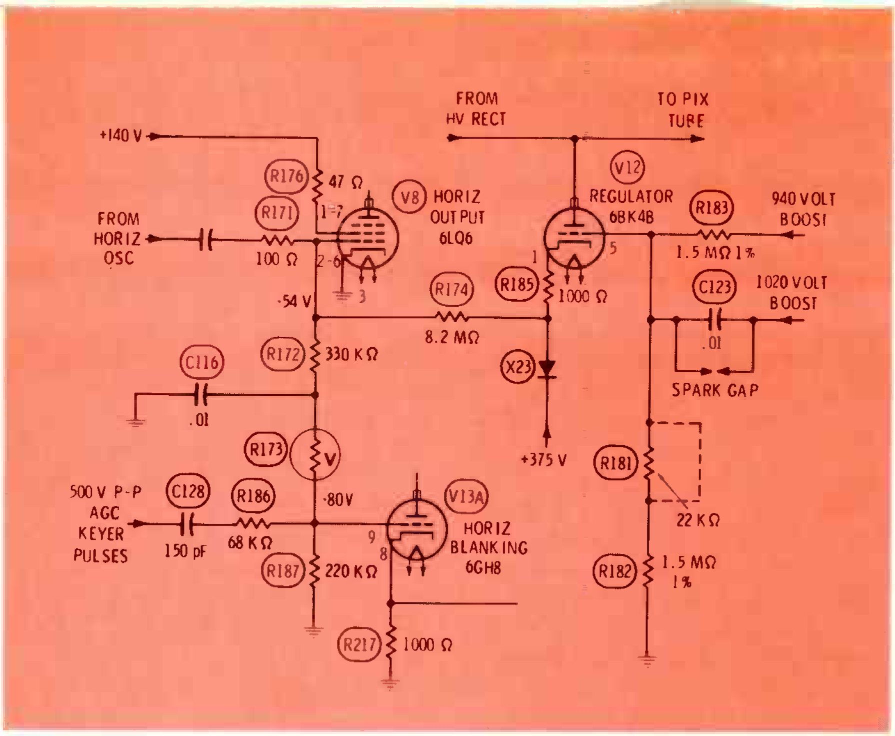


Fig. 2 Late-production RCA CTC38 chassis obtained negative voltage for the back-up circuit from the blanker grid. R173 was changed to a varistor to conduct more of the change of voltage to the output grid. Positive voltage needed to cancel the normal negative voltage of the back-up circuit was obtained from X23. When the regulator drew no current, there was no positive voltage at the anode of X23. Therefore, nearly all of the negative blanker voltage reached the grid of the output tube, which weakened the sweep and high voltage.

caused by insufficient regulator current, replace both R182 and R183 with 1% types known to be good.

Redundant Regulation

In military and space applications where reliability is a "must", critical circuits often have back-up or apparently superfluous circuits. Older color sets connected some of the negative DC voltage from the grid circuit of the blanker to the grid circuit of the horizontal-output tube. Without this connection, loss of HV regulation and zero picture tube current together would skyrocket the HV nearly to 50KV. With the blanker connection, the HV would not exceed 32KV. In other words, the small amount of redundant regulation was enough to prevent arcs, but not sufficient for protection against radiation.

A variation of the basic back-up circuit improves the protection. As shown in Figure 1, negative voltage is produced by X23 rectifying horizontal pulses. But the most important change is R173, now a varistor. When the pulse amplitude increases (and with it the high voltage), a larger voltage appears across R173, causing it to decrease in value and pass more negative voltage to the output control grid. This results in improved hold-down action, compared to that if R173 were a linear resistance. Normally, the positive voltage reaching the output grid through R170 is about cancelled by the negative voltage through R172. The bias is that produced alone by grid rectification of the oscillator signal. But an increase of negative voltage from R173 increases the negative bias of the output grid, limits the maximum plate current, and with it the high voltage.

Defects of the redundant regulator

Even though the extra regulator does very little so long as the high voltage is regulated properly, defects can cause troubles. For example, a shorted or open diode removes that one source of negative grid voltage and tends to reduce the bias of the output tube. There are no obvious symptoms, but the output tube and damper are likely to have a short operating life.

Defects that increase the negative voltage at the control grid (such as an open R170, shorted R173 or an open R175) reduce the high voltage and possibly narrow the raster. Normal grid voltage is -53 to -54 volts. If the grid voltage is more than -57, but the drive at the grid is a normal 320 volts peak-to-peak, a defect affecting the grid bias is indicated.

Shunt-Regulator Monitor

Circuits of the late-production CTC38 were modified as shown in Figure 2.

The grid-voltage type of redundant regulation was continued, but with some changes. Instead of using a separate diode rectifier to produce the negative voltage that varied with high voltage, the grid-leak bias of the blanker tube furnished the negative voltage. And this negative voltage was cancelled by positive voltage taken from a different point. The positive voltage is missing when the HV regulation fails, and the resulting symptoms are drastic and unmistakable. Here's how it's done.

Diode X23 is added in series between the 1K cathode resistor of the 6BK4 regulator tube and B+. Whenever any regulator current flows, it forward biases X23 which acts as a low-value resistance. R174 is connected to the anode of X23 (source of +275 volts), bringing positive voltage to the output grid and cancelling the negative voltage from R173. This is normal operation.

If for any reason the 6BK4 fails to draw current, X23 becomes an open circuit. No longer is there any positive voltage at the anode of X23, so the negative voltage coming from the blanker grid is not cancelled. Bias at the grid of the output tube might rise to any voltage between -60 and -71. Such excessive bias weakens the horizontal sweep circuit, causing decreased high voltage and narrow width.

The redundant circuit has protected against radiation and also made the picture quality so poor that the customer is spurred to request repairs.

Troubleshooting the fail-safe

Notice that the only component added to make the redundant regulator monitor the action of the shunt regulator was diode X23. If X23 shorts, and the shunt regulator is operating okay, there are no symptoms; the circuit is the same essentially as the older one.

On the other hand, if X23 opens, the regulator tube conducts enough to keep the anode of X23 near the supply voltage. The only symptom is a loss of high-voltage regulation through the 6BK4.

Because diodes are susceptible to damage from high-voltage arcs, X23 should be checked anytime you service the sweep circuit. An easy way is to turn off the power and measure from the cathode of the regulator tube to the anode of the damper. If X23 is good, one polarity of the test leads should show an open circuit, and the other polarity should show 1000 ohms in series with a diode. (The exact reading of the diode varies with the ohmmeter range used.) The same 1000-ohm reading with both polarities indicates X23 is shorted. An open circuit with both polarities shows that either X23 or the cathode resistor is open.

Symptoms of failure

We mentioned that loss of 6BK4 regulation causes a reduction of width and decreased high voltage. We also should make mention of a most-spectacular symptom occurring when the brightness control is adjusted through its range.

At low-brightness levels, the picture has blurred focus, and is narrow, particularly along the left edge. As you increase the brightness, the width increases and the focus improves. At maximum brightness, the picture quality is nearly normal, just the opposite symptoms of blooming.

Voltage-Doubler Hold Down

Late-production runs of the RCA CTC39 chassis have yet another variation of the redundant regulator. It's a voltage-doubler type (Figure 3). Just to keep the record straight, early-production CTC39 chassis used the same circuit as in the late-production CTC38.

C127, CR106, C141 and CR103 form a conventional voltage doubler supplying about -175 volts at C127. That would be the whole story, if zener CR107 were not there. This 120-volt zener reduces the voltage at C127 during normal operation to nearly the same as the grid voltage of the output tube. Therefore, the circuit has no effect on the sweep circuit so long as the shunt regulator draws current.

If the regulator draws too little current, yet enough to maintain conduction of the diode in the cathode circuit, the stronger horizontal pulses force the doubler circuit to produce more negative voltage. Because of the regulating action of zener CR107, nearly all of the **change** of voltage is passed along to the grid of the output tube, where it reduces the maximum amount of plate current to weaken the sweep. Thus this hold-down circuit more effectively minimizes excessive high voltage than did the previous circuits. And, because the results are more effective, a defective hold-down circuit produces symptoms that are more noticeable.

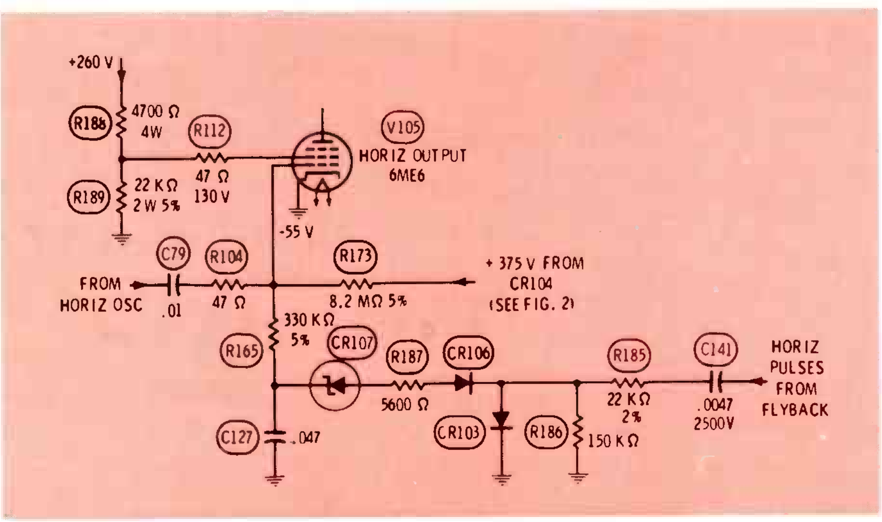


Fig. 3 The modified circuit of late-production CTC39 chassis was more effective in leveling excessive high voltage that might occur if the shunt-regulator current was weak. A voltage doubler provided more negative voltage, and the zener CR107 acted to pass more of the change of voltage on to the output grid.

Troubleshooting the voltage doubler

Many of the failures which might occur in this circuit produce no symptoms, unless a defect also occurs in the shunt regulator. In that case, the most-likely symptom would be excessive high voltage, perhaps with arcs. We advise you to test all three diodes in the hold-down circuit each time you service one of these chassis.

One fault can produce insufficient high voltage and reduced width. If CR107 shorts, the full negative voltage from the voltage doubler will be conducted to the grid of the output tube at all times. Check this diode first if a narrow picture and reduced high voltage are the symptoms.

Summary

Operation of the DC-shunt regulator is conventional in the RCA CTC38 and CTC39 chassis, although the variable control for setting the high voltage was replaced by fixed resistors in some versions.

For more than ten years, RCA color chassis have applied some of the negative voltage from the blanker grid to the control grid of the horizontal output tube. This is a back-up for the shunt regulator. Except for a few cases in which the blanker grid resistor opened and increased the negative voltage too much, the circuit has operated without problems. In fact, many technicians apparently didn't know why the interconnection was there.

However, when the circuit was changed to add the diode in the cathode circuit of the shunt regulator, the symptoms and the number of problems from the back-up circuit were multiplied. A loss of current through the shunt regulator drastically increased the negative bias at the grid of the horizontal output tube and narrowed the picture by about one-third.

Symptoms of decreased high voltage and narrowed width can be very mysterious and hard to find for a technician who doesn't know how the fail-safe circuits operate. Remember to test this circuit before spending too much time on the more conventional causes of a weak horizontal-sweep system.

Next month, we will discuss the fail-safe and disabling circuits used in RCA portable color receivers. □

NESDA Items

Because of energy shortages, the January 24-25 meeting of the NESDA House of Representatives was postponed. It will be held April 11-14 at the Menger Hotel in San Antonio, Texas, and will be followed by the Texas Electronics Association meeting.

More than 7,000 technicians are registered CET's. Although exams are available for related fields, 98% of the CET's passed the tests for repairing home-entertainment products. There are CET's now in all 50 states, Canada, Mexico and 15 foreign countries. Next CET exam day is March 15, 1974.

According to the results of a survey by NESDA, the number of electronic service dealers was 77,230 at the end of 1973, an increase of 2830. Also, the number of technicians now is estimated at 207,950, an increase of 3950. In addition, about 12,250 work as apprentice technicians, and about 18,000 attend technical classes.

Henry V. Golden of Kansas City (see photo) has been presented by Bob Meade with a certificate of Special Recognition by NESDA for his help with the convention last August. Henry is also a proud new CET.

Contact NESDA or ISCET at 1715 Expo Lane, Indianapolis, Indiana 46224.

Valerie Miller (Mrs. Vern Miller), CET, is the new Chairman of ISCET; Henry V. Golden, new CET, happily displays the Certificate of special recognition awarded him by NESDA.

Ladies In The News

The name of Ester J. Ljunggren was omitted accidentally from a list of feminine-type CET's published several months ago. She was the second woman in Oregon and third in the nation to become a CET, and also has a current 3rd-Class FCC lincense. To our delight, she reports reading Electronic Servicing (one of her favorite magazines) since 1962. We commend her for remaining in business following the death of her husband, who also was a technician.

Valerie Miller, CET, now is the Chairman of ISCET, replacing Les Nesvik who resigned to become a full-time NESDA staff member. Mrs. Miller is the wife of Vern Miller, also a CET, co-operator of Audio Service Company of Portland, Oregon, and mother of five children. She has been active in ISCET, serving as secretary last year. Many NEA (NESDA) members have met her at the many regional meetings she has attended.

News From NARDA

A typical service technician, according to a survey taken by Henry Ford Community College and reported by NARDA, spends 24% of his time in parts installation work, 21% in maintenance, 17% in troubleshooting and analysis, and the remaining 13% in customer relations and routine paper work. Reportedly, the average work week was 47 hours.

Dr. Salvatore Bella, Dean of the School of Business of Notre Dame University, was keynote speaker at the NARDA School of Business Management held in Chicago on February 3 through 5. His address, "The Manager As A Manager", was appropriate as the keynote for the three-day meeting. On February 4th, a new analysis of "The Future of Independent Service" was presented by industrialist W. H. (Bill) Anderson. Conclusion of this 16th annual school was a field trip to the Central Service Company where manager Tony D'Angelo escorted the group through his facilities. NARDA's address is 318 West Randolph Street, Chicago, Illinois 60606.

NATESA Solves Parts Problems

NATESA headquarters staff members have developed a system of obtaining backordered components for their shops. In the past, several hundred NATESA service dealers have been helped by various means to obtain parts rapidly. This accumulated knowledge now is placed at the disposal of all members. If parts have not been received through normal trade channels within ten days or two weeks, the members should fill out the cards, which have been supplied to them, with the necessary information and mail them to NATESA headquarters. NATESA, in turn, will take action to obtain the parts. NATESA is located at 5909 South Troy Street, Chicago, Illinois 60629.

Oklahoma TESA Items

Leon Skalish, NATESA president, is quoted in "The Antenna" as being amazed by newspaper ads in Long Island offering up to $428 per week for technicians. In answer to his question as to how they could afford to pay so much, company officials replied that the company sells **only** service contracts. Leon suggests this might be a solution to some of your financial problems.

George Weiss, President of NATESA, Chicago, has prepared and is now selling a book of service contracts for $15. □

SERVICING ELECTRONIC CALCULATORS PART 1

By Joseph J. Carr, CET

The new generation of small electronic calculators was made possible by digital techniques using IC's. Information presented in this article should interest you in the general electronic theories used in calculators, as well as supplying enough facts to get you started repairing them.

Miniature electronic calculators probably are the hottest new sales item on the market today. They are beginning to exceed transistor radios as desirable gifts. And even the low-priced ones are minor miracles of integrated-circuit technology. Except for lack of a permanent readout on paper, a tiny pocket-sized calculator can outperform in speed, quietness, and lack of operator effort any mechanical calculator hundreds of times larger.

Another noteworthy fact (in view of the extreme diversity of circuits in solid-state TV's) is that many brands and models of calculators appear to have nearly-identical electronic circuits. To a large degree, when you learn one, you know them all.

Before covering details, we'll digress for a general wide-angle view of these calculators.

Four-Function Calculators

Typical layout of the best-selling type of calculator is shown in Figure 1. Because they perform the basic arithmetical functions of addition, subtraction, multiplication, and division, such machines are called "four-function" types.

Individual-digit keys must be pressed in the proper sequence to enter a complete number. Then one of the arithmetical-function keys is pressed to tell the machine that the number is finished, and which function to calculate.

Most calculators have internal ni-cad batteries that can be recharged, but each charge only supplies a total of two to four hours of operation. Therefore, if the calculator is to be unused for more than a few minutes, the power switch should be shut off.

Two separate "clear" keys are provided on most calculators. The one marked "C" completely wipes out any previous data. It should be used only at the beginning of each new problem. However, if the operator makes a mistake during one entry, he can eliminate that one entry by pressing the "clear entry" (CE) key. This is similar to the pencil eraser I use so much.

Another key permits locating the decimal point between any two digits of a number. Without this feature, only whole numbers could be calculated. Functions involving cents, percentages or decimals would not be possible without errors. For example, the quantity 4 + 1.5 equals 5.5. But without the decimal point, it becomes 4 + 2 = 6. That's not very accurate.

The "D" button is a display-recall key; it's part of the circuitry to conserve battery power. Most of

Typical of the four-function calculators is the Heathkit IC-2009. **(Courtesy of Heath)**

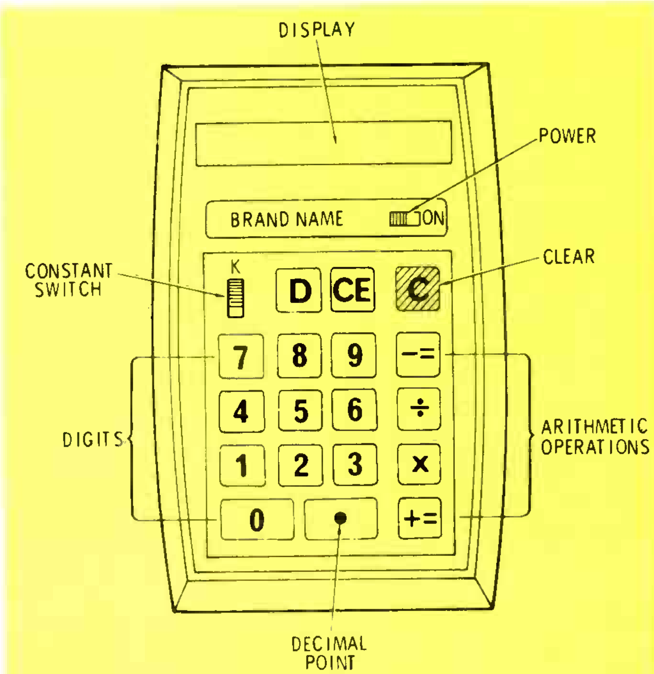


Fig. 1 General layout of a typical four-function calculator.

Fig. 2 Texas Instrument SR-10 performs some of the engineering calculations. **(Courtesy of Texas Instruments)**

Fig. 3 Nearly all scientific problems can be calculated using the Hewlett-Packard HP-35 or the HP-45 (not shown). **(Courtesy of Hewlett-Packard)**

the power in a calculator is consumed by the display. When an entry is made, but the calculator is not used again for a preset amount of time, a time-delay circuit blanks out the display. If he wants to recall the last digits that appeared before the blanking, the operator merely presses the "D" key.

A time-saving feature is the constant key, "K". With this key, the operator enters a number in its entirety. When it's used again, over and over, he just uses the "K" button.

Engineering Calculators

Simple four-function calculators are much too slow when used to solve formulas involving square root, pi, and other mathematical necessities. Most engineers and scientists require a more sophisticated machine.

One example of an intermediate-class calculator is the Texas Instruments Model SR-10 (Figure 2). In addition to the four basic functions, the SR-10 can perform the square of a number, extract the square root, and take the reciprocal of a number.

Most models also can display the numbers entered and the results obtained in the power-of-ten notation. In that case, the sign of the exponent and the magnitude are displayed on the right edge of the readout. For example, 27182341 X 10^{-7} would be displayed as 27182341 -07. This gives extreme accuracy, because the answer is 2.7182341.

The Hewlett-Packard Company, long known to the electronics trade as a manufacturer of laboratory-grade test equipment, has gone into the scientific-calculator market in a big way with three models. Model HP-35 (Figure 3) is a pocket-sized unit that exceeds by far the speed and accuracy of even the best of engineering slide rules.

In addition to the classic four functions, the HP-35 can do these things:

- raise a number (X) to the power of another number (Y);
- calculate $\log_{10}X$;
- calculate $\log_{E}X$;
- raise E to the power of X;
- calculate the more-common trigonometric functions of an angle;
- provide several memory stacks to store temporarily the constants and subroutine results which are to be used again during the same calculation; and
- has a one-key entry for the quantity "pi".

Even more functions are performed by the Hewlett-Packard HP-45, and there is a third model intended for financial calculations.

Surprisingly, the circuitry necessary to add these subroutines is less than might be imagined. The main integrated circuit for a four-function calculator is a special 24-pin D.I.P. number incorporating medium-scale-integration (MSI) techniques. In addition, either two or four special 14-pin IC's are required to decode the output of the calculator and drive the display panel.

Any special functions are usually performed by special-purpose IC's called "read-only-memory" (ROM). ROM's are used to program the calculator to act somewhat in computer style (although the machine actually does the calculation and does not merely retrieve the values of the functions stored in memory banks as a true computer does). Even complex calculations are completed rapidly. For example, when extracting a square root, the display just blanks out for a fraction of a second before showing the answer.

Display Systems

Modern electronic calculators use some variation of the seven-segment

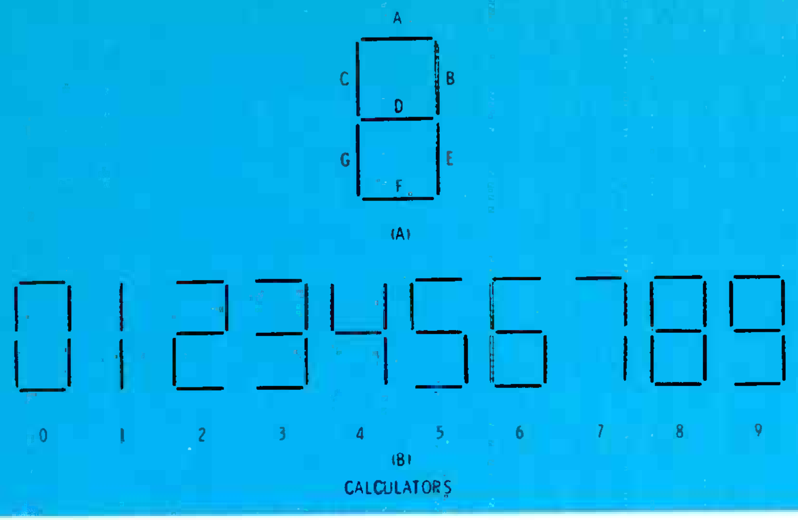
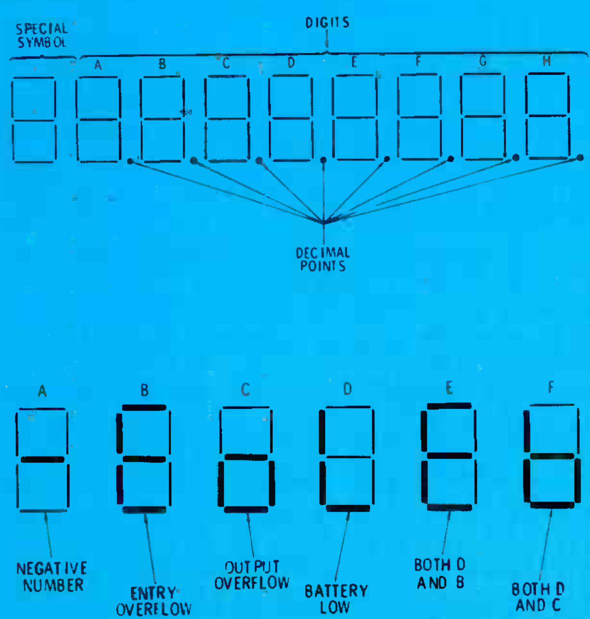


Fig. 4 Various combinations of the seven-segment elements form approximations of all numbers from zero to nine.

Size and appearance of the special 24-pin IC used in calculators compared to that of a standard 14-pin IC.

Fig. 5 Typical calculator has eight digits with possible decimal point between each, and one or more special symbols.



(A) Appearance of an eight-digit display when unlighted.

(B) Some of the more-common special symbols.

readout as shown in Figure 4. Any combination of segments can be lighted to form the numbers from zero to nine, plus several alphabetic and special characters. Figure 5A shows a drawing of an eight-digit display with decimals, and one special symbol at the extreme left. Some of the special characters and what they usually indicate are shown in Figure 5B. Two very important characters are the entry and the result overflow flags. These let the operator know that either an entered number (entry overflow) or a computed number (output overflow) is too large for the calculator to handle.

Because of limited battery power, most calculators employ leading-zero suppression. This means all zeros to the left of the most-significant figure are turned off. When the calculator has been cleared (value is zero), the only figure appearing will be a single zero at the extreme right.

Most pocket calculators have displays with numbers only about .1-inch tall, illuminated by light-emitting diodes (LED's). All LED anodes are connected together (Figure 6) to a B+ source, often through a current-limiting resistor. Transistors inside the IC ground the proper cathodes, causing those segments to light. Sometimes a plastic lens is installed over the LED's to magnify their small size.

Other Displays

Desk-top calculators are AC operated, and current drain is no problem. Therefore, most of them use larger displays of various kinds.

Incandescent displays have heated-wire filaments (similar to light bulbs), one for each number or character stacked from front to back. One example is the RCA Numeritron.

Fluorescent display tubes come in either grid or gridless types (Figure 7). The segments are coated with P-15 (blue-green) phosphor. A heated cathode emits electrons which cause a segment to glow only when it is connected through a decoder switch to a B+ source of about 25 volts. (Old-style tuning-eye tubes operated by the same princi-

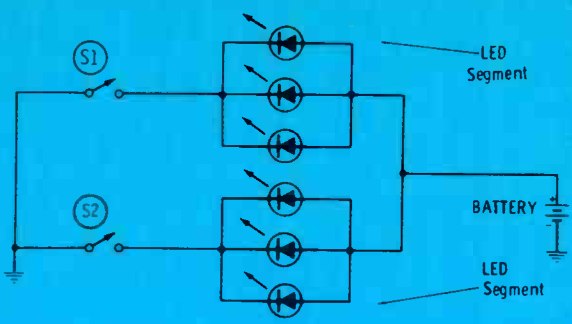


Fig. 6 Wiring of the LED's. The switches shown actually are transistors inside IC's.

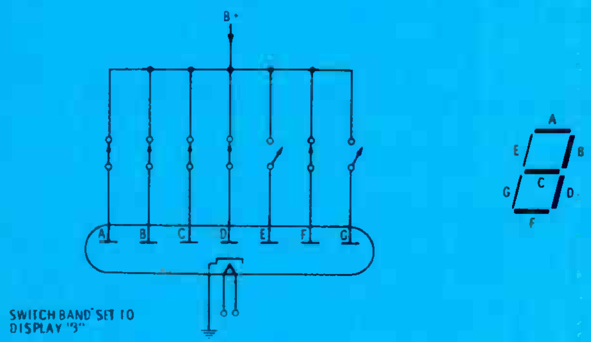


Fig. 7 One type of display for desk calculators has segments that light in the same way as the old tuning-eye tubes.

ple.) Grid-type tubes are similar, but include a control grid between the cathodes and phosphors. A negative grid voltage cuts off light from the display, if strobed operation is desired.

Cold-cathode discharge tubes are similar to neon bulbs. All of the metal numbers or characters are stacked front to back inside a vacuum tube filled with neon gas. The numbers are made of mesh so each can be seen through the others. A common anode completes the circuit. Whichever number has B+ applied to it glows with the characteristic neon orange color. Examples are the famous Nixie tube, and the Burroughs Panaplex.

Gas-discharge displays of a new type have only four parts; two nickel-iron-alloy lead frames and two pieces of window glass, plus some neon gas. The glow is the same as that from the cold-cathode tubes just described, but seven-segment digits are used in these tubes manufactured by Diacon, Inc.

Liquid-crystal displays also are quite new. They have two transparent windows with electrodes for electrical connections, and a liquid between that lights when current flows. The only ones I have seen were of the seven-segment design. Liquid crystals are unique in two ways: the current required is very small; and external light introduced through either back or front increases the brilliance (making the display well suited for use under high-brightness light).

Checking A Calculator

When testing an ailing calculator, the first step is to do a "prodromal evaluation". In plain talk, this means to look it over, then run through a few sample calculations to see if you can identify the problem from the symptoms.

Make up a few sample calculations that are easy to remember. One I like is: 23456789 minus 12345678 equals 11111111. It checks eight digits, and even I can remember the answer!

Because these are small, plastic-cased, hand-held machines, we can expect many of the defects to result from their being dropped. Therefore, examine cases, circuit boards, board-to-board connections, and protruding controls for visible damage. This is very similar to the process of repairing small transistor radios.

Next Month

Typical calculator circuitry will be the subject next month, and we will outline additional service tests. □

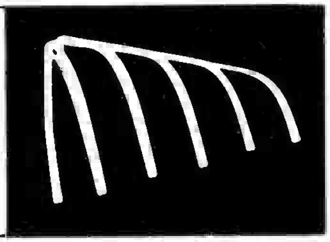
SIGNATURE PATTERNS

Made On Sprague/Jud Williams Model A Curve Tracer

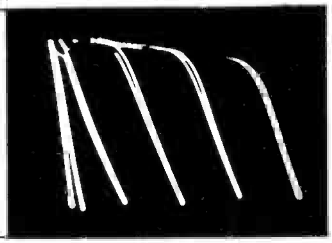
GENERAL ELECTRIC CHASSIS JA

MANUFACTURER	MODEL OR CHASSIS
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS GENERAL ELECTRIC	SIGNATURE PATTERNS JA

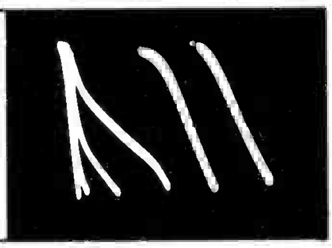
Q100 RF AGC AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 100μA



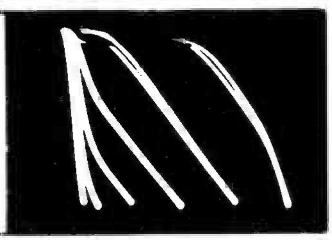
Q103 VIDEO IF AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 200μA



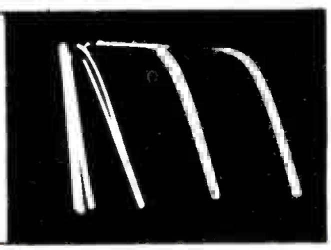
Q104 1ST VIDEO AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 50μA



Q105 1ST SYNC AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 50μA

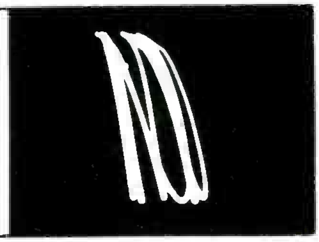


Q106 2ND VIDEO AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 100μA

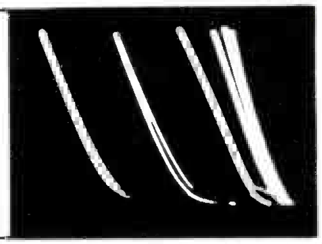


MANUFACTURER	MODEL OR CHASSIS
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS GENERAL ELECTRIC	SIGNATURE PATTERNS JA

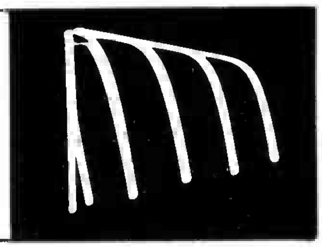
Q108 3RD VIDEO AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 100μA



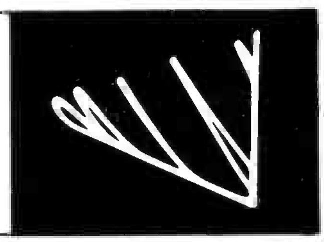
Q109 5TH VIDEO AMP
POLARITY PNP
SWEEP VOLTAGE 30V
BASE CURRENT 100μA



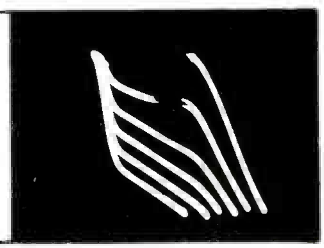
Q110 4TH VIDEO AMP
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 100μA

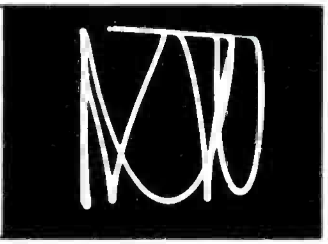
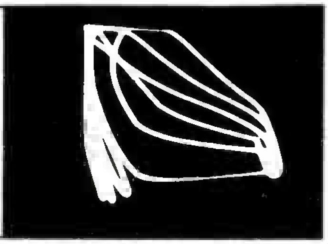
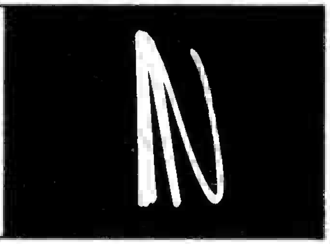
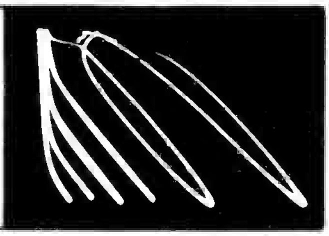
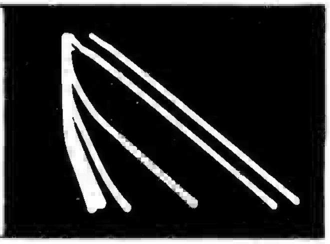
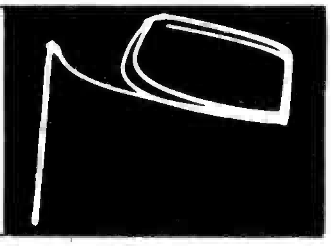


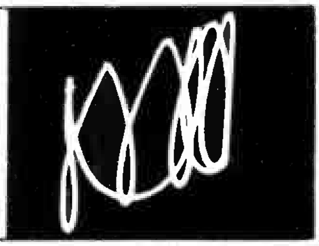
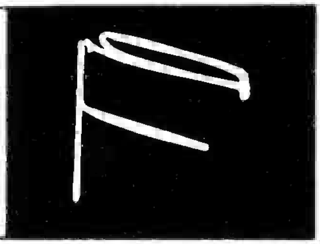
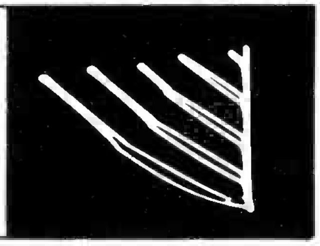
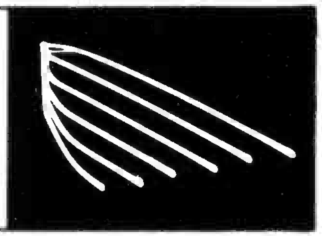
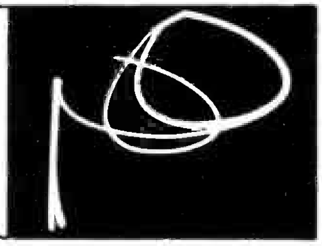
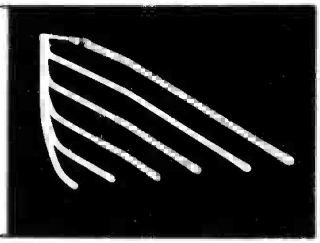
Q111 HORIZ BLANKING
POLARITY PNP
SWEEP VOLTAGE 30V
BASE CURRENT 50μA



Q112 VERT BLANKING
POLARITY NPN
SWEEP VOLTAGE 30V
BASE CURRENT 20μA



MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	SIGNATURE PATTERNS
Q113 CRT BEAM CURRENT LIMITER POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 50μA	
Q201 SYNC SEP POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 10μA	
Q202 REACT POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 200μA	
Q203 HORIZ OUT POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 20μA	
Q204 TIMER POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 20μA	
Q205 HORIZ DRIVER POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 200μA	

MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	SIGNATURE PATTERNS
Q206 HORIZ OUTPUT REMOVE 68Ω RESISTOR POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 200μA	
Q207 HORIZ SAWTOOTH GEN POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 100μA	
Q260 VERT OSC POLARITY PNP SWEEP VOLTAGE 30V BASE CURRENT 20μA	
Q261 VERT OSC POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 20μA	
Q262 VERT AMP POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 50μA	
Q263 VERT DIFF PAIR POLARITY NPN SWEEP VOLTAGE 30V BASE CURRENT 10μA	

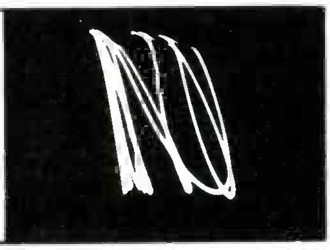
MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	**SIGNATURE PATTERNS**

Q264 VERT DIFF PAIR

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 50μA

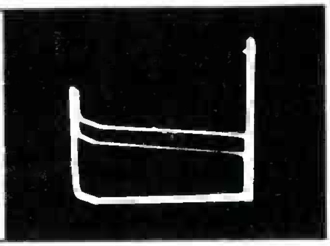


Q266 VERT DRIVER

POLARITY PNP

SWEEP VOLTAGE 30V

BASE CURRENT 200μA

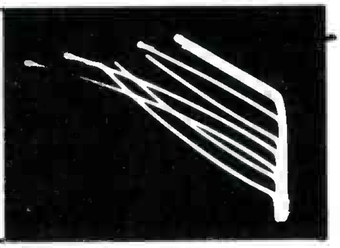


Q267 VERT OUTPUT

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 50μA

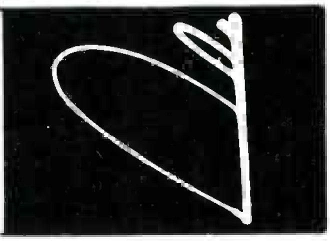


Q268 VERT OUTPUT

POLARITY PNP

SWEEP VOLTAGE 30V

BASE CURRENT 50μA

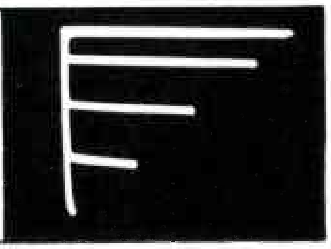


Q301 AUDIO OUT

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 50μA

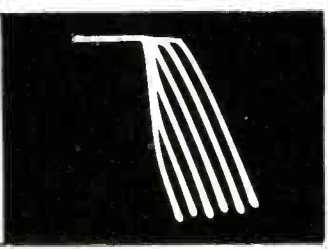


Q400 REGULATOR

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 20μA



MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	**SIGNATURE PATTERNS**

Q402 OVERLOAD PROTECTOR

POLARITY

SWEEP VOLTAGE

BASE CURRENT

NO SIGNATURE PATTERN:

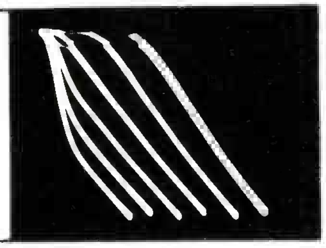
REMOVE FROM CIRCUIT TO CHECK

Q501 CHROMA PEAKER

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 20μA

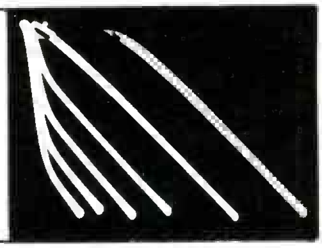


Q502 CHROMA FOLLOWER

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 20μA

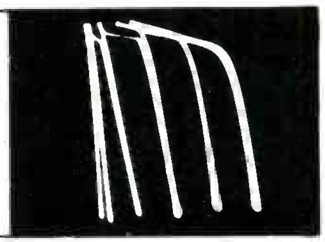


Q503 CHROMA OUT

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 100μA

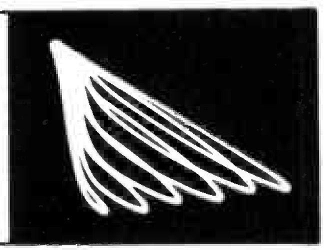


Q504 BURST AMP

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 10μA

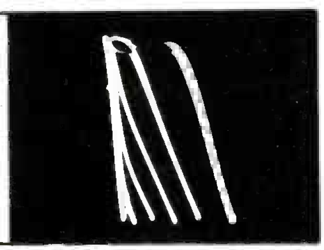


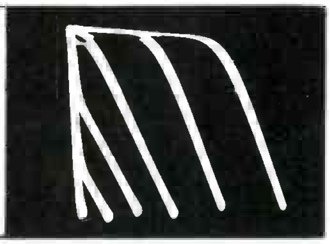
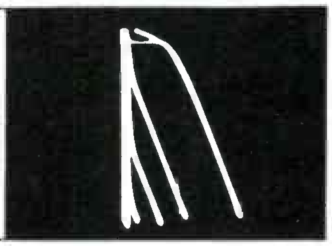
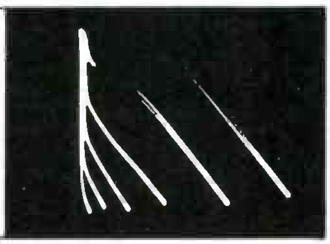
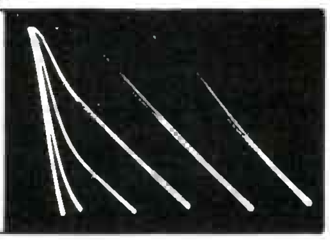
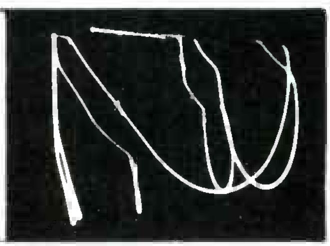
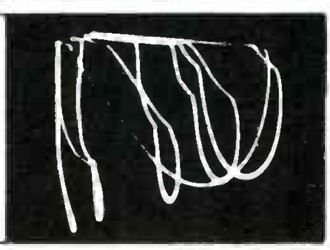
Q505 3.58 AMP

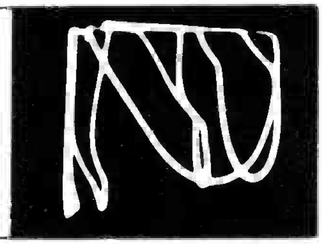
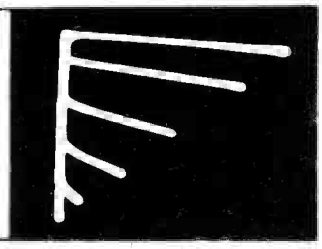
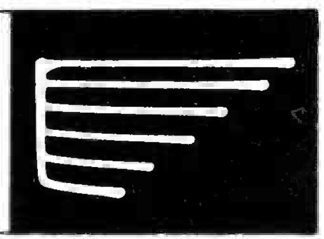
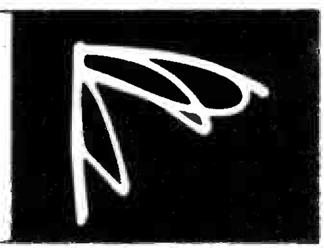
POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 50μA



MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	**SIGNATURE PATTERNS**
Q506 3.58 AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	
Q507 3.58 OUT **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	
Q509 ONE TOUCH **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	
Q510 ONE TOUCH **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 100μA	
Q600 BLUE AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	
Q604 RED AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	

MANUFACTURER GENERAL ELECTRIC	MODEL OR CHASSIS JA
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	**SIGNATURE PATTERNS**
Q606 GRN AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 50μA	
Q650 COLOR KILLER SWITCH **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 10μA	
Q651 COLOR KILLER AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 20μA	
Q652 COLOR LEVEL AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 10μA	
Q653 COLOR LEVEL AMP **POLARITY** NPN **SWEEP VOLTAGE** 30V **BASE CURRENT** 20μA	
POLARITY **SWEEP VOLTAGE** **BASE CURRENT**	

test equipment report

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

Portable TV Tuner

An all-transistorized VHF/UHF portable TV tuner is available from **PTS Electronics, Inc.** Model 3001 Port-A-Tuner is designed to substitute the TV set's tuners while they are removed for overhaul; thus, the customer enjoys uninterrupted use of his TV.

Model 3001 features solid-state tuners (82 channels), high gain and low noise. It operates on AC and can be connected to any TV by a simple hookup. Completely isolated and easy to operate, the Port-A-Tuner is safe even for children to use.

Model 3001 Port-A-Tuner sells for $49.95, complete with hookups.

For More Details Circle (31) on Reply Card

Generator/Counter

A waveform generator/frequency counter is available from **MITS, Inc.**

Model 1700A generates six carrier waveforms including sine, triangle, square, ramp, sawtooth, and pulse. The carrier frequency range is from 1 Hz to 1.5 MHz in twelve overlapping ranges. Included are three internal AM or FM modulator waveforms: sine, triangle, and square. The frequency range of the modulator waveforms is 100 Hz to 150 KHz in six overlapping ranges.

The frequency counter measures frequency of the waveform generator output or frequency of external signals from 1 Hz to over 10 MHz. Other features include adjustable sensitivity, flashing overrange indication, and an event counter which can be used for counting external pulses. The four-digit display is a Sperry gas discharge type.

Model 1700A waveform generator/frequency counter sells for $139.95 in kit form, $199.95 assembled.

For More Details Circle (32) on Reply Card

Digital VOM

The Simpson 360 VOM is a solid-state meter having a 3-1/2 digit, non-blinking, 0.33-inch high LED display with bright red numerals easily read at a distance of 15 feet.

Polarity selection is automatic, with an appropriate + or - indication; overrange indication is also automatic. An overrange measurement will cause the lower half of the "1" to flash while the remaining three digits register the amount of overrange, up to 250 counts beyond maximum. A unique analog indicator located just beneath the digital display is useful for quickly scanning nulls and peaks.

The new digital VOM features 29 AC, DC, and resistance ranges including low-power ohms. An analog output jack on the front panel makes it easy to interface with recorders and other instruments. Maximum full-scale response time to within rated accuracy is 2 seconds on DC, 5 seconds on AC. The unit operates from rechargeable batteries or AC line and may be operated while it is being charged.

Model 360 is offered by **Simpson Electric Company** and sells for $275.00.

For More Details Circle (33) on Reply Card

Multimeter

A 3-1/2 digit, 2000-count bench multimeter that measures AC and DC volts, ohms, and capacitance has been introduced by **Data Technology Corporation**.

Model 20 has a resolution of 1 pf and an accuracy of 0.2% of reading for capacitance; four DC-voltage ranges with 1-mV resolution and 0.1% accuracy; four AC-voltage ranges with 1-mV resolution and 0.5% accuracy; and four resistance ranges with 1-ohm resolution and 0.2% accuracy. Other specifications include 3.5-watt power supply and 1/3-inch-high Sperry display.

The multimeter measures 2-1/2 X 6-1/4 X 9 inches and weighs 2-1/2 pounds. Model 20 sells for $269.00.

For More Details Circle (34) on Reply Card

Transistor and FET Tester

Sencore has introduced a pushbutton transistor and FET tester, the TF26 Touch Tone Cricket. The unique design of the Cricket allows for solid-state testing without any actual knowledge of the transistor required. The tester requires no set up book or knowledge of lead configuration. The test leads can be connected in any order. The pushbutton operation, coupled with the NPN, PNP button, tests all possible combinations of basing for any transistor or FET. The type and basing information of a transistor or FET can be directly obtained from the tester by referring to a basing chart in the instruction manual. This time-saving feature eliminates the need for a reference book to verify transistor specifications when a component is being replaced.

The Cricket was designed with portability and ruggedness in mind. The unit is housed in an unbreakable acrylic case and sliding meter cover. A specially designed spring-loaded, jewel pivot meter movement, built to absorb shock, is also featured in the unit.

The TF26 Touch Tone Cricket sells for $140.00. ☐

For More Details Circle (35) on Reply Card

product report

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

Desoldering Kit

A 12-piece desoldering kit with everything needed to handle desoldering and resoldering jobs is available from **Enterprise Development Corporation.**

Model 500K includes Endeco Model 500 desoldering/resoldering iron, eight different-sized tips, and a stand for the iron and cleaning tool. Internal diameters of the tips range from .025 to .090.

Designed for heavy-duty professional or hobby use, the iron features a safety indicating light in the handle, flexible burn-resistant neoprene 2-wire cord set, cool unbreakable polycarbonate handle and stainless steel construction.

The Model 500K kit sells for $21.55.

For More Details Circle (36) on Reply Card

Digital Calculator

The RCA digital clock/calculator Model 3C3030 represents the latest technological advancements in solid-state and integrated circuits electronics.

It is fast, efficient, handsome and never idle. When simple or complex mathematical problems are not being solved, it is operating as a digital clock or as an automatic calendar or as an electronic timer or as a stopwatch or as an important date reminder unit.

As an electronic calculator it remembers the decimal point to 16 places in extra large, high-intensity 8 digit displays. It adds, subtracts, multiplies, divides, and does complicated chain or mixed calculations.

The digital clock operates by counting the voltage cycles in the electric wiring into which unit is plugged. When the calculator is not being used, a touch of the clock key displays hours, minutes and seconds.

The RCA digital clock/calculator measures 10 X 5-1/2 X 2-1/4 inches and sells for $149.95.

For More Details Circle (37) on Reply Card

Solid-State Tubes

Electronic Devices, Inc. has announced a new line of plug-in, solid-state tubes that are exact replacements for industrial rectifier tubes. The silicon EDI solid-tubes will replace most regular gaseous and vacuum rectifier tubes with ratings up to 1750 mA and 60 KV. Higher voltages and currents are available as specials. The new tubes are developed from EDI's TV and communications Solid-Tube rectifier line that features no need for filament transformers, solid-state reliability, constant output, long life, no heat generation, compact rugged construction, and fast warm up.

For More Details Circle (38) on Reply Card

Aerosol Chemical Sprays

Five new aerosol products are available from **Workman Electronic Products.**

Blast-Off dispenses dry air under pressure to remove dust and loose oxide deposits from delicate electronic assemblies. Stik-E spray adhesive is useful for permanent or temporary bonds of almost any kind of material. Corona Dope is a silicone spray that stops squeaks, prevents rust and lubricates; it can be used wherever sticking is a problem. WE40, a lubricant and moisture displacer, cleans, lubricates, and frees rust from tools, locks, and other metal products. It also corrects electrical shorts due to moisture. □

For More Details Circle (39) on Reply Card

catalogs literature

Circle appropriate number on Reader Service Card.

103. Centralab—presents a 36-page catalog describing Centralab's line of standard capacitors and ceramic substrates. Products listed in the catalog include disc, monolithic, and special application ceramic capacitors, aluminum electrolytic capacitors, polystyrene-film capacitors, and a new line of 95% alumina-ceramic substrates.

104. EV. Game, Inc.—has issued a combined replacement catalog of the most needed parts for phonograph and tape recorders. The new catalog contains 240 pages listing phonograph cartridges and needles, wheels and belts, phonograph-changer motors, center-posts, adapters, plug-in heads, shells, cartridge mounts, and accessories.

105. Fordham Radio Supply Co.—has published a 32-page catalog of replacement parts and service supplies. The catalog lists features and specifications for products which include service kits, antennas, microphones, speakers, phono cartridges, and transistor testers.

106. H. K. Simon Co.—offers details of actual business increases gained by shop owners who applied the principles given in the business-promotion package which includes "How To Double Your Business" and "Television Sales and TV Service Promotion" supplement.

107. Jensen Tools and Alloys—offers a tool catalog describing 1900 items. "Tools for Electronic Assembly and Precision Mechanics" is a handbook of particular interest to electronic technicians. A feature of the catalog is the inclusion of technical data on tool selection. Known as "Jensen's Tool Tips", these four pages include sections on screwdriver selection, machine screw data, tool materials, plier facts, metal conductivity, color coding, wire and insulation data, solderability of metals, temperature conversion, drill sizes, metal gauges, and safety.

108. Metropolitan Supply Co.—has a directory of electronic tubes which lists some 5000 industrial, entertainment and military tube types in alphanumerical order with quantity discount prices. Copies are available free when requested on company letterhead.

109. Motorola, Inc.—has released a full-line catalog on "Motorola Test Equipment" covering products ranging from service monitors to tone generators and wattmeters. The 36-page color catalog includes photographs and complete listings of features, specifications and model nomenclatures for available test equipment.

110. Rohde & Schwarz—has a new addition to the 1973 Rohde & Schwarz Instrument Catalog containing a selection of new test and measuring instruments. Those covered include mobile RF meter and test set, RF-DC millivoltmeter, directional-power meter, frequency counter, service-test set, VHF-UHF monitoring system, radio-monitoring/recording system, TV-relay receiver, and TV-monitoring receiver.

111. Stackpole Carbon Company—presents a comprehensive guide to performance characteristics and application criteria for fixed composition resistors. Bulletin No. 80-101 features selection and dimension data for 1/4, 1/2, 1, and 2 watt sizes, construction features, dimensions for various types of cut and formed leads, packaging options, and performance and testing curves.

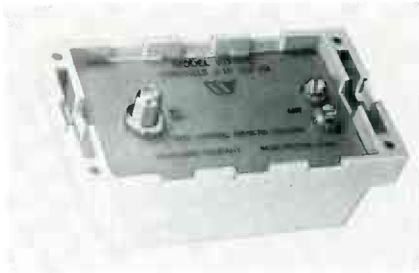
112. Triplett Corp.—has released the 59-T, a 16-page test-instrument catalog featuring a tester-selection guide that allows direct comparison of performance characteristics of each model now available from Triplett Corp. The 59-T lists VOM's and accessories, including general purpose, special feature, laboratory accuracy, digital, FET, portable, leakage adapters, cases, shunts, probes, and tester stands. ☐

antenna systems report

75-Ohm Antenna Preamp

Winegard Company has introduced a VHF-FM antenna preamplifier Model RD-375 that features a 75-ohm output designed for noisy signal areas or where use of 300-ohm twinlead is undesirable.

The circuitry incorporates a new RF stage using the A-210 overlay transistor for increased output and gain (16 dB).



High-input capability of 228,000 dBmV reduces overload in areas having both weak and strong signals, and the 75-ohm coax minimizes noise pickup. The high output level provides enough signal in most areas to operate several TV sets.

The RD-375 comes with a handy five-way mounting bracket and no-strip screw terminals. It is AC-powered with an isolation transformer to eliminate polarity problems and shock hazard.

For More Details Circle (40) on Reply Card

Antenna Rotor

A solid-state antenna rotor is offered by **Cornell Dubilier Electronics.** The unit, Model AR-40, features completely silent operation, a decorator design that fits into any room decor, high-stall torque and an on-off light that indicates when the system is operating.

The rooftop portion of the system is housed in a heavy-duty "bell housing". It can be rotated a full 360 degrees and has repeatability with an accuracy of 1%.

For More Details Circle (41) on Reply Card

Remote Plug For MATV

A new saddle plate with a 6-pin connector for remote functions in MATV systems is now being offered by **Jerrold Electronics.** The new unit can easily be snapped into Jerrold Ultra-Tap outlets.

Each new Model UTS-R saddle and 6-pin jack is shipped complete with a 6-pin mating plug.

This arrangement is especially convenient for hospital systems where remote TV receiver control is required, educational TV systems which include audio, and any sophisticated MATV system where extra functions are desired in MATV outlets.

Model UTS-R sells for $2.20.

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SAFETY

(Continued from page 35)

can't pass 60 Hz or DC. Or add capacitors in series with the 300-ohm wires.

Of course the "hot" sets are supposed to have protective RC filters in their antenna leads, but a capristor might be shorted. Even more likely is the possibility of an antenna "clothes-pin" falling accidentally on a "hot" chassis. Probably more MATV transformers are ruined this way than by all other causes combined.

Isolation transformers

Most manufacturers recommend you use an isolation transformer to protect your equipment from damage and you from shocks when servicing "hot" chassis receivers. Isolation transformers have a 1-to-1 ratio of primary to secondary, but no connection between the two windings. Plug the isolated primary into a 120-volt outlet and operate the "hot" chassis from the secondary winding.

To go first class, obtain an isolation transformer that has taps for adjusting the line voltage. Then add a line-voltage meter to make your setup complete. This provides isolation for safety, plus known, adjustable voltages for those tests with line voltages above or below normal. Be sure the transformer has a wattage rating (perhaps 500 watts, or more) that's sufficient to handle tube-type color chassis.

Of course, only **one** "hot" chassis should be used with **each** isolation transformer, else the shock and damage hazards are restored.

Slogan

Perhaps you could start a safety campaign in your shop. If so, we suggest this slogan: **THINK SMART—THINK SAFETY.** ☐

photofact bulletin

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

PHILCO-FORD
Chassis 2CY80B 1381-3

RCA
Chassis CTC71A/B 1380-2
Remote Control Receiver,
Transmitter CRK19A 1380-2-A

SEARS
528.43600200 thru 600257/606200/606201/610200
thru 610257/616200/616201/620200
thru 620257/626200/626201/630200
thru 630257/636200/636201 1383-1
Remote Control Receiver, Transmitter 90-928 .... 1383-1-A

SHARP
C-1923, C-1925 1380-3
Remote Control Receiver 701406,
Transmitter 702406 .... 1380-3-A

TELEDYNE PACKARD BELL
Chassis 98C32/C34 (Revised), 98C35/C35A/C36 ... 1374-2
Remote Control Mark 73/93 (WRT-11, WRR-19) .. 1374-2-A
Remote Control Mark 53 (WRT-12, WRR-20) 1374-2-B

TELEDYNE PACKARD BELL
Chassis 98C39, 98C40 1383-2

TOSHIBA
C927 (Ch. TAC-7410, TAC-7411) 1384-3

TRAV-LER
T12P800, T12P817 (Ch. T9H1-1A) 1375-2

TRAV-LER
Chassis TR2-1A, TR2-2A 1378-3

TRUETONE
MNM3410A-47 (2DC3410) 1383-3

WARDS AIRLINE
GAI-11104A/B/C/D, GAI-11114A/B/C/D,
GAI-11134A/B/C/D, GAI-11204A/B,
GAI-11234A/B 1369-3

WARDS AIRLINE
GAI-12462A/B 1376-3

ZENITH
Chassis 17EC45, 19EC45 1377-3
Tuner Used in Chassis 17EC45, 19EC45 .... 1377-3-A
Remote Control Receiver S-94892X,
Transmitter S-94463 .... 1377-3-B
Remote Control Receiver S-94929X,
Transmitter S-94828 .... 1377-3-C

ZENITH
Chassis 25DC56 (L.P.), 25DC58Z 1375-3
Tuner Used in Chassis 25DC56 (L.P.),
25DC58Z 1375-3-A
Remote Control Receiver S-91768,
Transmitter S-91227 .... 1375-3-B
Remote Control Receiver S-93744,
Transmitter S-93063 .... 1375-3-C

The MARKETPLACE

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

Advertising Rates in the Classified Section are:

- 25 cents per word (minimum $3.00)
- "Blind" ads $2.00 additional
- All letters capitalized 35 cents per word

Each ad insertion must be accompanied by a check for the full cost of the ad.

Deadline for acceptance is 30 days prior to the date of the issue in which the ad is to be published.

This classified section is not open to the regular paid product advertising of manufacturers.

FOR SALE

TV & RADIO TUBES 36c EA!! Free color catalog. Cornell, 4221 University, San Diego, California 92105. 2-74-6t

USE YOUR SCOPE (ANY MODEL. NO REWIRING) TO TEST TRANSISTOR IN/OUT CIRCUIT. SIMPLE ISTRUCTIONS $1.00. SCHEK TECHNICAL SERVICES, 8101 SCHRIDER ST., SILVER SPRING, MARYLAND 20910. 10-73-12

UNUSUAL SURPLUS AND PARTS Catalog. $1. ETCO Electronics Dept. E.S., Box 741, Montreal "A" H3C 2V2 12-73-12t

SAMS PHOTOFACTS: Consecutive #1 to #755, mint condition. Most unused. Best offer. Russell T. Mohr, RR2, New Palestine, Ind. 46163. 3-74-1t

DRIVE-IN T.V. REPAIR BUSINESS. 5 to 10 year lease available. Established 12 years—one owner. For cost of inventory and equipment. Separate building with parking in front. Dade TV Service. 17381 N.W. 27th Avenue. Miami. Florida 33054. 3-74-1t

TUBES: Old, obsolete and out of production. Write for prices and availability. Send stamped self-addressed envelope to M. Howe, 83 Lucerne Rd., Springfield, Mass. 01119. 3-74-1t

TV REPAIR BUSINESS in Bridgeport, Nebr., for someone who wants plenty of work. Equipment & stock list $5000. All SAM's too. Asking $3000. Great hunting & fishing country. Write Box 670, Bridgeport, Nebraska 69336. 3-74-2t

FOR SALE: Television Business. First year in business grossing $45,000. 2 Vans. authorized Zenith, Motorola, Admiral. Some motel contracts. Pocono Lake, Pa. 18347. c/o Ben Fick. 3-74-1t

FOR SALE (CONT.)

RADIO-TELEVISION Service Diagrams. 14 volume library. 2,454 pages, only $14.95. Beitman, 409 E Chalmers, Champaign, Illinois 61820. 3-74-1t

BUILD YOUR OWN TUNER substitute from junk TV chassis. Unit takes place of set tuner when checking TV for defective tuner. Simple plans $1. William Morgan, Bruce, Miss. 38915. 3-74-1t

WANTED

NEEDED: Used modulation meter model Lampkin 205A or any professional model. Antonio Acevedo, 1240 Boynton Ave., Bronx, N.Y. 10472. 3-74-1t

EDUCATION INSTRUCTION

REPAIR TV TUNERS—High Earnings; Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for $2. Refundable. Frank Bocek, Box 3236 Enterprise, Redding, Calif. 96001. 9-73-7t

advertisers' index

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We help him make it easier for you.

Your GE tube distributor is always there when you need him. With a complete line of GE entertainment receiving tubes, replacement semiconductors and ULTRACOLOR® or all-new Spectra-Brite® picture tubes.

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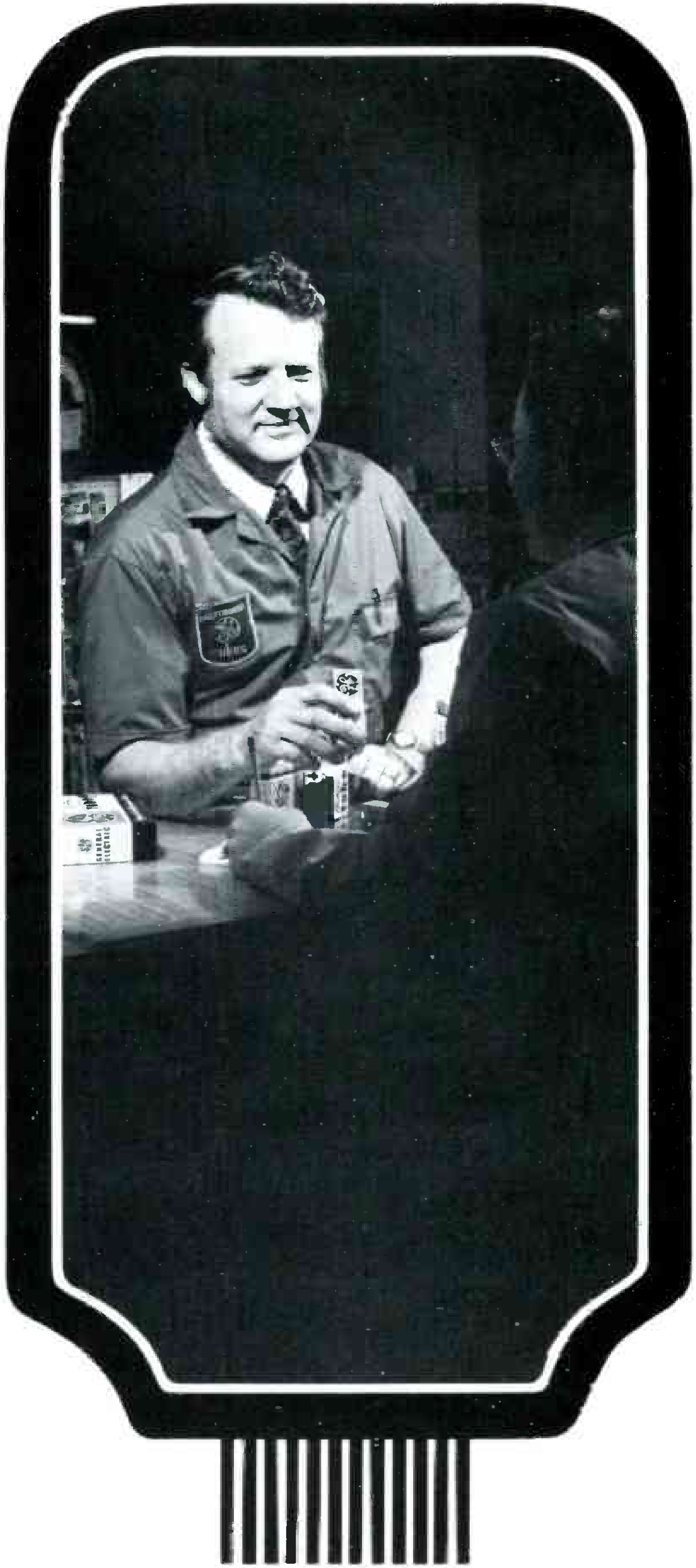
GENERAL ELECTRIC



NEW AC & BATTERY POWERED SUBBER™

Latest, all solid state version of the sensational signal circuit analyzing timesaver originated by Castle.

Invaluable for locating the break in the tuner and i.f. signal chain or analyzing agc system defects in tube TV receivers . . . essential for speedy location of signal circuit defects in modular IC, solid state and hybrid TV receivers.

A NEW APPROACH to agc system analyzing!

Permits signal injection after the agc controlled stages to simplify testing for agc defects.

- Works with any 40MHz receiver . . . color or black and white . . . solid state, tube or hybrid.
- High level, low impedance output furnishes signal usable at input of final i.f. stage.
- Special output circuit works equally well into first i.f. input of late model, link coupled systems and older, low "C" bandpass coupled systems.
- Antenna input and i.f. output electrically isolated; no "hot" chassis hazards.
- No need to disconnect supply leads from suspected tuner being tested. Substitutes the VHF tuner and tests the UHF tuner.
- Tunes all 12 VHF channels, has preset (memory) fine tuning on all channels.
- Higher overall gain than previous models with wide range gain reduction control of 60db.
- Completely self contained and battery operated, uses popular batteries available everywhere. Simple battery replacement; battery compartment in rear of custom molded case.
- Reduced current consumption extends battery life to as much as double that of previous models. Bright LED indicator warns when unit is ON.
- Use on the bench or in the home . . . anywhere.
- Comes complete with extension cables, batteries and instructions.

Specifications

Inputs:	300 ohms balanced VHF antenna terminals, electrically isolated. 75 ohms 40 MHz amplifier (Ch.#1) RCA phono jack.
Sensitivity:	30 microvolts. Input signal handling capability; over 100,000 microvolts.
Output:	40 MHz TV i.f.: bandwidth 6 MHz. "Mastermatchcoupler" output circuit with matched cable to furnish usable signal for all input circuits. Termination is RCA phono jack, electrically isolated.
Tuning Range:	All 12 VHF TV channels, plus Ch.#1 40 MHz amplifier position for testing UHF tuners. High stability of 40 MHz amplifier permits two Mk.IV Subbers to be cascaded for high level 40 MHz output signal from any VHF channel.
Tuning:	Preset (memory) fine tuning.
Gain Control:	Gain reduction 60 dB.
Power supply:	18 volts. Uses two 9v transistor batteries.
Size & Weight:	6.5"x 6.5"x 3.25" exclusive of control knobs and handle. 1.5 lbs complete with batteries.
Accessories:	"Mastermatchcoupler" output cable with RCA phono jack termination. "Mastermatchcoupler" output cable with alligator clip terminations. UHF tuner test cable.

Contact your distributor.

TV TUNER SUBBER™ Mark IV (Battery model) net $45.95

TV TUNER SUBBER™ Mark IV-A (120 VAC + Battery model) net $54.95

All battery only models of the SUBBER may be factory modified for 120VAC use. Contact your distributor for details and cost.

CASTLE TV TUNER SERVICE, INC.

5701 N. Western Ave., Chicago, Illinois 60645 • **Phone: (312) – 561-6354**

In Canada: Len Finkler Co., Ontario

For More Details Circle (2) on Reply Card