

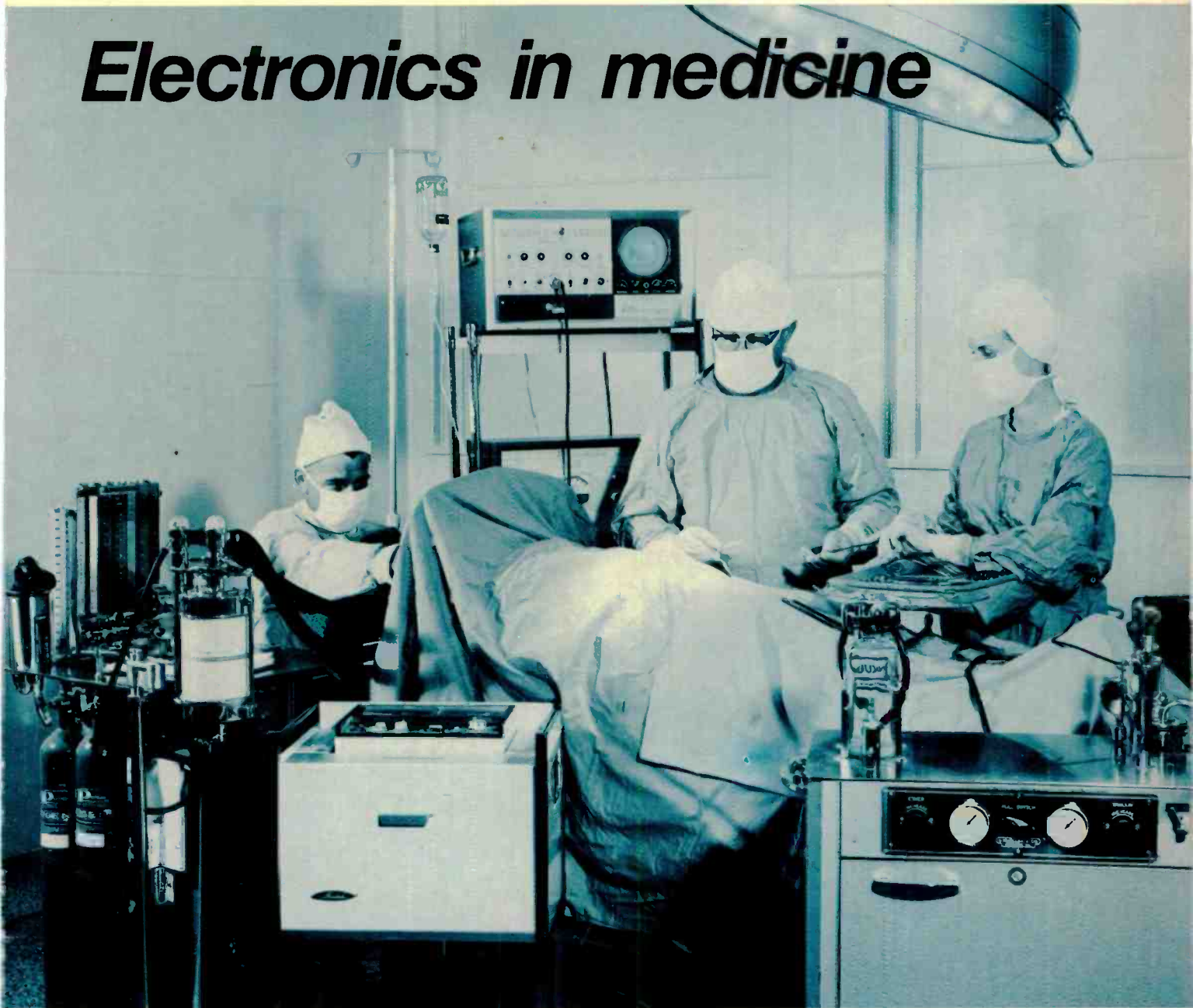
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Electronic Servicing



A HOWARD W. SAMS PUBLICATION

Electronics in medicine



**Servicing RCA AGC
Prevent Costly Callbacks
Faster TV Repairs**

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- INDIANA:**
PTS ELECTRONICS, INC.
P.O. BOX 272
BLOOMINGTON, IND. 47401
TEL. 812, 824-9331
- KANSAS:**
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PTS is proud to be the only tuner service to publish a **TUNER REPLACEMENT PARTS CATALOG** (80 pages of tuner blow-ups, tuner-antenna coil-and shaft replacement guides available for \$1.00).

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Tubes • Varactor • Detent UHF
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UV-COMBO 16.95
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over 4000 exact tuner replacements available for \$14.95 up (new or rebuilt)

for finer, faster,
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Send faulty unit with tubes, shields and all broken parts to

For More Details Circle (1) on Reply Card



IC replacement guide

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Electronic Servicing

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Second class postage paid at Shawnee Mission, Kansas and additional mailing offices. Published monthly by INTERTEC PUBLISHING CORP., 1014 Wyandotte St., Kansas City, Mo. 64105. Vol. 24, No. 2. Subscription rate \$6 per year in U.S., its possessions and Canada; other countries \$7 per year. Send Form 3579 to 9221 Quivira Road, Shawnee Mission, Ks. 66215.

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EDITORIAL
RONALD N. MERRELL, Director
CARL H. BABCOKE, Managing Editor
LESLEE ANDERSON, Editorial Assistant
WEBB G. STREIT, Graphic Designer

CONTRIBUTING AUTHORS
Lawrence Bowen
Joseph J. Carr
Wayne Lemons
Robert G. Amick

TECHNICAL CONSULTANT
JOE A. GROVES

EDITORIAL ADVISORY BOARD
LES NELSON, Chairman
Howard W. Sams & Co., Indianapolis

CIRCULATION
EVELYN ROGERS, Manager

ADVERTISING SALES
Kansas City, Missouri 64105
Tele: 913/888-4664
E. P. LANGAN, Director
R. J. HANCOCK, Manager
JAKE STOCKWELL
RON ROBINETTE
GREG GARRISON, Production

REGIONAL ADVERTISING SALES OFFICES
Indianapolis, Indiana 46280
ROY HENRY
2469 E. 98th St.
Tele: 317/846-7026

New York, New York 10017
STAN OSBORN
Room 1227
60 E. 42nd St.
Tele: 212/687-7240

Los Angeles, California 90005
MIKE KREITER
3600 Wilshire Blvd., Suite 1510
Tele: 213/383-1552

London W. C. 2, England
JOHN ASHCRAFT & CO.
12 Bear Street
Leicester Square
Tele: 930-0525

Amsterdam C. Holland
JOHN ASHCRAFT & CO.
W. J. M. Sanders, Mgr.
for Benelux & Germany
Herengracht 365
Tele: 020-240908

Tokyo, Japan
INTERNATIONAL MEDIA
REPRESENTATIVES LTD.
1, Shiba-Kotohiracho, Minatoku
Tele: 502-0656



ELECTRONIC SERVICING (with which is combined PF Reporter) is published monthly by Intertec Publishing Corp., 1014 Wyandotte Street, Kansas City, Missouri 64105.

Subscription Prices: 1 year — \$6.00, 2 years — \$10.00, 3 years — \$13.00, in the U.S.A. its possessions and Canada.

All other foreign countries: 1 year — \$7.00, 2 years — \$12.00, 3 years — \$18.00. Single copy 75c; back copies \$1. Adjustment necessitated by subscription termination at single copy rate.



Robert E. Hertel, Publisher

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"TV REPAIR" PROMOTION SUPPLEMENT —

ONE TV Repair Shop in your locality . . . will soon stand out head and shoulders above every other competitor in town. It could be YOU.

Want to know HOW? Very simply:

by using a regular series of clever, inexpensive 'column' ads in your local newspaper! You doubt it? Well . . .

. . . A TV shop in Maryland had to hire more help within 3 weeks after starting their series!

. . . A dealer in Montreal has had people come in from all over Canada, from his ads.

. . . An enterprising repair man in Louisiana has acquired 4 other places in his area from the surge of business that his series brought.

. . . Two cousins in a New England community attribute 75% of their business to these ads.

You can see their secret . . . adapt their method . . . improve your business . . . gain an immediate edge on competition . . . and develop a friendly, permanent clientele . . . by judiciously using the same inexpensive idea!

Our new folio—which we'd like you to try out for six months—is called "How to Double Your Business with Unique 'Column' Ads."

It shows how others have done it . . . replete with case histories.

It shows how you can do it, too.

It shows how and when, where and why—the whole fascinating story of this cheapest means of advertising . . . with most effective RESULTS! Here are ads that will attract attention—stimulate curiosity . . . arouse interest, amuse readers and make YOU known and remembered for quality service . . . integrity . . . dependability.

All at trivial cost!

Among the Advantages you will learn . . . how to create interest among prospects who never even knew you existed!

. . . how to influence people to switch over to your business or service!

. . . how to create excitement—even though your business seems dull and drab!

. . . how to get the most out of your promotional dollar (something most business men never learn!)

. . . how to get your customers to "work" for you!

. . . how to get fast action from a \$3 investment!

. . . how to keep interest sustained over an extended period!

. . . how to make people laugh . . . and agree with you . . . and seek to meet you personally!

. . . how to get maximum assistance without charge from the newspaper staff!

. . . how to develop continuing ideas!

And, above all —

A Special "TV REPAIR" PROMOTION SUPPLEMENT!

H. K. SIMON ADVERTISING

**BOX 236
HASTINGS-ON-HUDSON
NEW YORK 10706**

shows you:

. . . How to out-smart (instead of out-spend) the competition!
. . . Why most ads fail . . .

The ONE BIG SECRET of successful TV Repair advertising.

. . . The Greatest Compliment any ad can Pay You.

. . . The mistake that is made by 98 out of 100 local advertisers.

. . . 94 examples of enticing "come on in" copy (distilled from thousands).

. . . 26 Merchandising Ideas that you can adapt, to stimulate business.

. . . 37 Illustrations that enliven the ad, attract the eye.

Here are "Big Time" ideas at "small time" prices. Prepared by a \$25,000 copy group . . . but your cost is less than 40¢ per week!

You'll refer to this for years—every time you need copy to promote special occasions . . . or an idea for a layout . . . or an eye-catching border . . . or a good illustration!

You'll see how to establish your name as an outstanding source: as helpful . . . friendly . . . sincere . . . intelligent . . . courteous . . . dependable.

You'll see how to have people looking forward to your ads—wondering what you will say next!

You run very little risk, if you accept this opportunity—because we GUARANTEE that any one using these ideas six months or more who does NOT hear favorable comment—who does NOT think his own staff has been stimulated—who does NOT see direct results at lower cost—can simply say so, and we'll REFUND 100% of every penny you paid us!

We think this offer is unique. We dare to make it only because we KNOW this will prove profitable to you.

Who in your community will benefit by this? Will YOU? Better advise us at once.

Write or wire us TODAY. Use the handy blank below.

Suppose YOU spent 3 weeks with an advertising agency . . .

. . . developing a year's program for your business that would make you well known—give you a competitive edge . . . bring customers to your door . . . stimulate your sales . . . save wasted efforts an unproductive promotion.

Personal service, of course, is expensive. The ad agency's fee would be about \$2,000, plus your traveling and maintenance expenses.

But we have completed just such an intensive 3-week conference . . . and you may have the results for a tiny fraction of that cost!

Let me ask: how is your present ad program going—now? Was it prepared well in advance, by a "pro"? Or do you promote your services, catch-as-catch-can, when you can spare a moment?

The difference between the two methods can mean a doubling of your annual gross.

Perhaps you've always thought, "I can't afford a high-priced ad man."

But surely, you COULD afford him if he cost you only 40¢ a week!

And if that 40¢ weekly expense brought you \$7,500 a year—you couldn't afford to be without him!

"True", you say, "if it is so good as all that."

We think it is. But we want YOU to be the judge.

Try the ideas for the next six months. Then—6 months from now—if you don't expect to get back at least \$1,995 for your \$19.95 investment (a return of 100 to 1—or better) simply send it back for full refund.

Could anything be fairer?

Since there's no obligation, why not accept? Promotion-wise, I doubt if you'll EVER get another opportunity to equal it. But . . .

Better act TODAY. This offer may be withdrawn when our supply of copies run out. So write or wire NOW!

H. K. SIMON, Advertising Co.

Box 236, Dept. ES-44
Hastings-on-Hudson, N. Y. 10706

Kindly send "HOW TO DOUBLE YOUR BUSINESS WITH UNIQUE 'COLUMN' ADS" along with your "TV REPAIR" PROMOTION SUPPLEMENT to:

NAME _____

ADDRESS _____

CITY, STATE _____

ZIP _____

We enclose our check for \$19.95.

It is understood that if we use your ideas for six months or more and are not fully satisfied, every cent will be refunded.

REFERENCES: Any publication in the U.S.A. • Rated by Dun & Bradstreet

electronic scanner

news of the industry

If you want to record a message in noisy surroundings, such as a factory floor, then talk through your ears. Sound crazy? It's true according to Battelli Institute in Frankfurt, as reported in the *Kansas City Star*. After months of tests, German scientists discovered that a minimicrophone worn in the ear picks up less noise than a mike held close to the mouth. The principle is that when you talk some of the sound is carried through the skullbones to the ear. The scientists invited 15 men to use ear mikes in a busy airplane hangar. All recorded messages amid the racket, and each recording was completely free of background noise.

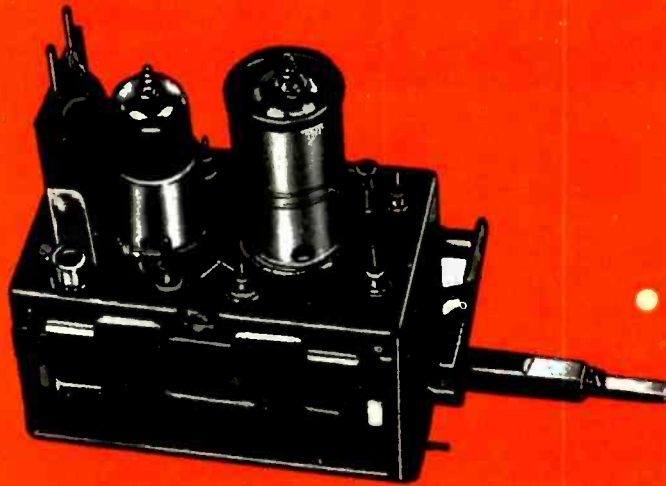
Grundig By Amerex Electronics, Inc. has announced what company officials believe to be the industry's first life-time guarantee covering transistors. The Grundig Life-Time Guarantee applies to all transistors in every Grundig product category for as long as that instrument is with its original owner. Labor is additional, unless covered by the original first-year free-labor warranty.

PTS Electronics, Inc. has formed a manufacturing division to develop and manufacture Tuner Analysts, Port-A-Tuners, and related electronic devices. The new facility will be located adjacent to the home office division in Bloomington, Indiana.

Major Electronics Corp. has acquired from National Union Electric Corp. the exclusive rights to manufacture and market home-electronics products under the Emerson brand name. According to *Merchandising Week*, the agreement with National Union limits Major's rights to the United States and Canada. The Emerson label will be used on all Major home-entertainment products including stereo components, phonographs, compacts, tape recorders and radios. Air conditioners and other appliances will continue to be produced and marketed by National Union through its Emerson Quiet Kool division.

A new idea for sending identical messages to a small, select group has been introduced by Tape Reproductions Corp. Instead of being dictated in the usual letter, the message is recorded on a cassette, permitting the executive or professional to express his own personality, placing emphasis where needed, and developing the story in much greater detail. The original cassette is then duplicated within 24 hours of receipt by Tape Reproductions. To speed the messages, each cassette will be mailed directly to the end user if a set of addressed labels or a mailing list is supplied with the original tape. Duplicate cassettes are available in lengths from fifteen minutes to two hours.

(Continued on page 6)



\$9.95

ALL PARTS INCLUDED
EXCEPT TUBES & TRANSISTORS

ONE YEAR GUARANTEE

TUNER SERVICE CORPORATION

PROVIDES YOU WITH A COMPLETE SERVICE FOR ALL YOUR TELEVISION TUNER REQUIREMENTS.

REPLACE

Universal Replacement Tuner **\$9.95** (In Canada \$14.95)

This price buys you a complete new tuner built specifically by **SARKES TARZIAN INC.** for this purpose.

All shafts have a maximum length of 10½" which can be cut to 1½".

Specify heater type parallel and series 450mA or 600mA.

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VHF Or UHF Any Type **\$9.95.**
UHF/VHF Combo **\$15.00.**

In this price all parts are included, tubes, transistors, diodes, and nuvistors are charged extra. This price does not cover mutilated tuners.

Fast efficient service at our conveniently located service centers.

All tuners ultrasonically cleaned, repaired, realigned and air tested.

CUSTOMIZE

Customized tuners are available at a cost of only **\$15.95;** (with trade-in **\$13.95**) (In Canada \$17.95/\$15.95)

Send in your original tuner for comparison purposes.



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	TOLEDO, OHIO 43624	119 North Erie Street.....	Tel. 419-243-6733
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FOR INFORMATION ON FRANCHISE, CONTACT HEADQUARTERS

February, 1974/ELECTRONIC SERVICING 5

In the past, most picture tubes were designed for operation without X-radiation danger up to 25 KV. Now, at least two models of TV chassis generate up to 30 KV, and special glasses are used in the picture tube to minimize any radiation. If you operate one of these chassis on your test jig, you don't have the protection. We recommend the test tube in each jig be exchanged for one of this new type.

RCF Development is seeking licensees for a new television projection system which uses no phosphors, according to Home Furnishings Daily. Invented and patented by Edgar Price, the system features a bundle of optic fibers arranged in a straight line to project the TV image onto a rotating prism. The prism scans the image, which is then projected to a screen. Color and brightness are said to be improved by the elimination of phosphors. The system operates by using lower voltages, with reduced radiation problems. Modulated Optical Fibers, Inc. has been formed to handle sales and licensing.

The Consumer Product Safety Commission intends to develop safety rules covering portable television sets. It is asking for information on television danger potentials and will give public notice of hearings to develop safety standards. According to **Home Furnishings Daily**, nearly 100,000 sets in the past few months have been found by the commission to pose potential fire and shock hazards. There is "a problem of pretty good size" with the TV sets said Commission Chairman Richard O. Simpson, but the CPSC has not determined what all the problems are. Simpson warned manufacturers and retailers that failure to report product hazards found in factory or store could result in severe legal and civil penalties. During the past year, CPSC field offices have surveyed fire marshalls in three counties in each of their areas for cases where television was the suspected cause of fires. Simpson stated that the regional offices produced 914 reports of suspected TV-related fires in 42 inquiries. "I think we have enough evidence to be persuasive," he said.

Montgomery Ward is recalling 52,000 of its Airline-brand 23-inch color consoles and TV/stereo combinations. A company spokesman said they might have circuit defects that "under a combination of circumstances could create an electrical shock hazard." Most of the potentially-defective sets were sold in the fall of 1969, but only recently was it discovered that some models were missing a resistor. Montgomery Ward has not received any field reports of consumers suffering electric shocks.

**Here's everything
you'd expect from a high-priced
signal generator.**

Except a high price.

Our new B&K Model 2050 Solid-state RF Signal Generator has features other companies charge much more for. Look at our specs: 100% Solid-state silicon circuitry with FET's in RF and audio oscillator stages. 6 bands with 1.5% accuracy from 100 kHz to 30 MHz. 3 outputs: RF, modulated RF (400 Hz), and externally modulated RF. Positive anti-backlash dial drive. Zener-regulated power supply. You needn't pay high prices for versatility, accuracy and reliability—now there's the Model 2050. And that's just what you'd expect from B&K.

Contact your distributor, or write Dynascan Corporation.

\$99⁹⁵



B&K Very good equipment at a very good price.
Dynascan Corporation.
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

**Here's everything
you'd expect from a high-priced
Hi-Low FET multimeter.**

Except a high price.

Introducing the B&K Model 290 solid-state FET Multimeter. Just by glancing at its specs, you can tell that the 290 is capable of more applications than any other multimeter in its class. 75 ranges. Hi-Lo power ohms ranges (low power only 33 mV). 15 megohms input impedance. A large 7" meter. 50 mV to 1500V full-scale sensitivity on both AC and DC. 50 micro-amp current range. Rx0.1 ohm range with 1 ohm center scale lets you measure low resistance down to .01 ohm. Circuit provides automatic overload protection with fuses and spark gaps. More multimeter for your money—that's

just what you expect from B&K.

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Model 290 Hi-Low FET Multimeter including Model PR-21 Probe:

\$139⁹⁵



B&K Very good equipment at a very good price.
Dynascan Corporation.
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

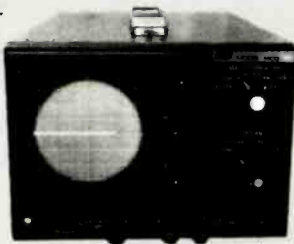
**You'd probably expect a
portable oscilloscope as rugged and
reliable as this one to cost a lot.**

You'd be wrong.

Introducing the B&K Model 1403 3" Solid-state oscilloscope. It's so compact, reliable, and inexpensive that it's the perfect scope for most on-the-line monitoring applications. Look at its specs: DC to 2MHz bandwidth at 20mV/cm. Recurrent sweep speeds from 10Hz to 100KHz. New wide-angle CRT to reduce case depth to a minimum. Direct-deflection terminals for waveforms up to 150 MHz. Weighs only 8½ pounds. And has a smoked acrylic graticule for trace sharpness and easy reading. All the reliability and accuracy you need in a monitor scope—at a surprisingly low price.

Contact your distributor, or write Dynascan Corporation.

\$179⁹⁵



B&K Very good equipment at a very good price.
Dynascan Corporation.
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

**Introducing the
expensive digital
multimeter that
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The B&K Precision Model 281.

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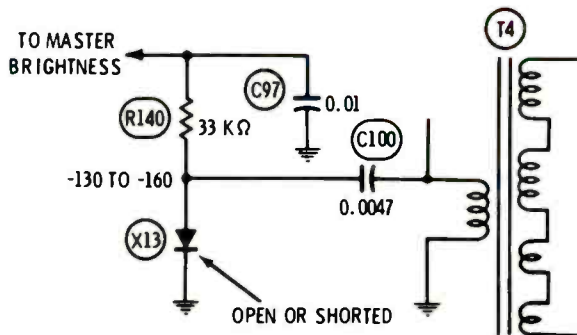
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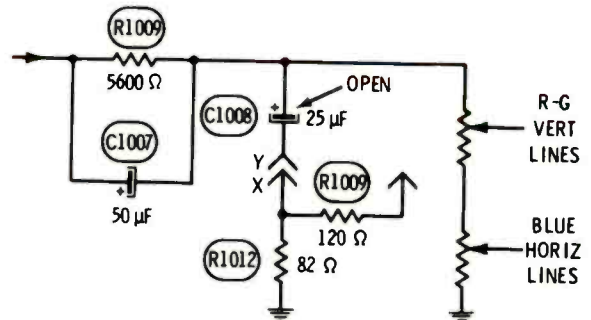
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Chassis—Admiral K16
PHOTOFACT—1204-1



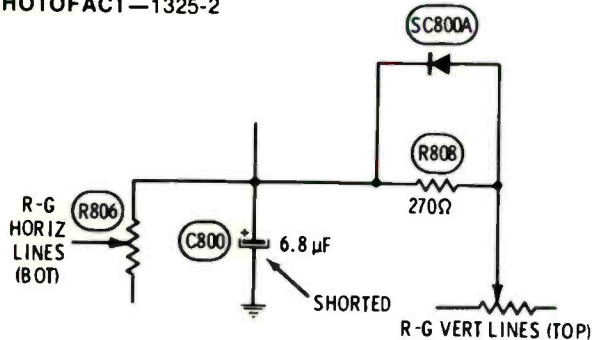
Symptom—No control of brightness
Cure—Check X13 diode, and replace if it is open or shorted

Chassis—Admiral K19
PHOTOFACT—1358-1



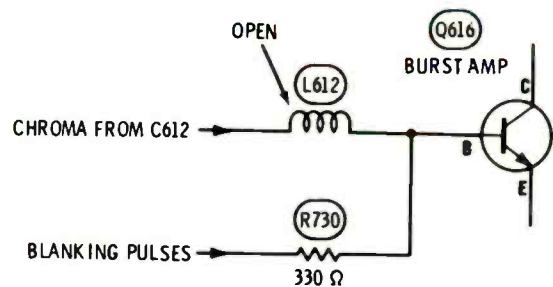
Symptom—Insufficient height at bottom, and poor R-G convergence
Cure—Check C1008 on convergence board, and replace if it is open

Chassis—Sylvania D16
PHOTOFACT—1325-2



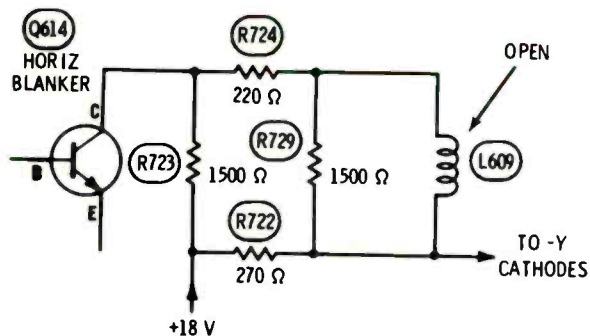
Symptom—Poor convergence of R-G vertical lines
Cure—Check C800 on convergence board, and replace if it is open

Chassis—Sylvania D16
PHOTOFACT—1325-2



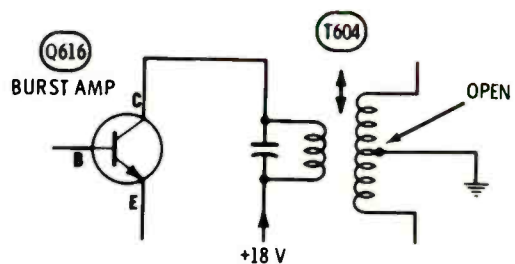
Symptom—No color locking
Cure—Check L612, and replace if it is open

Chassis—Sylvania D16
PHOTOFACT—1325-2



Symptom—Low brightness
Cure—Check L609 in the blanker circuit, and replace if it is open

Chassis—Sylvania D16
PHOTOFACT—1325-2



Symptom—No color locking
Cure—Check burst transformer T604, and replace if it has an open secondary

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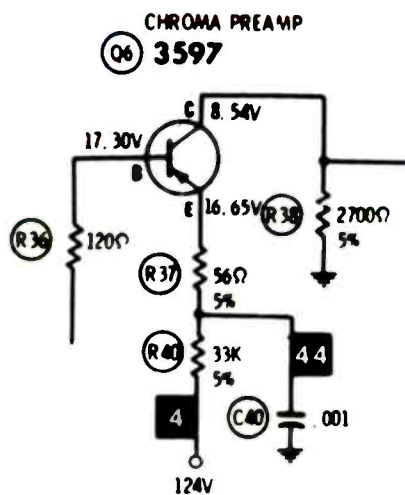
RCA Solid State



SK

No video RCA CTC51 color TV chassis (Photofact 1209-3)

No video information could be seen on the screen, and a higher setting of the color control produced only a small change of picture quality.



These symptoms indicated a defect in a video stage. When I signal traced with the scope, I found no signal at the grid of the video-output tube, V6, but a good signal at the base of Q6, chroma pre-amp transistor. In-circuit tests of the transistor indicated it was bad, and replacement brought back a picture.

However, the value of R37 measured about 20K instead of the rated 33K. Perhaps this was the reason for the failure of the transistor. After the transistor and resistor were replaced, both color and b-w were perfect.

Joseph Rotello, Jr.
Tucson, Arizona

Service hint All chassis

To remove or reinstall those "hard-to-get-at" screws without dropping them in the chassis, use

beeswax in socket of the nutdriver or on point of the screwdriver.

Of course, you could use magnetized tools to do the same job. But the wax and ordinary tools avoid problems around critical areas, such as color picture tubes and technician's watches.

Beeswax can be purchased in large cakes that last indefinitely from many hardware stores.

Ken Barton, CET
Columbus, Ohio

Bend at the top of the picture Zenith b-w chassis 14L36 (Photofact 707-4)

This was a real "tough dog" repair. The bending of the picture resembled that caused by poor sync, and was worse at the top. Adjustments of the horizontal hold control could not correct it.

First, I disconnected C50, which is between the AFC tube and the oscillator tube, and adjusted for the nearest locking. As the picture floated by, I could see there was no bend; the sides were straight. This indicated the trouble was in the AFC stage and not in the oscillator or sweep circuit.

I reconnected C50 and checked or replaced all of the parts in the AFC circuit, including the duodiode, but found nothing wrong.

Finally, when R75 and R72 were disconnected, I found a 15-megohm reading from C48 to ground. This is the point where C42 is supposed to feed in a small amount of parabolic waveform to straighten up the vertical lines of the picture. And that was a clue!

By disconnecting parts, I was able to trace the 15-megohm leakage back to pin 4 of the 6FM7 vertical tube. Pin 4 is not connected internally to any tube elements, and is used as a tiepoint for C42. When I removed the vertical tube from its socket, the leakage was gone. A new vertical tube removed the picture bending.

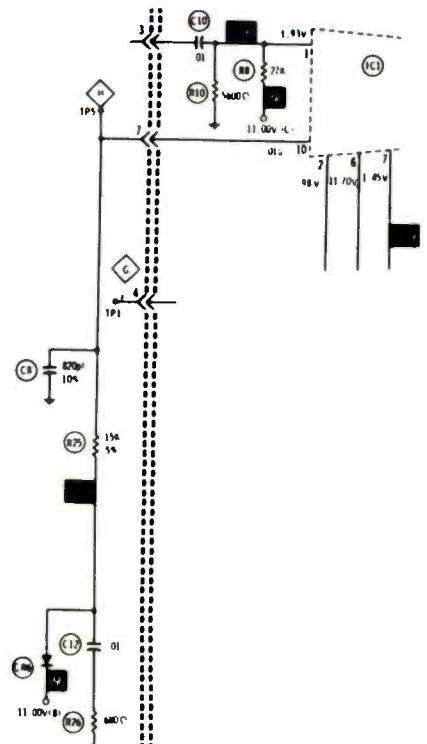
Apparently, the unused pin 4 was leaking inside the tube either to the grid pin 3 or the plate pin 5, and the leakage was feeding some of the trapezoidal waveform to the horizontal oscillator and the horizontal AFC stage.

Arthur T. Linck
Baltimore, Maryland

No color RCA CTC59 color TV chassis (Photofact 1275-3)

Replacement of Chroma 1, Chroma 2 and Pix-IF/AFT modules failed to bring back the color.

After spending some time checking, I found CR6 was shorted. CR5 and CR6 are a matched pair and should be replaced with RCA stock



number 125528, or an exact substitute.

Bill Duaine
Oconto, Wisconsin

Imported b-w TV receivers Several brands

Many of the small imported b-w receivers, that reach the shop with

no high voltage because the horizontal oscillator is dead, are found to have a defective polystyrene-insulated capacitor. Also, in most cases, these capacitors were physically located very near a hot tube.

We suggest you locate visually any such capacitors and check them first to prevent wasted time.

Joseph Rotello, Jr.
Tucson, Arizona

Cure for blooming RCA CTC12A chassis

(Photofact 640-3)

This chassis showed a bad case of blooming, defocusing and slightly narrowing on the left side of the raster, especially when the background was blue, as in newscasts. It appeared to be classical regulator trouble, but changing all HV tubes and checking voltages and components, including the video amp, gave no cure or clue. Later, I noticed the blue-red Y amp tube (V22) was sparking between elements and I changed the tube. The trouble was cured. Possibly, blooming mainly on a blue background should have been a clue.

R. Stanley
Philadelphia, Pa.

No picture, no sound RCA CTC48 chassis

(Photofact 1300-2)

This color set was brought in because it would not turn on. The triac was jumped as the RCA literature suggested, and an audible hum was evident. Neither picture nor raster showed signs of an open filter; sound was the only clue. The problem proved to be an open filter capacitor in the remote power supply.

Richard Castanie, CET
Grand Rapids, Michigan

Got A Troubleshooting Tip?

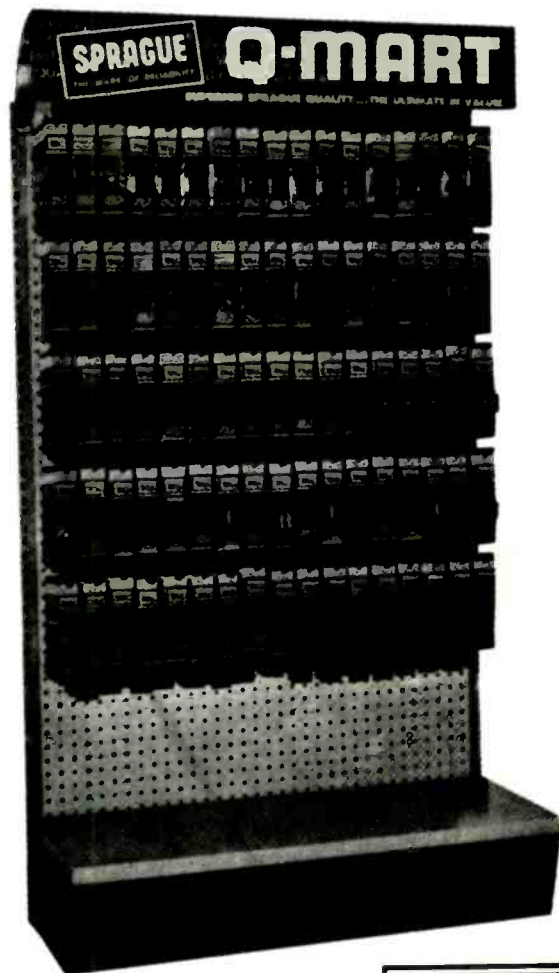
If you've recently run across an unusual trouble symptom, send a thorough description of it and the solution to:

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5095 Sandy Ave. SE
Canton, Ohio 44707

Needed: Schematic for a "Knight Laboratory O'Scope" (plug in vertical section). No model number.

H. Stuhler
55 Blenheim Road
Englishtown, New Jersey 07726

Needed: Schematic and manual for an old Supreme 385 automatic tube tester.

Justo C. Goitia
80 Hato Viejo Buzon 620
Arecibo, Puerto Rico 00612

Needed: Schematic for RCA model T62 all-wave receiver.

Kevin M. Quinn
924 Wadsworth St.
Syracuse, New York 13208

Needed: One Tannoy 12-inch dual-concentric speaker with crossover network. Must be the older 16-ohm model.

T. J. Jones
4915 Sierra Madre
San Antonio, Texas 78233

Needed: Addresses for Crystal Corp. and Microdek Co., makers of radiation testers for micro-wave ovens.

A. J. Edwards
Royal Oaks Park Space 3
18145 Soledad Canyon
Canyon Country, Calif. 91351

Needed: Viking/Telex model 88 RMQ tape deck for parts. Request price and description of condition.

M. Deflorio, Jr.
Suffolf Audio Systems
350 Brookville Ave.
Islip, New York 11751

Needed: Power transformer, part number P101-S1 for a Fliteway radio manufactured by Multitech International Corp. of Japan.

C. F. Kegley
202 N. Bridge St.
Bedford, Va. 24523

Needed: Power transformer for 1936 Grunow radio, chassis 12B, 5Z3 rectifier.

Guy's Radio-TV
Winfield, Iowa 52659

Needed: Schematic and parts list for the construction of a theremin.

Joe's Radio and TV
65 Plainfield Ave.
Shrewsbury, Mass. 01545

Needed: Schematic for Atwater Kent model 84 super-hetrodyne.

Claud Brasher
108 W. Main Cross St.
Greenville, Ky. 42345

Needed: Schematic for an Ampeg J12 amplifier or location of distributor or manufacturer.

M. Ohringer
11 Morningside
Westbury, New York 11590

Needed: Schematic and service manual for Superior Instruments Co. model 77 VTVM. Will pay reasonable price.

Paul L. Marcum
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For Sale: Sencore model SS137 Sweep-Circuit Analyzer, fairly new. Make offer or trade for a Heathkit scope.

Barnet Toyen
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Wanted: Books on TV Tuner Servicing, either "TUN-1 Practical TV Tuner Repairs" by Robert Middleton or "STD-1 Servicing TV Tuners" by Jesse Dines, or both.

D. R. Sterling
P.O. Box 162
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Wanted: Coils for Heathkit grid-dip meter model GD-1B. Also Heathkit impedance meter kit model AM-1.

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(Continued on page 43)

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GENERAL  ELECTRIC

ELECTRONICS... Medicine's Liveliest Helper

By Joseph J. Carr, CET

Both electronic technology and electronic equipment have been drafted into the day-by-day practice of medicine to such an amazing extent that many hospitals now employ staff electronic technicians. In some cases (such as at Massachusetts General in Boston, George Washington University Hospital in Washington, D. C., and the University of Kansas in Kansas City) hospitals have established large bio-electronics laboratories or medical engineering facilities staffed with both electronic engineers and assisting technicians. We might expect this in the huge medical complexes, but even in clinics or smaller hospitals, an impressive array of electronic/

medical equipment is in constant use by physician/nurse teams to collect, display, and store vital data about the patient's condition. Modern medicine would be seriously crippled without the assistance of electronics. This detailed report is presented to inform those of you who might intend to service such equipment, and to be interesting to the rest of us.

Electrical Signals Of The Heart

A simplified drawing of the human heart is shown in Figure 1. Pulses from the brain travel through the nervous system to a small electrochemical digital clock called

the SinoAtrial (SA) node. Output pulses from the SA node spread through the atria starting the initial contraction of the heart muscle. The spreading pulses travel down the conduction system and energize another node called the Atrio-Ventricular (AV) node.

From the AV node the pulses pass through a structure called the Bundle of His to the Right and Left Bundle Branches and the Purkinje Fibers located in the ventricular region of the heart. Notice that these pulses and the contractions they produce do not occur simultaneously, but in succession. Truly a marvel of electronic engineering carried out biochemically!

Another important point is that the electrical signals described so far are **not** the ones normally viewed on the medical "test equipment".

Muscle electricity

Each individual cell of the heart muscles is actually a sodium-potassium battery, with the inside negative and the outside positive. When the muscles are energized,

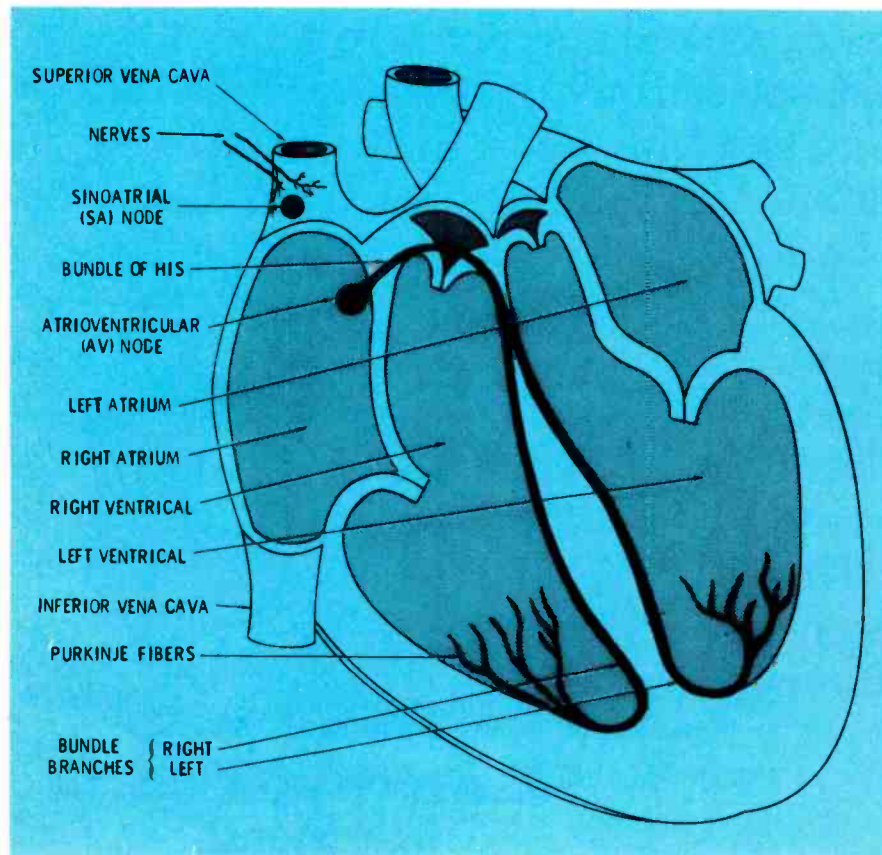


Fig. 1 Simplified drawing of the electrical-conduction system of the human heart.

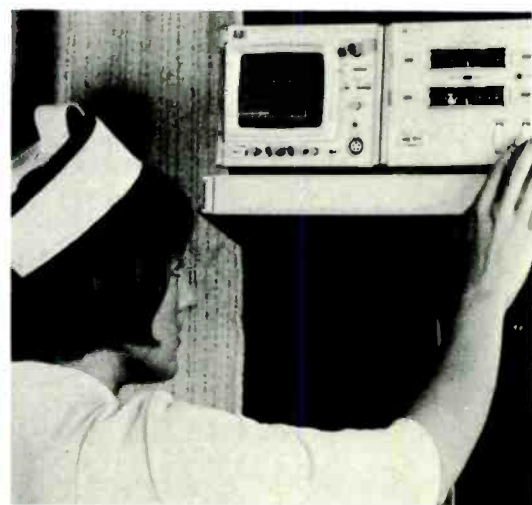
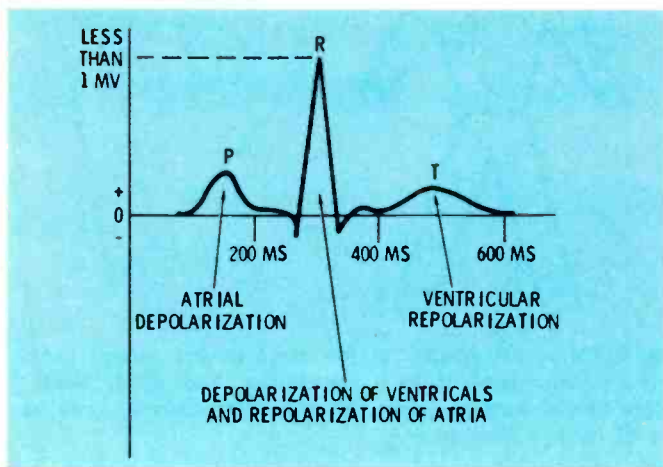


Fig. 2 Both ECG and blood-pressure waveforms are displayed at bedside on a dual-beam oscilloscope. Meters provide numerical readout. (Courtesy of Hewlett-Packard)

Fig. 3 Electrical heart waveforms.



(A) Drawing showing the elapsed time, and which heart actions supply the various areas of the waveform.



(B) Sample of an actual ECG waveform on paper tape from a strip-chart recorder.

the cells go through a depolarization-repolarization cycle producing an electrical signal powerful enough (because of the many cells) to be measured even at the surface of the skin. These voltages can be picked up by conductive pads placed on the body, amplified, and then displayed on an Electrocardiograph (Figure 2). The word is so long it's usually shortened to ECG, or perhaps to EKG after the German spelling of Kardio. More about ECGs later.

Heart waveforms

An amplitude-time waveform of typical heart voltages is charted in Figure 3, along with an actual sample of a paper record from an ECG machine. Each complete waveform is about 600 milliseconds in duration, with an amplitude (at the electrodes) of about 1 millivolt.

To expedite communication, medical people have assigned a series of alphabetical letters to the different portions of the waveform. The section marked P is the result of the depolarization of the atrial cells. The QRS section (called the QRS complex) is a sharp spike resulting from the repolarization of the atria, which occurs simultaneously with the depolarization of the ventricular cells. Repolarization of the ventricles generates the T-wave. Some patients have a low-amplitude hump called the U-wave following the T-wave.

Because the action producing

each portion of the heart waveform is known and understood, doctors can examine the waveform to determine if the heart is normal, and often they can analyze what is wrong with an abnormal one.

Electronically, the analysis is quite different. We are dealing in complex waveforms having fundamentals and various harmonics, and requiring certain equipment performance for satisfactory operation.

If the pulse rate is 60 beats-per-minute, the fundamental of the ECG waveform is 1 Hertz, and the significant harmonics all are below 100 Hertz. This is fortunate in one way, and a disadvantage in another.

First, by using a simple 100-Hz low-pass filter, we can eliminate most of the "artifacts" (undesired additions to the waveform) of local electrical interference as well as the high frequencies of signals generated by other muscles.

On the other hand, the 60-Hz power frequency is right in the center of the desired band of frequencies. A filter designed to reduce 60 Hz has a tendency also to change the desired waveform, and this is not wanted. Such filters should not be used unless they are absolutely necessary.

ECG design features

Because of the extremely low amplitude of voltage measured at the skin of a patient (less than 1 MV), the input stages of ECG

machines present design problems not present in TV or Hi-Fi equipment. High gain is required, typically more than 60 dB.

If you have ever touched a finger to the probe of a scope and noticed the large distorted sine wave obtained, you can appreciate the huge amount of hum picked up by both the unshielded ECG cables and the patient's body. The 60-Hz hum signal of several volts would completely obliterate the tiny 1-MV heart signal, and a filter of sufficient attenuation to remove the hum would also remove too much of the waveform. Solution of the problem is made possible by the normal use of multiple inputs to the ECG machine.

As shown in Figure 4, heart signals enter the ECG in what we might term push-pull fashion to the "inverting" and "non-inverting" inputs. Inside the IC, both the signals are paralleled. Therefore, there is no output signal when there is no input signal, or when the same signal is applied to both inputs.

But suppose the heart signal applied to the inverting input was positive-going. At the output of the IC, the signal would be negative-going. At the same time, the signal to the non-inverting input would be negative-going. After amplification, the IC output signal would still be negative-going, and there would be a signal. Of course, a heart waveform of opposite polarity would

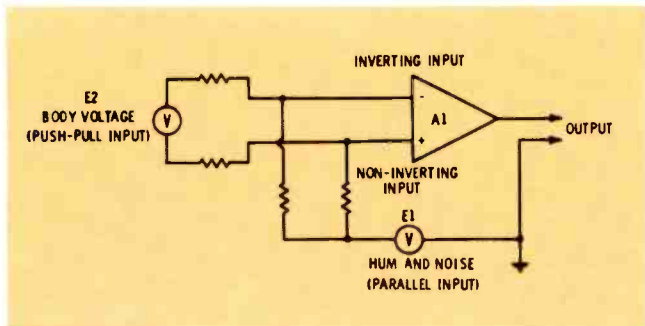


Fig. 4 Illustration of how hum and noise are cancelled in the differential amplifier of the IC, yet the wanted signal receives full amplification.

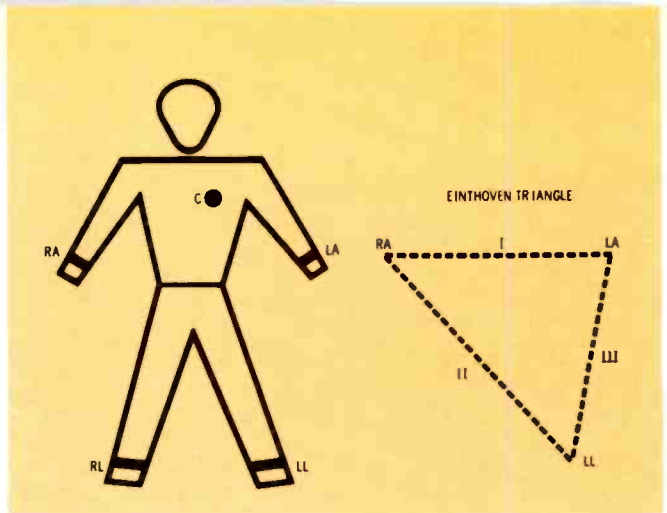


Fig. 5 Placement points for the wires of the patient cable when taking standard ECG waveforms. The word "leads" refers to the voltage drops between these points, such as the Einthoven Triangle.

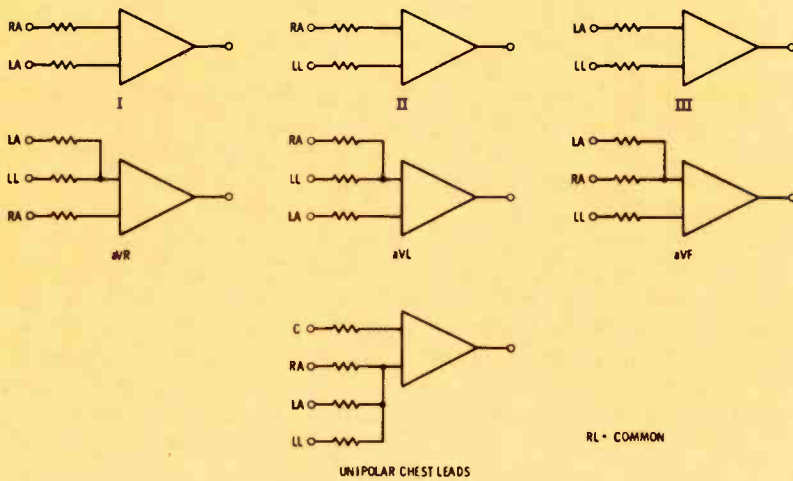
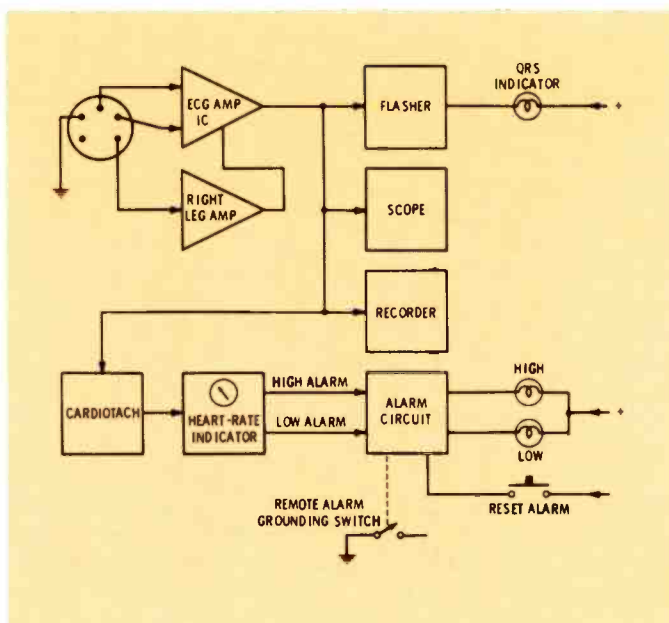


Fig. 6 Different connections of the wires for the "leads" shown.

Fig. 7 Block diagram of a heart-rate meter, including an ECG pre-amplifier.



cause a positive-going output from the IC.

Any unwanted signals coming with the same phase into both inputs are cancelled by the internal inversion. This is called common-mode rejection, and it is usually stated in decibels.

Sufficient common-mode rejection can be obtained only by near-perfect balance of gain inside the IC, or a design that includes a control for achieving balance. If all else fails, a 60-Hz notch filter is switched in.

ECG inputs

A typical ECG system includes up to five input wires connected to a selector switch, so the voltage drop across different portions of the body (cardiologists call them "leads") can be obtained.

Basic connections for the five input wires of the patient cable are shown in Figure 5. The right leg is used as the common point. "Einthoven Triangle" connections are made to the right arm (RA), left arm (LA) and left leg (LL).

Commonly used ECG "leads" are diagrammed in Figure 6. These are the unipolar limb leads (designated I, II, III), the unipolar chest lead, and the augmented limb leads (aVL, aVF and aVR).

Waveforms for a quick look, or for monitoring for hours, are displayed on a cathode ray tube, very similar to the one in a service scope. Heart waveforms for permanent records are preserved by the type of ECG that uses either an ink pen or a heated stylus (which writes on special paraffin-based paper) to



Fig. 8 Top view of the Model 7807C Hewlett-Packard heart-rate meter. The meter on front has a long, horizontal, analog scale. Complexity of the circuit is shown by the several plug-in circuit boards.

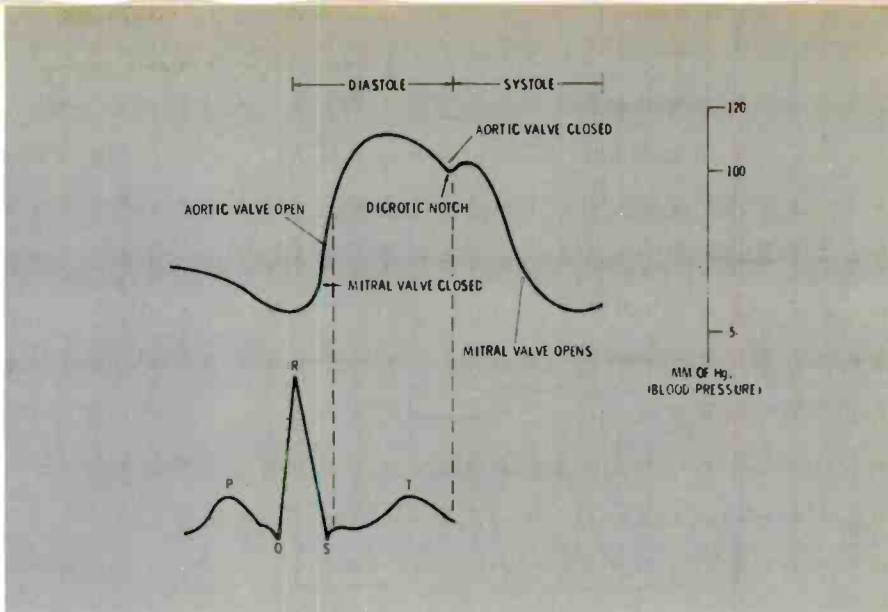


Fig. 9 Drawing of blood-pressure waveform, showing the timing relative to the ECG signal.

scribe the waveform onto special graph paper that moves through the machine.

Patient Measuring Equipment

Seriously-ill heart patients often must be constantly monitored for heart waveform and pulse rate. This kind of equipment (Figure 7) starts out with a ECG-type differential amplifier which drives these individual instruments:

- a heart-beat meter called a cardio-tach,
- a QRS (heart beat) flasher, and
- a heart-waveform scope.

The QRS flasher is a panel lamp which flashes with each heart beat, and it is convenient for across-the-room monitoring.

All cardio-tach circuits do not use the same principles, but all create a DC voltage that is proportional to the repetition rate of the heart beat. Then the DC voltage either drives a conventional analog meter (Figure 8) or a digital voltmeter calibrated to read in "beats-per-minute". The usual scale is 0-300 BPM.

Because both rapid heart rate (tachycardia) and slow heart rate (bradycardia) can indicate severe medical problems requiring immediate attention, there are alarm circuits for both high and low readings.

For example, in the Hewlett-Packard 7807 series, the alarm is actuated by high and low vanes attached to the meter movement. These vanes follow the pointer so

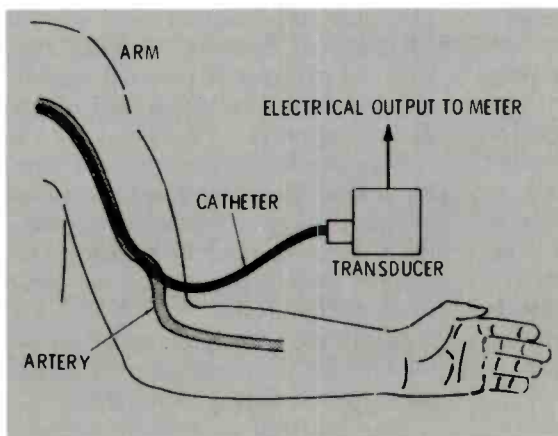


Fig. 10 Continuous measurement of blood pressure is by a catheter inserted by a doctor into the artery of an arm. Pressure of the saline solution in the end of the catheter follows the variations of blood pressure. Then the saline pressure unbalances a bridge to provide an output electrical signal.



Fig. 11 Portable electronic thermometer (IVAC Model 811) uses a thermister inside a disposable tip. The thermister is in a bridge circuit, and any unbalance is displayed by the digital readout. (Courtesy of IVAC Corp.)

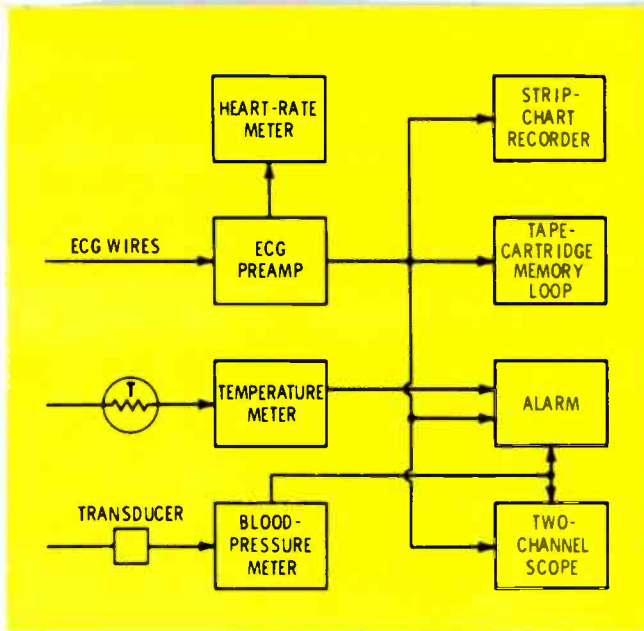


Fig. 12 Block diagram of a typical patient-monitor system.

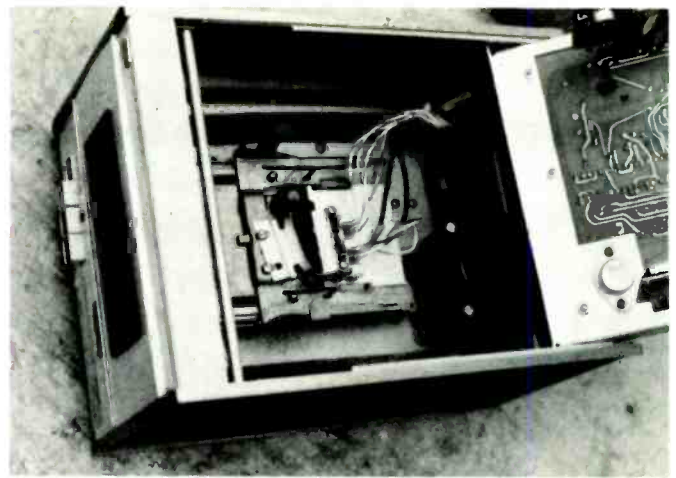


Fig. 13 Top view of the Hewlett-Packard Model 7805 showing the tape mechanism giving ten seconds of ECG waveforms.

they keep a photocell in the dark when the heart rate is within the limits set by a pair of subsidiary pointers on the meter face (these can be manually adjusted as desired). When the heart rate exceeds these presets, the photocell is blinded by the vane, causing a change of resistance which can trigger a SCR used as a switch.

In other cases, the heart rate is indicated by a special left-justified trace on the lower channel of a dual-trace scope.

Blood-Pressure Monitors

A drawing of the waveform of blood pressure during each heart beat is shown in Figure 9. As the aortic valve opens at the beginning of diastole, the arterial pressure begins rising to a peak, and then falls slightly. The dicrotic notch marks both the point where the aortic valve is fully closed and the beginning of systole. The peak following the onset of systole is lower than the diastolic peak. "Blood pressure" usually is expressed as a ratio of diastolic to systolic (that is, 120/80, or whatever). Also shown is the timing of the blood-pressure curve relative to the ECG waveform.

When blood-pressure readings are taken manually, the doctor or nurse wraps an occluding tourniquet around the upper arm and pumps up the pressure until the flow of blood is cut off. Then the operator listens with stethoscope placed over an artery for the ap-

pearance and disappearance of the "Korotkoff Sounds" during the time the pressure is released gradually from the tourniquet and blood flow is resumed.

This mechanical method is fine for taking blood pressure occasionally, but is not efficient for recording a large number of pressures in a short period of time, or for continuous monitoring.

Electronic principles make possible continuous readings plus blood pressure waveforms for analysis.

One method requires a saline-filled catheter to be inserted into an artery (Figure 10); the rise and fall of the saline pressure is in step with that of the blood pressure. In the pressure transducer, the saline pressure wave presses against a flexible membrane which in turn drives either a resistive or an inductive strain gauge. Some machines, such as the Statham models, have the resistive element as part of a Wheatstone Bridge built into the transducer. In others, notably the Hewlett-Packard 1280 series, the inductances in the transducer are matched with resistors in the blood-pressure monitor to form an AC bridge.

Regardless of the pressure-to-voltage interface method, all monitors use an amplifier to increase the signal to about the 1-volt level needed to drive a scope.

Special analog computer circuitry converts the pressure levels into DC voltages corresponding to diastolic and systolic pressures. A third com-

puter circuit reads out the mean blood pressure, which is defined as the systolic pressure plus one-third the difference between systolic and diastolic.

Temperature Monitors

Taking a patient's temperature is done more often than any other medical test. By the traditional method, the temperature is measured with a mercury-filled glass thermometer placed under the tongue or in the rectum. There are several drawbacks to this, such as the possibility of glass breakage, difficulty in reading markings on the glass, and the disinfecting which must be done before each use of the thermometer.

These shortcomings are eliminated (for a price) by the design of electronic thermometers (Figure 11). Portable units for use with many patients have oral probes with sanitary disposable plastic covers. Inside each probe is a thermistor connected by wires to a Wheatstone Bridge located in the main unit. Electronic thermometers used for continuous monitoring are fitted with a rectal probe. In both machines, the output signal from the bridge is amplified and then displayed either on an analog meter or a digital readout.

Patient-Monitoring Systems

Several individual instruments often are mounted in one cabinet (Figure 12 block diagram) for use at bedside or in the operating room

(OR). Usually the ECG waveforms and the arterial blood pressure are displayed on a two-channel scope.

Alternately, four-, six- or eight-channel scopes are available so that venous pressure or other ECG leads can be monitored. Heart rate, the respective blood-pressure levels, and temperature are read out from either analog or digital panel meters.

Endless-loop tape recorder

The heart activity in the ten seconds prior to a heart attack is of greatest interest to a doctor. Of course, it's possible to operate a strip-chart recorder constantly, but the expense and trouble of storing all that paper make this impractical. There is an ingenious solution by the use of a ten-second tape recorder (Figure 13).

In the Constant-Care Unit (CCU) when the onset of a heart attack seems likely, the ECG is wired to feed an endless-loop tape recorder. This recorder runs continuously, recording the ECG waveforms on tape, and retaining it for ten seconds before re-recording. At any given time, ten seconds of ECG signals are on the tape.

Suppose the automatic high or low heart-rate alarm sounds, indicating a heart attack. The tape machine stops recording and turns on a paper-strip-chart recorder. Now the doctor has all the data he

needs, for the tape machine has the last ten seconds of ECG signal just prior to the attack, and the paper-strip recorder has the waveforms following the attack.

Other Monitoring Systems

Typical of patient-monitoring systems is the General Electric central station shown in Figure 14. It is the usual practice to have a set of instruments at each bedside and another set remotely connected at the central station. In this way the nurses can very effectively monitor at once the condition of several patients.

Figure 15 shows a rack-mounted central station built by Sanborn (predecessor of Hewlett-Packard Medical Electronics Division) that is used in the control room of the operating room suite in a large hospital. At the left is an eight-channel scope, coupled to the gating amplifier (below the scope) which acts as an electronic switch to time the scope presentation. The scope phosphor is a blue long-persistence P-7 type.

In the middle rack are mostly signal conditioners and preamplifiers tied to the input lines from the various operating rooms. At the top of the center rack is a multiple readout device that displays heart rate, blood pressures, etc. in numerical form.

Almost out of the picture on the

right is a fourteen-track instrumentation tape recorder using one-inch tape. This machine converts the low-frequency ECG waveforms or blood-pressure waveforms to a higher audio frequency (usually the waveform frequency modulates an audio carrier) for recording onto the tape.

This system allows the monitoring and recording of ECG, EEG (brain waves), and pressures from patients in several operating rooms and in the Post Anesthesia Recovery Room (PARR). Day-to-day operation of the instruments and the collection of data records are functions of an instrumentation nurse and a staff of several monitor technicians. An electronics technician is responsible for maintenance of the instruments, and it is necessary that he work closely with the medical people who use the system daily.

ET's In A Hospital Environment

As you might imagine, an electronic technician repairing equipment in a hospital is in a strange, different world.

For example, if a breakdown occurs in the OR, you will have to dress in the appropriate green or blue surgical garb (scrub suits) before entering. In fact, you will come into contact with any number of little rules, for which you won't see

(Continued on page 56)

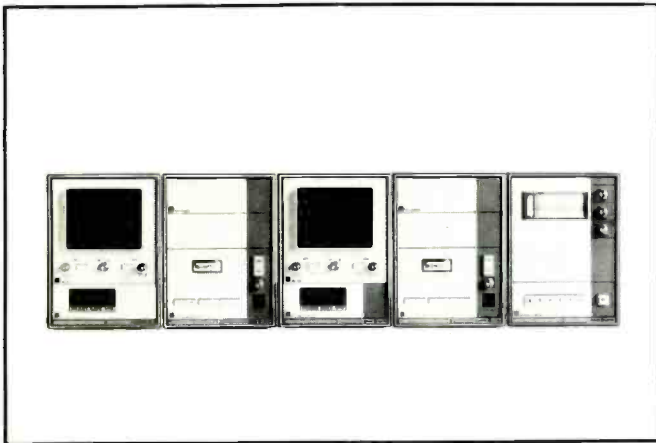


Fig. 14 This General Electric remote console allows one nurse to monitor the condition of several patients. (Courtesy of General Electric Co.)

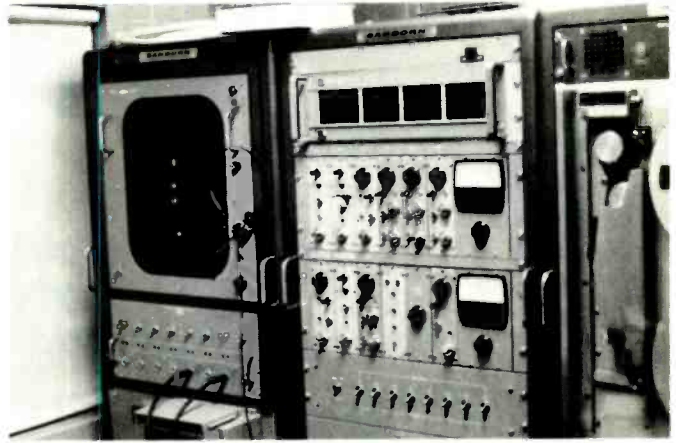
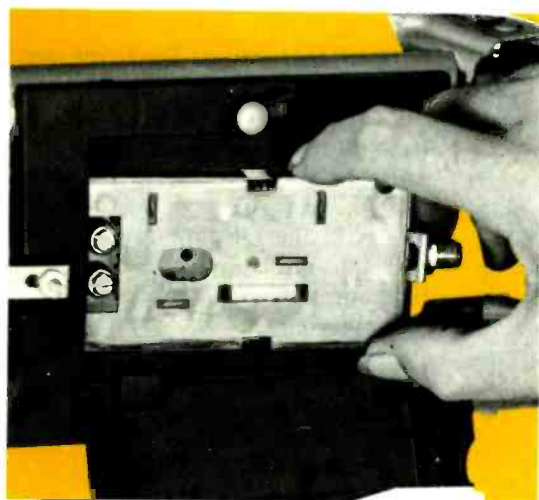
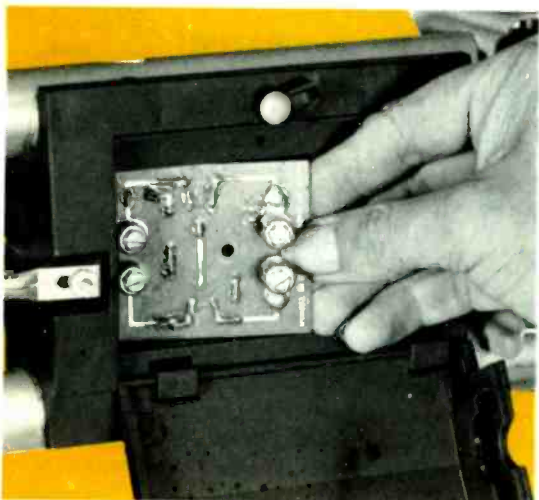


Fig. 15 Control-room instrumentation in the operating complex of George Washington University Hospital can monitor up to eight parameters, or the same parameter of eight different patients.

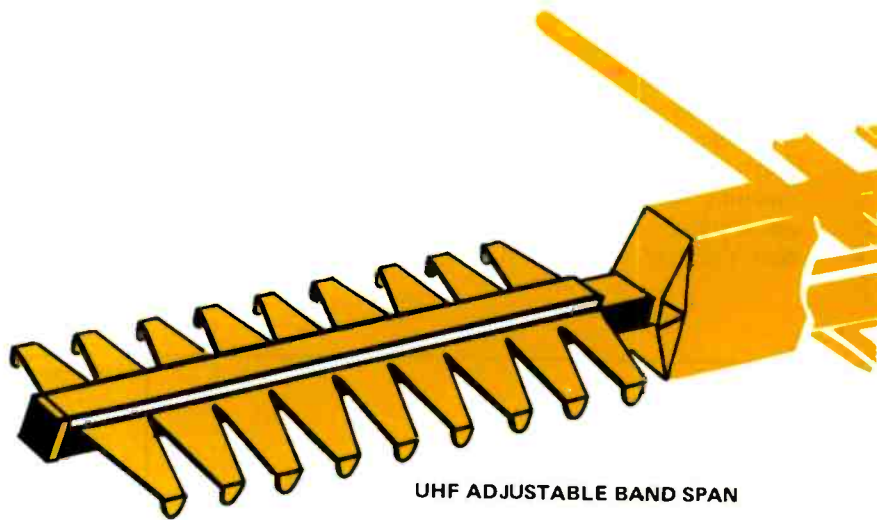
One easy solution to five difficult reception problems



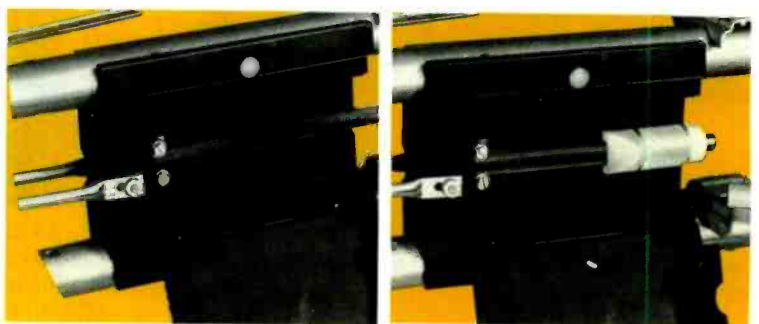
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- 2. WEAK SIGNALS:** The Quantum's optional amplifier modules* provide up to a 15dB boost for color and black and white reception in fringe areas! The solid state modules provide high gain, low noise and unconditionally stable operation through a wide temperature range, and include switchable FM traps. The amplifiers fit snugly into the Quantum's weather protected terminal housing.
- 3. FM INTERFERENCE:** A growing problem with the FM boom. Quantum optional FM traps provide up to 25dB effective attenuation across the entire band without affecting the powerful front to back performance in any way. The printed circuit board traps are easy to install in the terminal housing.
- 4. WEAK UHF PERFORMANCE:** The Quantum provides exceptional UHF power with an adjustable band span that permits you to market an antenna tuned to current and future UHF channels in your area. Gain as high as 13dB meets the critical demands of UHF color reception!
- 5. IMPEDANCE MATCHING:** The Quantum provides an excellent match to both 300 and 75 ohm impedances! It uses insulation piercing terminals for 300 ohm hookup, and an optional balun/matching transformer for 75 ohm installation. The balun/matching transformer fits into the terminal housing.

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Shortcuts for servicing AGC in RCA portables

By Lawrence Bowen

There are two general approaches to servicing solid-state AGC systems: DC voltage analysis and substitution of AGC bias. Both are explained relative to RCA portable color receivers.

Beginning with the CTC42 chassis, RCA has marketed a family of similar chassis for their hybrid portable color receivers. First introduced in 1969 and 1970 were the CTC41, CTC42 and CTC43. Following these came the CTC51, CTC52, CTC53 and CTC55, with principal differences only in the horizontal-deflection and high-voltage systems.

Earlier chassis used a solid-state damper diode and a pulse HV regulator, but the later ones shifted to a vacuum-tube damper and grid-voltage regulation of the horizontal-output tube. Next in the series came the CTC63 and CTC66, with a solid-state tripler that replaced the vacuum-tube high-voltage rectifier.

Also, there have been other differences, such as the addition of vertical-retrace blankers, high-voltage protection circuits, Accumatic, etc; but the IF amplifiers, video stages, tuners, and the AGC systems are very similar throughout the line. In effect, when you understand one chassis, you know them all.

Basic AGC System

Practically all modern television receivers use keyed AGC to maintain a constant output from the video detector. There are two major advantages in using keyed AGC. First, the amount of gain reduction depends on the amplitude of the horizontal sync pulses, not on the video level which can change drastically with picture content. Also, the circuit is nearly noise-immune because the amplitude of signal is

sampled **only** during the horizontal retrace time. Noise signals received at other times can be seen in the picture, but they cannot affect the locking.

Tube-type keyers

An older AGC circuit using a tube keyer is shown in Figure 1. The basic circuit action is described most accurately as a grid-controlled rectifier, and the explanation is clearer when taken in steps.

First, imagine the grid connected to the cathode to give zero bias. Pulses at the plate are rectified to produce a negative voltage. It's interesting how positive-going pulses can manufacture a negative voltage. Assume a pulse amplitude from the flyback of +150 volts, and that V1 conducts enough to make the plate-to-ground voltage +50 volts. That means 100 volts is dropped across C1, with the flyback side positive and the tube side negative. Next, the no-voltage space between pulses arrives, and the tube stops conducting (becomes an open circuit). But C1 still has a 100-volt

charge across it. To DC, C1 is grounded through the winding of the flyback; therefore, the end of C1 at the plate measures a **negative** 100 volts. This is generally true even when the tube is replaced by a diode or a transistor junction. Polarity of the DC voltage is determined by polarity of the diode, not by waveform of the input signal (although the amount of DC changes according to the waveshape).

If the grid of V1 is made negative relative to its cathode, the plate resistance is increased. This decreases the efficiency of the rectification, and results in a lower negative voltage reading. In practical circuits, positive-going video is applied to the grid, and a fixed positive DC voltage clamps the cathode voltage. Bias during horizontal retrace time is the difference in voltage between the horizontal sync tips and the DC cathode voltage. An AGC control usually is provided to adjust this voltage so that the desired video signal is obtained.

A stronger station signal de-

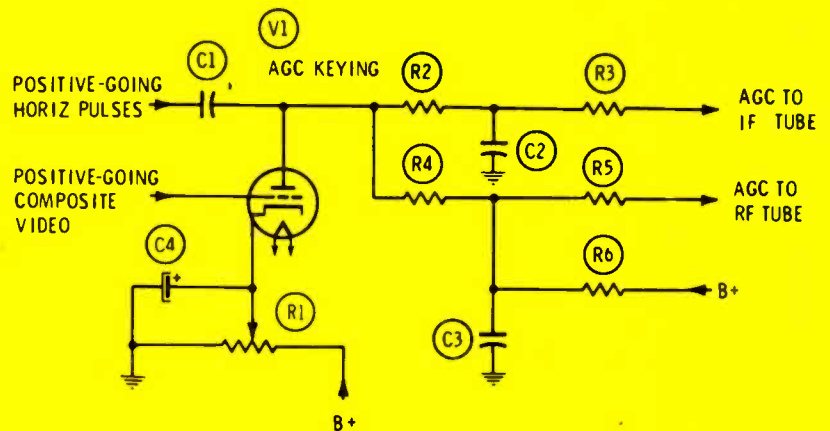


Fig. 1 Basic AGC keyer stage using a tube. Bias changes the plate resistance, and the plate resistance determines the amount of rectified negative voltage.

creases the bias of the keyer tube, increases the negative voltage at the plate, decreases the gain of the IF and tuner tubes, and produces a weaker video signal. This sequence is reversed when the station signal becomes less strong.

AGC voltages for the RF and IF tubes are filtered to remove the horizontal pulses, but they do not require amplification because tubes do not draw grid current on negative voltages.

To minimize snow on medium-strength station signals, B+ is brought in through R6 to cancel the negative AGC voltage to the RF stage until the signal strength exceeds the design threshold. More about this important voltage delay later.

Transistor/diode keyers

Transistorized AGC keyers (Figure 2) work about the same as those with tubes, with two exceptions. Transistors come in two polarities, so positive-going pulses are used with NPN, and negative-going pulses are applied to PNP transistors. The latter condition produces a positive DC voltage.

The other difference is the addition of the diode, CR1. Let's consider what would happen if we re-

placed CR1 with a piece of wire. The positive-going pulses would provide a voltage drop across C1, because the transistor has the correct polarity for collector-to-emitter current flow (assuming base/emitter forward bias). A negative voltage would be formed at the collector after each pulse has passed, except it is the polarity to flow through the collector/base junction. In other words, the diode current of transistors shorts out the desired negative voltage. A transistor cannot be used in the tube circuit without a diode to block the leakage.

In transistorized versions of AGC keyers, the tube functions are divided into diode action (CR1 diode) and series variable resistance (Q1 transistor). Sometimes a resistor is added to limit the peak current.

Complete AGC-Keyer Circuit

Figure 3 shows the AGC-keyer circuit of the RCA CTC66 chassis. Direct coupling is used all the way from the video detector to the AGC keyer. The second-video amplifier is shown since a brief explanation of its operation is in order.

The first video amplifier is an emitter follower which drives the second video amplifier and also the

chroma system. Sync pulses are positive-going from the video detector, and the polarity is the same into the second video amplifier. Both the emitter and the collector of the second video amplifier are loaded. Output from the collector drives the video delay line. Emitter output drives the AGC keyer and the sync separator.

L108 and C120 are series resonant at 3.58 MHz to trap chroma out of the luminance video. C241 returns this trap to ground and also acts as a low-pass filter for the video that is directed to the AGC and sync separator. There is no necessity to have wide-band video for them, and C241 will bypass to ground any noise spikes which might be riding on top of the sync pulses.

Operation of the keyer itself was explained before, except for the function of C508. It and C505 form a capacitive voltage divider to reduce the amplitude of the flyback pulse of the CTC66 to what it was in earlier chassis of this family. This type of pulse-voltage division is frequently used when a manufacturer adapts an existing AGC circuit to a new chassis.

Tuner AGC

The AGC keyer has two outputs, one for the tuner and one for the IF amplifiers. Consider the tuner AGC system first. R504 and C503 filter the AGC voltage. C4003 is located on the tuner assembly where it is used to filter out any hum which might be picked up in the cable harness. Hum in the AGC will produce hum in the video. C17 is a feed-through capacitor through the tuner shield.

R4001, R4003, and R4005 determine the AGC delay and its effect on receiver noise. A good signal-to-noise ratio is needed to minimize snow when the signal from the antenna is below about 500 microvolts, and this ratio is obtained when the RF stage operates at maximum gain. Therefore, the AGC bias should not begin to decrease the RF amplifier gain until this minimum signal level is

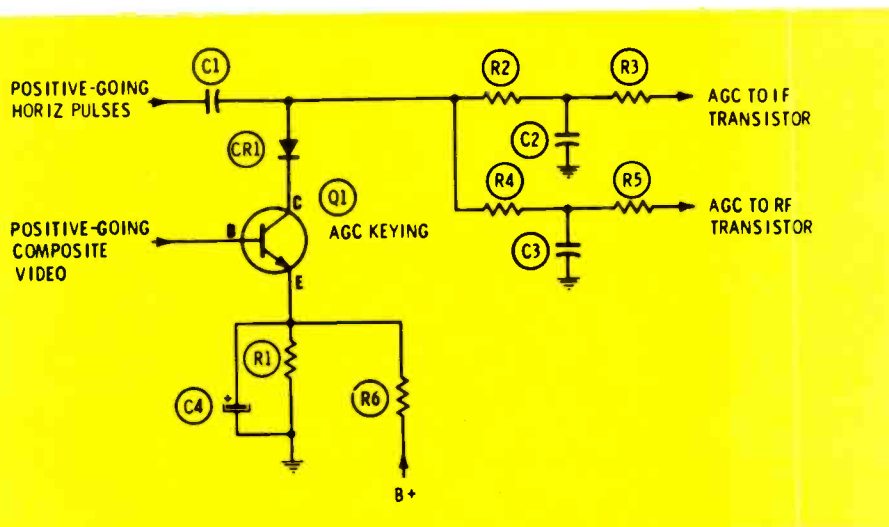


Fig. 2 When a transistor is substituted for a tube in the keyer circuit, a diode in series with the collector is necessary to prevent the negative rectified voltage from leaking away through the collector-to-base circuit.

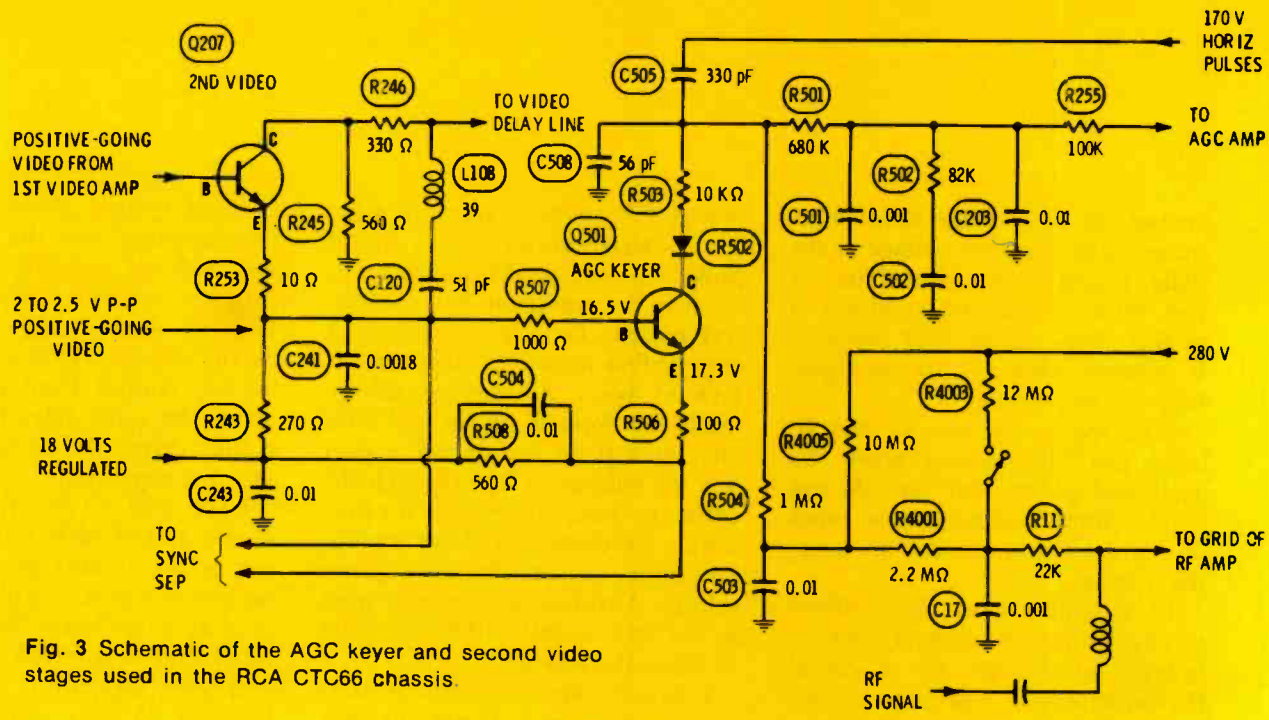


Fig. 3 Schematic of the AGC keyer and second video stages used in the RCA CTC66 chassis.

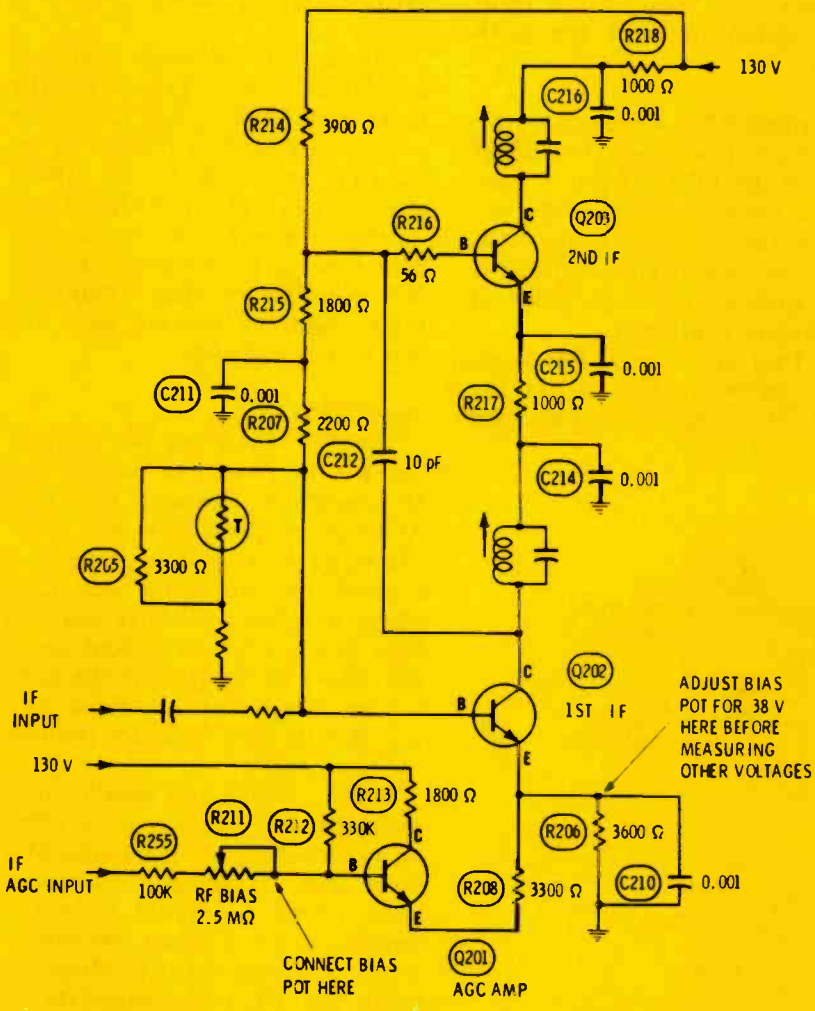


Fig. 4 The first and second IF transistors are in series to DC in the RCA CTC66 chassis. Emitter current of Q201 also flows through R206 to control the IF gain.

exceeded. AGC voltage at the keyer begins to be developed at a much lower signal level, but R4001, R4003, and R4005 "hold off" this bias until a sizable signal is received.

When there is no station tuned in, and thus no negative voltage coming from the keyer, it appears the grid of the RF tube would be supplied with about +30 volts, enough to damage the tube. However, the grid/cathode part of the tube acts as a diode to bleed it down to about +2 volts. About 50 volts is dropped across R4001 and the balance of the 280-supply volts is developed across R4005. The AGC keyer must develop -50 volts to overcome the +50 volts at the junction of R4001 and R4005 before the gain of the RF amplifier can be reduced. This should be at about 500 microvolts of signal, although setting of the RF Bias control determines the actual level at which gain reduction occurs. This is why a wrong adjustment of the RF Bias control can cause snow in the picture, even though the control is actually in the IF circuit. The separate AGC paths to RF and IF are nearly independent of each other. If one is kept from operating, the other tries even harder. So, when the IF's receive less gain reduction, the RF stage receives

more. The reduced RF gain makes the mixer gain more prominent, thus increasing the snow.

The switch which connects R4003 into the circuit is closed only when the VHF tuner is set to the UHF position. Its effect is to increase the no-signal positive bias of the RF amplifier tube. Therefore, a higher level of UHF signal is necessary to reduce the gain of the RF stage in the VHF tuner.

IF AGC

AGC voltage for the IF transistors does not come directly from the keyer (see Figure 4), but a part of the keyer voltage is filtered and used to change the bias of Q201. R255, R211 and R212 furnish a DC offset between the negative keyer output and the positive voltage required to bias the base of Q201. Emitter current of Q201 changes the biases and currents of Q202 and Q203 to vary their gain.

IF transistors Q202 and Q203 normally are biased to produce maximum gain when there is no station signal. Both are in series so they have essentially the same current. **Any increase of the current above the amount giving maximum gain decreases their gain.**

Q202 and Q203 are supplied with fixed base voltages by the bleeder network R214, R215, R203, R207 and RT201 connected from B+ to ground. (RT201 is a thermister added to keep constant the gain of the IF transistors as the temperature varies.) Therefore, the biases of Q202 and Q203 are controlled by changing their emitter voltages.

In normal operation, the voltage across (and the current through) R206 emitter resistor is stabilized to within a fraction of one volt. It must be this way, because the base voltages are clamped, and the variation of the emitter voltage represents nearly the total AGC voltage for the IF transistors. Typically, the voltage change is about .1 volt.

It appears at first glance that only the bias voltage of Q202 is changed by the AGC, so let's digress a moment. As the bias of Q202 is varied, its collector/emitter resistance changes. And this same

collector/emitter junction is the emitter load for Q203. For example, when the voltage at R206 is reduced, Q202 has more forward bias, draws more current and becomes a lower resistance between collector and emitter. This reduces the emitter-to-ground voltage of Q203, giving it increased forward bias and more current flow. Therefore, the AGC actually is applied to both IF transistors.

Normally, when there is no station signal, R206 carries the maximum current of Q201 and the minimum current of Q202/Q203. As the base of Q201 is driven less positive (by a stronger station signal, or adjustment of the RF bias control), its current decreases, thus increasing the current of Q202/Q203 and decreasing their gain. These facts should always be kept in mind when you troubleshoot this circuit.

RF-bias control

The relationship of snow to adjustments of the RF-bias control, R211, already has been discussed, along with comments about the peculiarity of a control in the IF circuit that changes the RF gain. Equally important is the overload of the mixer stage in the tuner that can occur if the control is turned too far in the other direction.

In most cases, you should adjust RF-bias control (211) until snow is seen in the picture, then reverse rotation until the snow barely is eliminated. No more than that. If there's no snow noticed on one channel, try another. Do not adjust the control again unless you notice a tendency towards overload on stronger channels.

Troubleshooting AGC

Suspect the AGC system if the symptoms are:

- a snowy picture,
- cross-talk between channels (windshield wiper),
- no (or weak) video, or
- excessive video (overloaded or black raster).

The first two symptoms can be caused by wrong adjustment of the RF-Gain control, so this should be

the first thing checked.

Only two tubes, the RF amplifier and the video-output amplifier, are used in the entire video chain. To keep from wasting time, test these tubes first before you proceed.

Next, use a reliable in-circuit transistor tester to check the IF, AGC keyer, AGC amplifier/inverter, and video transistors. This is a big time saver, even though a bad transistor might occasionally slip by the test.

DC-voltage tests

Don't waste a lot of time and effort measuring DC voltages in the RF, IF, video and AGC stages. If the AGC system is at fault, most of these voltages will be abnormal, anyway.

Voltages in the Q202/Q203 circuits change such a small amount as to be unnoticeable under most normal AGC conditions. Only when the emitter voltage of Q202 is out of tolerance should voltages there be of concern.

Bias clampers

Obtaining normal, maximum-gain AGC bias for the RF tube is easy; just ground the AGC at the tuner. In Figure 3, this is the junction of R504 and R4001. Physically, it is where the green wire connects to the tuner.

If the maximum RF gain obtained by grounding this point causes

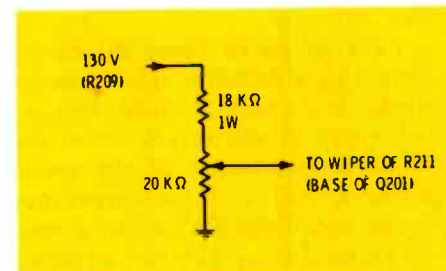


Fig. 5 Build this bias clamper to aid in testing the AGC action in RCA hybrid portable color receivers.

overload on strong station signals, remove one or both of the antenna leads to weaken the signal.

Clamping the bias of the IF amplifiers is slightly more difficult, but not much. Obtain a 20-K potentiometer and a 18-K 1-watt resistor and wire them as shown in Figure 5. R209 is easy to find; it's the large blue 1800-ohm 3-watt resistor at the top/left corner of the IF board. The upper end of it connects to the +130-volt supply.

After this clamper is connected to the wiper of the RF Bias control (base of Q201), adjust the pot in an effort to obtain a normal picture. If you get one, leave the clamper connected and troubleshoot the AGC keyer circuit. At the end of R507 away from Q501, you should measure about 2 to 2.5 volts of positive-going video. Amplitude of the flyback pulse at the junction of C505 and R505 should be 150 volts, positive-going. Be sure to check CR502. Leakage or a short allows the negative voltage to leak away through the collector/base junction of Q501, thus giving weak AGC action. An open in CR502 eliminates any path for the pulses to reach the keyer transistor, and takes away all AGC.

If adjustment of the clamper pot does not bring in a picture, connect a scope to the base of the first-video amplifier (Q205, not shown in the schematic), and adjust the clamper pot for a 2-volt p-p positive-going video signal. Normal video at this point tells us that the problem is in the video amplifiers that follow.

Lack of video there might be caused by a defective video-detector diode. It's under a shield, but we can check it indirectly. Connect the scope to terminal 3 of the sound module. Adjust the clamper pot again, and if you find about 2 volts of video during the adjustment, chances are good the video detector is faulty. No video there indicates a defect in the tuner or IF section.

Check the tuner output signal by using a scope with a detector probe connected to the variable-coupling capacitor that couples the tuner output to the first-IF amplifier.

This is C204, and it is located near the top of the IF-amplifier board. How much amplitude you can observe depends on the detector probe and the strength of the station. It helps to measure this signal in a receiver that is working okay, then write the figure on the wall for future use. Most tuners will produce about the same reading.

Of course, if your shop boasts one of the new "tuner subbers", you could reverse the procedure and inject the tuner signal at the IF input. However, it's still necessary to bias the IF amplifiers properly to localize the problem to the AGC system or the IF/video circuitry.

If the tuner has normal output, use the probe and scope to follow it stage-by-stage through the IF's. Because the amplitude of signal depends on the amount of bias-clamping voltage, you should adjust the clamper pot as necessary to obtain signals from the first and second IF stages.

Whenever the defect is either a shorted or open component, the signal-tracing technique will localize the trouble. However, it might not if a resistor in the biasing network for Q202 and Q203 is away off tolerance. The voltages shown in Figure 4 are normal for no-signal operation, but only if the emitter voltage of Q202 is correct. **Don't connect any kind of bias clamper directly to this emitter!** Instead, connect it as shown to the base of Q201 (or if that transistor is bad, to the emitter of Q201).

Conclusions

Two things add to the difficulties many technicians seem to have in servicing AGC problems. One is a lack of understanding of how the circuits work (a need we hope has been filled here). The second is attempting to find the trouble without first setting up controlled conditions for testing. A logical step-by-step procedure will save you many hours of troubleshooting time for all but the simplest problems.

The testing procedure is summarized as follows:

- Check tubes and transistors,
- ground the tuner bias and clamp the IF bias, and

- adjust clamped IF bias to obtain a picture.
- If a picture is obtained, the AGC keying system is at fault.

(A) Check video and pulse inputs to keyer.

(B) Check voltages and resistances in keyer stage.

- If no picture is obtained, the tuner, IF's or video stages are bad.

(A) Scope the base of first-video amplifier, and adjust clamper for 2 volts of video.

(B) Signal trace the video to AGC keyer, and to picture tube.

- If there is no 2-volt p-p video signal from the video detector, check for video from the sound detector (adjust clamper as necessary). Video there proves video detector is bad. No video indicates loss of signal in tuner or IF's.

- Check tuner output with detector probe and scope at input of the first IF. If insufficient, repair or replace tuner.

- Signal trace the IF stages while adjusting clamping voltage.

- With the clamper still connected to the base of Q201, adjust it for 38 volts at the emitter of Q202. Then measure voltages in the Q202 and Q203 stages.

- After trouble is cleared, adjust the RF Bias (noise control) for minimum snow on medium-to-weak signals, but without overload on strong signals.

Although you probably can find most AGC troubles in these RCA models by slavishly following this procedure, it's much better to know the theories behind the circuits and the tests. Then you can tailor the analysis for even better speed, and also extend the tests to other brands and models of TV receivers. □

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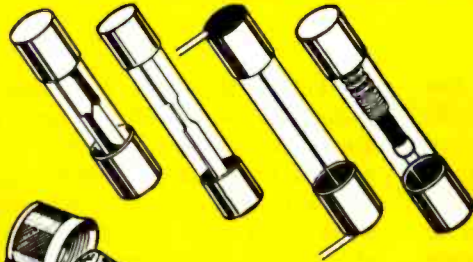
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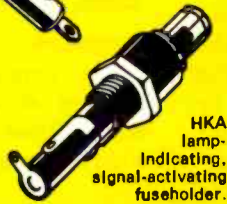
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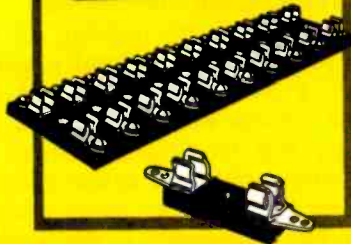
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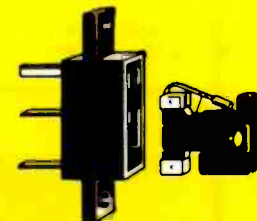


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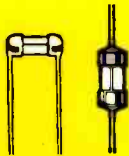


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Faster repairs of those TV "DOGS"



By Robert L. Goodman, CET

A top technician tells how he repairs those hairy "tough dogs" by using logical tests based on a knowledge of circuit actions.

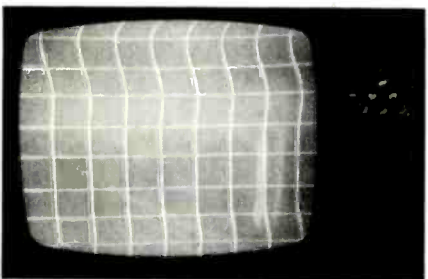
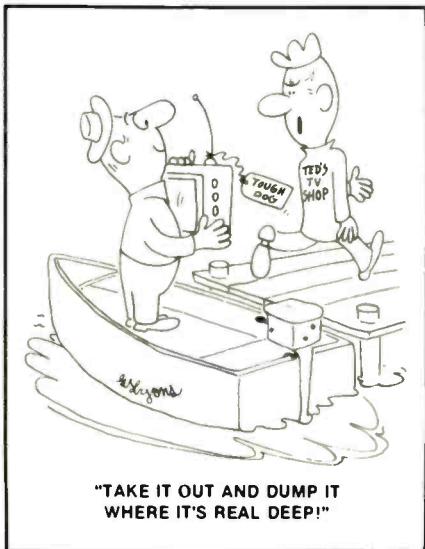


Fig. 1 Picture bending and two faint hum bars were on the screen of a Zenith color receiver.

Television receivers have far too many active parts to permit individual tests of each one. One or two defective components out of perhaps 400 in a color receiver represent very poor odds. If we are to finish the repairs in a reasonable length of time, we must narrow the list of suspects. Every basic circuit should be labelled "prime suspect", "possible culprit" or "no way".

This is done by noticing all the symptoms, then mentally going down a checklist to eliminate the basic circuits which **cannot** be the cause, and locating the circuit or circuits **capable** of causing those symptoms. Next, we employ whatever test equipment is appropriate to that circuit to determine either incorrect or normal **overall** operation. If the circuit appears to be malfunctioning, we use more tests to locate the stage, then proceed until the defective component is pinpointed. Many technicians follow this general procedure without realizing it. It is similar to the philosophy of the famous "1-2-3-4 Servicing" series of books by Forest Belt.

A thorough knowledge of **practi-**

cal circuit theory is necessary for successful use of this method. And don't let the word "theory" scare you. In this case, it merely means, "How is this circuit supposed to work, and how can I accurately check it in the shortest amount of time?"

To illustrate how the system works, let's take a few pages from the "Old Pro's Casebook".

Case Of The Double Hum Bars Symptoms

On crosshatch pattern, the picture showed bending of the vertical lines, and two gray, rounded-edge horizontal bars (Figure 1).

Background information

Broad, rounded-edge horizontal bars usually are caused by some kind of hum. One bar visible at a time indicates a ripple frequency of 60 Hz, from a half-wave or non-frequency-doubling rectifier circuit. Two bars are the result of 120 Hz ripple. If the program is in color (59.94 Hz vertical rate), the bars drift up the picture about one revolution in 17 seconds. AGC problems can produce bars of

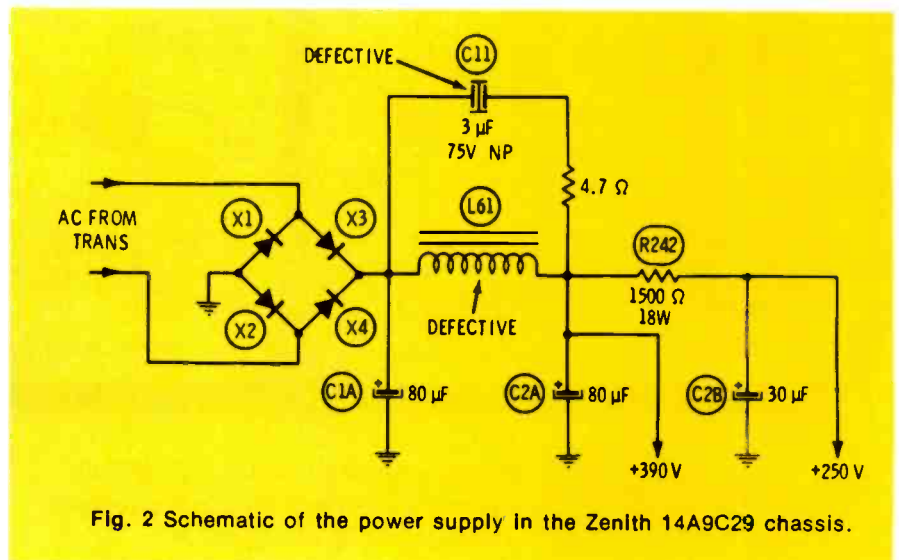


Fig. 2 Schematic of the power supply in the Zenith 14A9C29 chassis.

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Fig. 3 A General Electric TV showed this picture that varied in size, contrast and focus, with occasional black-outs.

similar appearance, but they will not drift, and will move erratically rather than steadily.

These bars and the picture bending moved upward slowly and regularly. Therefore, they were hum bars of 120 Hz frequency. This pointed the finger of suspicion at the power supply, because other types of hum are all 60 Hz.

In this case, the receiver was a Zenith color receiver using a 14A9C29 chassis (Photofact 1116-3). Figure 2 shows a simplified schematic of the power supply.

Specific tests

Rectification was by a bridge circuit using four silicon diodes, and the correct ripple frequency is 120 Hz, the same as indicated by the bars on the screen. Therefore, the diodes were cleared of suspicion; an open diode would have changed the ripple to 60 Hz.

The only parts remaining were the filter choke, two resistors, and four capacitors.

Tests with a capacitance bridge showed C1A, C2A and C2B to be apparently okay. However, in-circuit readings are not always reliable, so a 80-mfd test capacitor was paralleled across each in turn. No change in appearance of the hum bars on the screen.

In another receiver of the same model, previously repaired, the non-

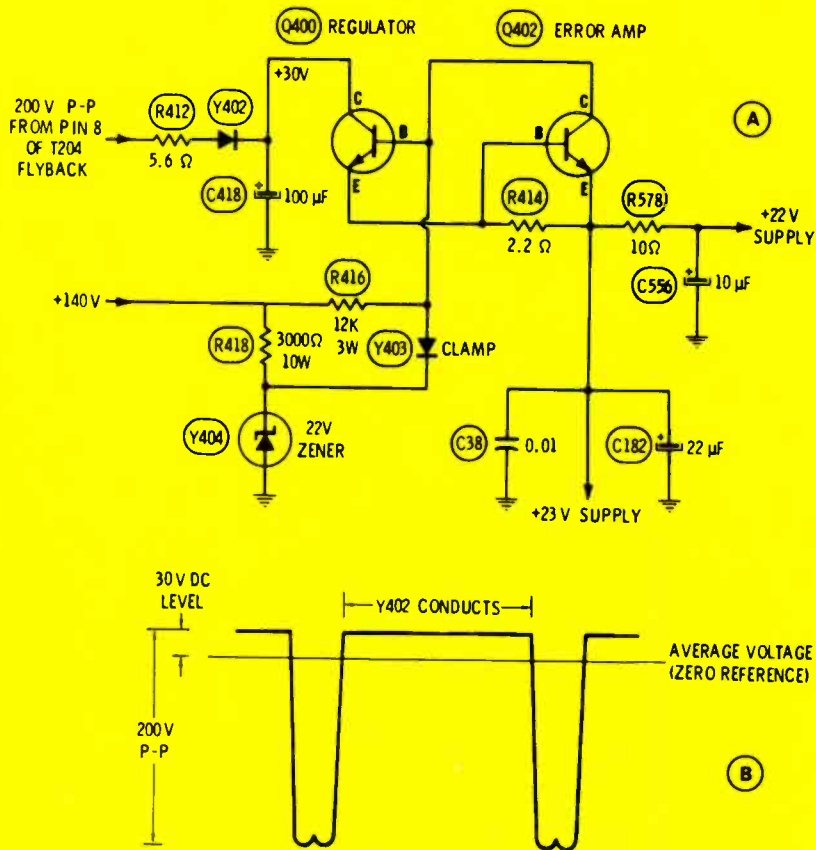


Fig. 4 Schematic of the "scan rectification" and 22-volt regulator circuit of the General Electric JA chassis.

polarized capacitor C11 had been shorted causing identical symptoms. Unfortunately, C11 tested okay, and substitution didn't change the symptoms.

Most power supplies don't have non-polarized capacitors, so an explanation is in order. Function of the capacitor is to resonate broadly with L61, thus forming a parallel-tuned circuit with maximum impedance at 120 Hz. This gives better filtering and less ripple than does the choke alone. An open capacitor slightly reduces the amount of filtering; a shorted one severely reduces the filtering.

R242 was checked for resistance and found to be within tolerance. Only one part remained untested.

The filter choke, L61, is difficult to check with ordinary shop equipment, and it's quite a bit of work to replace. Alternately, an analysis of the scope waveforms might supply the last proof that was needed.

The same large sawtooth waveform appeared at each end of L61, although the output side should have been at least 10 times less.

Because all the other components had been tested, this indicated the choke was defective, probably shorted turns.

Repair

Installation of a new filter choke eliminated the symptoms from the picture.

Pulsating Pictures

Symptoms

The picture on a General Electric (19JA chassis, Photofact 1328-2) was pulsating erratically in contrast, size and focus, as shown in Figure 3. Sometimes it bloomed to a black raster. Decreasing the brightness didn't improve the reception.

Background information

Ordinarily, the horizontal-sweep circuit is at fault when symptoms such as these are observed. Amplitude of the horizontal pulses affects the AGC, determining the contrast. Often a sample of B-boost is used in the vertical sweep, so the horizontal affects the height, also.

Chart 1 In-Circuit Resistances

Component	Forward biased	Reverse biased
Q400 (base-collector)	7 ohms	More than 1K
Q400 (collector-emitter)	18 ohms	More than 1K
Y403 (diode)	10 ohms	More than 1K
Y404 (zener)	7 ohms	More than 250 ohms

However, I remembered the instructor at a General Electric service meeting telling us to watch out for a certain power-supply condition which also can cause these same symptoms. In addition to the usual interconnections, the JA-series GE chassis use "scan rectification" to supply extra DC voltages. Scan rectification merely means that horizontal pulses from the flyback transformer are rectified, filtered, regulated, and used to supply DC to many circuits, such as IF's, horizontal oscillator, vertical stages, and many others. Obviously, any amplitude change of the horizontal pulses, or any variation of the regulated voltage, can affect the performance in many ways.

Incidentally, it's interesting to consider why pulses of 200 volts peak-to-peak are required to produce +30 volts after they are rectified (see Figure 4). The reason is found in the nature of pulses. Zero reference, or the average point of the waveform, is located near the long space between pulses. Therefore, rectification of the positive-going part waveform (Figure 4B) above the zero line produces a small DC voltage. If the polarity of the diode were reversed, rectification of the negative-going tips would give a much larger DC voltage, perhaps -170 volts, or so.

After reviewing all this information, I decided it worthwhile to check out the condition of the +22-volt supply.

Specific tests

A quickly-made voltage measurement revealed an excessive variation of the 22-volt supply that changed in step with the visible symptoms. This voltage should be within ± 2

volts of +22 volts, and should not change more than .5 volt from line-voltage variations between 110 to 130 volts, or from brightness changes.

One of the first tests should be ohmmeter measurements of Q400, Y403, and Y404, according to the typical in-circuit readings shown in Chart 1. If these readings don't indicate a defect, Q402 should be removed from the circuit to allow measurements of the base/emitter junctions of Q402 and Q400.

In this example, the ohmmeter checks were not conclusive. One more voltage measurement was made, across Y404, the zener diode. The voltage changed about the same amount as that at the +122 supply, although the +140-volt source did not vary. Now, this is a fairly-simple regulator circuit in which the base voltage of Q400, the regulator transistor, is clamped by the zener. Any variation of the



Fig. 5 A Motorola Quasar had displaced scanning lines over the entire picture.

emitter voltage of Q400 (also 122-volt supply) is a sensitive change of bias. Q400 changes collector-emitter resistivity in an effort to keep the emitter voltage .6 volt lower in voltage than the base. Therefore, any change of zener voltage forces the +122-volt supply to change the same amount.

Zeners can be tested out-of-circuit by connecting them through a limiting resistor to an external power supply. When the correct current flows through the zener, the voltage drop across it should be the rated voltage. However, that's so much trouble I just installed a re-

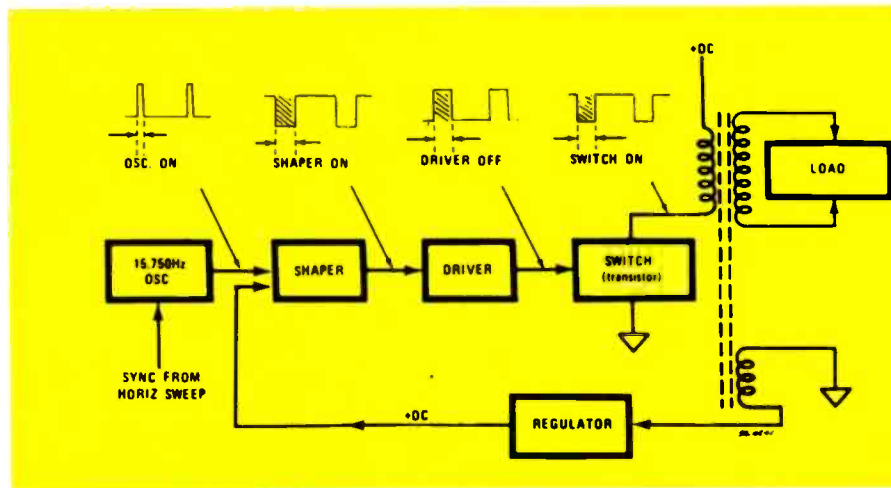


Fig. 6 Block diagram of the JA panel electronic regulation used in the TS931 and TS938 chassis. Synchronization from the horizontal oscillator in the sweep circuit is necessary to prevent the displaced scanning lines. (Courtesy of Motorola)

placement. No more blinking and pulsations.

Jagged Scanning Lines

Symptoms

One Motorola Quasar with a TS938 chassis (Photofact 1299-2) showed pictures with a ripple effect (see Figure 5). A closer view revealed that some of the scanning lines were displaced horizontally.

Background information

Certain types of arcs (such as those inside ceramic capacitors) in the horizontal-sweep circuit can cause displaced scanning lines. However, they are displaced at random, not evenly as these were.

Next-best bet is a defect in the horizontal AFC which changes the firing time of the horizontal oscillator.

Specific tests

Waveforms of the horizontal-AFC circuit indicated some disturbance, but no specific defect. I probably would have wasted considerable time in futile tests, but then I remembered this model used an electronically-regulated high-frequency power supply, which was described on pages 16 and 17 of Electronic Servicing for December, 1971. This power supply (block diagram in Figure 6) operates at the normal horizontal-scanning frequency. It is synchronized from the horizontal oscillator of the receiver to prevent problems that the factory didn't describe. I wondered if lack of synchronization or some other defect in the electronic power supply might cause the displaced lines.

One test that seemed promising

was to compare the frequencies of power supply and horizontal sweep by use of a dual-trace scope. Sure enough, the waveform of the power supply jumped back and forth when the scope was locked to the sweep frequency.

Next, the scope was connected to pin 4 of the power supply to measure sync amplitude. Normal sync there, as shown in Figure 7, should be about .8 volt, but in this case the amplitude was only .1 volt. It seemed certain the low amplitude was the reason for the lack of synchronism.

Ohmmeter tests of the 18K resistor (R813 external to the power supply), R25 and T2 on the power supply proved that R813 had increased drastically in resistance. Installation of a new resistor returned the picture performance to normal.

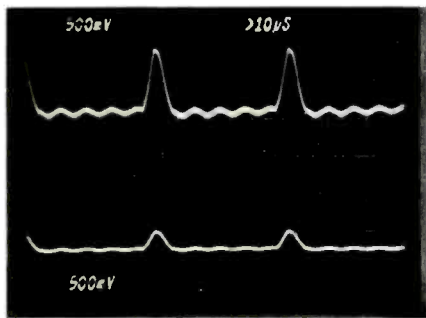


Fig. 7 Waveform at the top is the normal .8-volt regulator sync signal, and the one at the bottom is the .1-volt signal found in the defective Quasar.

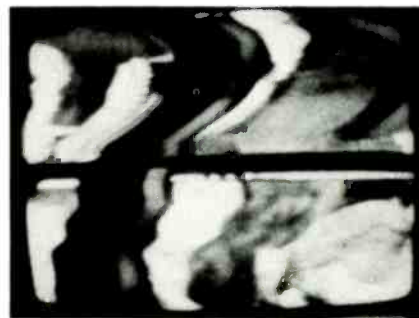


Fig. 8 Another Zenith color set had an excessively-dark picture without vertical or horizontal locking, caused by AGC failure.

Dark And Unstable Picture

Symptoms

As shown in Figure 8, the picture produced by the Zenith 16Z7C17 chassis (Photofact 1014-3) was too dark and had no vertical or horizontal lock. Snow off-channel was normal. Adjustment of the AGC control made the picture jump from a blank white raster to an overloaded condition.

Background information

Although this is an old circuit (Figure 9), it continues to confuse many technicians because of the many signals entering and leaving the tube. In the first place, the tube has three functions: AGC keying, sync separation and noise inversion. Sync is of only secondary consideration here, so we'll not discuss it.

It helps in understanding the operation of the AGC if we imagine that the tube consists only of plate, grid and cathode (pins 2, 5 and 8). Now the circuit is a simple AGC keyer having positive-going horizontal pulses applied to the plate positive-going video at the grid, and a variable DC voltage at the cathode to set the proper bias. The pulses at the plate are rectified to a degree determined by the grid/cathode instantaneous bias, and the negative voltage generated at the plate is filtered and used to control the gain of the IF and RF tubes.

To make the circuit noise immune, it's necessary to apply a

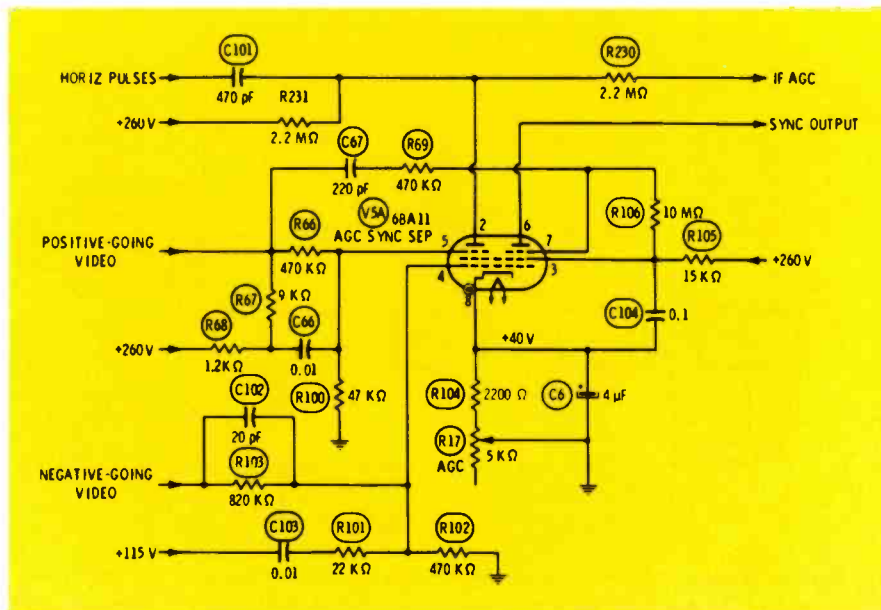


Fig. 9 AGC keying circuit of the Zenith 16Z7C17 color chassis.



Fig. 10 Narrow width at the bottom, and some horizontal displacement of scanning lines appeared on this Zenith 20CC50.

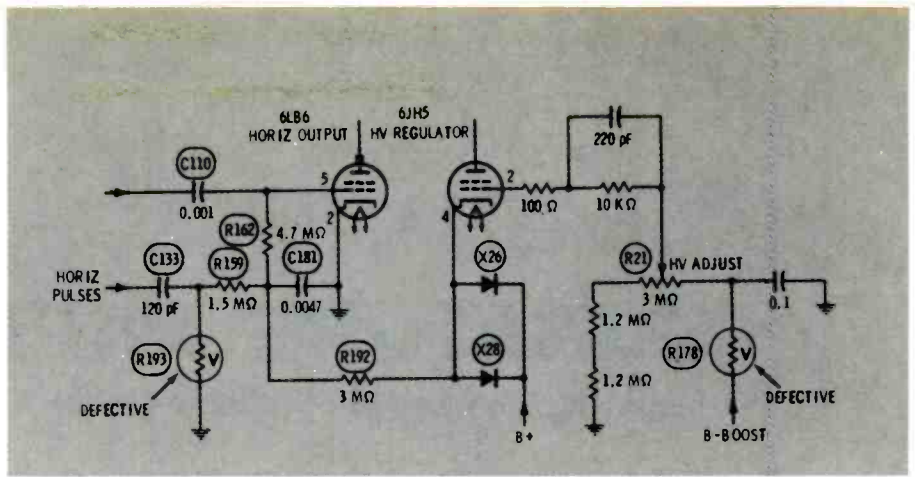


Fig. 11 HV-regulator and fail-safe circuits used in the 20CC50 Zenith.

negative-going video signal to the electron stream **only** when the noise exceeds the amplitude of sync tips. In this circuit, that is done by applying both a positive DC voltage and negative-going video to the control grid, pin 4. Positive voltage through R103 causes grid current to flow, clamping the grid voltage only slightly above the cathode voltage. Most of the video signal is clipped by the grid current and does not interfere with the normal AGC action previously described.

But when a negative-going noise pulse reaches the grid, it forces the grid temporarily to become more negative than the cathode. Grid current ceases, and this greatly increases the amplitude of the noise pulse; the cathode current is cut off, and no AGC voltage is produced at that time. Without this action, the tube would act on the noise pulse at pin 5 as though the video signal had increased, causing more negative AGC voltage, and decreasing the gain of the tubes to produce a picture having lower contrast (white-out).

Noise-immune operation of the sync-separator circuit is somewhat similar. The pin-7 grid is the normal one for sync separation, and the noise signal at pin 4 (control grid common to both halves) cuts off all sync. It's better to have no sync temporarily than to have noise pulses give false triggering of the sweep circuits.

Specific tests

Normal-amplitude horizontal pulses (about 140 volts p-p) were scoped at the plate, but a VTVM showed a lack of negative DC voltage there. For reasons yet un-

known, the tube was not conducting.

One of the simple, but effective, tricks in testing keyers is to connect grid and cathode together, giving zero grid bias. If the circuit is normal except for a keyer bias problem, a high negative voltage should be developed at the plate. I used a test lead connecting pins 5 and 8, but the plate remained slightly positive (the normal voltage for operation without a station signal). The result indicated a problem other than one of grid bias.

The tube had been changed, and the screen voltage (pin 3) measured okay. What did that leave? We would expect the DC voltage at pin 5 to be wrong because of the overload, and it was. But both the grid pin 4 and the cathode measured over 100 volts. A quick ohmmeter test proved the AGC control was open.

Yes, a new AGC control and a normal adjustment cured the problems.

Narrow Width At The Bottom

Symptoms

Scanning lines were displaced in groups, and the picture was slightly narrow at the bottom (Figure 10) on a Zenith 20CC50 (Photofact 1238-3). These effects decreased as the brightness was increased, until at full brightness most of the symptoms disappeared.

Background information

Say "trapezoidal picture" to almost any technician and he will reply "yoke". It's an automatic response. But a bad yoke doesn't allow the trapezoid to disappear merely because the brightness is

increased. That analysis was proved because the chassis was connected to my test jig at the time.

Rumors have been circulated that VDR's (varistors or voltage-sensitive resistors) can cause such problems. This chassis has two VDR's, one in the high-voltage regulation and one in the "fail safe" protective circuit which guards against operation without HV regulation (see Figure 11).

One fast way to test a whole circuit is to eliminate it and notice if the trouble is gone.

To eliminate the protective effect, I connected a test lead across C181. There was no change, and this meant that C181, R159, R192, C133 and the VDR, R193, were not the source of the symptoms. If the test had stopped the symptoms, it's likely R193 would have proved to be defective.

Before we try the next test, we should clarify the operation of the fail-safe protection circuit. When the regulator (6JH5) has current, the diodes connected from cathode to B+ are forward biased and act essentially as short circuits. From the cathode, a sample of the positive voltage there is brought through R192 to the grid circuit of the horizontal output tube. Normally, this would tend to drive the grid less negative. But rectification action of R193, the VDR, produces a negative voltage, also routed to the output grid via R159. Ideally, the positive voltage through R192 and the negative voltage through R159 are equal and cancel at C181. There is no change of grid bias, so the width and high voltage are not affected.

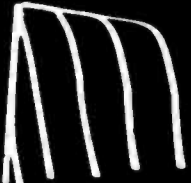
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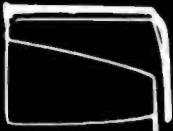
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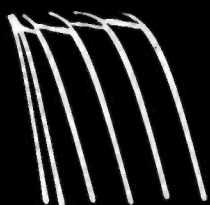
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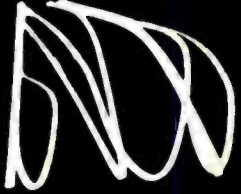
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BASE CURRENT 20uA	


Q104 AUDIO OUT	
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SWEEP VOLTAGE 30V	
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Q106 AUDIO OUT	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 20uA	

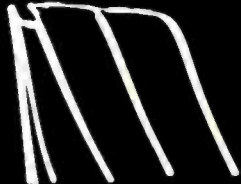
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BASE CURRENT 100uA	

Q206 3RD IF	
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BASE CURRENT 100uA	

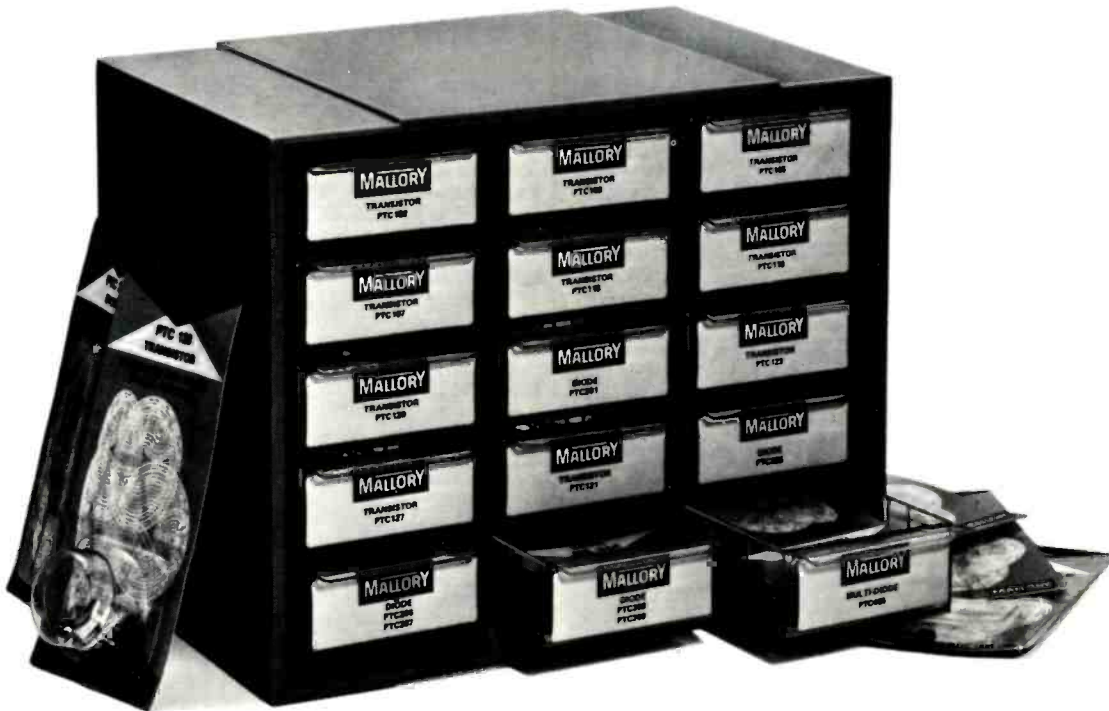
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BASE CURRENT 10uA	

Q310 VERT OUT	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 20uA	

Q214 AFC IF	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 100uA	

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POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

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BASE CURRENT 50uA	

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SWEEP VOLTAGE 30V 1000uA	
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POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q404 HORIZ DRIVER	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 200uA	

Q306 VERT DRIVER	
POLARITY PNP	
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POLARITY PNP	
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BASE CURRENT 500uA	

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Q606 CHROMA CONT AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 20uA	

Q412 B+ REG	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

Q608 CHROMA AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 500uA	

Q502 +24V REG	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 100uA	

Q902 2ND VIDEO AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q504 RIPPLE AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

Q904 3RD VIDEO AMP	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 200uA	

Q602 CHROMA AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

Q906 BRIGHT LIMIT	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 20uA	

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Q908 4TH VIDEO AMP	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 20uA	

Q910 VIDEO DRIVER	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 200uA	

Q912 BLANKER	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q914 GRN OUT	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

Q916 RED OUT	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

Q918 BLUE OUT	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 50uA	

MANUFACTURER SYLVANIA	MODEL OR CHASSIS E03,E04,E05
TRANSISTOR IDENTIFICATION & CURVE TRACER SETTINGS	SIGNATURE PATTERNS

Q1204 UHF AMP	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q1206 UHF BAND SW	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q1208 HI BAND AMP	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q1210 HI CH BAND SW	
POLARITY NPN	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

Q1212 LO BAND AMP	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

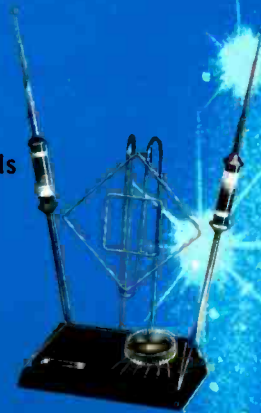
Q1214 LO CH BAND SW	
POLARITY PNP	
SWEEP VOLTAGE 30V	
BASE CURRENT 10uA	

MAGIC COLOR ANTENNAS

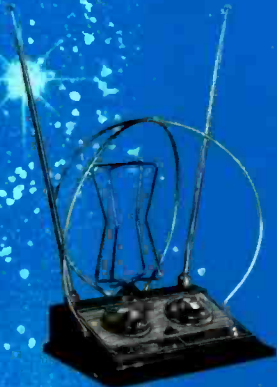
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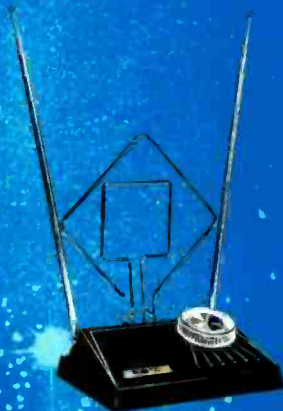
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Q1216 LO CH BAND SW

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 20uA

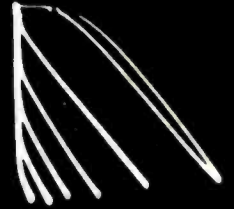


Q1218 TUN IND AMP

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 20uA

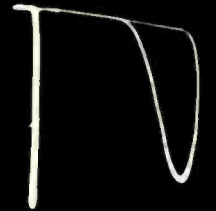


Q1220 UHF AGC

POLARITY NPN

SWEEP VOLTAGE 30V

BASE CURRENT 10uA



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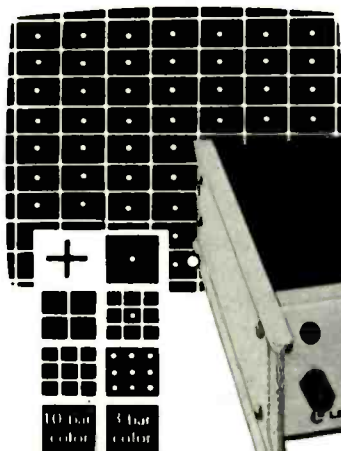
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For More Details Circle (31) on Reply Card

For More Details Circle (14) on Reply Card

Prevent those costly callbacks

By John Rozsa
and Carl Babcoke



Practice preventive maintenance to catch most questionable parts before they go completely bad and cost you a callback. Justify their replacement to any consumerists by knowing precisely the defect and why the component should have been replaced.

You want your customers to call you regularly for TV service. That's just good business. But those customers are going to blame you if they are forced to call you too often.

Of course, set owners can't be expected to understand the legitimate reasons about how a second defect (unrelated to the original one) can pop up in the near future. On the other hand, you certainly can't guarantee anything except the parts replaced and the adjustments you've made. Often you must make good beyond your responsibility (thus losing money), or anger a customer who then blackens your reputation.

There is a solution for some of these problems. It's called "preventive maintenance". That's what one filling-station attendant **didn't** do to my car when it was serviced just three days before the fan belt broke, stranding me miles from a garage. At the opposite extreme was the time another attendant told me positively I should have the fan belt (of a different car) replaced. I examined the belt and found no cracks, cuts, or evidence of wear, so I refused. That "bad" belt lasted three more years. I just missed being victimized. Needless to say, I didn't go back to that station.

The way to success is not only to replace the components causing the present complaint, but also to find other parts that are beginning to deteriorate and replace them before they cost you a callback. However, don't do any unnecessary repairs. Aside from moral considerations,

this is for your own protection from prosecution by some overly-ambitious district attorney or consumerist. **It's just as wrong to do too little as it is to do repairs that are not needed.**

Don't Hit-And-Run

It's easy to hurry so fast that we overlook additional problems. Only a few extra minutes are needed to find many potential trouble spots or below-par performances of the receiver being checked. If you take care of them during the first repair, you have made extra money, avoided a callback, and insured a happy customer.

Make up a checklist, something like this one, to guide you in finding secondary troubles:

- If the original complaint was about the picture, test the sound reproduction for volume, tone quality, hum and noise;
- Test other tubes in addition to the one main culprit. Tap them as a test for intermittents or arcs;
- Try the picture quality on all available channels. Recommend an outside antenna or antenna repairs, if needed;
- Rock the channel selector to check for corroded contacts;
- If the receiver has a past history of excessive tube replacements, measure the line voltage;
- Give the chassis an "eyeball" examination for burned resistors or gassy tubes;
- If the set is a color receiver, turn down the color control and look for blotchy purity and misconvergence;
- Diagnose color tint and saturation, and look for abnormal beat patterns in the color; and
- Try the height, linearity and all customer-operated controls for noisy or intermittent operation, then reset the height and linearity.

To help you decide which parts should be and which should not be replaced, we offer the following practical suggestions.

Facts And Myths About Tubes

"Tube testers provide accurate readings of all important conditions of tubes." **MYTH.** No tube tester designed for the service trade checks tubes under the same conditions that are encountered in receivers. This is particularly important with tubes used in the vertical and horizontal sections of TV receivers, because those tubes are operated with high pulse voltages which are impractical and unsafe to provide in a tester.

"Every technician should have and use a tube tester." **FACT.** Tube testers can be very valuable in finding dead, weak, intermittent, and gassy tubes, if we understand their limitations. For one thing, the indication of a short should be interpreted. A 2-megohm leakage from control grid-to-screen grid is very important, but the same leakage from heater-to-cathode is usually of no consequence.

"All tubes showing a blue glow should be replaced." **MYTH.** Blue glow on the inside of the metallic elements of small tubes **does** indicate gas, and that's reason for replacement. However, blue glow only on the glass is fluorescence and has nothing to do with the condition or life-expectancy of the tube.

"Any tube producing intermittent operation when it is tapped should be replaced." Both **FACT** and **MYTH.** The tube might be intermittent, but perhaps the shocks are moving something on the board. Or the socket might be corroded. To test for this possibility, gently rotate the tube in its socket. If this movement also triggers the intermittent, the socket is at fault, not the tube, and it should be cleaned or replaced. Tuner cleaner applied to each socket pin a drop at a time from the tip of a small screwdriver often is effective in stopping intermittents. Don't spray the entire area.

Facts And Myths About Cleaning Tuners

"To repair any tuner intermittent, fog large quantities of any bargain-counter spray cleaner into a hole through the shields." **MYTH.** First of all, many intermittents are not caused by corroded switch contacts, so spraying would be futile. Secondly, not all sprays are safe and effective to use. You should investigate to find a brand that does not attack plastic parts and does not detune the oscillator frequency. Use care not to get any spray inside neutralizing capacitors because even excellent kinds of spray might cause the RF stage to oscillate (give horizontal black bars) on some high-band stations.

It's advisable to obtain the customer's okay before spray cleaning a tuner. Explain that some tuner problems cannot be cleared this way, but require disassembly of the tuner, with cleaning and lubrication. Perhaps you could gain the customer's confidence by offering to apply the charge for spray cleaning against any additional tuner cleaning needed within a short period of time.

By the way, variable controls without DC voltages across them usually respond well to cleaning. Just get some cleaner on the element and turn the control end-to-end a few times. However, controls carrying DC (such as height, linearity, etc.) should be replaced if they become intermittent.

Facts And Myths About Resistors And Capacitors

"Resistors with bulges should al-

ways be replaced without any more testing." Partly **FACT** and partly **MYTH.** A composition-type resistor with a bulge or irregularity only on one side in one area probably is a normal resistor that was poorly molded during manufacture. If it checks within tolerance, don't replace it. A resistor that is within tolerance but shows some change of body and stripe colors from excessive heat usually doesn't require replacement. However, any resistors that appear burned and measure either higher or lower than tolerance should **always** be replaced.

"Resistors of values higher than 1 megohm are more likely to change slowly to a higher value than are lower values. Resistors of only a few-thousand ohms don't drift much from aging, but occasionally open without being overloaded." **FACT.** I can't explain why, but these statements are verified by both observation and heat tests.

"Resistors of the composition-type seldom become intermittent, but they sometimes become noisy." **FACT.** One simple test of a noisy resistor is to spray it with coolant. A noticeable change of noise level indicates the resistor is the source of the noise.

"Some capacitor defects will not show up on conventional test equipment." **FACT.** Open capacitors, and intermittently-open capacitors, can be found with capacitance meters and bridges, or with scopes by waveform analysis. But ohmmeters with a low-voltage battery often cannot show leakage of a capacitor, particularly those capacitors with leakages made worse by rising temperature.

One rare defect is a capacitor (usually a ceramic type) that leaks in an intermittent way similar to an arc, and does so only with specific conditions of voltage and temperature. We challenge the people who try to entrap technicians to test this kind of defect!

"Any capacitor of the same voltage and capacitance rating makes a suitable replacement." **MYTH.** In addition to any obvious physical size differences or wrong spacing of lead wires, such characteristics as a different temperature coefficient, lower "Q", drifting long-term stability, or excessive leakage might make some types a bad bet. Of

course, a superior type can be used, at a higher price. Mylar-dielectric capacitors are better than paper types, and mica or zero-temperature ceramics operate fine instead of general replacement ceramics. Just don't try to substitute the other way around. For example, an ordinary ceramic should not be installed to replace a silver mica.

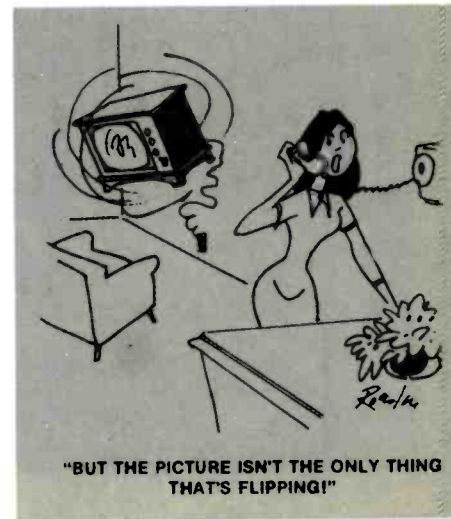
"A larger value of capacitance always works better." Partly **FACT** and partly **MYTH.** In a few applications (filters and bypasses), a larger value might help the performance. But in almost all other uses, only the original values should be used as replacements.

Summary

Every callback is costly in both time and money. If you make a second charge, the customer probably is infuriated. But, if you don't charge again, you lose money.

Of course, it's possible to "shot-gun" whole circuits and install many parts and tubes in an all-out effort to avoid callbacks. However, that's expensive, and also a dangerous practice in this age of emotional consumerism.

We recommend that every technician test the parts more carefully, so he can be positive each rejected part is actually defective. Then the general defect should be listed with the part on the invoice. This simple step aids memory, and gives a measure of protection if a question arises later asking why the part was replaced. □



Record changer workshop part 4



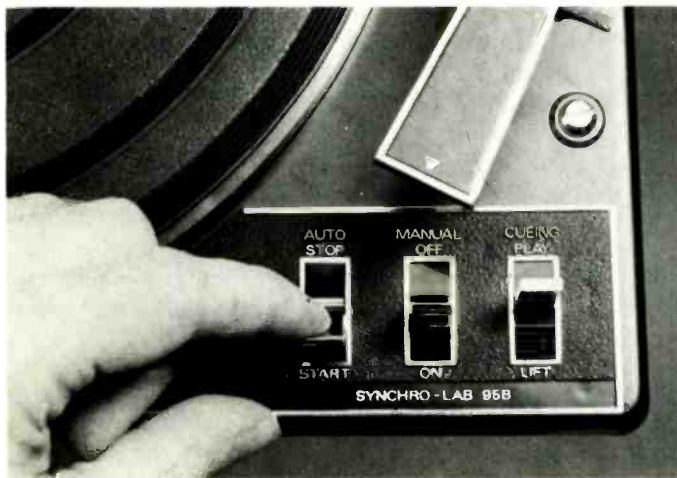
Forest H. Belt,
CET

An automatic turntable is the higher-priced, more versatile version of a record changer. The extra cost covers more than just profit, though. The buyer of an automatic turntable expects a platter that weighs more and therefore offers smoother performance, a delicately balanced tone arm that "tracks" with feather pressure on the stylus tip, perhaps a more powerful and steady motor, and the capability of playing single recordings without the change cycle. An automatic turntable, or for that matter a manual one, offers playing quality a record changer can't have.

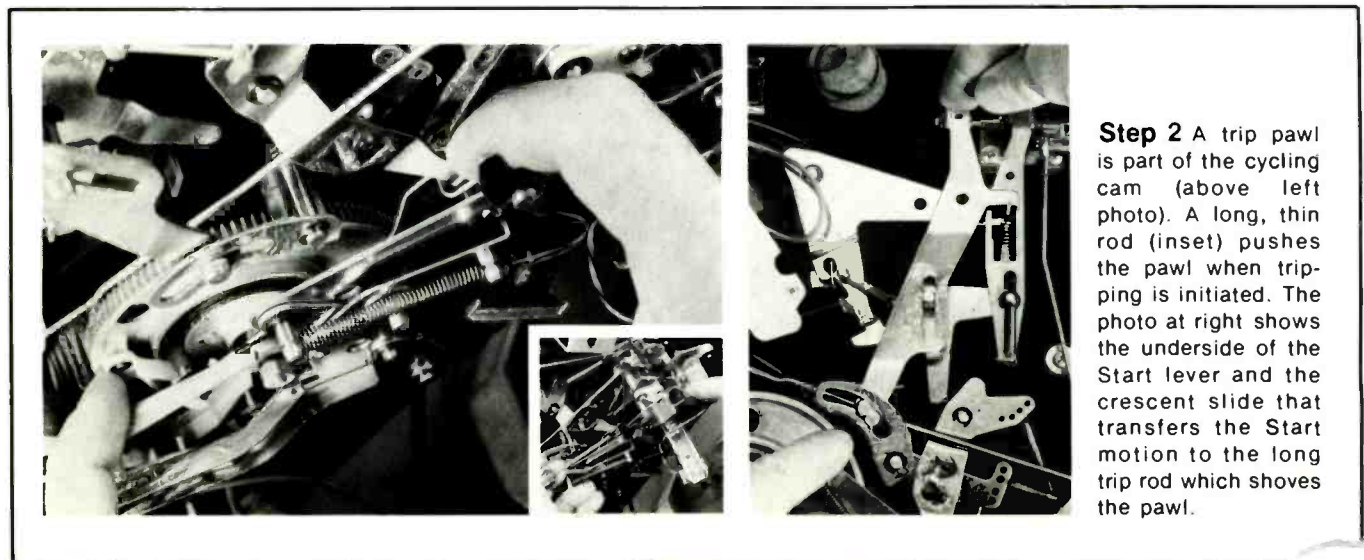
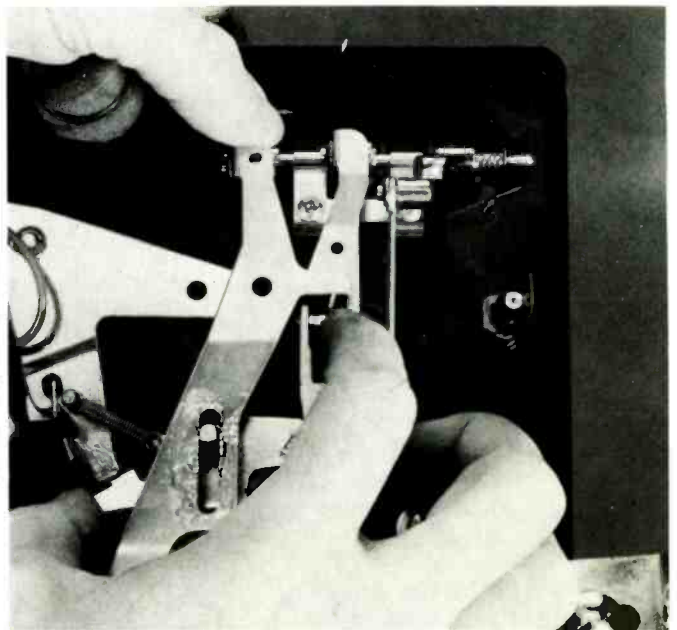
But servicing doesn't change much. As

you saw in earlier Workshop sessions, the turntable might have more adjustments. They permit careful alignment of the precision movements. That can actually make the turntable the easier of the two to troubleshoot and repair.

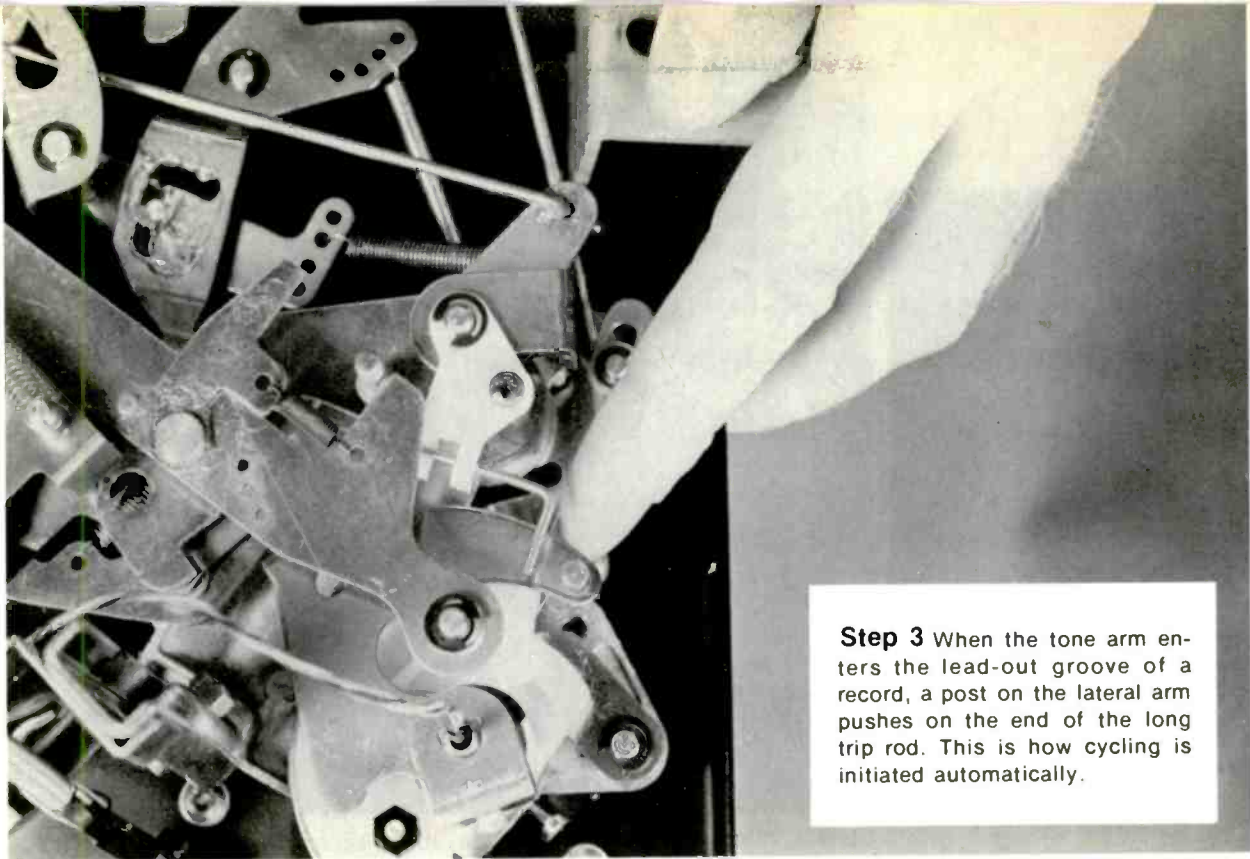
Inside, the automatic mechanisms perform the same tasks: spinning the record, playing it, swinging the arm up and out of the way and dropping the next record, then returning the arm to the playing position (or to a position for shutoff), and shutting the machine off after the last record is done. This final Workshop session on Record Changers and Turntables details the workings in a precision turntable.



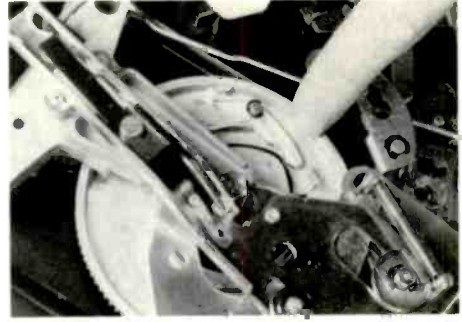
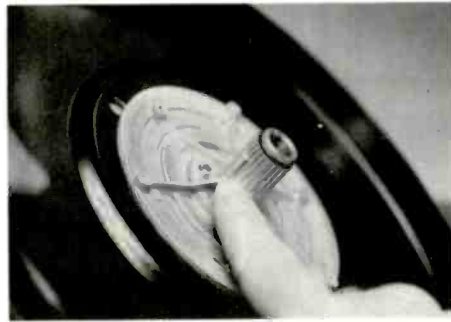
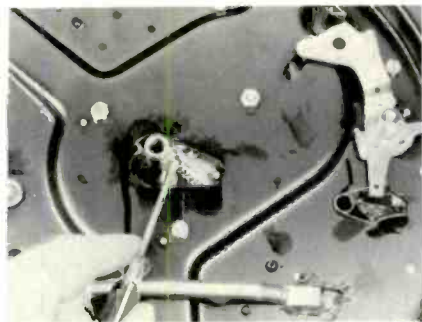
Step 1 Tripping (initiating the change cycle) happens manually when the Start lever is pulled. It interlocks with the Manual lever, and also pulls in to On. Underneath, you can see the interlocking parts, and the long slide that operates the tripping mechanism.



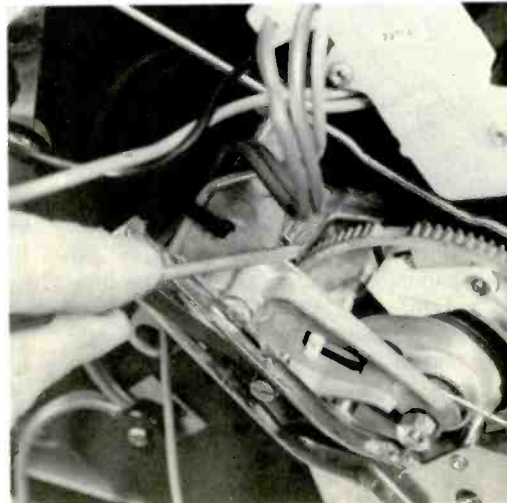
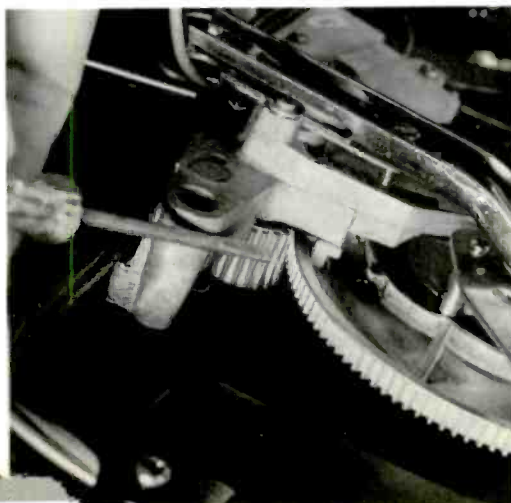
Step 2 A trip pawl is part of the cycling cam (above left photo). A long, thin rod (inset) pushes the pawl when tripping is initiated. The photo at right shows the underside of the Start lever and the crescent slide that transfers the Start motion to the long trip rod which shoves the pawl.



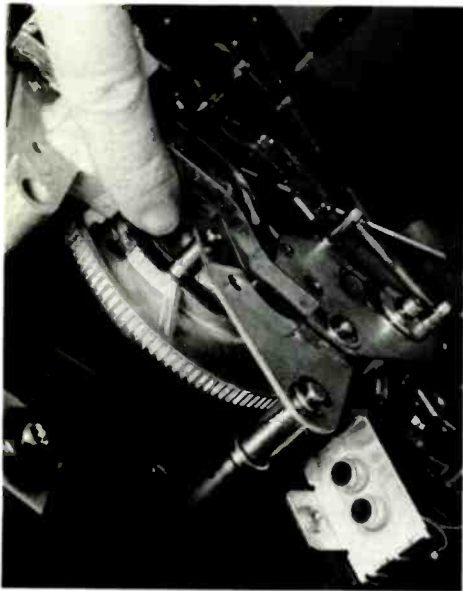
Step 3 When the tone arm enters the lead-out groove of a record, a post on the lateral arm pushes on the end of the long trip rod. This is how cycling is initiated automatically.



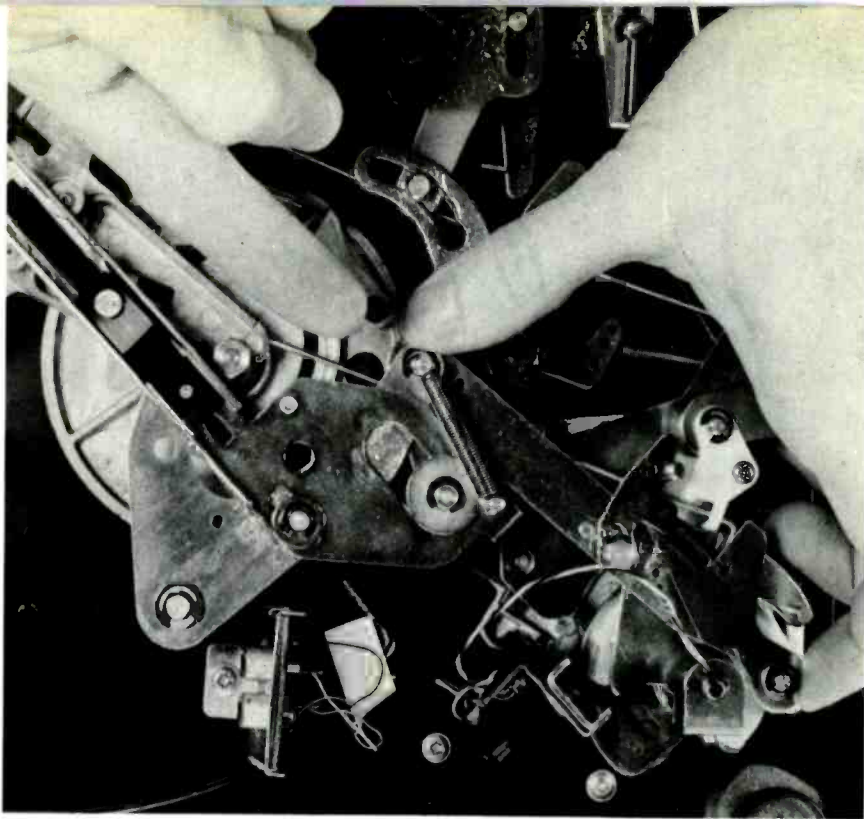
Step 4 In the photo at left is a view of the trip pawl in the tripped position. The turntable platter is off, but you can see its hub in the inset photo. The projection catches on the pawl, dragging the cycling cam into mesh with the gear teeth of the platter hub. You can see, in the photo on the right, the detent lock that holds the cycling cam in place while the record plays; the tug of the trip pawl moves the cam off that detent and into cycle.



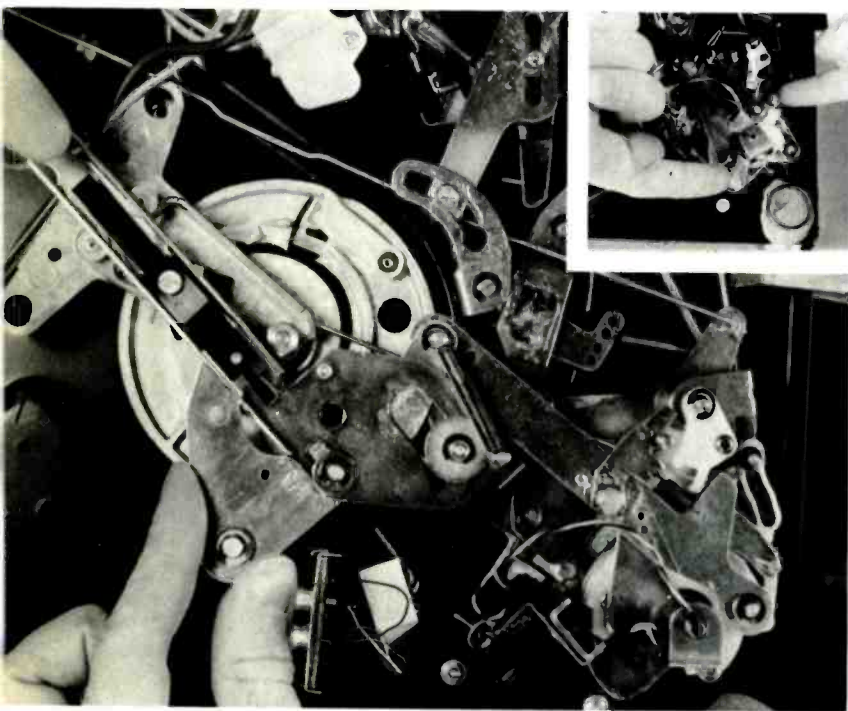
Step 5 These below-deck pictures show the two sides of the cycling cam when it is being driven by the turntable-platter hub. The photo at the right also gives you a good look at the underside of the cam, with the trip-pawl body. The tab that the platter hub catches is above the cam, but this view shows the pivot and the portion of the pawl the long trip rod pushes.



Step 6 From a groove in the cam, the cycling cam drives several cycling slides. The groove engages a post that is part of the main cycling slide.



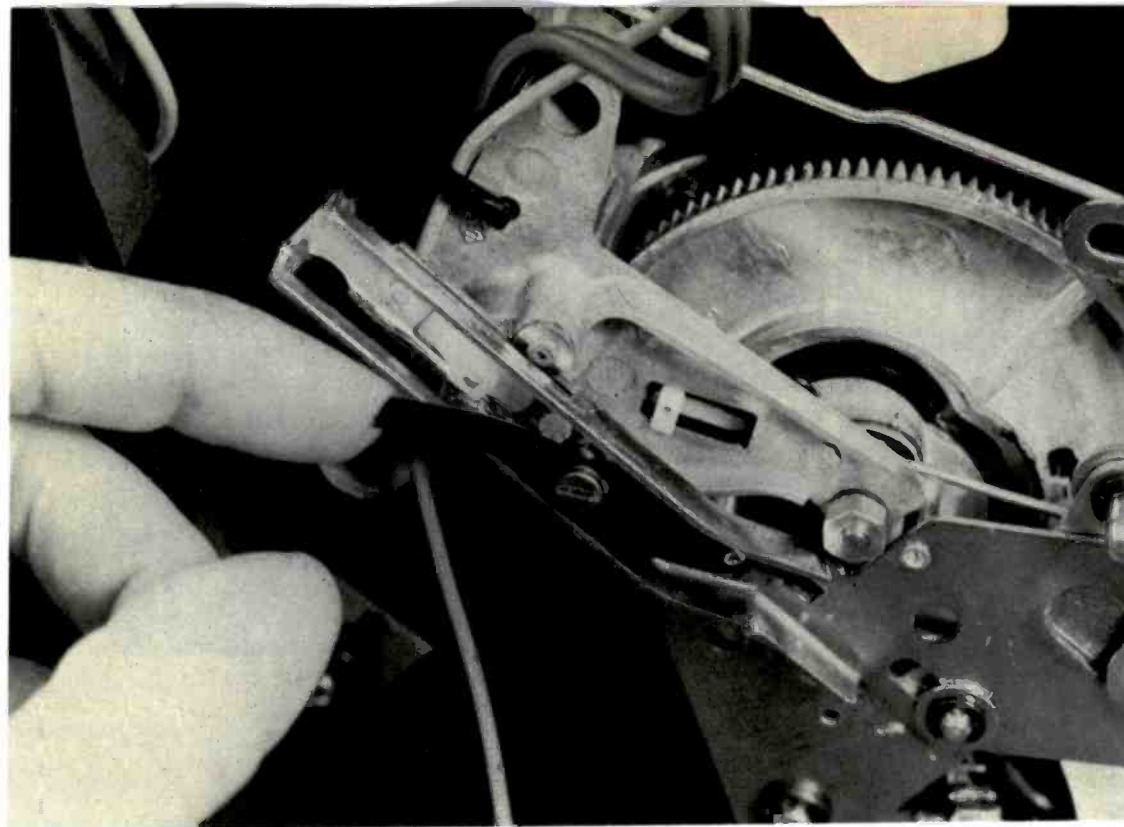
Step 7 This slide takes care of the lifting action of the tone arm. If you encounter faulty lifting, carry your diagnosis to this slide and its associated assemblies. Watch for springs that might have dropped out of place or might be stretched.



Step 8 Lateral motion (swinging out and back) of the tone arm mainly is accomplished by the triangular-shaped slide lever. The inset photo shows the assemblies it acts upon. The post, indicated by forefinger at the right, is part of the tone-arm lateral-movement arm; it's what hits the trip rod at the end of the record.



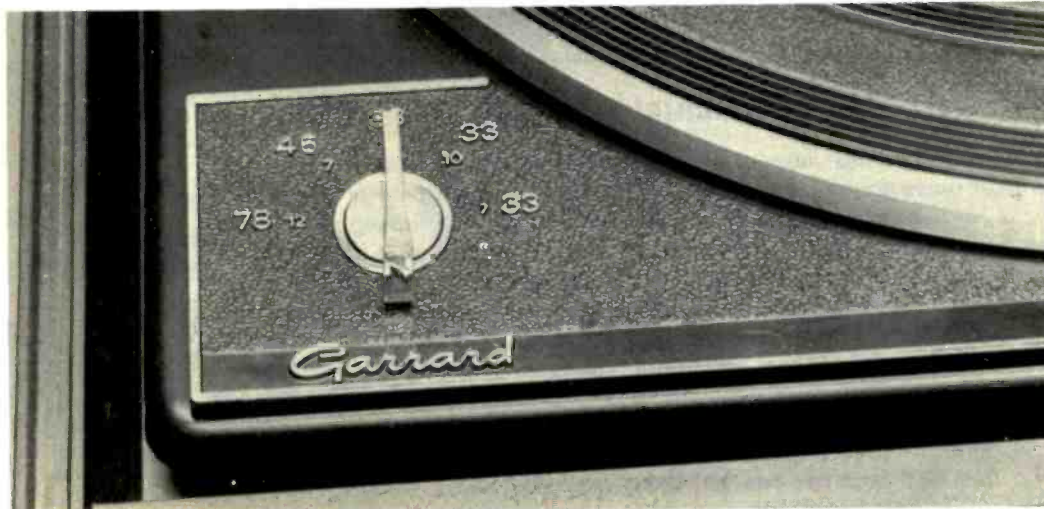
Step 9 This spindle is removable—as are most turntable spindles—and has a long activator rod. Movement of the activator rod is sideways, moving the pushoff tab out and back, and then a little further until it protrudes in the other direction. This far-forward motion senses any more records on the stack; if none, the machine shuts off after the record that just dropped has played.



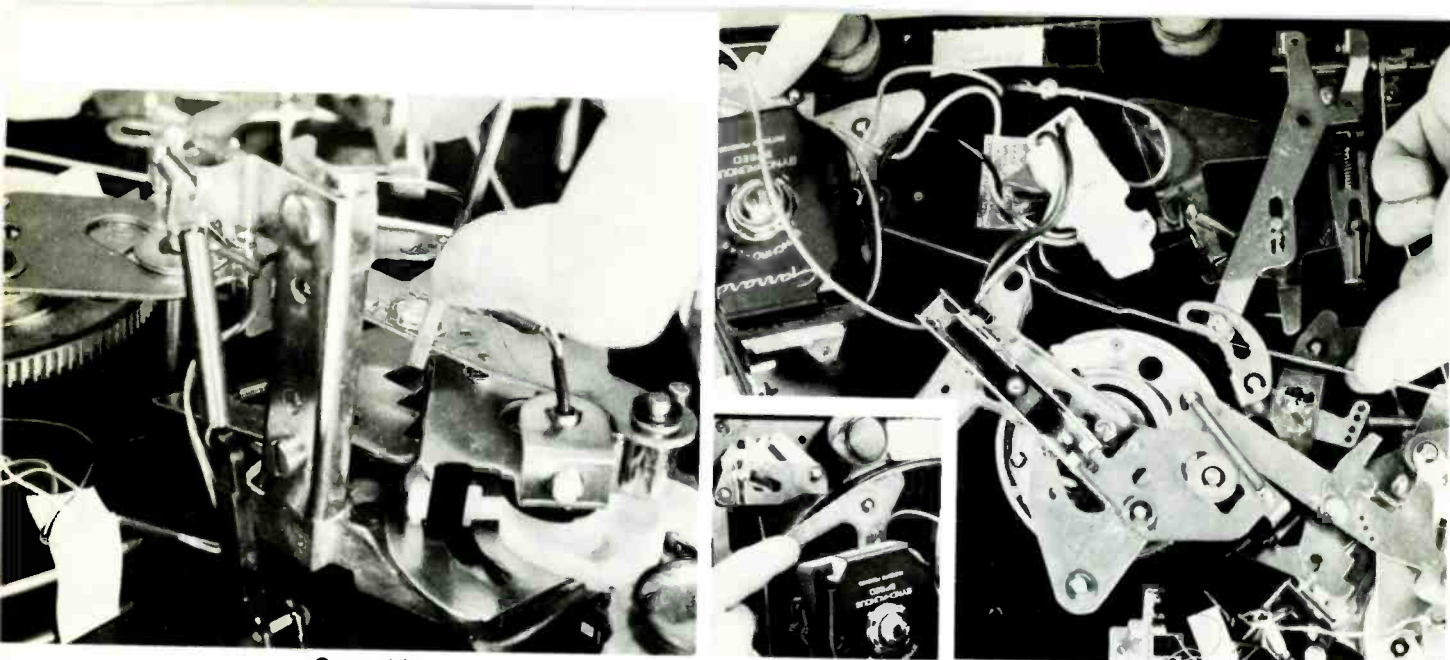
Step 10 A Teflon fitting holds the bottom end of the spindle lever into the cycling slide. This slide senses for shutoff. When the pushoff tab encounters the hole of a record still on the spindle platform, it prevents the slide moving back quite so far. That signals the shutoff mechanisms not to shut off until that final record has dropped and been played.



Step 11 Here you see the spindle actions during record-dropping, but without the records. In the left photo, the cycling slide has moved the lever inside the spindle slightly to the left; the record moves over and drops. The record (in the center photo) has dropped, and the guide tab positions the stack of records. The cycling slide moves far forward after dropping, and carries the lever and tab to the extreme position shown. But any record still on the spindle blocks the tab (and thus the slide below) so the shutoff mechanism doesn't operate. If there's no record to block the tab, the shutoff mechanism is allowed to operate. In the picture at right, the tab has returned to normal, ready to pushoff the next record.

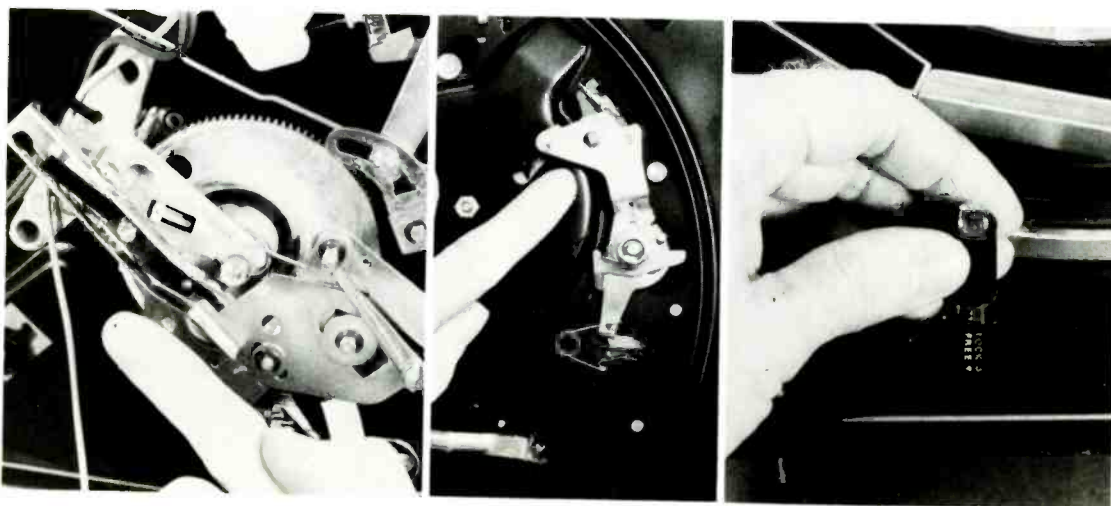


Step 12 Very few automatic turntables or record changers today do the indexing automatically. Instead, a size-selector knob chooses the desired set-down indexing. The one shown here combines size selection with speed change.



Step 13 Here's how indexing occurs. The photo at left shows a notched indexing block; the lateral-slide mechanism moves it into position and starts to pull it back. Connected to the block is a long rod (photo at right) that connects to a lever (inset photo) near the indexing-knob understructure. As the indexing block tries to move back, so does the long rod and indexing lever. The knob understructure stops it at the position selected by the knob. That prevents further motion and the indexing block is held at that position to stop the tone-arm lateral movement at the right diameter for setdown.

Step 14 I already have described the sensing step of automatic shutoff in conjunction with the spindle photos (Step 11). After the record plays, the main slide does not catch the shutoff mechanism and the machine cycles toward shutoff. An extra notch on the index block stops the tone arm before it moves inward. The turn-on mechanism (above-deck parts in center photo) turns off the switch after the tone arm has settled to its rest post (photo at right).



Conclusion

These past four sessions have given you a fairly thorough understanding of the mechanical operations in typical record changers and automatic turntables. If you use a logical approach—cleaning, inspecting, adjusting, and then diagnosing from your study of the machine in operation—you should become an expert in a short time. You have seen from the photos and explanations in these Workshop sessions that various machines have operations in common. Knowing how key operations work, you can adapt that knowledge to any brand or model.

This concludes my Workshop on record changers and hi-fi turntables. If these sessions have suited your need for help with mechanical units, I'll put together others. The next ones could explain eight-track tape mechanisms. With the new two-channel/four-channel machines, you probably wonder what the insides look like and how you can go about troubleshooting them. Watch for the next Forest H. Belt Workshop.

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.

AC/Battery-Operated Tuner Subber

Just announced by Castle TV Tuner Service is the Mark IV - A TV Tuner Subber. The new version incorporates an internal voltage supply powered from 120 volts AC through a plug on the rear panel. This AC operation prevents drain of the two 9-volt batteries when the unit is used for long periods of time. Continuous operation at the test bench is now practical, or the tuner can be used as a loaner by leaving it connected to the TV receiver when the set's tuner is removed for repairs. Normal use by the internal batteries is not changed.



In addition to the primary function as a temporary test tuner to verify positively the operation of the customer's tuner, the Subber can be used to analyze many AGC problems. The high-amplitude output signal, the RF gain control, and the non-critical matching between the "Mastermatch-coupler" of the tuner and the chassis make possible an injection of signal into the last IF stage, which is not AGC controlled.

For More Details Circle (34) on Reply Card

Test Jig

Telematic offers the Combo-Rig Model CJ175, a test jig designed for both tube and solid-state service work.

The Combo-Rig is a complete set-up which eliminates the need to haul heavy cabinets and breakable picture tubes from the home. It is packaged without the picture tube and includes all extensions and deflection components needed for a 19-inch CRT. The Telematic Transverter, a plug-in

3 ways to power 4 sets

Good

The A-104 U/V signal divider feeds four TV and/or FM sets from one antenna. Low loss, high isolation between sets. Mounts indoors or on mast with optional jiffy mount. 300-ohm connections. One of ten band separator/combiner and signal divider devices.



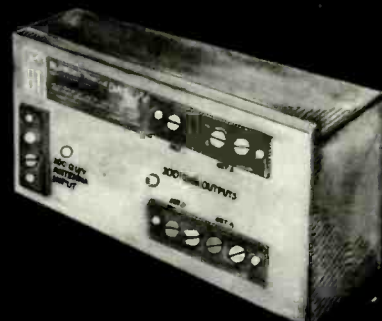
Better

HOVIER 300 U/V—Economy priced, amplified, four-way splitter (four 300-ohm outputs). Excellent choice for moderate signal areas where passive splitter degrades TV pictures. Gain 8.5 dB VHF, 2.5 dB UHF with four sets operating. 4-way lightning and surge protection. One of four Homer models: all channel, 75 ohm, plus a 75 and 300 model featuring patented wide dynamic range ICEF circuit.



Best

DA-4 U/V-300—High performance, all channel amplifier delivers superior picture power to four sets in areas with both strong and weak signals. Features patented ICEF circuit for wide dynamic range. Three transistors, transformer power supply. Typical gain: VHF 7.0 dB, UHF 8.0 dB on four sets. Also available in 75-ohm, all channel version, as well as VHF/FM 300 and 75 ohm models.



In addition to these high quality products, Blonder-Tongue offers TV and FM reception improving products from TV antenna to matching transformers. Available at your local electronics supplier. Blonder-Tongue Laboratories, Inc., One Jake Brown Rd., Old Bridge, N.J. C8857.


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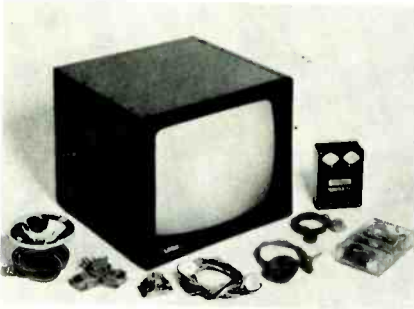
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accessory, is used in servicing solid-state work.



Telematic MAP 3500 includes the Transverter and four adapters for Motorola, Sylvania, RCA, and Zenith TV sets. The CJ175 includes these four adapters and is priced at \$89.95, without the picture tube.

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Digit Multimeter

A 20,000 count (4-1/2) digit multimeter is offered by Data Technology Corporation.

Model 41 multimeter is a 24-range instrument. It has four AC-voltage ranges with 100 μ V resolution, five DC-voltage ranges with 10 μ V resolution, five resistance ranges with 100 megohm resolution and five AC and DC current ranges with 10 μ A resolution. Line power is 115 or 230 VAC, switch selectable; power consumption is 8.5 watts.

Model 41 is priced at \$595.00.

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Portable VOM

VTVM accuracy and battery-operated portability are among the principal features of the new solid-state Model LV-71 FET volt/ohm meter now available from Leader Instruments Corp.

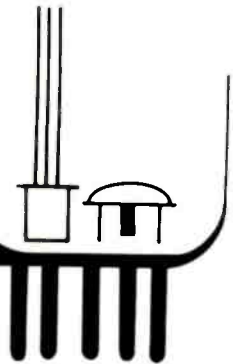
The LV-71 features dual FET (differential) amplifier circuitry, polarity-reversal switch, battery-condition switch, and diode-overload meter protection. DC impedance is 10 megohms with AC impedance to 1 megohm. There is a zero-center scale on a 4-1/2-inch meter with taut band construction.

Other features include 12 voltage ranges DC, 7 steps, from as low as 0.3 full scale to 1200 volts; and AC, 5 steps, to 600 volts. DC current is from 0.3 mA full scale to 300 mA. Resistance is in 4 steps from RX1 ohm to RX1 megohm. Dual-scale output readings are from -20 to +17 dB; +15 to +31 dB.

The LV-71 measures 6-1/2 X 4 X 2 inches and weighs 2 lbs. It sells for \$64.95, complete with one set of test leads and alligator clip adaptors.

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productreport

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Mobile Shelving Systems

Compact, modular, mobile shelving systems that require half the floor space of conventional shelves are available from **Automated Storage Systems, a Division of Estey Corp.**

The systems utilize a single-access aisle. By moving rows of shelves, individually or in multiples, the access aisle can be formed between any two ranges of shelves.

Systems are available electrically powered, or they can be manually operated. The automated system offers pushbutton control, automatic illumination, and four separate fail-safe systems to safeguard persons and articles. Other features include modular design, high-quality steel shelving, colors for decorating or color coding, good visibility of shelved contents, and bottom shelves that protect items from floor-cleaning and transport equipment.

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Solder Feeder

One-hand soldering with all popular brand soldering guns now is possible with the "Free-Hand" solder feeder by **Schurman Products.**

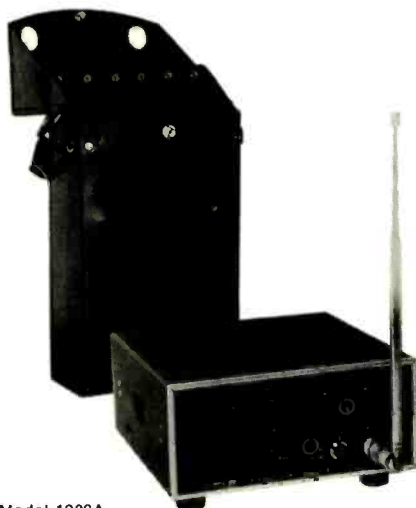


The device frees one hand for small-parts handling and allows pliers to be used as a heat sink, and the thumb-actuated trigger (which can be positioned on either side of the gun) feeds solder at any desired amount.

The "Free Hand" features heavy-duty construction, with durable nylon and precision-made steel parts. The entire unit weighs 5 ounces, including solder, and sells for \$8.95, complete with a 10-foot spool of solder.

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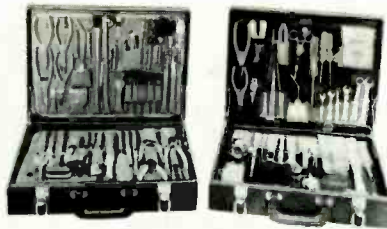
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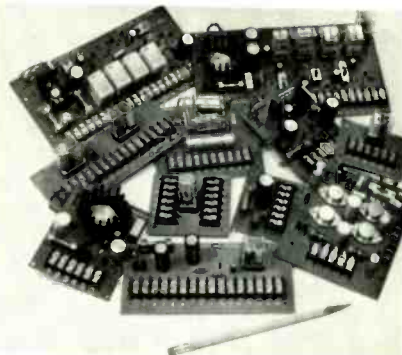
The tool case is functional but adds to the professional look of the technician and his company. Design of the case improves the efficiency of the technician by making tools easier to find and reducing tool losses; an empty pocket is a signal that a tool has been left behind.

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Detconr Security Systems, Inc. announces the availability of a complete line of solid-state security modules.

Included in the line are burglary and fire-control modules with electronic features, such as programmable exit and entry delays, selection of latchup or automatic recycling, electronically-regulated power supply circuits which may be used with rechargeable batteries, and first and second alarms (each with its own set of relay contacts).



The company also has medium- and high-power electronic siren modules, electronic latching-relay modules, reversing relay and auxiliary relay modules, and a number of electronically-regulated power supply modules.

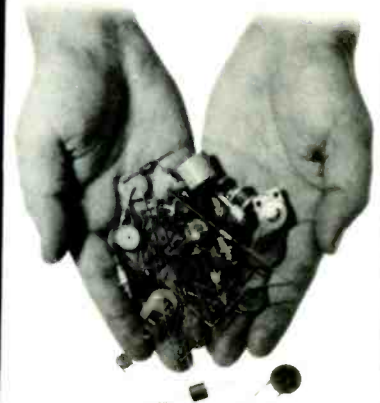
All of the modules are terminated in screw-type barrier strips and are designed to be interconnected to each other in various combinations. All modules are supplied with complete mounting hardware and installation instructions.

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catalogs literature

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100. Amphenol Sales Division—has published a full-color pocket-sized catalog which describes connector and socket devices designed specifically for use in hobbyist equipment. The catalog provides details on Amphenol's microphone, hexagonal, and RF connector families, and on its chassis socket, dual-in-line and T.O. can socket lines.

101. The Antenna Specialists Co.—offers an 8-page brochure entitled "Why CB Antennas?". Illustrated with diagrams, patterns, and sketches, the brochure explains the technical side of CB antennas and a gain-to-effective power chart.

102. Bell Industries, J. W. Miller Division—offers a comprehensive 100-page radio and TV coil-replacement guide with a cross-reference directory. The guide lists 30,000 replacement coils for 375 manufacturers' names.

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.

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56 ELECTRONIC SERVICING/February, 1974

(Continued from previous page)

106. Heath/Schlumberger Instruments—has published a catalog which provides descriptions, photos, and specifications for instruments such as frequency recorders, oscilloscopes, power supplies, digital multimeters, recorder systems, an analog-digital teaching system and the Heath/Malmstadt-Enke Lab Stations. Featured in the catalog is the new line of autoranging frequency counters and a low-cost strip-chart recorder. □

Those TV "Dogs"

(Continued from page 33)

But, suppose the 6JH5 fails to draw any current. Diodes X26 and X28 become open circuits, there is no voltage at the 6JH5 cathode, and no positive voltage can flow through R192. At the same time, the negative voltage from R193 continues, and, without the cancelling effect of the positive voltage, drives the grid of the 6LB6 more negative than usual. This reduces the maximum plate current, lowers the high voltage and narrows the picture width.

Two things are accomplished. The high voltage is reduced, so there is no X-ray danger, and the picture is poor which encourages the set owner to call a technician for needed repairs.

One interesting side effect happens when the HV regulator is not operating. Brightness, width and focus all become noticeably better as the brightness level is increased, although they don't ever become normal.

Now, back to testing the high-voltage regulator circuit. It can be made ineffective for testing pur-

poses by removing the tube from the socket, or by grounding the control grid. However, that would activate the fail-safe circuit and void the purpose of the test.

It is necessary to short across X26 and X28 using a test lead, plus removing the regulator tube in order to kill the regulation.

In this case, the symptoms on the screen were gone, and the high voltage was excessive (naturally).

VDR's are difficult to test accurately, so again I chose the easy way by replacing R178, and resetting the high voltage. No more displaced lines or trapezoidal pictures on the screen after that.

Conclusions

These excerpts from my Casebook are all actual examples of the servicing philosophy I use and advise others to adopt. First, know which basic circuits are capable of causing which symptoms. Then test those circuits in the fastest way possible. In most instances, this means checking the entire circuit as though it had only one stage. Then zero in on the one bad stage that contains the defect.

Wholesale parts replacements and replacement because of suspicion alone are minimized by this method of testing. □

Medical Electronics

(Continued from page 19)

any valid reason, but that are enforced with an iron hand by the strong-willed nurses who run the OR. This is not as tyrannical as it sounds, for the infection rate of any OR seems to be in direct proportion to the observance of those rules. If you are told to do something in a certain way, do it!

In most areas of the hospital, the security people will probably want you to wear a name badge or a white "lab coat" so the patients can see at a glance you belong.

Regardless of the "dress code", you will be required to do your servicing of the equipment accurately, rapidly, and with excellent craftsmanship. After all, human lives sometimes depend on your workmanship; and that's a lot more important than the disappointment of a viewer who can't see the Sunday afternoon football game! □

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photofactbulletin

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

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CORONADO TV2-2034A, TV2-2034B	1378-1
DUMONT 16DP40, 16DP41WR (Ch. T32K10-1A)	1373-1
J. C. PENNEY 4863A, 4864A, 4897A, 4922A, 4923A, 6898A	1375-1
MGA BB-093, BB-094	1374-1
MGA BB-126, BS-125	1376-1
MIDLAND 15-013	1377-1
OLYMPIC CT-518	1372-1
PANASONIC CT-26, CT-27	1371-1
PANASONIC CT-772	1373-2
PANASONIC CT-911 (Ch. ETA-3)	1379-2
RCA Chassis CTC59XD/XE/XF Remote Control Receiver, Transmitter CRK18A	1376-2 1376-2-A
RCA Chassis CTC68A/AE/AF/H/P Remote Control Receiver CTP22A, Transmitter CRK19A	1378-2 1378-2-A
RCA FS450W (Ch. CTC66XA)	1372-2
RCA Chassis KCS171XC/XE Remote Control Receiver, Transmitter KRT5D	1371-2 1371-2-A
RCA Chassis KCS190B/C	1373-3
SEARS 562.50170300, 562.50721200	1374-3
SEARS 564.50390200/0201/1300	1379-3
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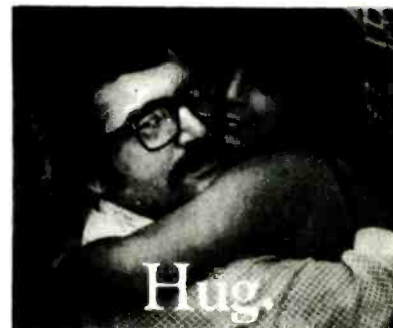
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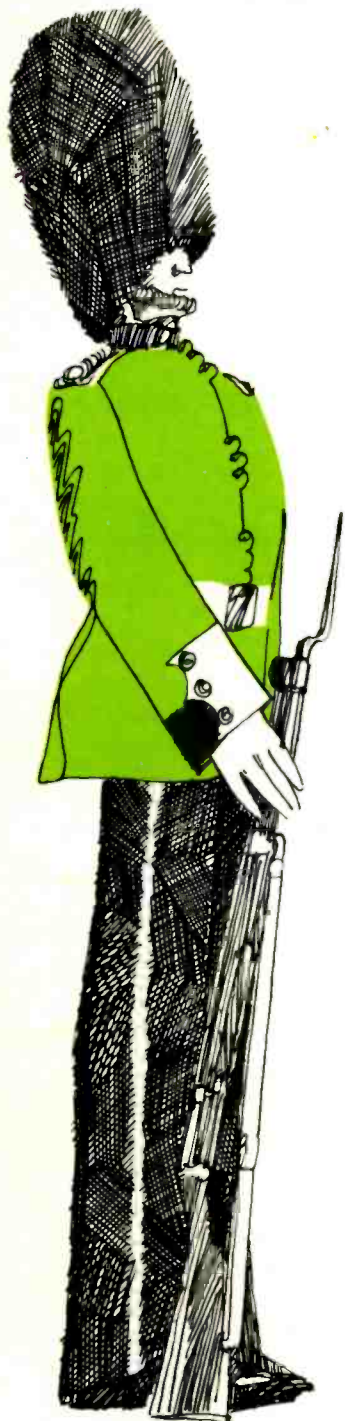


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