60¢ ■ AUG. 1974

Radio-Electronics

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34140

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

BUILD THIS $35
Infra-Red Viewer

INSTALLING SECURITY SYSTEMS
Road To Profits Or Problems?

DESIGN SOLID-STATE
Transformerless Output Circuits

NEW KIND OF TV SOUND
Goes Hi-Fi Stereo

TUNNEL DIODES
Theory And Circuits

ABC'S OF PUBLIC ADDRESS
Basics Are Vital

PLUS
- Appliance Clinic
- 2 Equipment Reports
- Jack Darr's Service Clinic
- Bob Scott's Technical Topics
- R-E's Transistor Guide

A GERNSBACK PUBLICATION

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Circle 6 on reader service card

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

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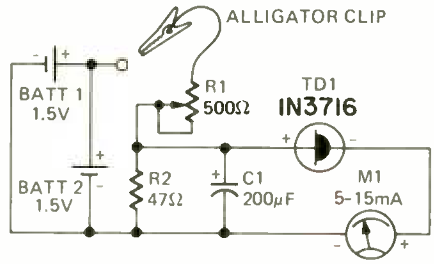
HI-FI STEREO SOUND from your TV is one of the fringe benefits you get from this pay TV decoder. **. . . see page 45**



BASIC TUNNEL DIODE EXPERIMENTER'S circuit. Several other circuits are in the article. **. . . turn to page 52**

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looking ahead

U.S. audio code

After Nov. 4, shoppers for audio equipment will be able to make direct comparisons of power output frequency response and distortion specifications of competing brands on the basis of advertising claims. The Federal Trade Commission has set that effective date for its long-incubating trade regulation rule which establishes standards for measurements and specs given in ads. The rule was designed to end the confusion over such terminology and standards as IHF measurement, "peak power output," "music power" and the like.

The new rules provide that whenever any advertising claim is made concerning power output, frequency response or distortion characteristics, these facts must be disclosed:

1. Manufacturer's rated minimum sine wave continuous average power output (RMS) in watts per channel for each load impedance for which the equipment is designed, measured with all channels fully driven to the rated power.

2. The load impedances for which the equipment is designed.

3. Manufacturer's rated power band or power frequency response in Hertz.

4. Manufacturer's rated percentage of maximum distortion at any power level from 250 mW to the rated power output.

To make certain that all claims are comparable, the Commission also specifies standard test conditions to arrive at these ratings.

1. Power-line voltage of 120 volts rms, 60 Hz, (for equipment designed for sale in the U.S.), using a sinusoidal wave containing less than 2% harmonic content.

2. Amplifier to be warmed up for an hour by operating all channels at one-third rated power using 1000-Hz sine wave.

3. Rated power to be obtainable at all frequencies without exceeding rated maximum percentage of total harmonic distortion after input signals have been continuously applied for five minutes at full-rated power.

4. Tone loudness-contour and other controls to be set for flattest response.

Many audio equipment manufacturers have already switched to rms measurement in anticipation of the rule. Nevertheless, one of the most immediate effects will be to cut down drastically on power claims. Not only is rms power far lower than such virtually mythical types of measurement as "maximum music power," but the new rule doesn't permit addition of all channels' output for a total figure. Thus a quadriphonic amplifier which today can be advertising as having 40 watts rms output will in the future be cited as having 10 watts per channel. Manufacturers who don't wish to use the government-specified system won't be permitted to advertise power or frequency response at all. The rule applies to retail and distributor as well as manufacturer advertising.

Slot mask tubes

Probably the most significant aspect of the new 1975 model television receivers is the first widespread defection from the conventional shadow-mask tube with its round phosphor dots and delta electron-gun configuration. Virtually every American-made and imported TV brand — Zenith is the single major exception — has changed over to the slot-mask tube for at least a portion of its portable line. We'll keep you up to date on later developments in this new type of color picture tube.

The slot-mask tubes use horizontal in-line electron guns and have alternate strips of red, green and blue phosphor on the face plate. The mask contains a series of slits corresponding with the phosphor strips. Two principal types of slot-mask tube are being manufactured in the United States — a narrow-neck type with the yoke precemented to the neck and a wide-neck version with a more conventional, removable yoke. The cemented-yoke type eliminates all dynamic convergence adjustments, while the wide-neck version eliminates most of them. Designed especially for solid-state sets, the new tubes save money on circuitry and adjustment, are designed to require less service. They're about two inches shorter than conventional 90-degree tubes.

Slot-mask tubes are now being featured in 13-, 15-, 17-, and 19-inch sizes by American manufacturers and in smaller sizes as well by Japanese set makers. Most of the slot-mask tubes use the black-matrix principle for contrast enhancement. Zenith is sticking to its Chromacolor tube, with no slot-mask in sight, but it's known to be working on a short 110-degree deflection tube for portables. Sony, which can be said to have inspired the slot-mask fever, is holding onto the Trinitron, which officially is classed as a "slit-mask" tube since the vertical holes in its shadow mask run the entire height of the tube without being broken by cross-pieces. A 21-inch Trinitron is now being sold in Japan, but no date has been stated for it's introduction in the United States.

Mavica

The newest proposed home videoplayer has been demonstrated in prototype form by Sony. It's called "Mavica," which stands for magnetic video card. A flat envelope, or "Mavicard," measuring 6¼ × 8½ inches, is fed into a slot in a player and provides 10 minutes of color TV programming. The envelope contains two sheets of magnetic material, one recorded with color video information, the other with two channels of audio. Inside the player they're removed from the envelope and each is automatically inserted inside a drum, where they're scanned by revolving playback heads. After playing, they're reinserted in the envelope, which is then disgorged through the slot as a complete package.

Sony says it has no plans to commercialize Mavica, which could be marketed as a playback-only or record-and-play unit. It's testing reaction before making any decision. In mass production, it could be marketed for $450 to $600. To achieve longer playing time, Sony engineers say the card, and thus the machine itself, would have to be made larger. Sony gave the resolution of its system as 220 lines horizontal and 250 lines vertical and said prerecorded videocards could be reproduced by heat transfer at the rate of 20 per second. For LP video recordings, Sony still prefers the now standard videocassette.

Dated television

Federal and state governments these days are requiring dating on an increasing number of products — generally food and other perishable items. Would you believe that beginning next Jan. 1, all television sets must be dated? Yes, that's the rule, established by — guess who? — the Food and Drug Administration.

A new FDA regulation, adopted over the protests of television manufacturers, requires that the month and year of manufacturer be "clearly and legibly" printed on product identification tags or labels of all television sets sold in the U.S. How did the Food and Drug Administration get into the act? The FDA's Bureau of Radiological Health is responsible for government X-radiation regulations, and the purpose of the date rule is to make it easy to determine which X-ray regulations were in effect at the time the set was made. It also presumably will protect the public from stale TV sets. **R-E**

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The new Mallory CA3 Intrusion Alarm.

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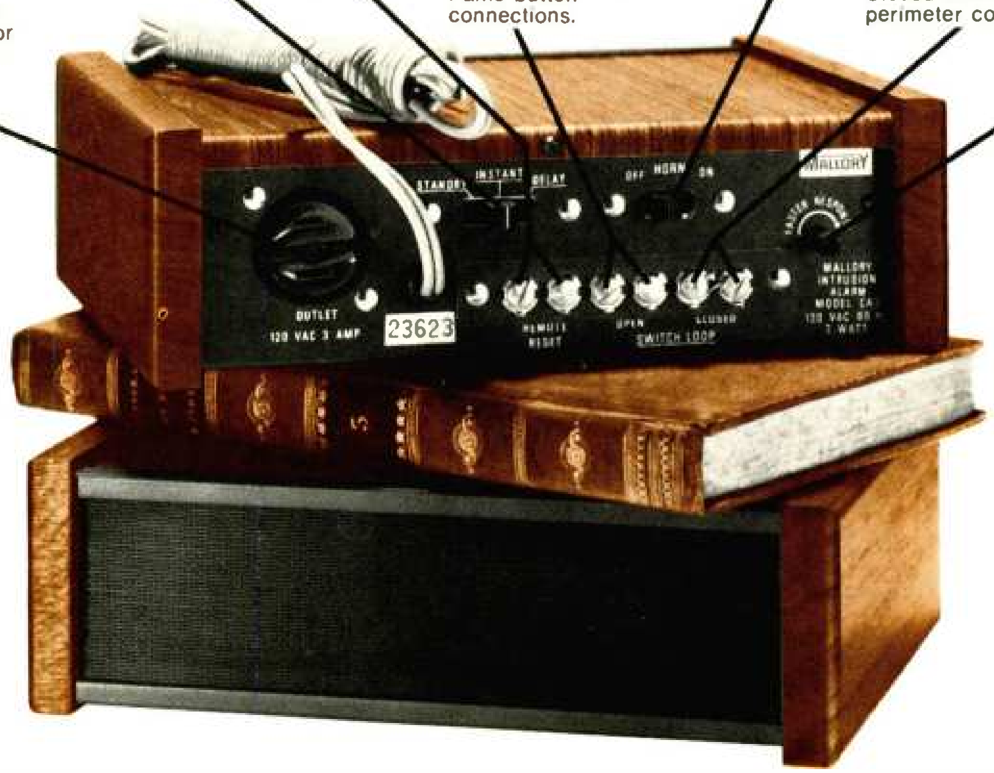

(And inconspicuous.)

This area-and-perimeter device creates and transmits an ultrasonic wavelength field for detection up to a distance of 20 feet. And because of its modern design and walnut-grain finish, the CA3 is attractive and inconspicuous enough to pass as a radio or stereo tuner.

Virtually any movement by an intruder (or a break in the perimeter circuit) activates the built-in horn and the remote outlet for two minutes. An automatic reset handles the possibility of a new or renewed intrusion. And special CA3 circuitry guards against false alarms from line transients and insects. A variety of companion indoor or outdoor accessory devices is available.

The Mallory CA3 Ultrasonic Intrusion Alarm. From the manufacturer of the most complete line of do-it-yourself security products. Another sound reason to see your Mallory distributor today.

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25,000 phone calls on one laser beam possible with new light modulator?

As many as 25,000 persons may some day be able to talk simultaneously over a single laser beam using a new electro-optic modulator recently designed by RCA scientists. This bandwidth would accommodate 20 TV channels, reports Dr. William M. Webster of the RCA Laboratories, Princeton, N.J.

The new electro-optic modulator is the first that is truly compatible with integrated circuits and capable of spatial switching or aiming a laser beam. It can operate over light wavelengths ranging from the visible to the near infrared.

The active portion of the new modulator occupies only 0.12 x 0.02 x 0.02 inch. The important feature is a thin lithium niobium tantalate film that acts as a waveguide for the laser light. The film is only 20 millionths of an inch thick. Modulation voltages are applied to minute interleaved metal fingers over it. Varying these voltages changes the refractive index of the film material, altering the direction and the velocity of the light passing through.

Voltages required are low — 80 percent modulation can be obtained with 6 volts for red light and 3 volts for a blue laser beam. Modulation frequency limits are far beyond the requirements of any present applications.

High-purity optical fibers with losses comparable to those of conventional electronic waveguides have already been developed and it seems that optical transmission systems, with such fiber-optic waveguides and light from laser sources, may become practical communications systems in the not-so-distant future. Being practically perfect insulators, they are free from electromagnetic interference or noise. Their losses are independent of frequency instead of increasing rapidly with frequency, as is the case with present-day coaxial cables. They are lighter than metallic waveguides and are much safer in environments where electric sparks or arcs could start a fire or trigger an explosion. For these two reasons, optical transmission systems are already in use on some military aircraft. Much greater bandwidths than can be obtained with electric waveguides are also possible.

But — the problem of modulation has presented a difficulty. Light sources themselves can be modulated at high frequencies, but appreciable currents have to be varied at high speeds. Using the light-producing device as a constant source and modulating the light beam is preferred as a more practical approach.

Successful modulators which insert information into a laser beam have been developed. These have been comparatively large and heavy, demanding in their power requirements and slow in action. The new device, besides being smaller, faster and less power-consuming, is simple to make and can probably be produced for a fraction of the cost of older units. Thus the new modulator may truly be called a breakthrough.

Probable future applications may be found not only in telephone, radio and television communications and specialized space and military systems, but in a variety of systems requiring a wide range of laser modulation, from a few cycles per second to the gigahertz range. One promising application is in controlling lasers in facsimile systems. •

Robert Cook wins Gernsback Award

Robert A. Cook is the recipient of the first 1974 Hugo Gernsback Scholarship Award. **Radio-Electronics** gives out nine of these $125 awards annually, one to a student in each of the nine leading electronics home-study schools.

Mr. Cook is the nominee of the Cleveland Institute of Electronics and is enrolled in that school's Electronics Technology with Laboratory program. He lives in Astoria, N.Y. and is employed by the Consolidated Edison Co.

The second-place award of an RCA WV-529A service special vom goes to CIE student Thomas M. Nielsen from Milwaukee, Wisc. •

Electronic pocket calculators take over a classroom

Flying in the face of traditional attitudes that hold that the disciplinary advantages students gain from plodding through pencil-and-paper work may outweigh those gained from the knowledge of mathematics obtained, Menlo College (Menlo Park, Calif.) equipped an entire classroom with pocket calculators.

Evaluated after one year, the program has been pronounced an unqualified success. "The calculators help students understand the logic of problem solving while eliminating much of the drudgery," explains Donald J. Albers, head of the math department. "Many students, especially the weaker ones, acquire a significantly faster and firmer grasp of what math is all about."

An important advantage is that more examples can be discussed in a class period and that more complex problems can be introduced than when valuable class time had to be spent figuring out answers. No longer does the trignometry instructor have to keep the problem to the traditional tidy 45- and 60- to 30-degree angles nor the professor in business courses keep interest rates and payment problems simple. More realistic and "messy" problems can be presented with the students solving them in seconds. Now 20 to 30 examples can be discussed in a class period in place of the traditional three or four.

MATHEMATICS DEPARTMENT CHAIRMAN Donald J. Albers uses an HP-45 pocket-size scientific calculator to explain a problem to a student. The machines are used by Menlo's science, mathematics and business departments.

The effects of the more intensive and realistic approach are marked. One professor had to rewrite the final class exam in statistics because the class had covered considerably more ground and understood the subject more thoroughly than had been the case in previous years.

A number of colleges ban calculators on the ground that they give an unfair advantage to students who can afford one. Menlo solved the problem by supplying the calculators, at a cost of about $14,000 to the college. •

Semiconductors are vulnerable to "innocuous" rf interference

Apparently innocuous radio interference can disrupt normal functions in

(continued on page 12)

We're making it our business to make your business easier.

All GE 18" and 19" diagonal color TV's have in-home warranty service.

Whatever went wrong with their new General Electric television set isn't your fault. But by the time your customers get around to calling you, somehow you're the guy they vent their frustrations on. So to try to save wear and tear on your nerves, we're doing what we can to help reduce your customers' irritation.

Specifically, we're giving in-home warranty service on all our 18 and 19-inch diagonal color sets (with and without handles). And if you don't think that's important, ask the next lady who has to lug a 60 lb. set into your shop.

We're keeping your customers happier by keeping their sets at home.

GENERAL ELECTRIC

TV Receiver Products Dept., Portsmouth, Va.

Circle 1 on reader service card

You get the same 25" DIAGONAL hobby-kit color TV from three different schools.

You get this designed-for-learning 25" DIAGONAL color TV only with NRI training.

No other home-study school gives you a TV like the one you build with NRI's Master Course in Color TV/Audio servicing. Some schools give you three or four plug-in sub-assemblies off the production line to put together a commercial set. Others give you a hobby-kit bought from outside sources. And because neither type was originally designed to train people for TV servicing, lessons and experiments must be "retro-fitted" to the set as it comes.

That's why we went to the trouble to engineer our own, exclusive solid-state TV. It's the only way a student can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building a complete set from the "ground" up, (3) perform over 25 "inset" experiments during construction, and (4) end up with a beautiful 25" diagonal solid-state color TV with wood-grain cabinet and all the modern features for top performance. Nobody else can give you this combination of advantages because nobody else invested the time and money to design a set with learning in mind.

More know-how per dollar

That's what it all boils down to, the quality of training you get for the money you spend. In our 60-year history, almost a million students have come to NRI and we're fully approved for the G.I. Bill. We must be teaching something right.

Some of those "right" things are bite-size lessons to ease understanding and speed learning . . . personal grading of all tests, with comments or explanations where needed . . . a full-time staff of engineer/instructors to help if you need it . . . plenty of "real-life" kits and experiments to give you hands-on training . . . and fully professional programs oriented to full- or part-time career needs.

NRI passes the savings on to you

This unique TV doesn't cost you more . . . it costs you less, because NRI engineering eliminates the extra cost of buying from an outside source. NRI training also costs less because we sell only by mail. No salesmen. We pass the savings along to you in the form of lower tuition fees, extras like the TV cabinet (another $140 with other courses) and a solid state radio you learn on as you build, plus the actual instruments you'll need to service TVs . . . triggered sweep oscilloscope, integrated circuit TV pattern generator, and digital multimeter. You can pay as much as $800 more for a similar course and not get a nickel's worth extra in training and equipment.

Widest choice of career opportunities

NRI offers not one, but five excellent TV/Audio servicing courses so you can tailor your training to your budget. Or, you can study other opportunity fields like Computer Electronics, Communications, Aircraft or Marine Electronics, Mobile Radio, and more. Free catalog describes them all, showing lesson plans, equipment and kits, and career opportunities. There's no obligation and no salesman will ever call, so send for your copy today. See for yourself why NRI experience, selection, and exclusives give you something no other school can.

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3939 Wisconsin Avenue,
Washington, D.C. 20016

new & timely *(continued from page 6)*

some semiconductor devices and, in some instances, can destroy them completely, according to a paper presented to the IEEE International Symposium on Electromagnetic Compatability in July. The paper, offered by the U.S. Naval Weapons Laboratory, reports on a study of more than a thousand devices involving 160,000 measurements.

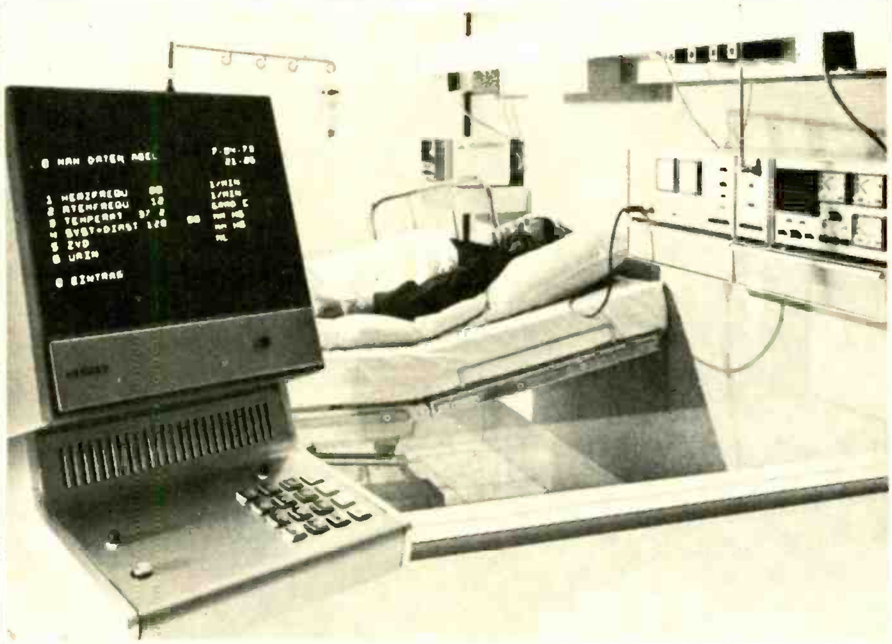
Catastrophic failures, according to the study, have been induced in logic modules and operational amplifiers with bursts of rf power of less than 100 watts, lasting only 500 microseconds. Logic state changes have been induced in 7400 series NAND gates at absorbed rf power levels as low as 10 milliwatts. Output changes of several volts have been observed on 741 operational amplifiers at absorbed rf power levels of less than 10 microwatts says the report. •

I.R.I. award to Wm. G. Pfann

The Bell Laboratories scientist who developed the zone melting technique, William G. Pfann, has been selected by the Industrial Research Institute to receive its second I.R.I. Achievement Award. The Institute is composed of some 230 of the larger companies engaged in industrial research.

Zone melting is the process in which a position — or zone — of a crystal is melted and the melted portion moved slowly along the crystal. As this melted disc — usually produced by an induction heating ring around the cylindrical crystal rod — moves along, it carries the impurities with it and they can be swept along to the end of the rod. This Pfann technique makes possible the high-purity material needed for any but the crudest types of transistors. It is therefore basic to modern transistor development.

The award is in the form of an original work of art symbolizing creativity in industrial research. •



SIEMEN' "SIMON" DISPLAY SCREEN (extreme left in the photo) spells out all the information on the patient in letters anyone can read. In the rear is the patient whose condition is being monitored by the instrumentation. •

INDEPENDENT SERVICE TECHNICIANS evaluate and criticize General Electric service data in a day-long Indianapolis meeting. Left to right: Robert C. Hannum, General Electric supervisor of training and publications, Portsmouth, Va.; Dick Raub, president, ITTA; Buzz Padgett, CET, service manager, wholesale TV; Claude Desmeules, CET, TV & Stereo Service; Jim Candler, Economy TV; Dick Glass, CET, executive vice president, NESDA—all of Indianapolis—and Dean Mock, CET, Mock's Television, Elkhart, Ind. •

Computer intensive-care unit "spells out" patient's condition

An important improvement in intensive-care monitoring the "Simon" computer-assisted patient monitoring unit—has been introduced Siemens.

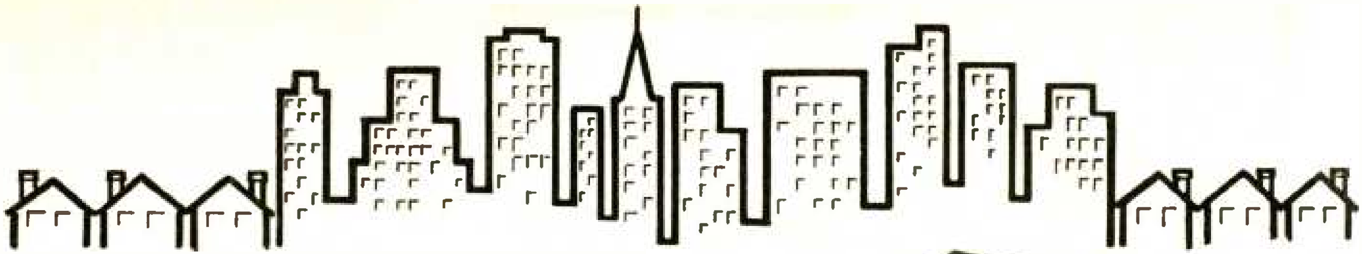
Most striking feature of Simon is the display unit on which all information on the patient is spelled out in words and figures on a display screen. The information is updated every 30 seconds. In older types of intensive-care units, the information on a single patient was often transmitted to the supervisory booth in a variety of forms, making it slower and more difficult to read out all the information on a patient.

An equally important, if less striking, feature is that the computer, while checking that the various conditions do not go beyond preset limits (common to all intensive-care instrumentation systems) also analyzes the variables in relation to each other and in relation to preceeding values. Thus the doctor or nurse may be able to note information expressed by two or more factors more quickly than if it had to be correlated from the readings of two or more instruments and can also note trends in any one variable before the condition reaches a danger point. •

Hunter can now "home in" on wounded quarry

Wounded game may often escape a

(continued on page 14)



Announcing the WINEGARD METRO-LINE TV-FM DISTRIBUTION AMPLIFIERS

...the first high input, high output, low-cost MATV system amplifiers for strong signal areas

Winegard's new Metro-Line amplifiers are specifically engineered to accommodate strong signals and eliminate overload economically and efficiently. Because they have the same commercial quality construction and circuitry as the DA-830, DA-825B and DA-815, they are ideal for home, hotel, apartment and office building systems.

Check these other important performance features:

- High output capability makes a Metro-Line your best db buy
- High input solves distortion and overload problems common in strong signal areas
- Lightning protection diode
- 82 channel models have separate VHF and UHF amplifier stages
- Extended band pass (54 to 300MHz) includes mid and super band coverage making Metro-Line approved for CATV use
- Eliminates multiple outlet charge for extra sets or MATV systems on cable TV
- UL listed
- Easy for any competent TV service dealer to install
- Choose from 3 VHF-FM and 2 VHF-UHF-FM models; suggested list prices from $30.85 to $47.30

		DA-203	DA-205	DA-215	DA-803	DA-805
OUTPUT PER CHANNEL*	**VHF**	46dbmv	46dbmv	53dbmv	43dbmv	45dbmv
	UHF	NA	NA	NA	35dbmv	35dbmv
INPUT PER CHANNEL*	**VHF**	31dbmv	31dbmv	40dbmv	31dbmv	31dbmv
	UHF	NA	NA	NA	26dbmv	26dbmv
GAIN	**VHF**	15db	15db	13db	12db	14db
	UHF	NA	NA	NA	9db	9db
IMPEDANCE		300 ohm	75 ohm	75 ohm	300 ohm	75 ohm
Bandpass	**VHF**	54 to 300MHz	54 to 300MHz	54 to 300MHz	54 to 300MHz	54 to 300MHz
	UHF	NA	NA	NA	470 to 810MHz	470 to 810MHz
NOISE FIGURE	**VHF**	4.2db	3.3db	4.8db	4.3 db	3.3db
	UHF	NA	NA	NA	10.0db	7.3db
POWER REQUIREMENTS		117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 2.3 watts	117VAC, 60Hz, 3.5 watts	117VAC, 60Hz, 3.5 watts

*7 channels VHF, 5 channels UHF   0.5% Cross Modulation

For additional information and sample system layouts, request New Product Bulletin No. 24.

WINEGARD TELEVISION SYSTEMS
Winegard Company / 3000 Kirkwood Street
Burlington, Iowa 52601
Circle 2 on reader service card

new & timely

(continued from page 12)

bow-and-arrow hunter. An invention awarded Patent 3,790,948 may put an end to that. Issued to John M. Ratkovich, it describes an arrowhead containing a radio transmitter which emits signals that can be picked up on a radio receiver carried by the hunter. With a directional receiver, it is necessary only to "home in" on the signals, often coming from an animal hiding in deep brush. (If the hunter misses, he has no trouble retrieving his lost arrow.)

Arrows that emit smoke or unroll a line of yarn have been used for the same purpose, but the one is shortrange in time and the other in space and they have the further disadvantage that smoke may be invisible in thick woods and yarn may break in underbrush. •

Cancer cells discovered by tuning to their frequency

A patent has been issued to Dr. Raymond V. Damadian of the New York State University Downtown Medical Center in Brooklyn for a method of detecting cancer electronically. The mothod consists of bombarding the tissue under inspection with radio signals. At a given frequency, atoms of the cancer cells act as transmitters, sending signals on distinct wavelengths.

Many tumors are permeable to X-rays and can often be disclosed only when they have pushed aside surrounding tissues. Since the new process employs nuclear resonance, it is not subject to this disadvantage which hampers early detection with X-rays.

More than 100 specimens of surgically removed tissue have been tested for the presents of cancer cells with the test successful in all cases.

Another method covered by the patent is to flood the body with radiation and conduct tests without surgery. This method has been successful in experiments with mice and apparatus for applying it to humans is under development. •

"Watch you language," says Ohio computer

Students at the University of Akron apparently found it humorous to give the university computer obscene instructions or to program it with four-letter words.

All this is now changed, says a university spokesman. A protective program has been installed that makes the computer demand an apology from any student who types in an obscene instruction. If the student doesn't come back with a fast "I'm sorry!" the computer indignantly turns itself off. •

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by Courtney Hall

This book examines the various types of multivibrators at the introductory level. It explains how multivibrator circuits work in switching rapidly from one state to another, how they can be designed using a minimum number of components, and how they can be applied in practical circuits. Many specific projects for multivibrator circuits are covered. 96 pages, softbound. **No. 21043 $3.95**

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This book has provided the basic knowledge for thousands who have become skilled in the field of television engineering and service. Newly updated, it presents a complete course in black-and-white television, describes the functions of important circuits, and is supported by numerous schematics. Each chapter is followed by questions, with answers at the back of the book. 208 pages, softbound. **No. 20981 $6.95**

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Circle 4 on reader service card

letters

MOLEX CONNECTORS FOR TV TYPEWRITERS

We wish to furnish the following information regarding the two Molex parts presently being used in the TV Typewriter in the September 1973 issue.

After a long period of poor inventory conditions, we can now announce that parts are readily available from stock for immediate delivery.

There has been a small recent increase in the prices of the parts and the new prices are as follows:

part No. 09-52-3103—$ .37 each
part No. 09-64-1101—$ .43 each

These increases will result in an additional $2.00 for the average size order.

We regret the delay in processing the mail orders which you have so kindly referred to us and we appreciate the patience shown by your readers.

We would like to take this opportunity to express our appreciation for your efforts in referring your readers to us for parts for your projects and we will do our utmost to perform in a manner which would make you and your readers happy. If we can be of any further service to you and your readers please let us know.

EUGENE J. RESNICK
Force Electronics
Inglewood, Calif.

YOU MISSED A STEP

Regarding the article from Sylvania Service Notebook entitled "Matrix-Tube Purity Set-Up" in **Radio-Electronics,** March 1974, steps seem to have been left out of the procedure.

Step number 6 should have read: Turn on 12-volt dc supply, then immediately turn if off (Note . . .

I would like to say that when the dc voltage is applied to the degaussing coil, you do not get the pattern shown in Fig. 3. The pattern that does result is a vast number of what appears to be tri-colored stars.

Step number 7 can be performed, but on a trial-and-error as is step number 8.

However, the operation does work very well, and there is no need to degauss the set each time the 12-volts dc is applied as the degaussing coil will produce a new figure number 3 each time step number 8 is performed only as long as you remember to TURN ON then OFF the dc voltage.

In other words steps 7 and 8 must go back to step 6.

The remaining steps are correct.

SHERMAN F. WATSTEIN
Chatsworth, Calif.

TV TYPEWRITER CHANGES

I have finished the TV Typewriter and would like to thank you for a beautiful project. I had to make some changes that may interest your readers. First, I could not get any 2524's so I substituted MM5016's 512-bit MOS. This requires some external recirculate logic. (See diagram enclosed.) The same clock driver can be used as in the article. This approach works very well if you cannot get 2524 IC's. Also, I designed a multiplexed keyboard encoder using standard TTL. It

(continued on page 22)

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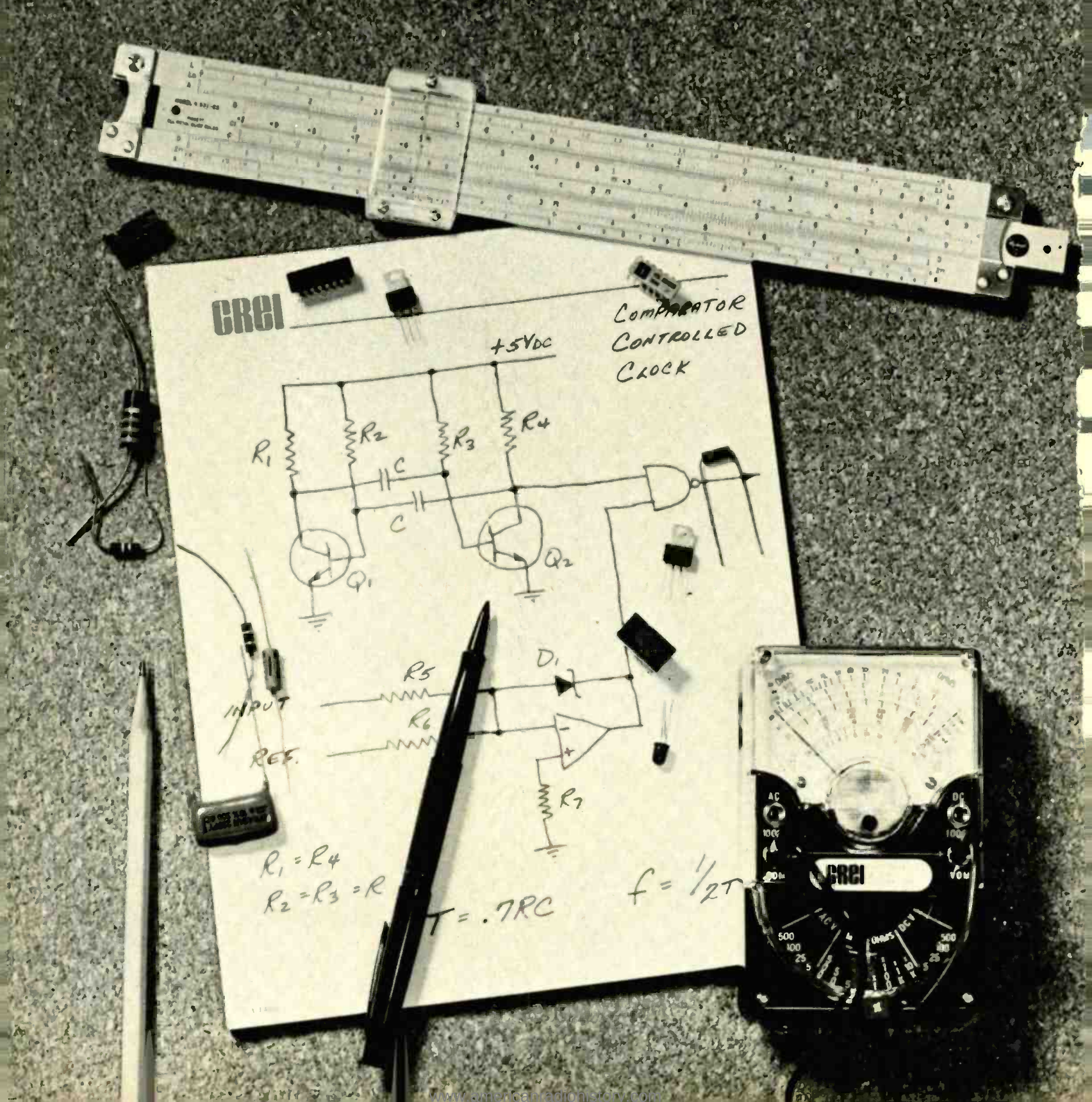

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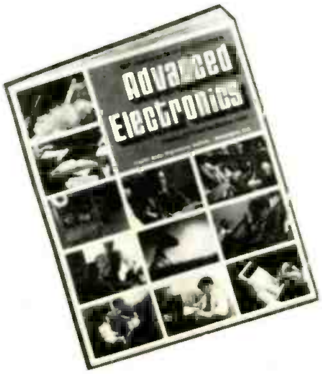

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LETTERS
(continued from page 16)

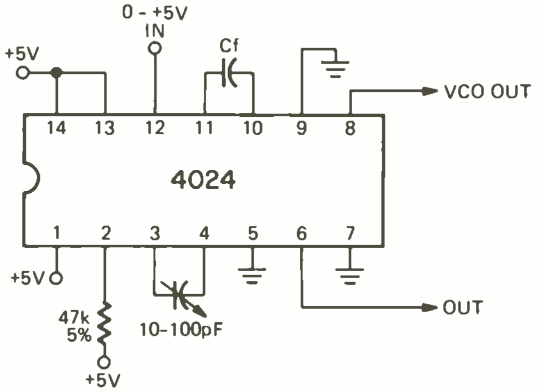
provides keyboard debounce and uses spst-n.o contacts. I used edge connectors instead of the Molex connectors. This works fine and costs only about 50c/board.

Finally, I could not get any 74197's so I substituted two 7476's as diagrammed. Allow me to thank Don Lancaster and suggest an FSK MODEM using TTL and incorporating half of the 4024 IC as the VCO modulator and a NE565 PLL as the demodulator. I would like to know where I can get the 4.56-MHz crystal. I am using a trimmer capacitor now.

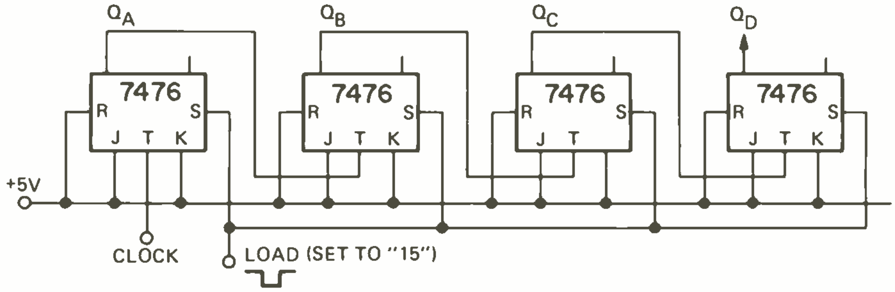
Boyce Steadman
Spartanburg, S.C.

Thank you Mr. Boyce for your comments on the TV Typewriter. I am certain that many other readers will benefit from them.

We can help you when it comes to obtaining the proper 4.56-MHz crystal. This crystal for the TV Typewriter may be ordered from International Crystal Manufacturing Company, 10 North Lee Street, Oklahoma City, Okla. 73102. It is a commercial standard (CS) type calibrated to ±0025% in a series-resonant mode. Holder type HC-6/U. The crystal costs $5.10 postpaid. Delivery time is approximately three weeks at this time.—Editor



4.56 mHz OSC. USING TRIMMER CAP.



÷ 16 SN74197 SUBSTITUTE

NY technicians elect officers

The Empire State Federation of Electronic Technicians Association (ESFETA) re-elected Warren Baker, CET, of Baker Electronics, 514 Second St., Albany, president of the Association for the 1974 season. His vice president is Richard (Dick) Jones, Sr., Jones's TV, RD-1, Box 383—1/2, Kingston.

Kenneth Parese, CET, C-P Electronics, 19 Martin Drive, Wappingers Falls, is the recording secretary, and Ronald Palluth, CET, Auido Fixit Centres, Inc., 25 Collegeview Ave., Poughkeepsie, NY, the corresponding secretary. Robert (Bob) Ocasio, Telefix, Inc., 882 Gerard Ave., Bronx, NY, was elected treasurer.

ESFETA is a state-wide association of electronic technicians and membership is open to all electronic technicians practicing within the State. Information may be obtained by contacting any of the officers. •

NESDA meets in San Antonio

THE BOARD OF GOVERNORS OF ISCET (International Society of Certified Electronic Technicians) meeting in conjunction with the Board meeting of the National Electronic Service Dealers Association (NESDA) at San Antonio, TX. Standingat center rear is Ms. Valerie Miller, who chaired the meeting.

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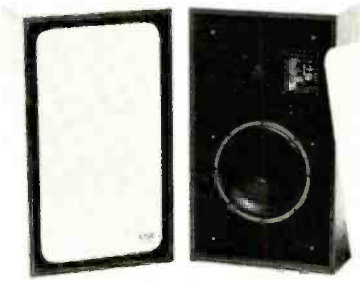
 Circle 11 on reader service card

equipment report

Avid Model 102



Circle 90 on reader service card

THE MODEL 102 IS A TWO-WAY ACOUSTIC suspension speaker midway in Avid's three-model 100 series. We have made the analogy between acoustic suspension speakers and broadband tuned circuits before, but it is helpful to remember that this design technique gives good performance to price ratio by trading gain or sound output in exchange for frequency response and smoothness. With todays efficient cool running transistor amplifiers the sacrifice is a small one; the only cost is the larger power supply needed to produce sufficient power. 15 watts is the minimum recommended amplifier power for the 102.

One watt of white-noise into the 102's terminals produces a sound pressure of 85 dB at 1 meter, while a 20-watt amplifier will give about 100-dB sound pressure level in a large 2500-cubic-foot room with average acoustics.

One o the key features of this loudspeaker system is its high power-handling capacity. Avid points out that power handling capability is limited by speaker coil movement at low frequencies and tweeter power dissipation in the high audio range. The limit for the model 102 is 100 watts of average music information. Single-tone power input is limited to a lower figure of 15 watts. The high frequency driver is protected by a 1-amp quick-acting fuse.

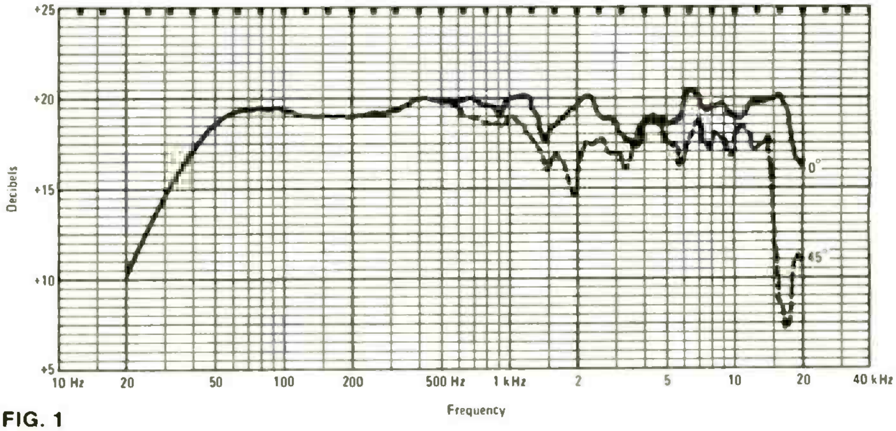


FIG. 1

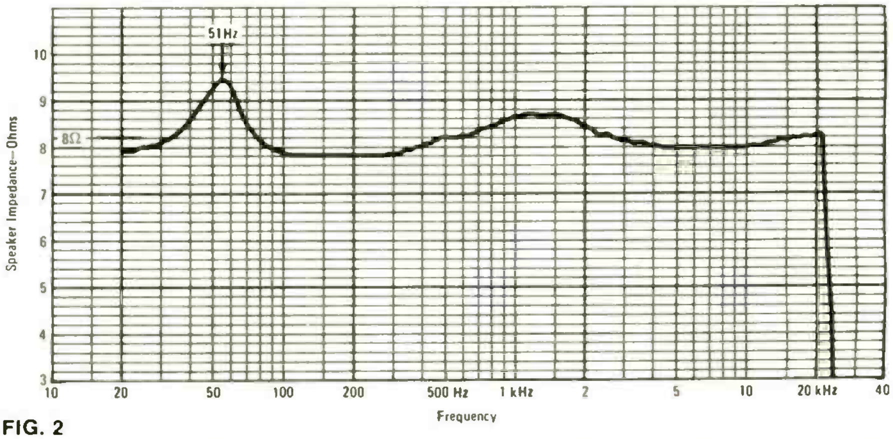


FIG. 2

At the rear of the speaker system cabinet all you see are a pair of push type quick connectors. Unconventionally located on the front panel is the three position balance or high-frequency level control along with the tweeter protection fuse. The edges of the grille cloth panel are recessed from the cabinet sides so it can be easily removed by pulling it towards you. The panel is secured by pressure holding corner studs and sockets. Easy panel removal lets the listener adjust the speaker response for room acoustics without the annoyance of reaching behind or turning around the sturdy 36-pound enclosure.

The balance control has a wide slot which conveniently accepts the edge of a coin. The second convenience of the removable panel system is that the woman of the house can join in the fun by being able to easily change the grille cloth. You can buy a standard $3.95 acoustically selected material from Avid in Orange, Green, Blue, Cream, Gold, Red, Brown or Burnt Orange. Gold is the color supplied with the Model 102. The cloth is held by a spline mounting system on the reverse panel side similar to that used on some window screens. Your second option is to pick you own cloth using the manufacturer's suggestions in selecting one that is acoustically transparent.

The speaker compliment is a 10-inch woofer supported by a highly flexible butyl surround designed with large voice coil travel for low distortion at the bass frequencies. A 1-inch dome tweeter gives extended frequency range and uniform distribution characteristics. The crossover frequency is 2200 Hz. Looking at the response curve, *Fig. 1*, the specified 35-Hz to 18-kHz response range is seen to be 3-dB down compared to a mid-range 1 kHz. The actual specification is ±5 dB. On the frequency plot supplied for our test model there was a 5-dB dip at 2 kHz.

At 20 Hz the response was down 9.5 dB and down 4 dB at 20 kHz. At 45° off the tweeter center axis, response falls about 2.5 dB from 2 kHz up to the high frequency limit. The balance switch gives about a ±3-dB adjustment in this same frequency range. These curves were measured in an anechoic chamber above 200 Hz. Below this a microphone was placed directly in front of the woofer. The well behaved impedance curve is *Fig. 2* shows a slight resonant peak of 9.4 ohms at 51 Hz relative to the nominal 8 ohm impedance.

Sealed in a 25 x 15 x 9⅜" cabinet the Model 102 is covered with simulated walnut vinyl. The shape factor is a little different from most speakers of comparable volume. The reduced 9⅜" depth may be useful to some who would like to use a shelf mounting arrangement.

The $109.50 speaker is supported by a three-year warranty. Fairly extensive operating instructions and suggestions are included covering amplifier connection, speaker placement, parallel operation of loudspeakers etc. An optional floor stand is available from Avid.

The Avid 102 looks like a good choice in a two-way speaker for those who want undistorted sound at a reasonable price. **R-E**

40 COSMOS IC PROJECTS IN SEPTEMBER 1974

Starting with next month's issue of Radio-Electronics we are going to present a series of articles by R.M. Marston. It will introduce the COSMOS micropower IC, explain how it works, and offer 40 projects you can build around it. Look for it next month.

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appliance clinic

IGNITION PROBLEMS IN SMALL ENGINES

by JACK DARR
SERVICE EDITOR

THIS IS A SLIGHTLY DIFFERENT BRANCH OF appliances; it's about power lawnmowers, and their ignition systems. It is electrical, and that's a link, and never mind the puns about the missing link! But if one cylinder misses in the typical mower, you've had it.

There's another problem. Some time ago, I pulled what I thought was a smart trick. My wife couldn't start the mower we had, though she loved to run it. So, I got a nice electric-start rider. Now, Ol' Dad could sit in the living room and watch the football game, while Mom taxied happily around the yard. There was one severe hitch in the git-along, though. The ignition system on the new job radiated TVI like crazy! Tore up the whole picture.

After some head-scratching, I decided that the simplest thing was the best, at least for a start. So, I checked the type of spark plug it used, which was an AC No. 45. I hypered into town and got a resistor type which is an R45. Installing this, cleaned up the ignition noise very nicely.

For the benefit of those old mechanics who think that this type of plug upsets the ignition, let me say that I ran a long series of tests on cars, a long time before resistive ignition wire became the standard. It has absolutely no effect on either the starting or running. If the ignition system is in shape to run at all, resistor plugs or resistive wiring won't bother it a penny's worth.

This will work in the magneto ignition systems of other engines, just as well. These don't seem to cause as much trouble with TVI as the electric (sic) systems, but if they do, it would be a good starting point. For those who have one with this type of engine, which includes all of the pull-start types, here's a very good hint. If the engine gets hard to start, the *first* thing to do is *replace* the spark plug.

If you're in a hurry and don't want to run to town and get a new plug, try this. (Actually, you ought to have a spare tucked away in the garage!) Take the old plug out and close the gap on the points. When these plugs have been used for too long, some of the metal of the points burns away, widening the gap. Tap the movable point gently with a screwdriver handle, etc. until it is very close: .025 inch is about right. (If you want a handy gap-gauge which will always be with you, the average male *thumbnail* will be very close to .025. Mike it and see.)

For a quick check of the ignition system, take the plug out, but leave it hooked to its wire. Lay it on the engine, and pull the starter. If you can see a pretty bright blue spark, your ignition is OK.

This leads to the next thing; most common offender here is a little water in the gas tank. You can get this from condensation in a partly filled tank. The water will drop to the bottom of the tank; if you take the cap off and look inside (with a flashlight! Not a match, Clyde!), you can usually see what looks like bubbles rolling around on the bottom. In most of these engines, the carburetor picks up the gas through a tiny tube that goes almost to the bottom; so, the first thing it gets is some of the water.

Cure is simple; turn the thing upside down and drain all of the gas and water out. If you can still see some liquid on the bottom afterward, wrap a small (non-lint type) rag on the end of a stick and swab it out until it's dry. Refill with fresh gas and try it.

Magneto ignition

Just as a refresher, a magneto is a coil, mounted on the engine, and a magnet. The magnet is cast into the inside of the flywheel. When this revolves, the magnet passes the core of the coil. The change in magnetic field generates a high-voltage pulse.

In some engines, you'll find a set of contact points, with a condenser, mounted on the top of the engine, under the flywheel. These are closed by a tiny spring-loaded plunger which goes into a recess in the shaft. This makes the magneto fire at exactly the right time. This is similar to the distributor on a car, but isn't in the high-voltage circuit at all. The spark-plug lead goes from the high-voltage coil directly to the plug.

After long use, these points get dirty. To get at them, you'll have to remove the flywheel and starter assembly. If these contacts are very dirty and pitted, a new set of points and a condenser will do wonders for that hard-starting old engine.

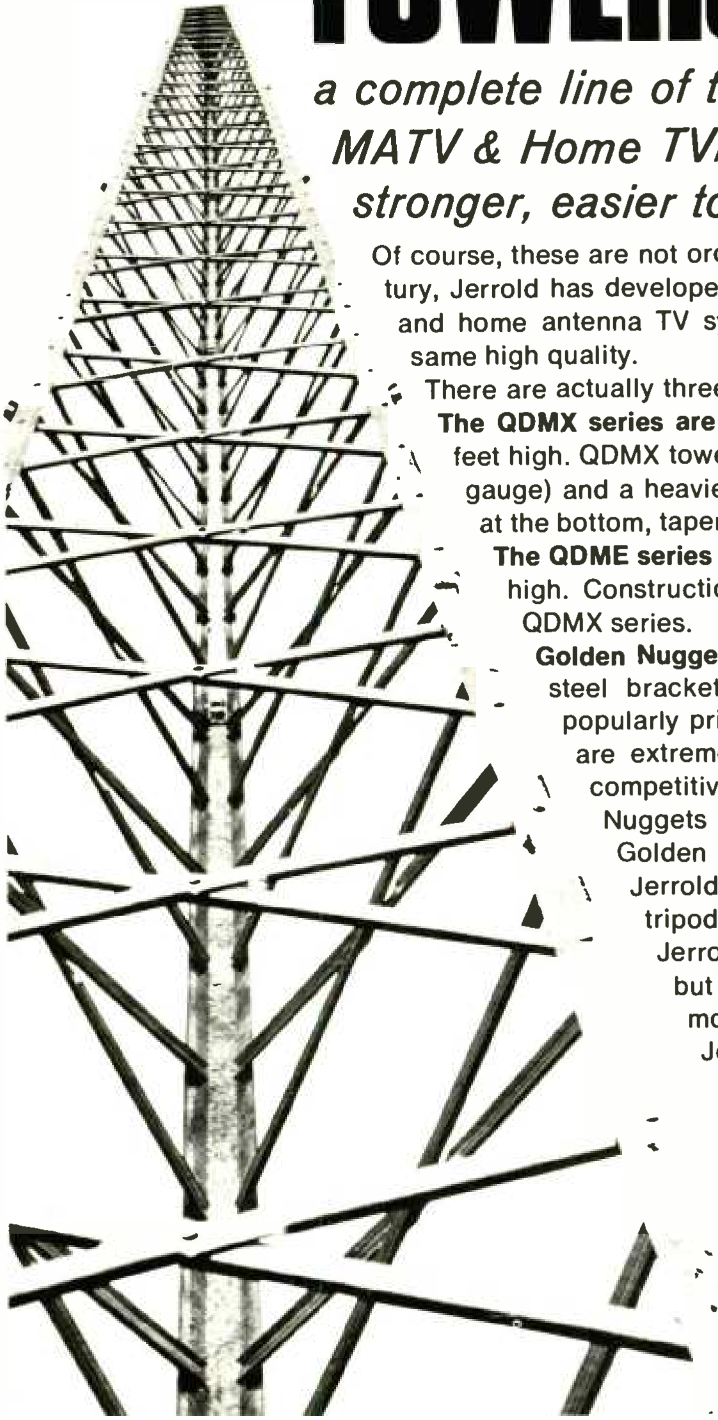
Actual magneto failure is pretty rare. One real whizzer can be found if the magnet loses its strength! This is also rare, but can happen if the flywheel is struck a hard blow right over the magnet, or if it's overheated. For a quick check, hold a screwdriver blade near it. It should be strong enough to pull the blade tip smartly.

Batteries

The batteries used in the electric-start units are small ones, mostly 12-volt, about the size of a motor-cycle battery or smaller. Some makes use a straight 12-volt dc system. The battery is connected to the starter, and cranks the engine. The starter will be gear-driven, so that after the engine starts, it is turned and will act as the generator, and recharges the battery.

In the later models, a dual-wound type of unit is used. There is a dc motor winding for starting; there is also an ac alternator winding. You'll usually find a pair of diodes, mounted in spring clips, with leads going to the battery. Caution: in most of these systems, you'll find a warning notice. The battery must be disconnected from the system before recharging with an external battery charger. Failure to do this may blow the diodes. (I'm taking their word for it. When I recharge mine, I disconnect it.) R-E

Look up to Jerrold's new line of TOWERS



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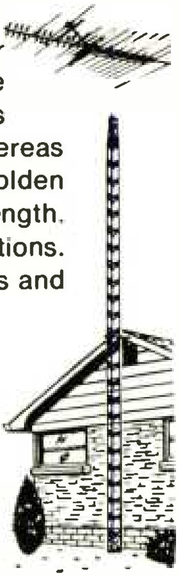
Of course, these are not ordinary towers. For more than a quarter of a century, Jerrold has developed and produced the finest equipment for MATV and home antenna TV systems. Our towers are proven designs of the same high quality.

There are actually three complete lines of Jerrold towers.

The QDMX series are self-supporting concrete-base towers, 28 to 68 feet high. QDMX towers use heavier steel (12 to 16 gauge vs. 14 to 18 gauge) and a heavier mast than competitive towers. They are wider at the bottom, tapering gracefully to the top.

The QDME series are bracketed towers, ranging from 20 to 52 feet high. Construction is of straight sections similar to that of the QDMX series.



Golden Nugget series towers are the finest tubular steel bracketed towers available, and they are popularly priced. Unique "Golden Nugget" welds are extremely strong and will never rust. Whereas competitive tubular towers use 18 gauge legs, Golden Nuggets use 16 gauge legs for extra strength. Golden Nuggets are available in 10-foot sections.

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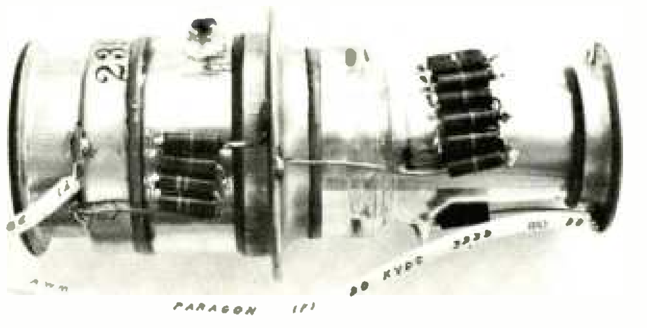
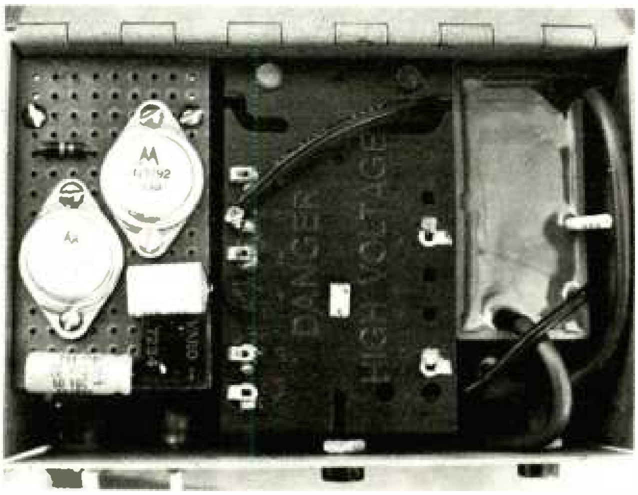


COMPLETE IR VIEWER (left) and a 6032 image tube (above) with voltage divider added. Power supply connections are high-voltage cable.

Build a $35 INFRARED Viewing System



Infrared technology has made rapid strides in surveillance, security, ecological surveys and other fields. This simple experimental viewer has many applications.

by FORREST M. MIMS

INTERNAL VIEW of image tube power supply. Oscillator is at left, T2 at center and voltage tripler at right. Never open supply housing when operating and never operate supply without a load.

INFRARED EMITTING LASERS AND LED'S ARE of great value in light beam communicators, intrusion alarms, and ranging systems. All these applications, however, would be easier to achieve if the invisible beam from the infrared source could be seen during alignment.

Phosphor viewing screens are available for as little as $25, but they suffer from low resolution and limited viewing time before requiring "recharging" from an ultraviolet source. The next least expensive solution is an infrared image converter tube, but even war surplus tubes with an integral power supply cost $300 or more.

An ideal solution to the problem is to assemble the infrared image converter described here. This device is centered around a variable-output high-voltage power supply capable of operating practically any new or surplus image tube. A surplus 6032 image tube can be purchased for as little as $9.00, and this permits an entire image conversion system to be put together for a tenth the cost of the least expensive commercial units.

How it works

Image converter tubes contain a light-sensitive photocathode which emits electrons when struck by light. Various cathode coatings are available for ultraviolet, visible, or infrared light. An anode surrounding a phosphor coated viewing screen is connected to a positive high voltage and attracts electrons emitted by the photocathode. As the electrons strike the phosphor screen, they excite individual phosphor atoms to higher than normal energy levels. When the atoms resume equilibrium, they emit a yellowish-green light.

Some image tubes require electrostatic focusing and include a central grid for the purpose. The 6032 is an example of an electrostatic focused tube. More recent tubes, such as the 6929, include prefocused internal grids and are easier to operate. Self focused tubes such as the 6929 will operate from about 12 kilovolts, while the 6032 requires a hefty 20 kV.

Too much voltage can damage or destroy an image tube, so a power supply designed to operate a variety of tubes must have a variable voltage control. The very high voltage required for the tube can be generated by several techniques. Since the image tube may be requitred to operate from batteries in such field applications as aligning an infrared communicator or intrusion alarm, the system should be capable of low voltage operation. In-house operation of the tube, however, is best accomplished by means of 117 Vac. For this reason a compromise circuit permitting both modes of operation at the least possible expense was chosen.

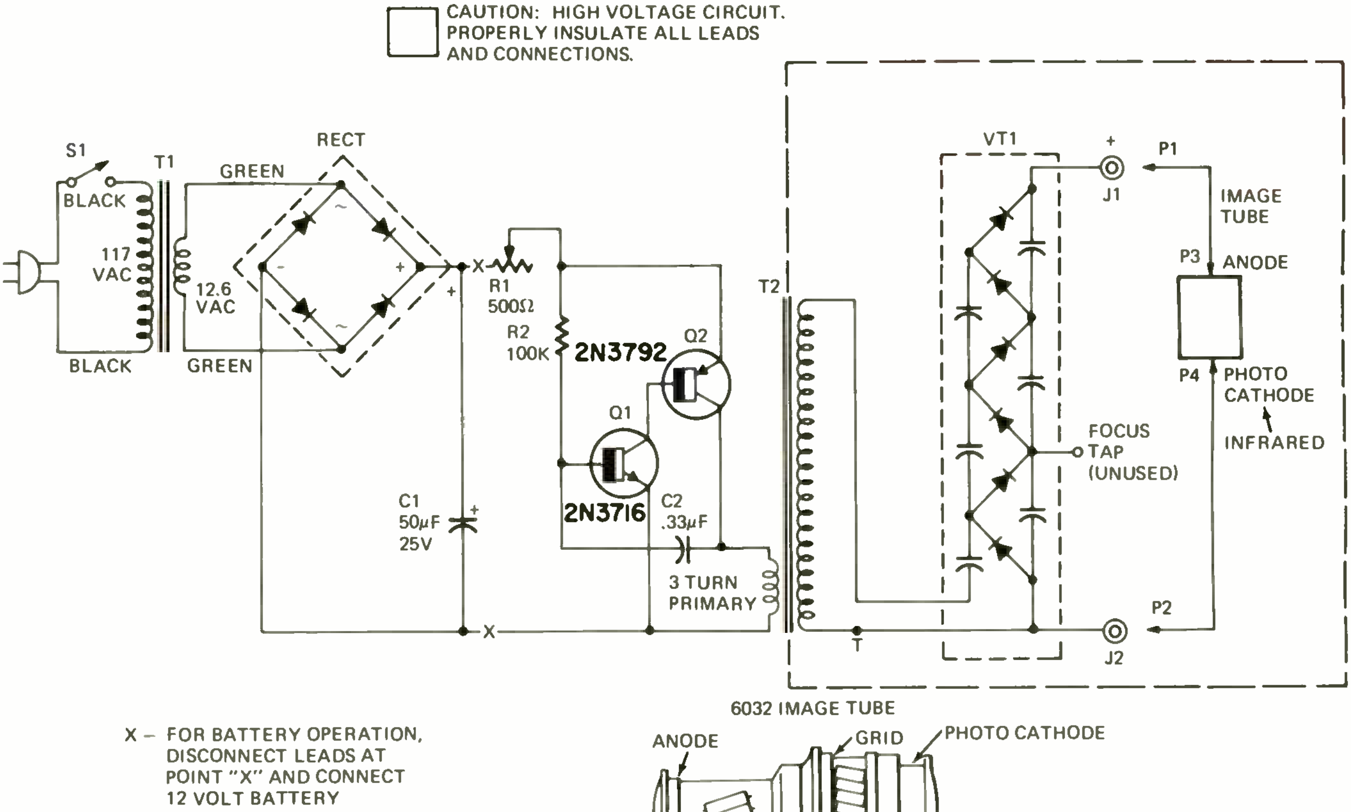
The circuit diagram for the power supply is shown in Fig. 1. In operation, transformer T1 and the rectifier bridge convert the 117 Vac delivered by the household line to 11 volts of pulsating dc. Filter capacitor C1 smoothes this voltage and passes it on to a regenerative amplifier composed of Q1 and Q2.

The regenative action of Q1 and Q2 causes an oscillation with pulses of dc at near the power supply voltage being delivered to the primary of high-voltage flyback transformer T2. R1 varies the voltage output of the oscillator and serves as a variable high voltage control. The dc pulses from the oscillator are converted to ac by the inductor action of T2's primary. T2's inductance causes the dc pulses switched by Q2 to have an undershoot nearly as great in amplitude as the pulse itself.

T2 has a very high turns ratio so a small voltage at its primary is stepped up to a high voltage at its secondary. The high-voltage output of T2, which ranges up to about 14 kV depending on R1's setting, is smoothed and increased by a factor of three by voltage tripler VT1. The output of the tripler is connected to the image tube.

Putting it together

Construction of the high-voltage power supply would be straightforward were it not



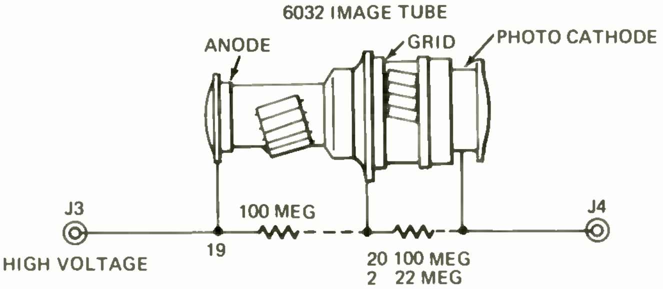


FIG. 1—THE POWER SUPPLY, ac or battery powered dc-to-dc converter develops the high voltage needed by the image converter tube. Parts are cheap and readily available.

for the hazards associated with very high voltages. While the actual assembly goes quite fast, use great care to properly wire and insulate *all* high voltage terminals and connections.

Begin assembly by preparing the power supply housing. The prototype circuit was installed in an LMB Blue Hinged cabinet (B-H 643) measuring 3 × 4 × 6 in., and a drilling pattern for this cabinet is shown in Fig. 2. If any component substitutions are made check the location of their mounting holes before drilling the cabinet.

When the cabinet is drilled, install R1, S1, T1, and the power cord. Use a rubber grommet to protect the power cord where it enters the cabinet. Tie a knot in the cord several inches from the exposed end to secure it in place. Insulate the connection between the power cord and T1's primary with electrical tape.

Install the two high-voltage output jacks in the housing next. The red (positive) jack should be installed in the hole nearest the edge of the cabinet.

Prepare T2 for installation by removing and discarding its 2-turn rectifier filament winding. Use a length of No. 16 or 18 insulated hookup wire to wind a substitute 3-turn winding in place of the original winding. The new winding, used as the primary, can be wound anywhere along the flyback's core so long as it is wound tightly around the core itself and not around the fiberboard supporting material. The prototype T2 primary was wound at the base of T2 in a manner which permitted the two leads to be readily accessible.

Clip T2's high-voltage output lead (it will probably have a cap on its free end) about an inch from where it enters the secondary winding and carefully remove its insulation. Temporarily install T2 in its position without mounting hardware.

Voltage tripler VT1 can be any high-voltage unit of the type used in late model color television sets. Many manufacturers use the Varo MH-383 and attach their own type number. For example, the Zenith 212-130 is an exact replacement for the MH-383. The only requirement is that the unit be capable of at least 10 kV input and delivering at least 25 kV. Triplers are available from television parts suppliers for about $12. The price may seem high for a handful of high-voltage rectifiers and capacitors, but the individual components would cost far more if purchased separately. And, of course, the pre-packaged tripler is properly and safely insulated with a thick layer of sealant.

If you use the MH-383 style tripler and the cabinet specified in the parts list, it will be necessary to remove one of the two plastic mounting brackets with a saw for a proper fit. Clip off the white focus lead about an inch from the tripler's case since it will not be needed. Finally, install the tripler in the housing with 4-40 hardware.

When the tripler is installed, trim the red high-voltage input lead to an appropriate length and solder it directly to the flyback's high-voltage output terminal (the one connected directly to the secondary winding). The black common lead should also be cut to an appropriate length and soldered to the black banana jack. The remainder of the black lead should be soldered to terminal "T" on the flyback. For a slightly higher output voltage you can connect the flyback's width coil winding (terminals 1 and 3) in series with the remainder of the secondary as was done in the prototype, but this is not necessary for most image tubes.

Finally, the tripler's high-voltage output lead is cut to an appropriate length and soldered to the red banana jack. At this point, carefully inspect all high-voltage wiring and connections for possible errors or shorts. In a high-voltage circuit, a "short" can occur if

PARTS LIST

C1—50 μF, 25 V electrolytic
C2—.33 μF, 25 V
J1-J4—Insulated banana jacks
P1-P4—Insulated banana plugs
Q1—2N3716 or other general-purpose npn power transistor
Q2—2N3792 or other general-purpose pnp power transistor
RECT1—50 volt full-wave rectifier (Radio Shack 276-1146 or equal)
R1—500-ohm potentiometer
R2—100,000 ohms, 1/2 W
S1—Spdt toggle switch
T1—Power transformer: primary 117 Vac secondary 12.6 Vac center tapped
T2—Television flyback transformer (Stancor A-8279 or equal; see text)*
VT1—High voltage tripler (Varo MH-383 or equal; see text)*
Image Tube—6032, 6929, or other IR image tube (see text)*
Misc.—Cabinet (3" x 4" x 6"; B-H 643 available from LMB, 729 Ceres Avenue. Los Angeles, Cal. 90021 for $3.50 or equal), high-voltage cable, high-voltage silicone sealant, perforated board, mounting hardware, marking labels, Plexiglas cylinder for image tube, etc. (see text for details)

* Flyback transformers available from electronics and TV parts dealers.
Image tubes are available from Edmund Scientific Co. (300 Edscorp Bldg, Barrington, N.J., 08007).

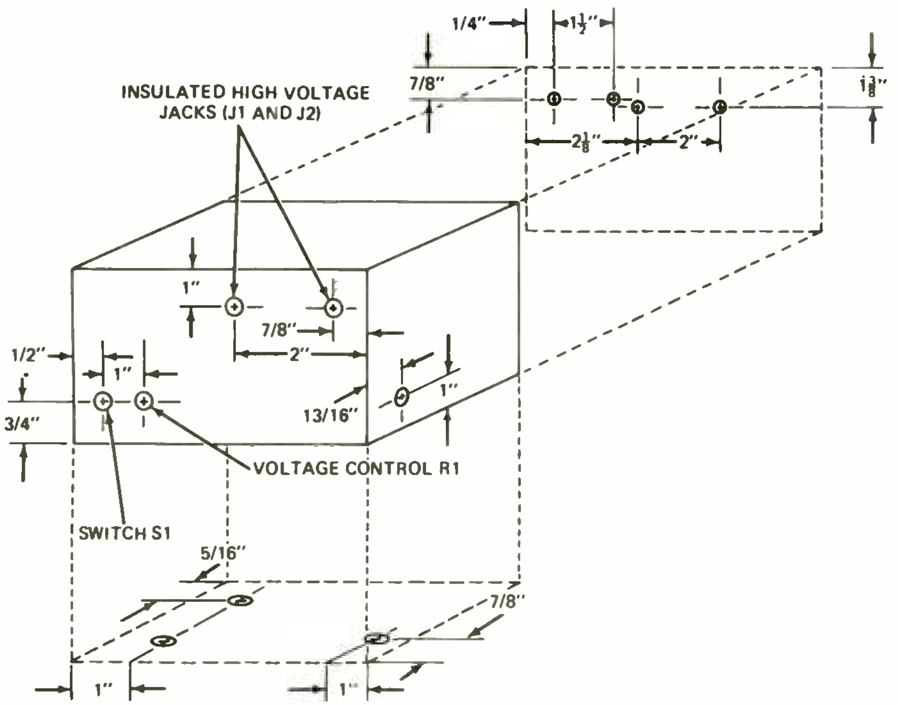


FIG. 2—DRILLING PATTERN for mounting the components in the 3 × 4 × 6 inch hinged-top cabinet. Before drilling, make sure all parts fit properly — especially if you've made changes.

an exposed terminal is in close proximity to a metal structure or other terminal. To prevent arcing and a resultant short, coat all exposed high-voltage terminals with a thick layer of silicone sealant. A tube of sealant is ordinarily packaged with new triplers, and the material can pe purchased separately under a variety of trade names. Besides preventing arcing, the sealant provides some protection against accidental shock and reduces power robbing corona. Corona is the bluish brush discharge which frequently occurs at high-voltage terminals.

When the high voltage wiring is complete, flyback T2 can be mounted in place with 4-40 hardware. Make sure the two primary leads are readily accessible before securing T2 in place.

Next, assemble the transistor oscillator on a 1-⅞ × 3-¼ in. perforated board following the component layout shown in the accompanying photograph. Make contact to the collectors of the transistors through a solder lug and 4-40 hardware. Most general purpose pnp and npn power transistors will work well as Q2 and Q1 respectively.

When the oscillator circuit is complete, the ends of T1's 12.6-volt secondary winding across the input (AC) terminals of the bridge rectifier. Connect the positive bridge terminal to C1 and R1 and the negative bridge terminal to the common ground point. This connection provides the highest available voltage as required by the 6032 converter tube. For lower voltages as required by such tubes as the 6929, connect the bridge input across *half* of the center-tapped 12-volt winding.

Next, connect the 3-turn primary of T2 to the oscillator as shown in Fig. 1. When the wiring is complete, install the oscillator board in the housing directly above T1 by means of two "L" brackets and 4-40 hardware.

Lettering should be applied to the power supply cabinet to ease operation and warn onlookers of the high voltage hazard. A tape labeler can be used, but a neater appearance will be obtained by using ¼" vinyl self-adhesive letters such as No. 401 E-Z Letter Quik Stik. A plus sign for the red high voltage jack can be made from two "I" letters.

Preliminary power supply test

Before operating the power supply, carefully inspect all connections, particularly those in the high-voltage circuit. Do not insert high-voltage leads or plugs into the two high-voltage jacks at this time; instead, bend the leads of an NE-2 neon glow lamp outward and slide each lead into an output jack. The lamp should emit a soft glow when the supply is turned on. Also, the supply itself should emit a hum, and a radio placed near the unit will buzz loudly.

CAUTION: The high-voltage produced by the power supply can be *lethal. Never* touch either of the high-voltage terminals when the circuit is in operation. Additional precautions are described later in this article and should be read before attempting to operate the supply.

Image tube mounting

Image converter tubes come in a variety of shapes and sizes so no one mounting technique can be used for all tubes. Since the 6032 is one of the least expensive and most difficult to mount tubes, a mounting procedure for it will be provided.

The 6032 is focused electrostatically by a voltage applied to a central grid. A simple way to obtain the 1720—2650 volts required for the grid is to use a voltage divider connected to the high-voltage power supply output. Since this output voltage is connected directly to the anode and photocathode of the tube, the divider can be mounted directly to the tube.

The divider used in the prototype consists of a series chain of twenty one 100-megohm resistors and two 22-megohm resistors. The optimum tap for the grid voltage was found by taping a small square of aluminum window screen over the photocathode and illuminating the tube with soft light from a flashlight covered with a sheet of white paper. When the shadow of the screen was in perfect focus, the correct grid voltage was being applied.

The accompanying photograph shows how the divider chain is connected to the image tube. The two strings of resistors are first soldered into chains on a flat surface and then soldered to the tube itself. Manufacturers of the 6032 and other image tubes recommend that no solder connections be made to the device for fear of damaging the glass-to-metal seals. However, solder connections *can* be made if the metal surface is lightly buffed with a fine sandpaper and the connection is made quickly and neatly. Metal connecting straps can be used if you prefer not to solder to the tube.

When the voltage divider resistors are soldered in place, the tube must be installed in a protective housing. The prototype system used a hollow Plexiglas cylinder 5-½ in. long and 2-½ in. in diameter. High-voltage connectors are made by installing two banana jacks at one end of the tube approximately 90° apart. The tube itself is installed by wrapping it in a cushion of flexible foamed plastic and inserting it in place. Use high-voltage wire to connect the tube to the terminals. Assembly details are shown in Fig. 3.

The outer Plexiglas cylinder must be purchased from a plastics company. The single inner cylinder used to support the viewing end of the tube is made by cutting the bottom from a bullion cube container and cutting a slit in one side to permit passage of the high-voltage anode lead.

Optics

The image tube can be used without external optics to view cross-sections of infrared light beams. For example, it is handy to use the tube to focus a lens designed to collimate the beam from an infrared LED by pointing the LED directly onto the tube's photocathode. The LED can then be quickly focused by observing the size of the spot on the viewing screen.

For viewing scenes, however, it is necessary to image the scene onto the photocathode with a lens. This can be easily accomplished by a simple low f/number glass lens available from Edmund Scientific Company. The prototype tube incorporates a simple double convex lens connected to the plastic lid of a bullion cube container. A hole cut in the soft plastic lid provides a mounting shoulder for the lens while permitting the light to pass. The bottom of the container is removed and the entire assembly inserted into a Plexiglas disc with a 1-¾ in. hole cemented to the photocathode end of the image tube's mounting cylinder. The lens tube is moved back and forth during focusing. For best results block all external light from the photocathode by painting the inside of the plastic lens tube and image tube mounting cylinder black.

Images formed by the tube are inverted, but since an imaging lens also forms an inverted image the image on the viewing screen will appear right-side up. The scene can be viewed by simply observing the viewing screen from several inches away, but ambient light will tend to mask details. For best results, mount an f/1 lens in a bullion cube container lid and snap the lid to the image tube's inner cylinder. The f/1 lens should be either single or double convex and have a diameter close to that of the viewing screen. Using this eyepiece lens, the tube can be placed very close to the eye. Besides blocking ambient light, the eyepiece lens enlarges the scene on the screen.

Final assembly and testing

Complete assembly of the image converter system by making up two high-voltage connection cables for the image tubes. You can use conventional high-voltage cable or automotive ignition wire. Remove ½ in. insulation from each end of each cable and install banana plugs. Use red plugs on one cable and black plugs on the other. It may be necessary to drill out the interior of the plug insulation sleeves for the cable to fit. *IMPORTANT:* Make sure the insulation on the cable fits within the banana plug insulated sleeve to preclude an accidental shock hazard.

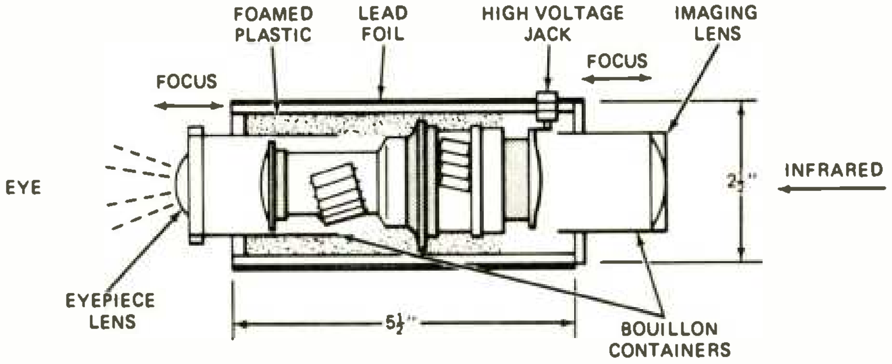


FIG. 3—ASSEMBLY DETAILS for the infrared viewer. Outer shell is 2½-inch plastic wrapped with lead foil. The imaging lens is not needed in some applications. See text for details.

Connect the cables from the power supply to the image tube to test the completed system. The rotor of R1 should be turned to its extreme left (maximum resistance) position before the power supply is turned on in order to insure that the lowest possible voltage is initially applied to the tube. Be sure to check the connections to R1 to make sure its resistance *decreases* as the rotor is turned clockwise.

Turn the power supply switch on and slowly advance R1 until the viewing screen emits a soft greenish glow. If the tube glows, the unit is ready for operation. If the unit fails to glow, disconnect the image tube after turning the power supply off and carefully recheck all wiring and connections. Be sure to discharge the voltage multiplier before opening the power supply cabinet by connecting one of the image tube high-voltage cables directly across the power supply output jacks.

If a 6929 or other self-focusing tube is used, optimum focus will be obtained at a tube potential of about 12.5 kV. The 6032 tube may require an adjustment of the voltage divider tap for optimum focusing. Test the tube for proper focus by turning the power supply off, disconnecting the image tube from its high-voltage cables, and taping a small square of aluminum window screen over the photocathode. When the tube is connected to the power supply again and pointed toward a soft light, the shadow of the screen will appear on the viewing screen. If the shadow of the screen is blurred, the tube assembly must be disassembled and a new voltage divider tap made. It may be necessary to break down one of the 100-megohm resistors into smaller values to provide a proper tap, but almost certainly the existing tap (as shown in Fig. 1) will be close to the proper point.

It is important not to exceed the maximum voltage allowed for a particular image tube. The voltage across a tube can be measured with a high-voltage meter or a small microammeter in series with the tube and power supply. If the latter technique is used, simply use high-voltage insulated clip leads to connect the meter (use a 0-50 microamp dc meter) in series with the tube. Knowing the total resistance of the voltage divider chain, it is possible to use Ohm's law to calculate the power supply voltage. For example, the total value of resistance in the prototype divider is 2,144,000,000 ohms. If a current meter indicates a current flow of 10 μA, the total voltage is equal to the product of resistance and current or 21,400 volts. (Use exponential notation to simplify the calculation: $2.144 \times 10^9 \times 1.0 \times 10^{-5} = 2.144 \times 10^4$.)

Using the IR viewer

The infrared viewer is extremely useful for observing the radiation emitted by infrared emitting lasers and LED's. As noted earlier, the tube can be used *without* an imaging lens to see beam cross sections. With a lens the tube can be used to observe LED and lased patterns projected against a white screen. A lens before the image tube permits the system to be used to align infrared communicators and intrusion alarms.

The image tube can be used to view scenes in total darkness by illuminating the scene with invisible infrared from an LED. For more infrared, use an array of LED's or an incandescent lamp and an infrared filter. Incandescent lamps are very efficient generators of near infrared, but most infrared filters permit some visible light to pass. Nevertheless, the source will be virtually invisible unless viewed directly. Infrared filters are available from the Edmund Scientific Company.

The infrared viewer can also be used to study *bioreflectance*. In this role, the viewer is operated as a sensor similar to those used on NASA's Earth Resources Satellite (ERTS). Most healthy foilage has a very high near infrared reflectance and appears almost snow white on the viewing screen. Diseased vegetation has a reduced reflectance and appears darker on the screen. The viewer also reveals the reflectance of human skin to near infrared. For example, both black and light skinned persons appear an equal shade of yellow-green on the viewing screen.

For portable operation, the system can be modified for battery operation by disconnecting the input transformer (T1), RECT1, and C1 and connecting a 12-volt battery as shown in Fig. 1. It is a simple procedure to connect these components to a switch to permit both battery and line operation. In this role, use of a larger power supply case can be considered to permit self-contained battery operation.

Operating precautions

As noted earlier, the high-voltage generated by the image tube power supply can be lethal. Therefore, avoid any shortcuts which result in exposed or poorly insulated high voltage wiring. If the power supply is constructed as detailed in this article, the completed unit is no more dangerous than an ordinary television set. For complete safety, follow these precautions when operating the system:

1. **Never turn on the power supply** unless a load is connected to the output. The load will prevent arcing from the output jacks to the metal case and will discharge the voltage tripler capacitors and prevent them from storing a dangerous shock for an extended time.
2. **Never open the power supply** cabinet when the unit is in operation.
3. **Always make sure** the power supply voltage tripler is discharged before servicing the unit by connecting a high-voltage lead directly across the output jacks.
4. **Make sure the high-voltage cables,** plugs, and image tube housing is well insulated. For example, it is possible to draw a ¼ in. arc from the anode to a fingertip when the unit is in operation. While this arc is small and probably harmless, prevent it from occurring by making sure the image tube is well insulated.

There is an additional safety consideration. Though image conversion tubes have been in use since before World War Two, it has recently been noted that some tubes emit a small quantity of X-rays when in operation. RCA and other manufacturers recommend that image tubes be shielded to prevent possible exposure to this radiation. The tube can be shielded by a layer of lead foil wrapped around the Plexiglas holder. The foil can be secured by a layer of vinyl tape.

Finally, avoid shining bright light sources on the image tube's photocathode as this can damage the tube. Even if the power supply is turned off a bright light falling upon the sensitive photocathode can temporarily decrease tube sensitivity. The tube should retain all or most of its sensitivity after exposure to temporary bright light after a time of inactivity. R-E

CET's Change Certificate Design

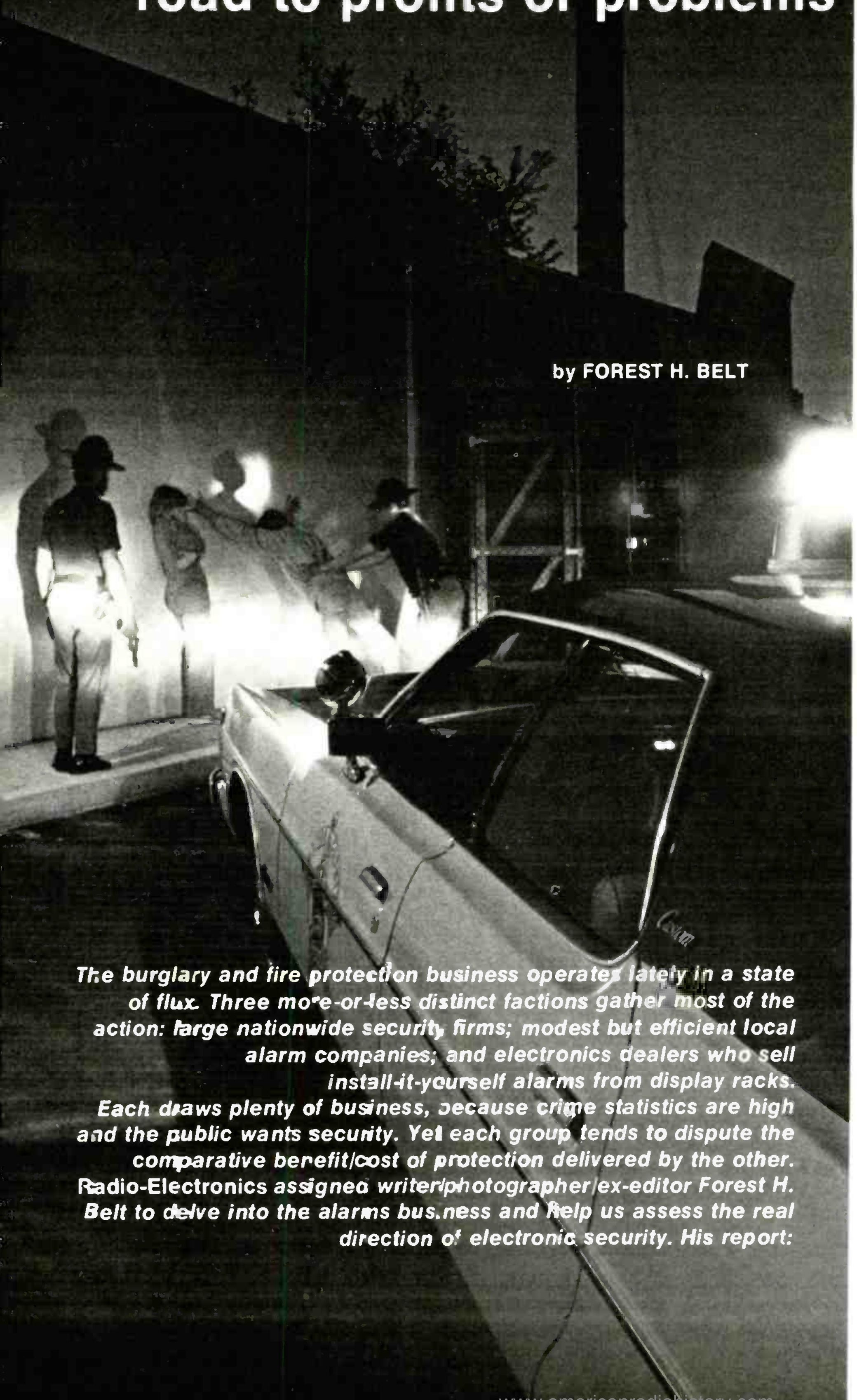
The International Society of Certified Electronic Technicians (ISCET) has announced a new certificate, replacing the one that has been used since 1967, during which time more than 7,000 certificates have been issued to technicians around the world.

While the design remains basically the same, the NEA emblem has been replaced by the ISCET logo, due to the merging of NEA (National Electronic Association) into NESDA (National Electronic Service Dealers Associations). The emblem of the accrediting facility, NESDA, has been included on the right and the universally recognized CET triangle on the left.

INSTALLING SECURITY SYSTEMS

road to profits or problems

by FOREST H. BELT



The burglary and fire protection business operates lately in a state of flux. Three more-or-less distinct factions gather most of the action: large nationwide security firms; modest but efficient local alarm companies; and electronics dealers who sell install-it-yourself alarms from display racks. Each draws plenty of business, because crime statistics are high and the public wants security. Yet each group tends to dispute the comparative benefit/cost of protection delivered by the other. Radio-Electronics assigned writer/photographer/ex-editor Forest H. Belt to delve into the alarms business and help us assess the real direction of electronic security. His report:

A CLEAR-CUT APPRAISAL OF THE alarms business is elusive. This derives partly from the unwillingness of some operators to give an interviewer definitive answers. Conversely, fast-sale proponents disguise the real scene with glib snow-jobs. Somewhere between these extremes lies the reality **Radio-Electronics** readers must see before they can contemplate sensibly this potentially lucrative business.

Inexperience ranks as the industry's worst bugaboo. Security specialists and law enforcement people recite countless tales of false alarms triggered by equipment wrongly chosen, unwisely or carelessly installed, or improperly adjusted. The "falsing" problem has become so prevalent in some localities, police and firemen won't respond to an unverified alarm from a home or office protection system.

Experts blame three situations for the majority of false alarms. In one, a person has bought a package of alarm components and connected them together with no real understanding of how his premises could best be protected. A homeowner or apartment dweller usually knows nothing of electric wiring or principles of sonic and ultrasonic space protection. Predictably, a system put in thus ineptly either doesn't really protect or produces so many false alarms its owner eventually shuts it off and does without security. This category of buyer/installer needs professional analysis to guide purchases and technical aid for installation and adjustment. Not many over-the-counter alarm dealers have time or expertise to offer this kind of guidance.

A second variety of trouble develops when the owner doesn't know how to use the system. An installer may have done okay installing and adjusting. Yet the owner, not comprehending system oddities, gradually forgets exactly what to do or how the system was designed to operate. The installation acquires a reputation for false alarms.

Third, and the troublemaker that professionals grumble most about, is the alarm system thrown together by the fly-by-night or minimally qualified installer. Security systems are easy to sell, whether they're good or bad. Planning and setting up even good equipment to work right takes expertise. Making marginal or ill-designed alarms work well becomes impossible. An untrained, inexperienced installer just can't expect to do a consistently acceptable job.

So here's the word for **Radio-Electronics** readers: Don't expect to make out in the security alarm business unless you gain training and experience first. How do you do that? Training in electricity, physics, and basic electronics comes first. Then, if you're good, a couple of years with an experienced hand (who also doesn't mind teaching you) will acquaint you with application and practice. You'll still have to supply brand-new ingenuity and judgement to almost every new installation and protection situation, but you'll at least have a base from which to start.

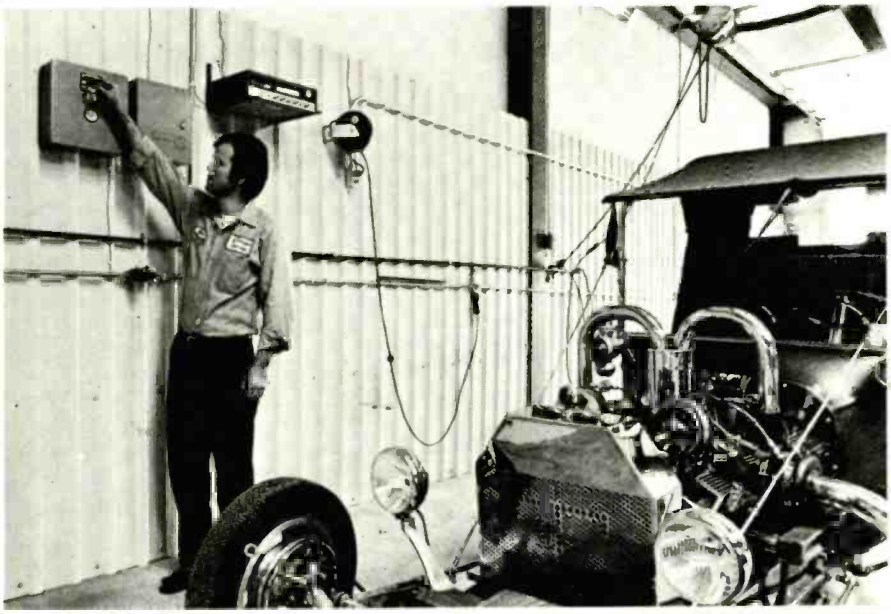
A few manufacturers offer seminars covering their equipment. They help you keep up with advancements, and that's important. But seminars are useful only if you have a solid foundation of experience to build on.

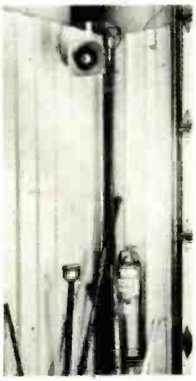
Tips from a professional

Success in any field entails certain key qualities: ambition, drive, know-how. Supplying a service as indefinable as *security* demands a special blend of patience and professionalism. And that latter quality — professionalism — seems the hardest to come by. You develop it; it doesn't just happen to you.

Tracing the career of a professional in any field sometimes guides others who aspire to similar goals. Consider this example in the security field: William Bowman, who operates a small but growing outfit called Guardian Alarm Co., Inc. Bowman became interested in electronics in his teens. After high school, he joined the Air Force and learned electronics as a radar repairman. Afterward, he dabbled briefly in TV repair, became an instrumentation technician with a large company, and then an electrician. Bowman tells how he got into security work.

WILLIAM BOWMAN, OWNER OF FOUR-YEAR-OLD ALARM COMPANY, burns some midnight oil on phone to client. Firm has been built slowly but solidly on good service to customers. Word-of-mouth accounts for majority of new sales leads, and experience supplies the self-confidence that converts prospects into new customers. Modest shop serves mainly for testing new equipment, as most repairs are completed right on the job.





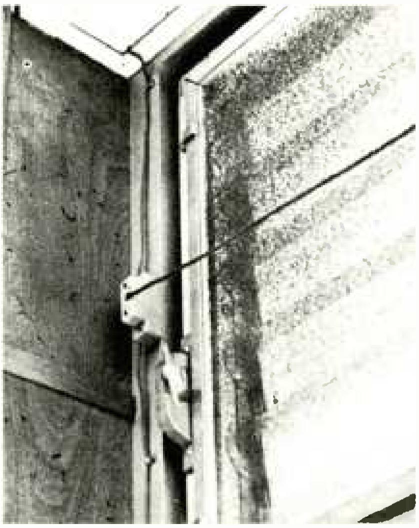
A FAIRLY NEW GUARDIAN CUSTOMER, master mechanic Jim Strange tests his alarm system before closing shop for the day. Low-frequency sonic motion detector protects valuable handmade custom hot-rod as well as customers' vehicles. Specially baffled sonic drivers hung strategically in the shop double (in daytime) as horns for music system. Baffles increase detection range.

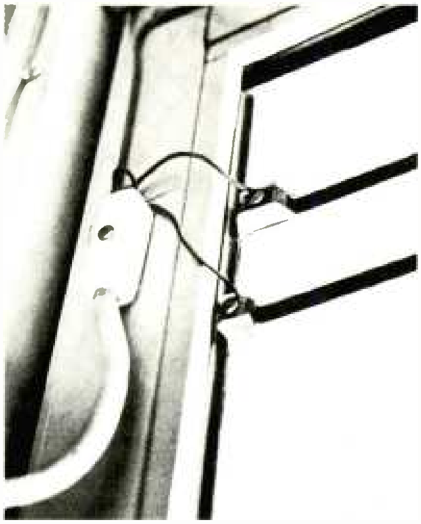
"A friend of mine started an alarms business a few years ago. I helped him with a few installations. But it turned out that technical help was what he needed. He was a good salesman, and he kept selling more sophisticated alarms and having troubles and not knowing how to rectify the problems. Particularly with ultrasonics . . . not knowing where to put them, how to run the wires, things like that. The early ones were especially touchy about wires crossing each other, or running close to ac lines.

"Anyway, he had a lot of alarm systems out, spread all over the place. He and his partner just couldn't keep up and finally decided to get out of the business. So I took the systems over."

The natural question: How do you build a business from a base of dissatisfied customers?

"Well, after I got their systems working, they weren't dissatisfied customers. There was nothing wrong with the equipment they'd been sold. The trouble was the way it was installed. And sometimes not the right equipment for the purpose. For example, you can't put an ultrasonic or sonic system into a place that's heated by forced hot air. It just can't do the job. If you desensitize the alarm enough to stop the





LAUNDROMAT INSTALLATION INCLUDES SOME HARD-WIRE PROTECTION. Trap-type switch on over-door transom is "supervised" — tamper-resistant method of wiring that triggers alarm if circuit is bridged or opened, either one. Circuit from foil on door, and from smoke and heat detectors (not shown) operate out of same central control box. Sets off loud electronic sirens. Could be hooked to automatic telephone dialer to call owner, alarm company, police or fire department, or security guard.

false alarms, it can't detect motion like it should. You have to figure out some other way — door and window switches, foil, spot protection, something.

"So, one by one I solved the problems. There were broken wires — normal things; the systems weren't all new. But mostly I dealt with improper intallations. Once these people began getting the service they expected, they liked the equipment.

"And then I began getting referrals. Those customers told others. At that time I still worked weekdays as an electrician (which, by the way, gives me an advantage in knowing how to run wiring), so I did some selling on Saturdays. Most of my business came from referrals, though, and still does. I get out and beat on doors a little more now that I can be here full-time. I build business steadily that way." Bowman employs three other installers.

Why the difficulties?

One problem until recently, agrees Bowman, was a lack of dependable knowledge of alarms and protection — even by most alarm manufacturers. The large nationwides had the security field to themselves. They did a fine job for big stores and companies that could afford elaborate services. But owners of small stores, until two or three years ago, had to make do with whatever they could find — and there wasn't much that really worked. And few people who knew how to make it work.

Now the whole alarms picture has changed. A certain few companies have devoted the engineering and applications effort necessary to overcome the operating bugs that plagued earlier medium-cost alarm systems. Highly dependable systems are priced reasonably enough that the average business owner can afford protection. Alarm companies today offer better — some very elaborate — installation manuals to qualified installers; that kind of help is something new. One company even will, if you're an established installer, come out and help you install your first system of theirs.

Bowman has his personal brand preferences, but concedes that several firms have most equipment problems licked. How does he decide what equipment is good or bad? "The only way you can: install it and try it," he says. One sample of a new brand he's considering (they came to him) has been in and operating some eight months for one of Bowman's customers. Regular visits and some out-of-the-ordinary testing have gone into this tryout, and so far the system has come through admirably. Bowman expects to begin selling this brand, "but ony for what it's best suited to do. Nobody makes one kind of alarm system that will handle everything. That's why experience is so important to the guy wanting into the business." Guardian carries ony two or three brands, to keep inventory at a sensible level.

Handling the business

A typical sale for Guardian begins with a survey of the premises: size, shape, openings, heating system, construction, location, neighborhood, trouble the prospective customer has had (why he called), what he needs to protect, and so on. One object is to figure out the best protection that won't overtax the customer's budget. Bowman often sketches out the locations of important factors, such as air blowers, windows, doors, etc., on a planning sheet. From that he designs a system and figures and estimate.

Installation usually follows Bowman's initial plan—but not always. Unforeseen difficulties often remain to be solved. An example: Guardian installed a sonic motion-detecting system in a shop. Every evening about 7 PM, the telephone dialer called the police. The second night, the owner called Guardian. The third night, Bowman unhooked the dialer and connected a chart recorder. No voltage problem. Bowman finally traced it to a leaky air-compressor egulator. As pressure dropped after closing time, a whistle caused by escaping air passed through a frequency the system could sense. One screw-turn on the compressor corrected the trouble. Only experience, the familiarity, and perseverance (and luck, adds Bowman) tracks down such troubles.

Warranty? "You're going to know in a couple months whether you've got any bugs. However, the manufacturer guarantees the equipment for a a year, so we do that too, labor and all. There are longer warranties — one for six years, but that's on a prorated basis. A year really is plenty. I wouldn't take on another brand just because they have a good warranty."

Equipment repairs after warranty are largely on a module-exchange basis. Much modern motion-sensing equipment is modular, using lots of integrated circuits. Swapping modules makes the most sense for both servicer and customer. Guardian stocks a small inventory of modules. Troubleshooting time stays at a minimum, and a customer doesn't lose protection at all. Each manufacturer reconditions modules for a nominal fee, so repair costs to the customer are small.

You—in the alarm business?

Bowman has this warning for new-

(continued on page 80)

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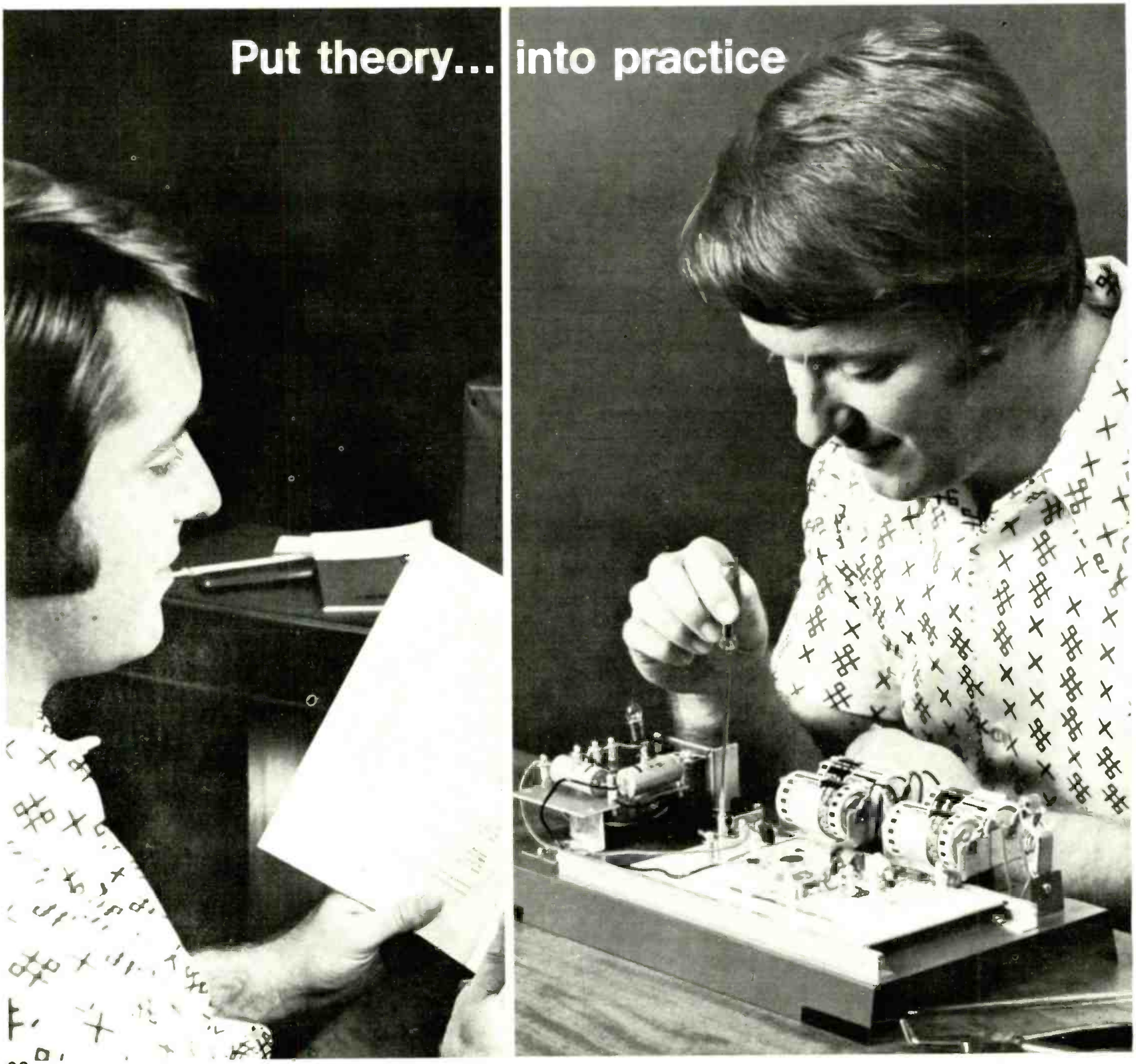

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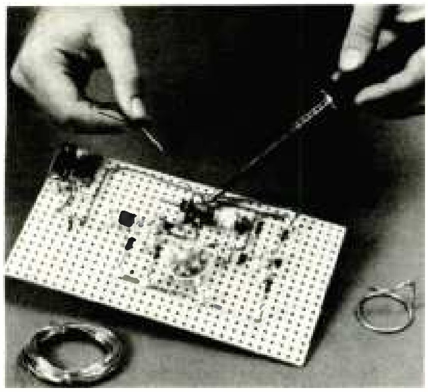

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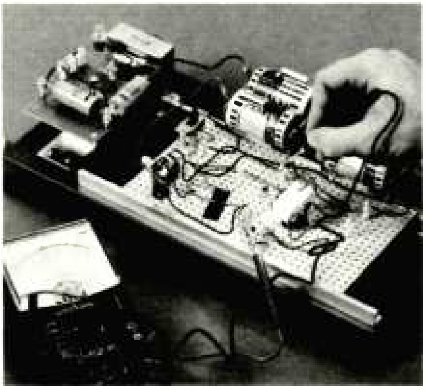

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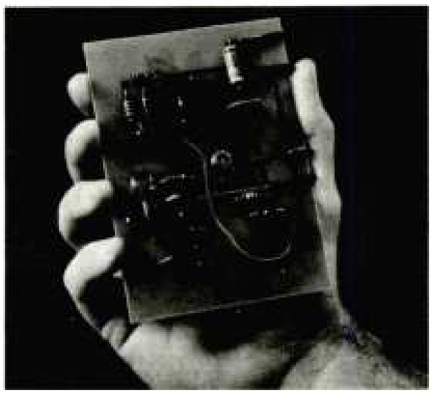

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Here's how two outstanding CIE students carved out new careers: After his CIE training, Edward J. Dulaney, President of D & A Manufacturing, Inc., Scottsbluff, Nebraska, moved from TV repairman to lab technician to radio station chief engineer to manufacturer of electronic equipment with annual sales of more than $500,000. Ed Dulaney says, "While studying with CIE, I learned the electronics theories that made my present business possible."

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

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Circle 17 on reader service card

ABC's of Sound Reinforcement

A brief look at the why's and how's of a relatively new field aimed at optimum intelligence and listener enjoyment wherever PA systems are used.

by MARK KOLLER*

When the sound from a rostrum or stage is distributed to a large audience, such as in an auditorium, stadium, house of worship or other public building, a sound reinforcement system must be used. This system should present the sound clearly and realistically to each listener, regardless of his location in the audience.

For years, sound engineers have been struggling with the problem of how to construct such sound systems. A system that would be able to both satisfy our sensitive ears and would overcome the acoustical drawbacks of the environment.

Our hearing indeed is sensitive; it can respond to pressure levels ranging up to 120 decibels from a zero level of 0.0002 microbars. This means that the loudest sound we can tolerate creates about one trillion times as much pressure on our ears as the faintest whisper we can detect. Besides the incredible range in sensitivity, the human ear has a frequency range of nearly 10 octaves (an octave being the interval between two sounds having a basic frequency ratio of two), far greater than most musical instruments.

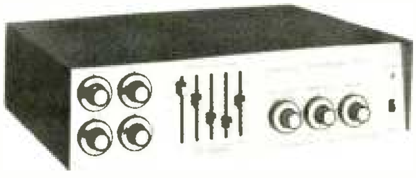
These outstanding characteristics of our hearing mechanism allow us to detect the slightest imperfection in a sound distribution system—thus making the sound engineer's job all the more difficult.

The problem of acoustics

When an audience is listening to a speaker or program, its eyes are drawn by the action at the microphone and its ears are "tuned in" to it. There is a line-of-sight rapport between the action and each member of the audience, the line representing listening as well as seeing.

Sound engineers use many techniques to try to establish the hearing line of sight to the audience. A loudspeaker (or cluster of loudspeakers) may be positioned up front, high enough to dominate all areas of the audience. The floor may be "rigged", elevating each succeeding row, to aid in loudspeaker effectiveness. At times, continuous-loop tape delay techniques are used in order to convey realism to a sound reinforcement system.

Some halls, such as those with curved walls or vaulted ceilings, present very strong echoes. A repetition of the same syllable due to echo tends to confuse and annoy the listener. Also, the system builds up a standing-wave pattern at a particular frequency. Any sound at this frequency will last much longer than the normal reverberation time of the room. It will mask or garble other sounds and is referred to as the "ring mode"[1] of the room. Ring modes can be overcome effectively through "sound equalization."



BOGEN CT30 AMPLIFIER has five equalizers to reduce a tendency toward howling.

REAR VIEW of the NXT-FB-1 feedback control unit shows its nine preset controls.

FEEDBACK CONTROL UNIT, Bogen's NXT-FB-1, has panel designed for rack mounting.

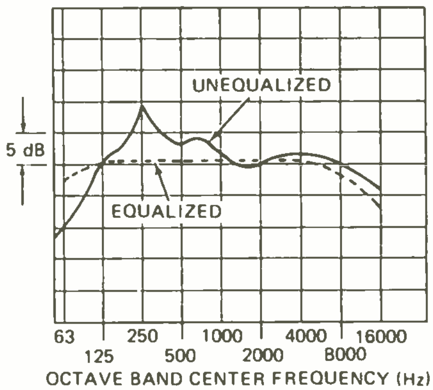


FIG. 1—THE AMPLIFIER IS EQUALIZED to compensate for house resonances so listeners hear performance with flat response.

Sound equalization is a method that permits the sound engineer to tailor a reinforcement system to the acoustics of a room. To do this, the engineer locates those frequencies at which the room "rings," or at which feedback (self-oscillation) occurs. Feedback occurs when the sound pressure level delivered by the performer to the microphone and the sound pressure level from the loudspeakers, have the same magnitude and phase. When feedback at a particular frequency occurs, the gain of the system must be reduced accordingly, limiting its efficiency.

The frequencies at which feedback occurs are isolated and reduced with the aid of a very narrow band (5 Hz) equalizer. To compensate for other acoustical peculiarities of the room, broadband equalizers or ⅓-octave equalizers are used.

The object of equalization is to get a high enough gain of the system (without feedback) to establish the same sound pressure level at each seat in the hall as is being applied to the microphone[2]. The frequency response curve of the hall (called the "house curve") is then plotted. The sound engineer strives to obtain a house curve that is within ±1 dB of the ideal curve (see Fig. 1). This can be done only by careful equalization.

In an equalized hall, each listener will hear clear, realistic sound, limited only by his own capacity to hear. With the techniques of modern sound engineering now available, no public building or arena need have anything less than a top-quality sound reinforcement system.

The future

A close collaboration is necessary between the architect and the acoustical engineer. With equalization a proven tool in achieving good results in the acoustical characteristics of a room, no guesswork is necessary. However, to predict full-scale performance, acoustical modeling is very helpful.

In a scaled model of a hall, all pertinent measurements can be made and the acoustical characteristics of the hall can be evaluated ahead of time. In cooperation with the architect, the hall can be built to attain the best possible sound reinforcement realism without affecting the aesthetic appearance of the hall. **R-E**

*PA Engineer, Bogen Div. of Lear Siegler, Paramus, N.J.

1. C. P. Boner and C. R. Boner, "The Gain of a Sound System." *Journal of the Audio Engineering Society*. April, 1969, XVII, p. 147.
2. *IBID*, p. 148.

the VIDEO DISCS are coming

The video discs of today–still in the developmental stage–will become a major home-entertainment medium of tomorrow. Can you guess which system will become the standard?

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

IN 1927, BRITISH TELEVISION PIONEER John Logie Baird demonstrated video signals stored on a phonograph record. His 30-line pictures had a bandwidth of only kHz, with 15 lines of horizontal resolution at 30 frames per second. Although this established the disc as the first video storage medium, his experiments were virtually forgotten.

Today, millions of dollars of research and development money are being poured into the videodisc in the belief that it may become the next major home electronic entertainment device. Ten systems are known to be under development and some have already advanced into the pre-production prototype stage.

All of the descendants of Baird's novelty are designed to produce color television pictures with stereophonic sound when fed into the antenna terminals of a standard color TV receiver (and the proper supplementary audio equipment for stereo). All but one of these systems are designed exclusively for the playback of prerecorded programming. Why discs instead of tape? Disc players generally can be produced at a lower cost than tape players and discs themselves can be duplicated (by stamping, printing or photographic exposure) for a cost comparable to pressing an audio record. And the disc format is familiar and convenient.

Four basic types of videodisc systems are now under active development. Of the ten known systems, six use optical readout, one is mechanically scanned, one employs an electronic-capacitance principle and one uses magnetic recording techniques.

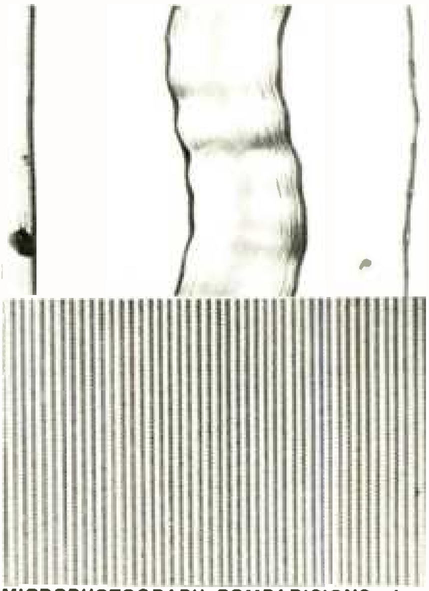
Big names are involved and the stakes are high. In America, each of the two largest color TV manufacturers—Zenith and RCA—is developing its own system. Europe's largest electronics firm, Philips Gloeilampenfabrieken, is ready to introduce a different system commercially; Germany's Telefunken has scheduled mass production of still another and France's biggest electronics concern, Thomson-Houston, advocates its own system. Here's a rundown of the systems currently under development.

TeD mechanical system

Developed jointly by German Telefunken and British Decca, this was the first modern videodisc system to be demonstrated and the first scheduled for production. TeD discs are thin, flexible and about 8¼ inches in diameter, providing up to ten minutes playing time. The compact player has no exposed working parts. The disc, enclosed in a paper sleeve, is slipped into a slot on the front of the player. It is drawn through a roller mechanism which removes the sleeve and is deposited on the turntable. After playing, it is automatically reinserted in the sleeve and ejected through the slot. An automatic changer is under development.

TeD uses a principle as old as the phonograph itself—the "hill-and-dale" recording technique originally used by Thomas A. Edison. The color information is converted into a frequency-modulated line-sequential signal (with the two sound channels multiplexed into the signal). A mechanical cutting

SECTION OF TELEFUNKEN/DECCA MOLDED DISC photographed with a raster-scanning electron microscope. Enlargement is 20,000 times.



MICROPHOTOGRAPH COMPARISIONS of a standard lateral-cut phono groove (top) and the hill-and-dale grooves in the TeD videodisc (bottom).

process similar to that used for audio mastering results in a disc with hills and dales. The flexible polyvinyl chloride foil records are duplicated by a conventional stamping process.

The system is the synchronous type—that is, each revolution of the disc represents one frame of the television picture. For European 625-line/50-Hz television systems, the disc rotates at 1500 rpm (or 25 rps). A version designed for the U.S.-Japanese 525-line/60-Hz TV system will have a speed of 1800 rpm (30 rps).

In playback, the disc is mounted on a stationary plate rather than a turntable. It's driven only from the center, the high-speed rotation creating a thin air-cushion between it and the plate. This cushion holds the disc against the pickup—a "pressure scanner" consisting of a flat diamond stylus connected to a piezo-ceramic transducer which converts the pressure pulses from the disc's hills and dales into electronic signals. The scanner arm is geared to a "forced advance" system which guides it toward the center of the disc. A short sequence may be repeated by pushing a button which disengages the forced advance. Despite the physical contact between stylus and disc, TeD's developers say a record may be played 100 times with no visible signs of wear and stylus life is also about 100 hours.

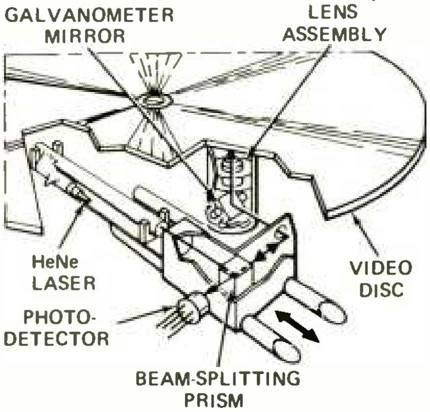
Plans for production of the TeD videoplayer have been announced by Telefunken in Germany, Decca in England and Sanyo in Japan. Several European and Japanese record firms have announced they will produce videodiscs for the system. Telefunken originally had planned to start marketing in Germany in January of this year at a price of around $450—but production was halted after a problem involving the record sleeve was discovered, requiring modification of the mechanism. It's now uncertain when the player will be offered by German dealers. Sanyo has announced that it will offer an NTSC color version next year, but this could be delayed by economic problems in Japan.

Optical systems

Most of the seven proposed optical systems bear a strong family resemblance, even though they currently are mutually incompatible. They all offer long playing time, from 20 minutes to an hour. Five of them are synchronous systems (one TV frame per revolution) and six can guarantee virtually no record or stylus wear because no stylus touches the record. In fact, there is no stylus—just a beam of light.

Philips VLP

Developed by the European electronics giant, the Video Long Play system has been demonstrated in preproduction prototype form and is scheduled for introduction in Europe next year. It is capable of storing 30 to 45 minutes of color TV programming (with 2-channel sound) on a 12-inch disc. (The production version is expected to have 30-minute capacity.) The discs are made of rigid transparent polyvinyl coated on one side with a thin reflective metal layer. They're duplicated by stamping from a glass master on which impressions have been deposited by a laser-etching process.



PHILIPS VLP PLAYBACK UNIT. Record is scanned from below by light from a He-Ne laser. Photo detector converts reflected light into video signal.

VLP DISCS ARE TRANSPARENT RIGID PLASTIC with thin reflective metal layer. Duplication is by stamping from glass master.

VIDEOPLAYER developed by Philips to play its VLP (Video Long Play) discs. Signal is fed to set's antenna terminals.

PITS STAMPED IN VLP DISC contain vidio and video information. This is a microphotograph of a section of the disc surface.

The resulting plastic disc contains a microscopic spiral track, 0.8 μm wide, consisting of a sequence of oblong pits of uniform width and depth but varied in length and in spacing. This pit pattern contains all necessary information in encoded form—the luminance signal being a frequency-modulated carrier, color information a quadrature-modulated subcarrier.

The playback system is based on light diffraction. A spot of light is projected on the track by a lens-and-mirror system. If it strikes the metal-coated surface of the disc between the pits, practically all of it is reflected back into the lens. If the light spot falls on a pit, it is diffracted and most of it bypasses the lens. The modulated portion of the reflected light picked up by the lens is fed into a photodiode which converts it into a proportional electric signal.

The light-source used by Philips is a low-powered (1-mW) helium-neon laser, said to be capable of mass production at low cost. Two separate servo systems are actuated by the same light source—one to keep the tiny spot of light centered in the microscopic track, the other to keep the beam precisely focused regardless of irregularities in the disc.

Because the disc spins at one frame per revolution with no physical contact between pickup and record, the Philips system permits many "tricks." Fast or slow motion is possible, either forward or reverse. Any frame may be held as a still picture simply by repeating the same track over and over. Philips' prototype model has a control panel containing infinitely variable fast and slow-motion slide controls, a pushbutton for frame-by-frame advance and an LED readout to permit the user to select any individual frame at random. The system can be used as sort of a super slide-projector since 45,000 single still pictures can be stored on a single 12-inch disc and located precisely by means of the frame readout.

Philips has announced that it intends to start production next year. The price will be "comparable" to that of a quality color receiver—which in Europe would be $900 to $1000. Although a 525-line NTSC version is being developed, no plans for production of the American-standard unit have been disclosed.

MCA Disco-Vision

This system was developed by MCA Inc., the entertainment conglomerate which owns Universal Pictures. It came as a surprise because it was so similar to the Philips VLP in principles and results. Disco-Vision also uses a 12-inch transparent disc with reflective coating on one side and is designed to play for 40 minutes. A helium-neon laser scanning system is employed. As demonstrated, the disc spins at 1800 revolutions per minute for American television standards.

Although MCA has revealed few technical details of its system, there are known to be some differences between

MCA DISCO-VISION PLAYER for single disc. Player uses laser read-out and feeds the antenna input of a standard TV receiver.

DISCO-VISION RECORD CHANGER gives user a viewing time of up to six and two-thirds hours. Controls are similar to phono changer.

it and Video Long Play. One is said to be a patented technique which eliminates the need for a servo to focus the scanning beam. Another is a signal expansion-contraction system which makes possible 40 minutes playing time although the recorded portion of the disc is limited to the outer three inches—which normally would produce only 20 minutes of play. Although there have been suggestions that VLP and Disco-Vision could be brought into compatibility, they're clearly incompatible at present—if only for the fact that the VLP record is scanned from the center to the outside while Disco-Vision is scanned from the outside in.

MCA says its players will be built by unnamed major manufacturers, with deliveries to start in mid-1975 at about $400 for a single-play unit and $500 for a 10-disc changer. Recorded videodiscs, including Universal feature pictures, are promosed at $2 to $10 per album.

Thomson-CSF

The audio-visual subsidiary of French Thomson-Houston has announced it's developing a system which appears to be a cross between VLP and TeD. Like VLP, it uses a laser-optical readout, but like TeD it employs a flexible disc which rides on a cushion of air. Thomson claims the air-cushion principle eliminates the need for a focusing servo. The system's developers say they have been able to play TeD mechanical videodiscs optically with their system.

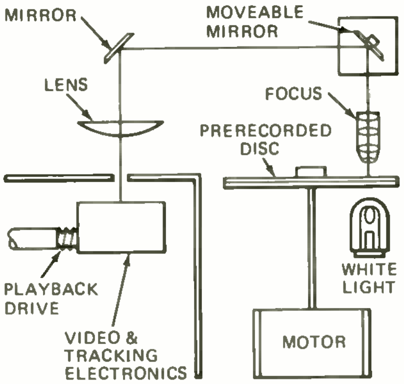
The Thomson discs are transparent instead of reflective. Like VLP and Disco-Vision, a low-powered laser is employed, but Thomson's laser shines through the disc to modulate a photodiode located on the opposite side of the record and turntable. To make possible greatest economies in the playback equipment, Thomson says it will settle for 20 to 25 minutes playing time per 12-inch disc in the interest of reducing the complexity and precision required for a longer-playing system. It is aiming at a market price considerably below that of VLP. No production plans have been announced.

Zenith

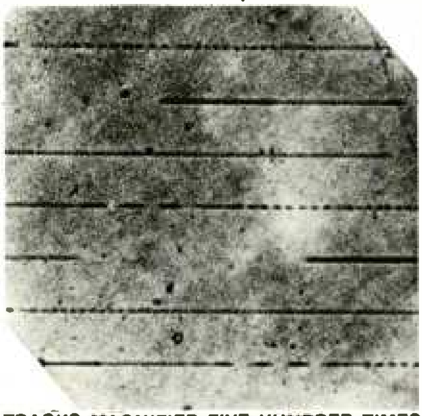
The videodisc is a high-priority item in the labs of this American TV leader. Zenith's current efforts are directed at a synchronous optical system similar to that under development by Thomson-CSF—using an air-cushioned, transparent, floppy disc. Although Zenith and Thomson are understood to have signed a technical information-exchange agreement on videodiscs, it's believed that Zenith's system employs some proprietary developments not used by Thomson. The Zenith disc, at last report, had about 20 minutes playing time. Zenith has not announced when—or, indeed, whether—it will produce the system.

i/o Metrics

The i/o Metrics Corp., a Sunnyvale, Calif. company specializing in film processing and data retrieval, has come up with what it claims is a low-cost high-performance variant on the synchronous optical videodisc systems, using photographic film as the disc material and substituting a low-intensity incandescent light for the laser scanner.



BLOCK DIAGRAM of i/o Metrics videodisc playback system. The videodisc spins at eighteen hundred revolutions per minute.



TRACKS MAGNIFIED FIVE HUNDRED TIMES show data spacing and density of encoded video in i/o Metrics photographically reproduced disc.

RECORDED DISC used with the i/o Metrics system is on film that can be rolled and handled without harming the recorded information.

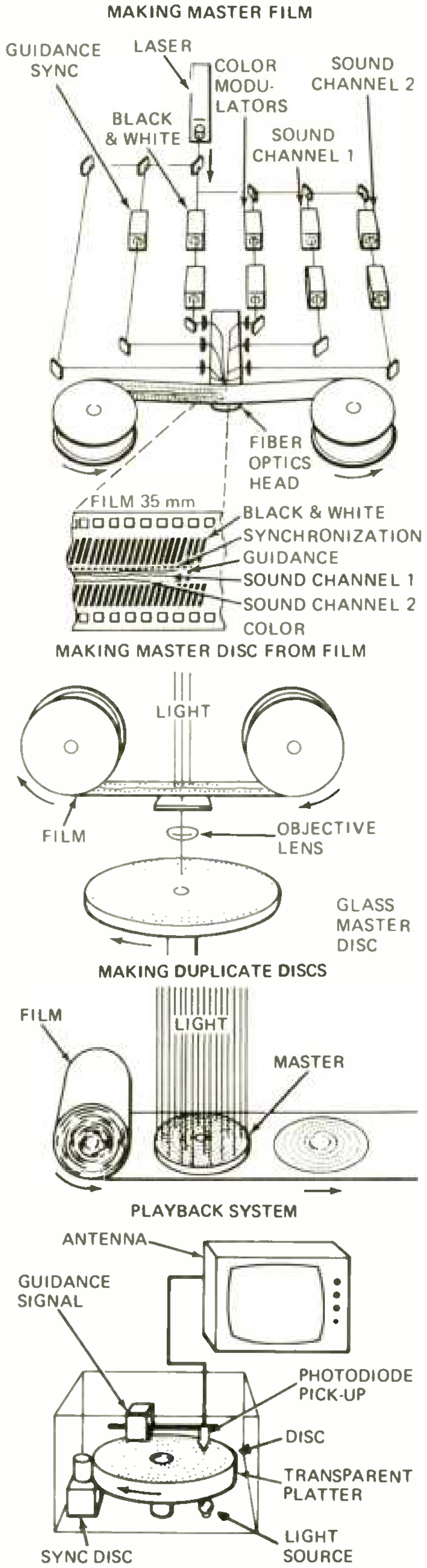
The master is also photographic. A complete composite color signal, with multiplexed sound channels, modulates a laser beam to expose a spiral track on a spinning disc made of high-resolution black-and-white film. This film master is processed by conventional means and the discs are duplicated from it by photo printing techniques. The system has been demonstrated using thin flexible Mylar-base discs with commercial holographic-grade emulsions developed by standard darkroom techniques.

The playback system uses a transparent turntable revolving at 1800 rpm. A 25-watt miniature bulb is mounted beneath the turntable, projecting the recorded image into a light-focusing lens and onto a photodiode which converts the light into electronic signals. As in the Philips VLP system, part of the light is used to activate servo systems governing tracking and focus.

Its developers claim that one of the advantages of the system is that it uses all standard off-the-shelf components and that the master recording as well as the playback processes are inherently low in cost. They say that a player could be made to retail for less than $300 and could be marketed early in 1975. The company is trying to interest major manufacturers in adopting its sytem.

Optidisc

A completely different type of optical system which also uses film-based discs has been developed by 28-year-old French inventor Guy Nathan. First models are scheduled for production for the industrial market early in 1975, with a consumer version to follow. Optidisc is claimed to eliminate most of the tight tolerances from



REPRESENTATION OF THE OPTIDISC recording, duplication and playback systems. Light from a laser is split by prisms into seven beams that are modulated with the various signal components that make up a composite color television signal with two sound channels. Video scanning lines are recorded crosswise on the 35-mm film. A glass-disc master is made from the film. Duplicate discs are made from the master by a photographic process. Photodiodes in the pickup scan the slow-moving disc to detect the composite color video signal.

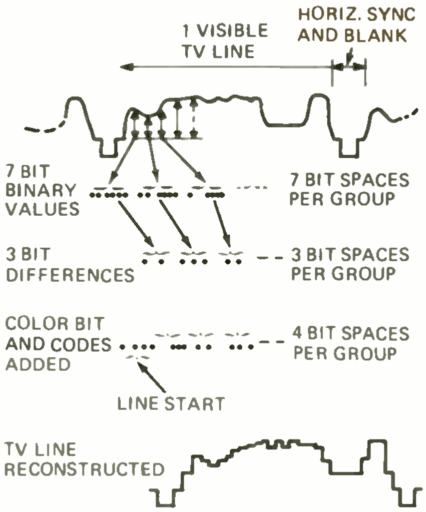
optical videodisc systems by using a signal format which makes possible speeds as low as 2 to 6 rpm and a very wide track.

Instead of recording the TV signal "Indian file" in a microscopically thin track, the Optidisc stores each individual scanning line on a plane perpendicular to the track. A light source shines through the transparent turntable and disc to an array of photodiodes in contact with the disc. The disc's slow movement is dictated by the fact it picks up one full scanning line at a time. To make the master, a modulated laser beam impresses a line at a time on 35-mm film. A photo-sensitized spinning glass master disc is then printed from the film. Duplication of the individual flexible film discs is accomplished by conventional photo printing. The Optidisc's track is 0.6-mm wide, 750 times the width of the track on the Philips VLP. Nathan hopes the consumer version of the Optidisc player can sell for about $200.

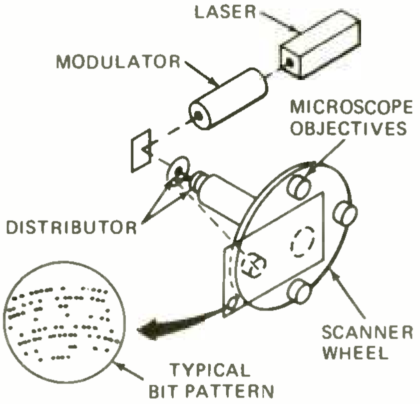
Digital Recording Corp.

Digital's record moves even slower than Optidisc's. In fact, it doesn't move at all. It's placed in a slot and the scanning system moves. This is one of several novel ideas in the system developed by Battelle-Northwest Laboratories in Richland, Wash. and licensed to Digital Recording Corp.

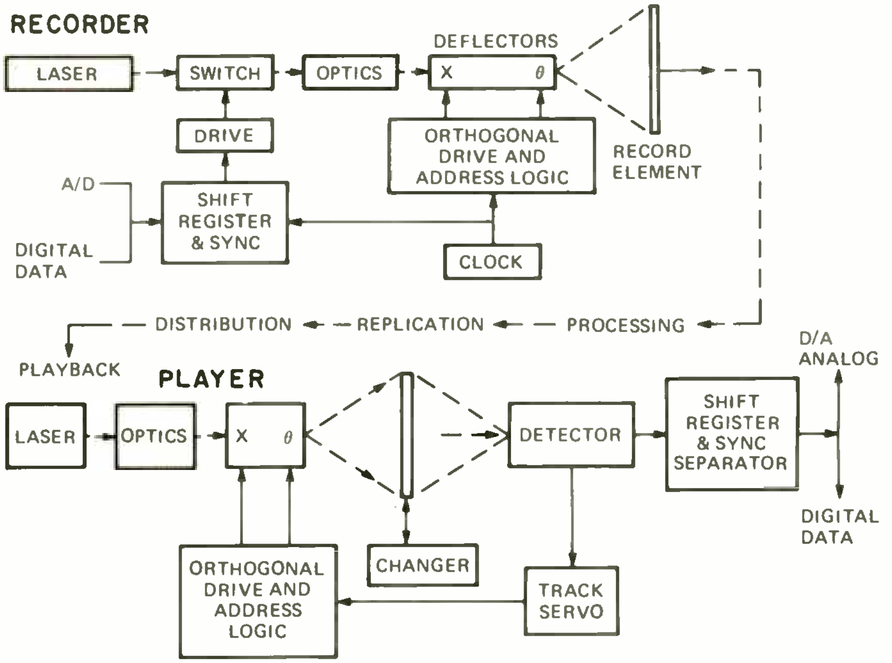
The non-spinning record eliminates many of the problems of off-center discs, wobbling turntables and so forth and makes it possible to transfer all of the precision into the scanning system



ANALOG TV SIGNAL is encoded into digital information in the scheme developed by Digital Recording Corp.



DIGITAL RECORDING'S SYSTEM uses stationary master film and rotating scanners for recording and playback.



BLOCK DIAGRAM of Digital Recording's recording and playback systems. The video record does not turn so it need not be round. It will probably resemble a piece of sheet film.

which is completely sealed. In making records, the video signal is converted into digital information which switches a laser on and off, resulting in a string of small spots on a photographic plate. As in the two preceeding systems, the record is duplicated photographically.

(continued on page 88)

HI-FI Stereo New Sound for TV

Pay-TV systems have been developed and tested, in the past, to give the viewer special programs and movies. Next month, New Yorker's will be offered pay-TV with stereo sound.

by LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

THE AVERAGE AUDIOPHILE WOULD probably be surprised to learn that the sound portion of a commercially broadcast TV signal (unlike the video signal) is transmitted via FM and is, therefore, a potentially "high fidelity" signal from an audio point of view. The parameters for transmission are somewhat different from those used in FM broadcasting, in that maxinum deviation of the sound carrier is limited to ± 25 kHz, whereas in FM broadcasting, maximum modulation is ± 75 kHz.

Since deviation is linearly proportional to audio loudness level, you would expect the maximum signal-to-noise level to be approximately 10 dB poorer for TV sound then for FM. In practice, this need not be the case. Maximum signal-to-noise is reached in modern FM receivers or tuners with signal input levels of 100 μV or less, even though the usual measurement is made with signal inputs of 1 mV or so.

Since most TV stations transmit at higher power levels than do typical FM stations, higher input signal strengths are generally available at the TV set's input terminals than are present at the antenna terminals of FM tuners and receivers. A signal input of less than 100 μV would generally result in a "snowy picture" which receivers would not deem acceptable, so that if the picture is free of snow, the audio carrier signal strength is usually more than great enough to achieve maximum S/N ratio in the receiver.

Preemphasis and deemphasis

Audio programming on TV can be transmitted with the same wide frequency response (30 Hz to 15,000 Hz) as FM. Just as in FM broadcasting, 75-μs pre-emphasis is introduced at the transmitting end and reciprocal deemphasis is provided in the receiver to reduce high frequency noise content.

Why then is TV audio so incredibly poor, as reproduced from nearly all TV sets? For one thing, TV manufacturers concentrate on improving video performance with little or no regard for audio quality. Most "portable" TV sets (even the 19- and 21-inch variety) use tiny speakers (4-inch units are typical) incapable of reproducing anything approaching the frequencies required for good high-fidelity sound. In most instances, even these miniscule speakers are poorly baffled or mounted wherever there are a few square inches of panel space.

There is another reason for the poor sound quality and this is the leased telephone lines used by the stations to carry audio signals. Local lines from the camera location to the transmitter do have hi-fi frequency characteristics. But the long-distance lines used to carry signals from one city to another, and these are used for nationwide network programs, are limited to a maximum of 5000 Hz audio response. And even in the instances where local, high-fidelity quality lines are available, the station will not necessarily put out a signal that goes all the way to 15,000 Hz.

If you are after high-fidelity sound, you've probably run across articles from time to time, which tell you how to hook into your TV set and feed the audio portion of the received program into your hi-fi stereo system. These do-it-yourself projects are often doomed to failure before you begin. Consider the arrangement shown in Fig. 1. If the existing speaker (in the TV set) is disconnected and audio voltage is taken from the secondary of the output transformer, the poor frequency response to the output transformer will restrict the fidelity of the audio program.

Even if the audio signal is extracted at the volume control point in the circuit, chances are that attenuation of low and high frequencies has already been deliberately introduced to prevent amplifier and speaker overload in the original design. The average frequency response of a typical audio system in a table-top TV set is shown in Fig. 2 — it hardly qualifies as high fidelity.

High-fidelity TV audio

All of which brings us to an exciting new service that is about to begin in the fall of 1974. At that time, in the New York metropolitan area, over-the-air pay TV is slated to be introduced by Blonder-Tongue Laboratories — a company that has been in the CATV and MATV business from the very inception of those services. Blonder-Tongue BTVision is not to be confused with any cable TV system, however. It is an over-the-air system that can be self-supporting and profitable with a minimum number of subscribers — a desireable feature that is not inherent in wired cable service as evidenced by the number of CATV operators who have failed over the years.

So, what is a high-fidelity contributing editor doing writing about pay TV? As you may have already guessed,

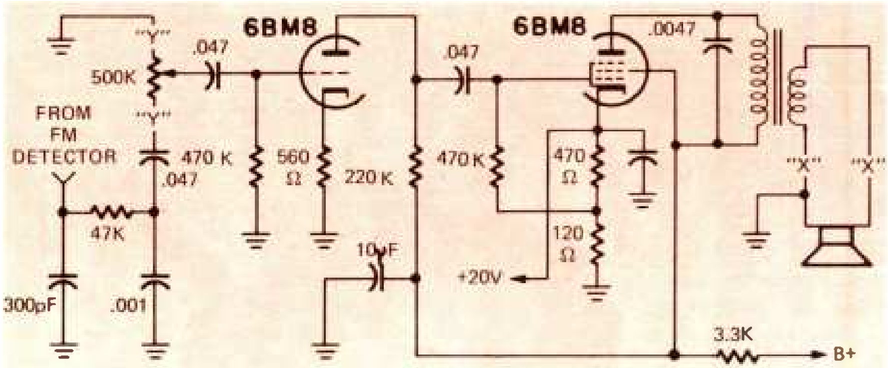


FIG. 1—TYPICAL TV AUDIO SYSTEM. Attempts to achieve hi-fi sound usually involve connecting a hi-fi amplifier at "X-X" or "Y-Y". Frequency response is still limited by design compromises.

there is an audio aspect to the new system which makes it highly interesting to the high fidelity enthusiast. More exciting, the system offers the promise of live concerts, broadcast in stereo, something the FCC has avoided approving for general commercial television service.

How BTVision will work

The subscriber who wants to avail himself of the new service will rent a decoder box such as that pictured in Fig. 4, much as he rents his telephone

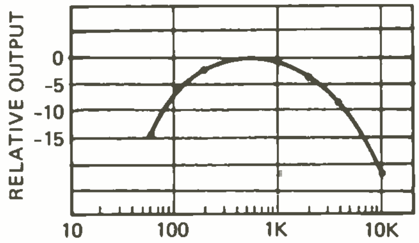


FIG. 2—TYPICAL FREQUENCY RESPONSE of a 19-inch color TV set, measured at the speaker terminals. Bandwidth at 5-dB points is 100—3000 Hz.

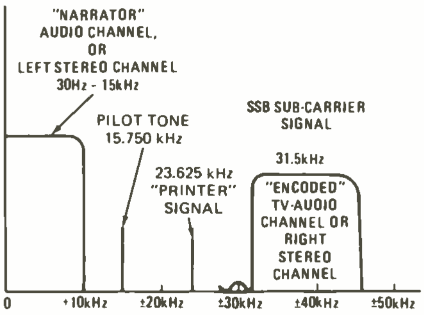


FIG. 3—FREQUENCY DISTRIBUTION of the audio and "print-out" signals in the new BTVision pay-TV system now ready for operation.

from the local phone company. The installation will include an outdoor mounted UHF antenna, which in the case of the New York operation will pick up signals from Channel 68. The decoder will convert this signal to Channel 3 (otherwise unused in New York) and the converted signal will be applied to the antenna terminals of your regular TV set.

Normally, what you will see on your screen if you tune to Channel 68 without the decoder, is a non-synchronized video picture which cannot be locked horizontally or vertically with any setting of your hold controls. Instead of the audio associated with the scrambled picture you will hear a narrator's voice, telling you what program is in progress, what programs are to follow, and what you must do to properly receive them.

If you decide that you want to see and hear a particular program, you turn a key in the side of the decoder and push a front panel momentary switch. (The key may be removed after locking the system to prevent accidental activation of the momentary switch.) The moment the button is depressed two things happen: The picture is synchronized, and the audio switches to that of the program in progress. The decoder contains a small but high-quality mono speaker system driven by a full frequency response amplifier. Even if you were to listen to this speaker, fidelity is significantly better. But Blonder-Tongue has wisely added an audio take-off jack on the back of the unit so that you can connect the sound signal directly to your hi-fi component system. Now here's the really unique part of the audio arrangement (see Fig. 5). When a suitable concert is programmed (and Blonder-Tongue is set to transmit programs from Lincoln Center in New York), the audio channel normaly used to "sell" the program (the one normally heard before you "buy" the program) can be used as one channel of a stereo pair while the encoded channel (normally heard after you make your "purchase") is used for the other. A second take-off jack is located on the decoder for this purpose — and the program audio channel have a frequency response from 50 Hz to 15 kHz (Barker channel 50 Hz to 10 kHz). Separation between channels has been

FIG. 4—THE DECODER used in the BTVision system. The built-in amplifier and speaker provide better sound than most TV sets.

in conventional stereo FM sets invariably results in some cross talk, particularly at higher audio frequencies where only the very best products are able to achieve 30 dB of separation. In the case of commercial stereo FM, this "sum and difference" technique was necessary so that mono listeners would obtain a complete program (L+R) even when stereo broadcasts were in progress. In the case of the new pay TV system this is no longer a problem. Even if a subscriber has no stereo hi-fi system, he could hear one channel from the decoder box and the other through his regular (if low fi) TV audio system. But for those of us who do own stereo systems, the technique holds promise for a return to live concert broadcasts, transmitted in color, and stereo sound.

The scrambled signal

The encoding technique used to transmit these visual and sonic wonders is really relatively simple and, at the same time pirate-proof. The BTVision encoder suppresses the horizontal sync-pulses by about 4 dB, enough to cause loss of horizontal sync when the signal is received on an ordinary receiver. This causes continuous random horizontal tear of the picture. In addition, the vertical sync pulses are altered, causing the received picture to have vertical roll at an annoying (and unwatchable) 10 Hz rate. The audio program is placed on a 31.5 kHz subcarrier, which is single sideband modulated as shown in the spectrum diagram of Fig. 3. This leaves the regular sound channel available for voice announcements to the potential program purchaser.

At the customer's home, the received

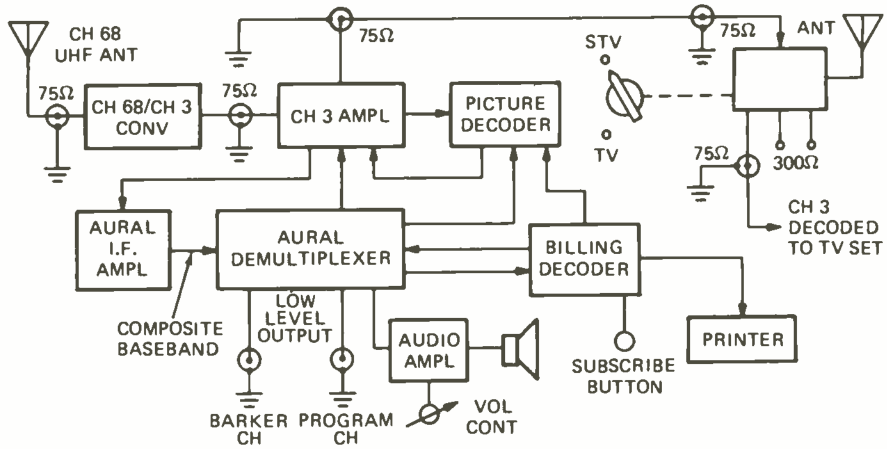


FIG. 5—DECODER BLOCK DIAGRAM. The encoded (scrambled) picture and sound are received on channel 68, down-converted to channel 3 and then decoded when the subscriber presses a button.

measured as 55 dB. This is so because each channel remains "discrete" throughout the entire process, unlike commercial stereo FM in which main channel is a mix of L+R while sub-channel contains L−R audio information. Re-matrixing of this combination

signal is connected to the BTVision decoder, pictured in Fig. 4. This decoder is activated by a single button on the front of the unit, restoring the original signal with full quality. Each time the decoder button is pushed a "real time" ticket is printed by an integral strip printer. The ticket is marked with a program identification number and a price for the particular program. The print outs are stored in the decoder until they are mailed in with the monthly payment. Referring again to Fig 3, a frequency of 23.625 kHz is used to activate the printer employing digital code techniques. The choice of this frequency (and 31.5 kHz) for the audio sub-carrier channel) is dictated by its relationship to the horizontal sync rate which is 15,750 Hz. Print out transmission at 23.625 kHz is 1½ times this sync rate, while the audio sub-carrier frequency is twice the horizontal frequency rate. Thus, there is a built in "pilot" signal already available for reconstituting the suppressed sub-carrier used for audio and single sideband audio detection is possible. Sideband products extend to 46.5 kHz (31.5 kHz plus 15 kHz maximum audio frequency).

A small audio amplifier feeds a built-in loudspeaker in the decoder, either with program or sales information audio, and the two audio output jacks shown are for connection to a monophonic or stereo hi fi system (see Fig. 5).

Since each decoder rented to a subscriber in a given area need receive only a single channel, there are no tuning or adjustment knobs for the customer to be concerned with, and stable drift-free performance can be built into the decoder.

From an audiophile's point of view, it is certainly to be hoped that Blonder-Tongue's system (and other pay systems) catch on and are an economic success. If indeed high-quality audio programming ever comes to TV, it will probably arrive in this format which is scheduled to begin in September, 1974. So keep those unused auxiliary inputs on your amplifiers or receivers ready — you're about to get new, high-quality audio signal to plug into those empty jacks. **R-E**

equipment report

Hickok Model 511 Wideband Triggered Scope

Circle 91 on reader service card

A LONG TIME AGO, THE HICKOK ELECTRICAL Instrument Co. of Cleveland was a major factor in the television-service test instrument field. I have Hickok test instruments in my shop that have been in use for 40 years, and they're still going. After a short spell in the lab instrumentation and industrial electronics area, they have gone back into the home entertainment electronics instrumentation field.

Hickok is producing several new units specifically designed for this type of servicing. From the one that I have seen, their old high-quality standards are still in force. This is the Model 511 triggered sweep scope, with a 10-MHz bandwidth. It's a descendant of a similar model they have been making for industrial use. The wideband triggered-sweep scope is fast becoming the standard instrument for servicing all kinds of electronic equipment.

As usual, I put it in the bench and gave it the works on several oddball service jobs. It came through very well. The triggering is very positive, making it easy to use. Patterns are steady as a rock, which is very useful. Sensitivity is high, 5 mv/cm; which means that it will "grab and lock" on even very low-level signals. One more handy feature has been added; this is a LOCATE switch. On many triggered-sweep scopes, screen. Just push the LOCATE switch, and the trace will appear. Its position will tell you whether the position controls are off, and if there really is a signal.

The vertical amplifier has a calibrated attenuator, with a range from 10 mV/cm to 50 V/cm, in 12 calibrated steps. A variable control can be used for adjustment of the pattern height, if necessary.

The horizontal sweep is also calibrated in time/cm, from 0.5 ms/cm up to 0.2 sec/cm, in 18 steps. A continuously-variable control is again used for fine adjustments if needed. There's also a "sweep-multiplier" which expands the trace 5 times, for examination of any part of a waveform. Maximum sweep-speed in this position is 100 ns/cm. (A nanosecond is 10^{-9} seconds.)

The trigger circuits can be used in NORMAL or AUTOMATIC mode. The AUTOMATIC position provides a baseline when the sweep is not being triggered by a signal. Either internal or external triggering pulses can be used for sweep alignment, etc. as well as for vectorscope display.

For checking the calibration of a probe, a PROBE CAL jack is provided on the front panel. This has a 7.5 volt p-p square-wave signal, at 1.0 kHz.

The power supply is solid-state, and tightly regulated for pattern stability. A transistorized dc/dc converter, working at about 18 kHz, provides the high accelerating voltage, as well as all other dc operating voltages. Due to the smaller size of the power transformer required with this type of design, the instrument is surprisingly light.

The horizontal time/cm switch has two special positions: TV-V and TV-H, for quick display of either horizontal or vertical TV signals. For these positions, a completely new sync-stripper circuit is included. This gives a very solid lock on these signals. Beside this, there's another function, about which more, very soon. All of the standard controls are provided for triggering; slope, so that either positive going or negative going parts of the waveform will trigger the sweep, a trigger-level control for either polarity, and so on.

The Model 511 has the brighest trace I have ever seen. They use a special CRT, a 5DEP31F, and with it, an accelerating voltage of 2500 volts. I didn't understand this, at first, but then I took a very unusual step; I read the instruction book. I found out why.

The last two positions on the HORIZONTAL TIME/CM switch are marked VITS-F1 and VITS-F2. VITS means Vertical Interval Test Signals. These are special test signals, transmitted by the TV networks, for use by TV transmitter engineers. One is transmitted on each of two lines during the vertical-blanking interval. There isn't enough room to go into all of the things about VITS here. However, they can be used for all kinds of tests *in the TV receiver*. For example, one of the test signals is called the MULTIBURST. It has square-wave pulse of video signals, at frequencies from 0.5 MHz to 4.5 MHz; there are six pulses.

The Model 511 will pick out *either* one of the two VITS signals. It does this with a very special sync separator and hold-off circuit. This keeps the beam blanked until it gets exactly the right signal from the input. Then, it turns the beam on and starts the sweep, for the duration of the VITS signal, then turns it off again until the next frame.

Now I found out why the high brightness. Since the VITS signal is of very short duration, and the CRT is scanned only once, high brightness is needed to display it. When this test is being used, the INTENSITY control is turned full on, a position which is far too high for normal scope work.

What can you do with VITS signals? With the multiburst alone, you can tell exactly what the bandwidth of the TV receiver under test is like. If it is too narrow, you'll see the amplitude of the multiburst pulses drop as you go toward the high-frequency end; the pattern will become wedge-shaped. To check this, scope the video detector output of a cheap B/W TV set and then of a good color TV. You'll be amazed. This will also show you if the color set needs *alignment*. By using external triggering of the sweep, you can trace VITS signals through chroma amplifiers, the video amplifier, and many other stages.

This is an instrument that can make your service work a lot easier, if properly used. For any kind of signal-tracing, gain-per-stage measurements or signal-location, the Model 511 will give you the data you need with the greatest of ease. **R-E**

DESIGNING OTL

A solid-state audio power amplifier can range from a multi-stage circuit using quite a few transistors and diodes determined by such factors as bandwidth, permissible distortion

AN OUTPUT TRANSFORMER IMPOSES SEVERE limitations on the quality of a design. To overcome the bandwidth restriction, the transformer must be both expensive and bulky. Furthermore, phase shifts at high and low frequencies set boundaries on the amount of feedback that can be placed successfully around a circuit before it becomes unstable.

While practical amplifiers designed for public address systems use output transformers, the transformer is omitted in just about all modern solid-state high fidelity amplifiers. The loudspeaker is capacitive or direct coupled to the output devices. The industry uses variations on three basic circuits.

One circuit uses a driver transformer for phase inversion. Here the transformer is not as taxed as when it is used as an output device. Hence its size and cost are relatively small. A second arrangement, the quasi-complementary circuit, uses two identical output device driven by two lower powered complementary transistors arranged to provide the equivalent of phase inversion. The third, the fully complementary amplifier, uses a complementary pair of devices in the output so that phase inversion occurs in the power output transistors themselves, or in the combination of the output transistors and their drivers. The basic characteristics of these three circuits are discussed here.

Transformer phase inverters

A circuit using a transformer as the phase inverter is shown in Fig. 1. Q1 and Q2 may be considered as a two-stage voltage amplifier driving the power transistors, Q3 and Q4, through the driver transformer. To be specific, each transistor stage can be thought of as a power amplifier. Thus Q1 delivers its minute amount of power to drive a somewhat larger device, Q2, which in turn, must deliver enough power to drive the high power output transistors, Q3 and Q4. Theoretically, Q3 and Q4 will be bigger devices than Q2, which is, in turn, bigger than Q1.

The input signal is capacitively coupled to Q1. Direct coupled to Q2, Q1 transistor receives its bias voltage from Q2's emitter circuit. As the dc feedback through R_{B1} from the junction of R_{E2} and R_{EB} is substantial, this circuit is extremely temperature stable. R_{EB} in the emitter circuit is bypassed to ground by C_{EB} to prevent any ac from being fed back from this point along with the dc.

The output from Q2 is fed to a transformer with two identical secondary windings — preferably bifilar wound. The phase relationship between the two windings are indicated by the dots. Dots at the ends of two windings indicate that these ends are in phase with respect to the unmarked ends.

Should the portion in a cycle be such that the unmarked ends are positive with respect to the ends with the dot, Q3 is forward biased and conducts while Q4 is reverse biased. In the next portion of the cycle, the opposite polarity exists at the bases and Q4 conducts while Q3 remains idle. The composite signal is reconstituted across R_L.

The impedance ratio of the transformer is based upon the goal of presenting an ideal load to the driver transistor. Conventional designs use an impedance ratio of about 9:1. The ratio should be optimized in the laboratory, specifying this ratio for minimum overall distortion.

Assuming adequate transistors and heat sinking, the amount of power the circuit can deliver is based upon the size of the supply voltage, E_{CC}, the collector to emitter saturation voltage, and the voltage across emitter resistors R_{E3} or R_{E4}. Power is related to the load at the output by the equations V_{rms}^2/R_L and $I_{rms}^2R_L$. Peak to peak voltage for a specific power output is $V_{p-p} = 2.82\ V_{rms}$ while peak to peak current is $I_{p-p} = 2.82\ I_{rms}$. The supply voltage must be capable of swinging the peak to peak voltage V_{p-p} across the load in addition to the peak to peak current across one of the emitter resistors, or $I_{p-p}\ R_{E3}$.

Collector to emitter saturation voltage limits the swing of the voltage across the load. Because two transistors are involved, the sum of both saturation voltages at the peak of the collector current swing, must be added to $v_{p-p} + I_{p-p}\ R_{E3}$ to estimate the minimum supply voltage required if the amplifier is to deliver a specified amount of power. Keeping the operation in the linear region requires that the specified saturation voltage is multiplied by a factor of at least three, before being added to the other quantities already in the relationship, to determine the minimum E_{CC} supply voltage required if the amplifier is to deliver a specific amount of power.

Diodes D3 and D4 in the output stage are forward biased and are in the circuit in the interest of stabilizing the quiescent current against variations of V_{BE} with temperature. The actual idling current is established by the voltage developed across the diodes as well as across the other resistors in the dc circuit.

In the emitter circuit, resistors R_{E3} and R_{E4} are used primarily to supply ac and dc feedback and provide some relief for the distortion and dc stability problems inherent in this circuit. As a "fringe" benefit, it somewhat limits the emitter current to offer some protection to the output devices against overdissipation when load R_L is accidentally shorted. In class-A amplifiers, about 0.5 to 1.5 volts is developed across the resistor. Similar voltages are desirable in class-AB or class-B circuits during peak current intervals in the cycle.

Diodes D_{E3} and D_{E4} are not absolutely required in this circuit. Should they be used, the emitter resistor can be increased in size to improve the temperature stabilization characteristics. Should the resistors be large, diodes are required to by-pass the re-

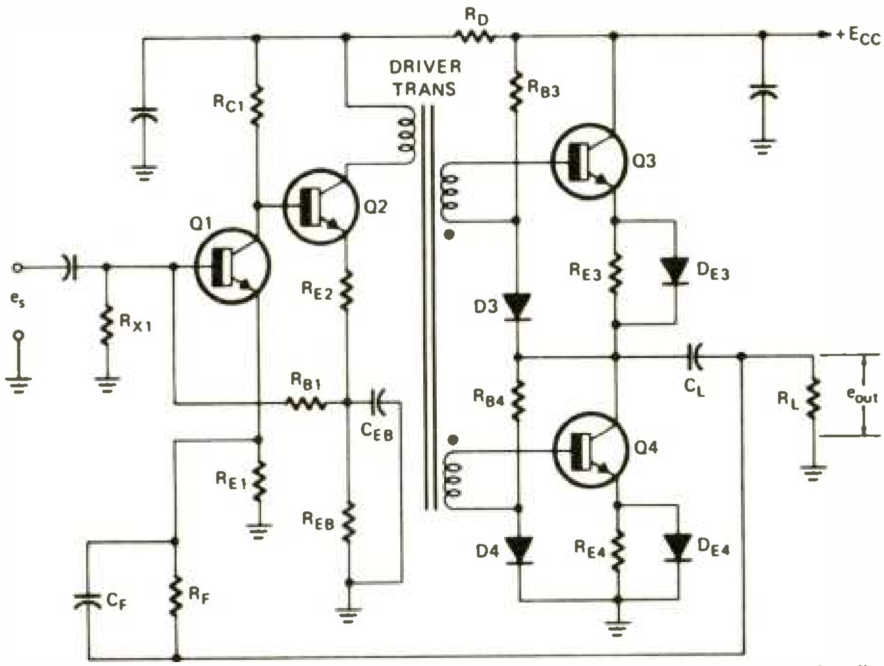


FIG. 1—A DRIVER TRANSFORMER is one method of providing phase inversion for the push-pull output stage. It simplifies circuit design and is sometimes used in inexpensive equipment.

POWER AMPLIFIERS

single transistor with transformer coupling to the speaker to a of various types. The choice of circuit design and components is and cost. Here's how to design output circuits for high fidelity.

sistors and allow large current swings.

The signal is capacitive coupled to output load R_L. The size of the capacitor limits the low-frequency output and should be chosen to be consistent with the acceptable performance requirements of the overall circuit.

R_F and C_F, in conjunction with R_{E1}, are the primary components of the feedback circuit. C_F is usually adjusted in the laboratory for the most faithful reproduction of square waves.

The output circuit in Fig. 1 can be simplified by omitting all diodes and replacing those in the base circuit with proper value resistors. But this can only be done at the expense of performance and temperature stability.

Circits using driver transformers are necessary when germanium output devices are used. Due to the relatively large leakage currents, complete isolation of the output transistors by the driver transformer is desirable. Although quasi-complementary circuits omitting the transformers have been used with germanium transistors, this circuit emerged as the primary arrangement when silicon transistors became readily and economically available.

Quasi-complementary power amplifiers

The basic circuit of the quasi-complementary arrangements is shown in Fig. 2. It is direct coupled throughout. The signal is amplified by Q1 and fed to the complementary pair, Q2 and Q3. During the positive portion of the cycle, the bases of the complementary pair are positive with respect to the emitters; the npn Q2 conducts while pnp transistor Q3 is turned off. The reverse is true during the alternate half cycle.

The half cycles are supplied to output transistors Q4 and Q5 after having been amplified by the complementary pair. Both portions of the cycle are fed to R_L through C_L and reconstituted across the load resistor. Feedback is fed through the parallel combination consisting of C_F and R_F.

The dc conditions are such that half the supply voltage must be present at the point labeled in the drawing as $E_{CC}/2$. Determined by resistors R_{B1} and R_{X1}, the bias current through Q1 is instrumental in establishing this quiescent condition. The collector load on the transistor consists essentially of $R_{B2} + R_{Y2}$ + D1 + D2. The diodes are used to set and maintain the idling current in the output circuit despite temperature fluctuations, and may be replaced by other temperature sensitive devices. Resistors are often used when compensations for temperature variation is not essential.

There are several inherent problems with this circuit. All are solved by adding capacitor C2 in a positive feedback bootstrapping arrangement. Note also that the resistors in the base circuit used to bias Q2, have been split into to components, R_{B2} and R_{Y2}, providing a junction to accept C2.

On large signals, the bias on the driver transistors tend to shift the operation to class B, producing crossover distortion. To compensate for this, large amounts of feedback must be placed around the circuit. Gain must be large to accommodate all the feedback that is required. Positive feedback supplied by capacitor C2 increases the load impedance the complementary pair presents to Q1 with the consequent increase in gain of the circuit.

Large positive peaks in the signal tend to cut off Q2 by placing the base and emitter of the transistor at $+V_{CC}$. However, there is a voltage across C2 due to its being charged while the circuit is idling. This voltage keeps the base at a positive potential with respect

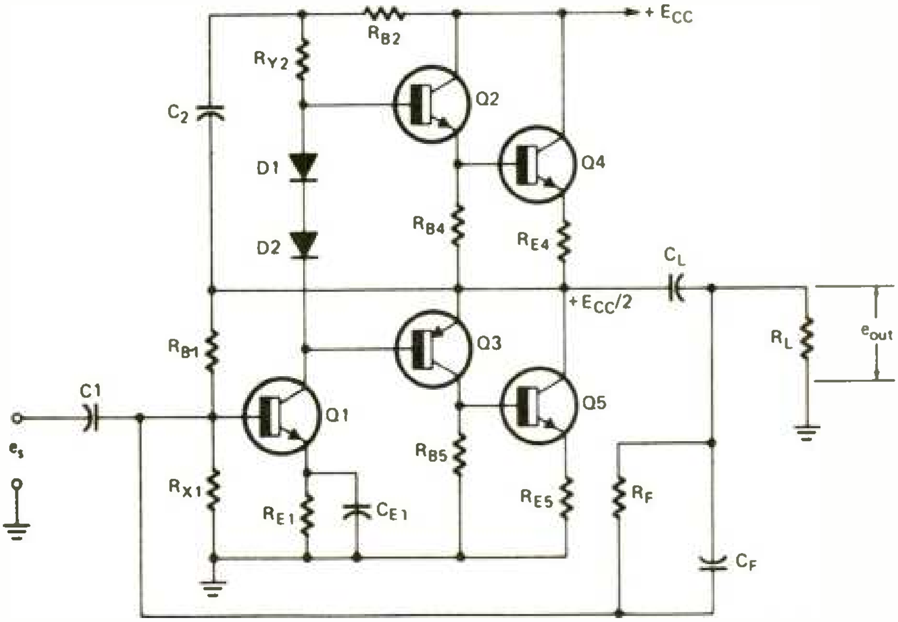


FIG. 2—BASIC QUASI-COMPLEMENTARY OUTPUT STAGE. The complementary pair, Q2 and Q3, acts as a phase splitter delivering equal signals 180° out of phase to Q4 and Q5.

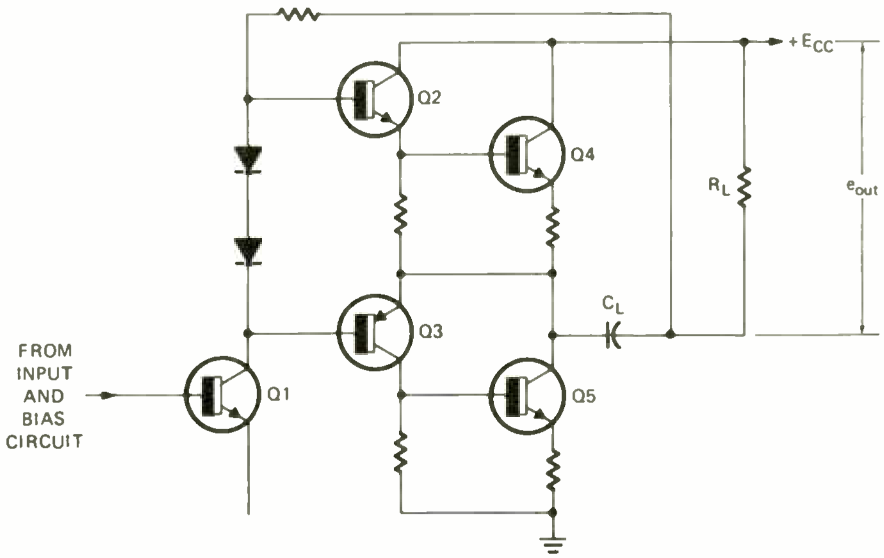


FIG. 3—BOOTSTRAP CAPACITOR, C1 in the previous figure, has been eliminated by combining its function with that of the output blocking capacitor. Load returns to ground through E_{cc}.

to the emitter so that Q2 continues conducting during all portions of the cycle.

The design of the bootstrap circuit is quite simple. Since R_{B2} and R_{Y2} are essentially across the load through C2, they should be made as large as possible consistent with the current requirements of the base circuit of Q2. Both resistors are usually specified as equal to each other.

Under quiescent conditions $E_{CC}/2$ appears across the series circuit formed by R_{B2} and R_{Y2} as well as across the circuit formed by R_{B2} and C2. As $R_{B2} = R_{Y2}$, the voltage across C2 is one half of $E_{CC}/2$ or is equal to $E_{CC}/4$. Charged to this voltage, C2 maintains a constant current through R_{Y2} and Q2's base-emitter junction. C2 must be large enough to maintain its charge even when low frequencies are being reproduced.

An alternate bootstrap circuit designed to eliminate the need of capacitor C2 and resistors R_{B2} and R_{Y2} is shown in Fig. 3. Instead of these components, a resistor is connected from the junction of C_L and R_L to the base of Q2. C_L doubles as the bootstrap capacitor besides coupling the signal to the output load resistor or speaker. R_L is connected to $+E_{CC}$, an ac ground. The major drawback of this circuit is that the dc base current for the drivers will flow through load R_L. If this current is very small, it should not affect the operation of the loudspeaker usually used as R_L.

A constant-current source at the bases of the complementary drivers can eliminate the need for the bootstrap capacitor. This circuit is in Fig. 4. A constant current is supplied to the drivers while a high impedance is presented to voltage amplifier stage Q1. The voltage drop between the base of Q6 and $+E_{CC}$ should be as small as practical so as not to limit the output voltage swing. Hence low forward-voltage dropping silicon diodes should be used in the constant-current circuit, rather than the higher voltage Zener diodes. The main advantages of this circuit include the improved distortion at low frequencies and more symmetrical clipping of the peaks in both halves of the signal.

Direct coupled load

In all quasi-complementary circuits discussed thus far, the load was coupled to the output transistors through a large electrolytic capacitor, C_L. Although frequently used, the capacitor has several drawbacks, not the least of which is the inherent nonlinearity of electrolytic coupling devices. Other reasons for eliminating C_L are the low frequency roll-off due to the R_L-C_L "high pass filter", and the corner frequency created by this roll-off which can contribute to instability when feedback is applied around the circuit. Finally, and perhaps the most important drawback, is that this capacitor must be charged through the output transistors. If, in the process, the transistor handles more energy (power X time) than it can dissipate, it will destroy itself.

In Fig. 2, one end of R_L is connected to ground. When idling, the other end of R_L must be at the same ground potential if there is to be no dc flowing through the resistor (or loudspeaker) load. This is easily accomplished when a coupling capacitor is used. In the absence of C_L, the junction of Q4 and Q5 must be placed at a zero potential with respect to ground while the circuit is idling.

To accomplish this, a positive voltage with respect to ground, $+E_{CC}$, is placed at Q4's collector while an identical negative voltage, $-E_{CC}$, is placed at the emitter of Q5, or more exactly at the lower end of resistor R_{E5}. If both transistors, Q4 and Q5, conduct idential amounts of current during the idling period, there is zero voltage at the junction of the two devices to which the load is connected (or at the junction of the collector of Q5 and the lower end of R_{E4}). With signal applied, the positive going portion swings the voltage across R_L from zero towards $+E_{CC}$ while the negative portion of the signal swings it from zero and towards $-E_{CC}$.

All would be great if the quiescent current can be maintained constant at all times, so that the voltage across R_L will not shift from zero volts. Unfortunately, Q1 will drift with temperature changes. But any change in the collector current through Q1 will upset the balance at the output more than will drifts in transistors further up the chain. Drift due to the drivers and outputs is minimized by maintaining the upper and corresponding lower devices at equal temperatures on heat sinks or in free air. In this manner, drift in one half of the driver and output circuit is

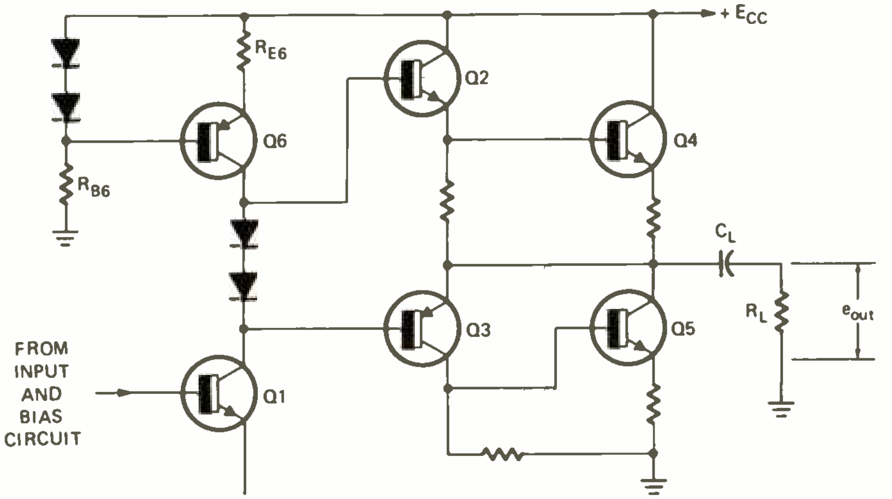


FIG. 4—CONSTANT-CURRENT SOURCE, Q6 for bases of the complementary drivers eliminates the need for boodstrap capacitor and reduces low-frequency distortion.

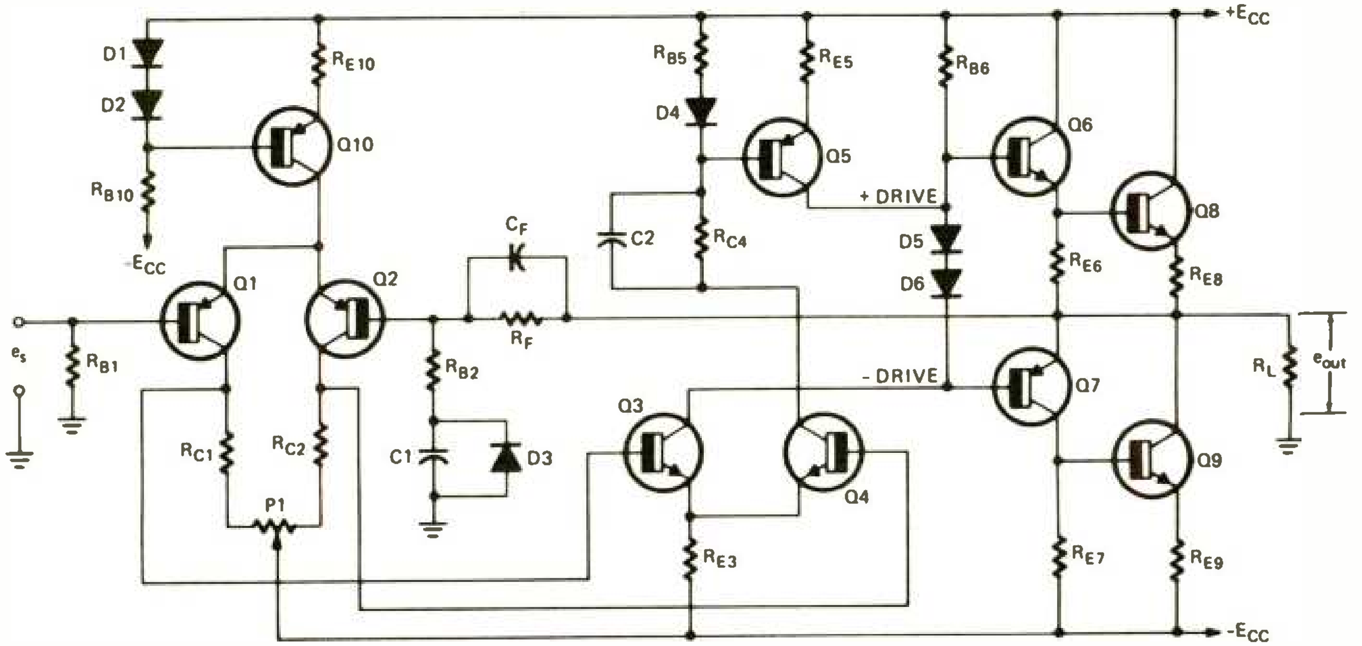


FIG. 5—DIFFERENTIAL AMPLIFIER replaces input transistor Q1 in the earlier circuits and thus minimizes changes in quiescent output current due to temperature changes.

balanced out by the drift in the other half. Q1 has no corresponding transistor to overcome or balance collector current changes due to drift. A partner must be added.

Differential amplifier circuits use two transistors. If one is placed in the proximity of the other, or in the same physical case, temperature variations would affect both equally. This is especially true if they are matched pairs. This type of arrangement is shown in Fig. 5. The differential circuit placed before the + and − DRIVES, replaces Q1, in the interest of stability.

Q1 and Q2 are a differential pair driving a second differential pair, Q3 and Q4. A signal at the input to Q1 appears amplified at the collectors of Q1 and Q2. While the input signal is in phase with the signal appearing at the collector of Q2, it is out of phase with the signal at the collector of Q1. When amplified further by Q3 and Q4, the signal suffers a 180° phase reversal between the bases and collectors of the respective transistors. The collectors of both transistors are driven to $-E_{CC}$ by the signal. "−Drive" is provided at the collector of Q3 to the lower pair of output devices, Q7 and Q9.

From Q4, the signal is fed to the base of Q5, which is arranged as a unity gain amplifier. The phase of the signal is once again reversed. The signal drives the collector of Q5 to $+E_{CC}$, providing the "+ Drive". The phase reversal in Q5 makes the + drive signal identical in phase with the − drive each aspect. Instability will be prevalent unless the frequency rolloff is carefully controlled at both ends of the audio band. Let us now carefully analyze various sections of the circuit.

Q10, the constant current amplifier, is designed to establish and maintain the sum of the idling currents through Q1 and Q2. Assuming all silicon devices are used, the voltage across the base-emitter junction and across D2 are identical. Hence the voltage across D1 and R_{E10} are identical and equal to about 0.7 volt, the voltage across a silicon diode. If the sum of the idling currents through Q1 and Q2 are adjusted to, let us say 2 mA., 2 mA must flow through R_{E10}. Then the resistor will be equal to 0.7 volt/2 mA = 350 ohms. R_{B10} is used to establish a

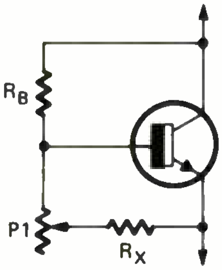


FIG. 6—TRANSISTOR as a replacement for D5 and D6 lets you adjust output bias while retaining temperature stability.

P1. The control is used to balance the relative quiescent current through each transistor and is adjusted for zero volts across R_L when the circuit is idling. The dc feedback is expected to maintain this idling condition.

The +Drive must be identical in amplitude to the −Drive. To accomplish this, R_{B5} is made equal to R_{E5}. Voltages across D4 and the base-emitter junction are equal. Hence the current through R_{B5} and R_{E5} are equal, producing a −Drive current in the collector circuit, equal to the current flowing through R_{B5}. As the current through R_{B5} is almost identical to the collector current flowing through Q3 and Q4, the −Drive is equal to the +Drive. R_{C4} dissipates power available at the collector of Q4 and not required at the base of Q5.

D5 and D6 set the quiescent idling current through the output devices. Should adjustment flexibility be desirable, one of the diodes may be replaced by a potentiometer. For better temperature compensation, the diodes can be replaced with the transistor circuit in Fig. 6, and still retains its ability to stabilize the current in the circuit.

A simplified variation of the circuit of Fig. 5 is shown in Fig. 7. Here, the differential output is taken from one transistor of the pair, Q1 and Q2. R_{E1} is made large enough so that a constant-current source is not required, eliminating the cost of one transistor.

The signal, fed to Q3, is then passed on to

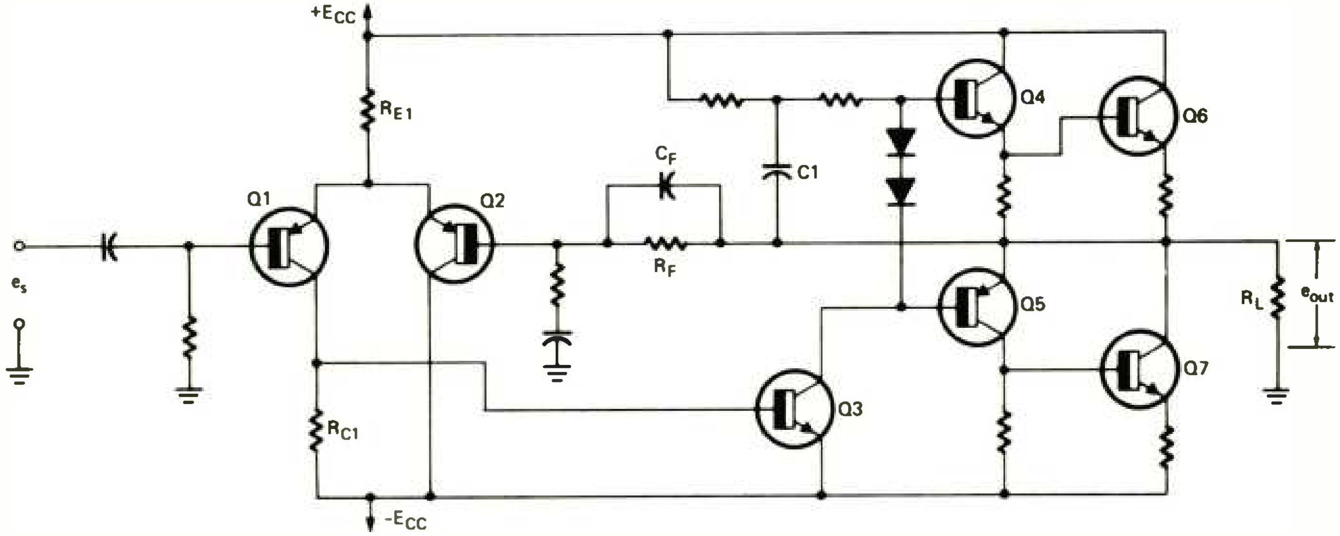


FIG. 7— A LESS EXPENSIVE VERSION of the differential amplifier circuit. The constant-current source and the differential amplifier drivers have been eliminated.

signal at Q3. Two signals with identical phase characteristics are fed to the quasi-complementary output circuit consisting of Q6 through Q9. Proper phase relationships are achieved here to provide the reconstituted amplified output of the input signal. The + Drive causes the upper pair of devices to swing to $+E_{CC}$ while the lower pair of devices swing from $-E_{CC}$ due to the − Drive. Equal swings of both halves of the output circuit to $+E_{CC}$ and $-E_{CC}$ makes bootstrapping unnecessary.

Feedback is applied from the output through R_F and C_F. Ac and dc feedback are developed across R_{B2}. It is bypassed to ground through C1 as a return for the ac feedback and connected to ground through D3 for the dc feedback return.

The circuit shown is raw. It will not operate properly unless it is designed carefully in current through and consequently fix the voltage across D1 and D2.

(The required idling current for Q1 and Q2 can be determined by first noting the maximum current required across the output load at the peak of the signal. It is divided by the product of the current gains of all stages excluding the first. This is the minimum collector current required from each of the two input devices.)

If Q3 and Q4 are to be capable of swinging almost to $-E_{CC}$, the voltage across R_{E3} must be small; let us make it 1.5 to 2 volts. This voltage must also be at the collectors of Q1 and Q2. Since during idling, 1 mA is to flow through each collector, a simple Ohm's law calculation will help determine the size of the resistances in the collector circuits. A portion of each collector resistor is taken off from R_{C1} and R_{C2} to compose potentiometer the quasi-complementary circuit consisting of Q4 through Q7. Capacitor C1 is a bootstrap capacitor required here so that the upper transistor, Q4, can swing to saturation. The independent drivers capable of swinging the signal to the limits of the power supply voltage, made the bootstrapping circuit unnecessary for the arrangement in Fig. 5.

Fully complementary output

A close look at the quasi-complementary arrangement reveals that the upper two transistors are a Darlington pair while the lower two from a complementary beta-multiplier pair. Although quite similar, the ultimate quality amplifier is designed by making both pairs identical. Either a complementary pair or a Darlington arrange-

(continued on page 90)

TUNNEL DIODES-

The tunnel diode has been around for about fifteen plications for it. Even so, it is seldom men- manual. Here are experiments and some practical

by STEPHEN DANIELS

IN THE MAD RUSH TOWARD INTEGRATED circuitry of the past 15 years, the tunnel diode has been shunted aside by multi-element packages. It's still very much around though and it may one day enjoy a resurgence as a component of some of those same chips that have replaced it.

The unusual properties of the tunnel diode lend themselves to some simple solutions of complex problems. Circuit design is inherently easy and TD's will amplify and oscillate at frequencies at which most other solid-state devices fall flat. In this article, we'll examine the negative-resistance phenomenon that the tunnel diode produces and show some possible audio and rf applications.

Experimental layout

Everything except the really high-frequency circuits can be assembled on a phenolic breadboard. The board, required brackets and hardware can be found at any well-stocked parts house.

Once you have the breadboard put together, set up the basic voltage divider biasing circuit diagrammed in Fig. 1. Watch the polarity carefully on the tunnel diode and batteries and also on C1 and M1. M1 reads the current through TD1 and can be rated from 5 to 15 mA. I used the low-current scale of my vom. BATT1 and BATT2, like any batteries used in tunnel diode circuits, *must* be mercury types. Zinc-carbons have a high internal resistance which tends to cancel the negative-resistance effect of the tunnel diode.

With R1 set at maximum resistance, apply power and *slowly* bring the resistance down, thus raising the voltage at the anode of TD1. As you would expect, the current through the tunnel diode increases . . . until you get to just over 4 mA. The point at which things begin to get peculiar will vary from diode to diode, but at about 4 mA the current will suddenly *dip* even though you've been increasing the voltage steadily. Increase the voltage some more and the current continues to dip and then starts to rise again. Confused? OK, let's turn to Ohm's law to straighten things out.

If we write Ohm's law as I = E/R, a little figuring will tell you that the only way E can get larger while I gets smaller is if R is some *negative* value. Yup, what you saw in that demonstration was the tunnel diode behaving as a *negative resistance*. As we'll see later, the unusual doping of the TD's pn junction is responsible for this effect. What can it be used for? You know that all that keeps a tuned circuit from oscillating spontaneously is the resistance

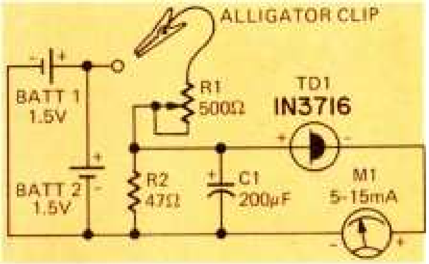


FIG. 1—THE DC PARAMETERS of the tunnel diode can be studied using this simple circuit. The batteries must be mercury types.

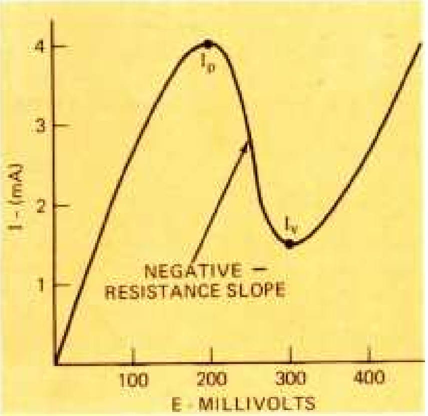


FIG. 2—VOLTAGE CURRENT CURVE of a tunnel diode. Note the negative-resistance slope.

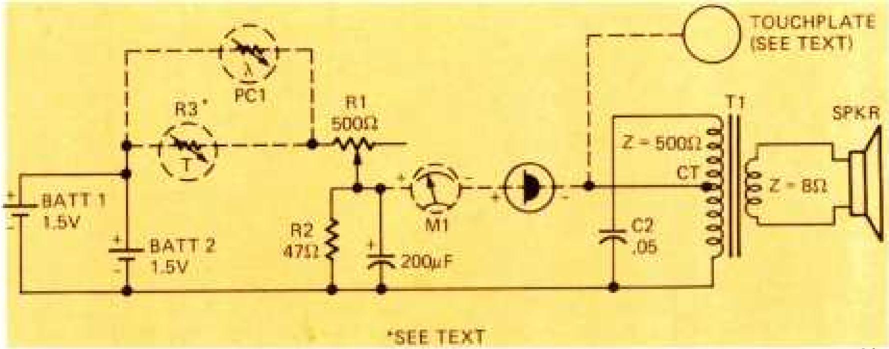


FIG. 3—BASIC TUNNEL-DIODE SINEWAVE OSCILLATOR operates at a frequency determined by the inductance of the transformer primary and the lumped and stray capacitances. It can be controlled by the touchplate, thermistor or photoresistive cell. Photocell PC1 is a CdS type such as the Clairex CL-504L. The value and type of thermistor depend on the application.

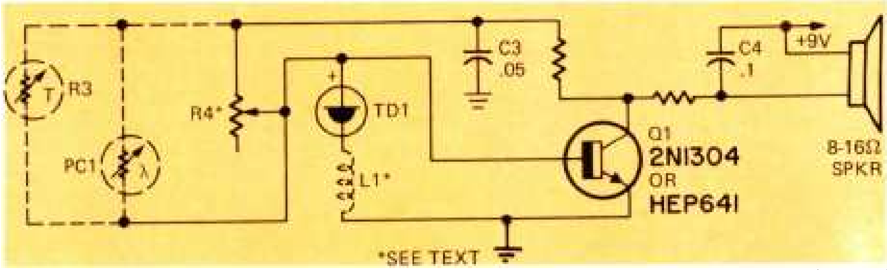


FIG. 4—SENSITIVE ALARM CURCUIT can be used to detect changes in temperature or light and the presence of signals from a rf transmitter type electronic bug. The two unmarked resistors should be selected so 1.5 volt is delivered to the top end of bias control R4. It can be used as a basic radio-control receiver.

theory and circuits

years and there are a number of practical ap-
tioned except on a few pages in a transistor
applications to help you learn about this device.

losses in the coil. The tunnel diode can, as we will see, be used to cancel the *positive* resistance in the tuned circuit with its own *negative* resistance and thus start and sustain oscillation.

History and basic physics

The tunnel diode is also referred to as the Esaki diode, named after the Japanese physicist, Dr. Leo Esaki, who developed its basic principles. Esaki was working as a physicist for Sony in the late '50's when he showed that a heavily doped pn junction could exhibit negative resistance. General Electric researchers came up with the first practical units based on Dr. Esaki's work.

Any pn diode has a region of relatively few current carriers right at the junction which is referred to as the *depletion region*. A normal diode is doped only lightly to give relatively few free charge carriers. The depletion region in this diode is effectively wide and a relatively large voltage will be required to get a current going, i.e. to move current carriers across the depletion region. In a tunnel diode, the semiconductor material is heavily doped to give a large number of current carriers in the depletion region and thus effectively narrow it. In a TD, even a tiny voltage will allow current carriers to "tunnel" across that narrow depletion region, hence the name of the device. With a slightly greater bias, however, quantum physics gets into the act.

One of the laws of quantum physics says that electrons can only exist at certain defined energy levels within an atom and not in between. It's a bit like the way fixed resistors are made in standard values; you can buy a 2700 or 3300, but not a 2900. Electron energy levels work similarly.

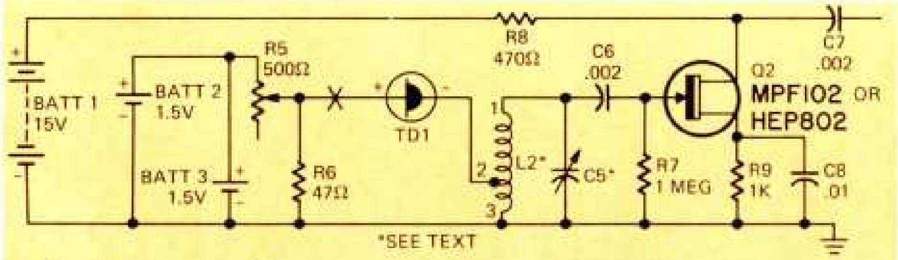
Thus an electron that wants to go from the n-type to the p-type region must have enough voltage behind it to get it up to a permissible energy "slot" in the p-type section. When the voltage across the tunnel diode is great enough to produce many electrons with "forbidden" energy levels, i.e. too much energy for a low level and not enough for a higher one, the result is a *decrease* in current. Here is the negative resistance phenomenon. The current will now keep decreasing as more electrons are brought to forbidden energy levels. Current will eventually increase again if the voltage is raised enough to bring some of the electrons to higher energy slots.

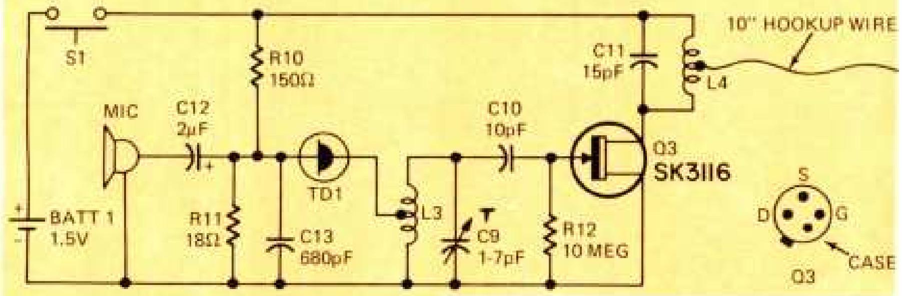
The graph (Fig. 2) shows the dc characteristics of the tunnel diode. Current rises to the point I_p, called the peak-point current. Now comes the drop into the negative resistance slope. I_v, the valley current, is the bottom of the slope and the point where normal current flow resumes.

Audio applications

Now that you know how the tunnel diode works, we'll get into some circuitry. Figure 3 shows a basic sinewave audio oscillator whose principle of operation stems directly from our theoretical digression. With TD1 electronically removing all resistance from the tuned circuit consisting of C2 and the primary of T1, the tuned circuit oscillates at its resonant frequency. Set up the circuit as shown in Fig. 3 and, with R1 at maximum resistance, apply power. Lower R1 very slowly and the speaker will suddenly break into a tone at some point. If you reconnect M1 as shown, you'll find, as you would expect, that the onset of oscillation coincides exactly with the beginning of the negative resistance slope. This unusually simple oscillator can be used anywhere that a tone source is required. It will be most stable if working into a relatively high impedance load.

Staying with this circuit for a minute,





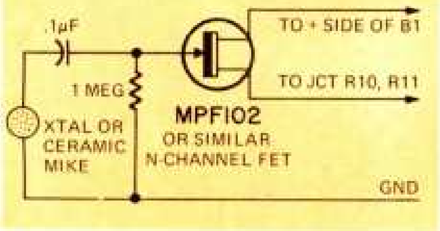


FIG. 5 (top)—SIMPLE RF SIGNAL GENERATOR can be both amplitude and frequency modulated by audio from a low-impedance source. FIG. 6-a (above)—FM WIRELESS MIKE. Coil L3 is 6 turns of No. 16 enameled wire closewound, ⅜ inch diameter with tap 1 turn from ground. L4 is 3 turns of No. 22 wire with the 10-inch antenna wire soldered to the midpoint. FIG. 6-b (left)—PREAMP for hi-Z mike. Remove the speaker and C12 and connect preamp as indicated.

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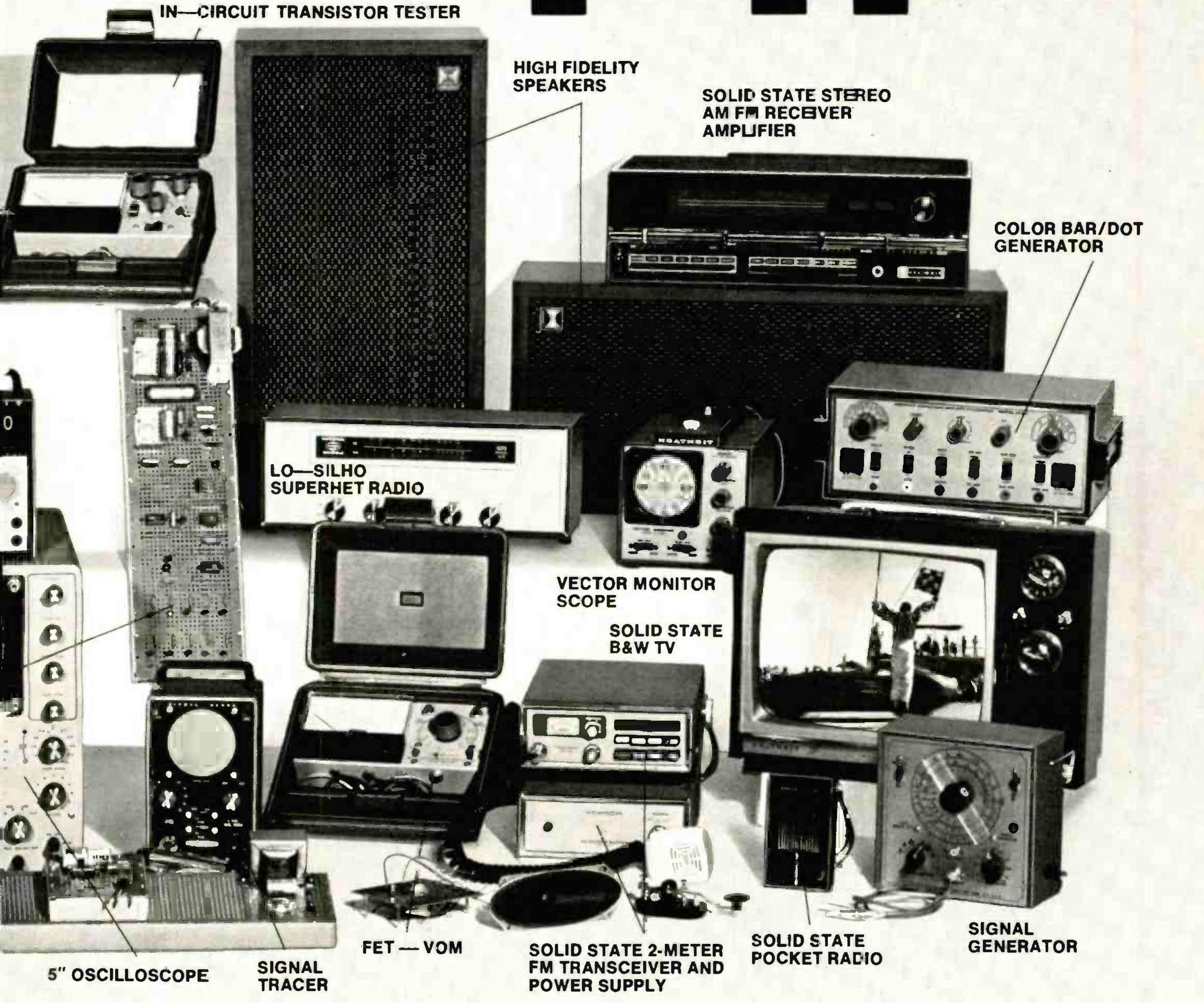

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I'm going to throw you a curve. Get R1 back to maximum resistance and remove C2 from the tuned circuit. Now apply power and look for the negative resistance point again. Surprised that you get a tone without a complete tuned circuit? What's happened here is that the distributed capacitance of the transformer's turns in combination with the half of the primary still in the circuit still acts like a parallel resonant circuit. This self-resonant effect is used to advantage in microwave tunnel diode oscillators where the TD is linked to a resonant cavity. The cavity doesn't have a capacitor physically present any more than this circuit, but a TD will produce oscillation in anything that *looks* to it like a tuned circuit and has the proper impedance.

Several possible modifications of this circuit are in dotted lines in Fig. 3. Adding photocell PC1 will give you a daylight alarm or "electronic rooster." By adjusting R1 carefully so that the circuit doesn't quite oscillate, you can make it sensitive to any small change in light intensity. Similarly, a thermistor (R3) connected in this position gives a temperature sensor. This could be used as a warning indicator or as part of a control circuit to maintain temperature within a certain range. Select R3 to satisfy the needs of the application.

If the bias is adjusted carefully, it is possible for an external signal to "shock excite" the tunnel diode into its negative-resistance region. The basic sinewave oscillator can work as a "touch switch" on this principle. Disconnect C2 from the circuit and connect a 2-inch diameter circle of sheet metal to the point shown in the schematic via a short piece of hookup wire. If you now adjust R1 to a point just before the circuit oscillates by itself, you'll find that the touch of a finger on the plate will start things up. The external signal that gets things going is the 60-Hz noise that your body is always picking up off the power lines. The adjustment of R1 is quite critical in this application, and a few trials may be required for best results.

Using a junction transistor in combination with a tunnel diode can produce a level sensor of much greater sensitivity than the basic oscillator. Figure 4 shows this circuit, which is capable of responding to .1 foot-candle or less when used as a light detector. In operation, C3 provides a feedback path for signal from the collector of Q1 to the cathode of TD1. The tunnel diode feeds the signal back to the base when the resistance of the sensor is low enough to get it into negative resistance. L1 is 2 turns of No. 14 wire, 1 in. diameter, turns spaced ⅛ in.

In these security-conscious times, the idea of a personal "bug detector" isn't such a far out idea. With a suitable pickup coil (L1) connected at the points shown, the small rf signal from a concealed transmitter is sufficient to shock excite the tunnel diode into negative resistance as in the touch switch described previously. R4 is the threshold/sensitivity control. When the circuit is used with a photocell or thermistor, it should be 10 K to 25 K ohms; 2 K or so when used as a bug detector. In operation, it is set just below the point of oscillation.

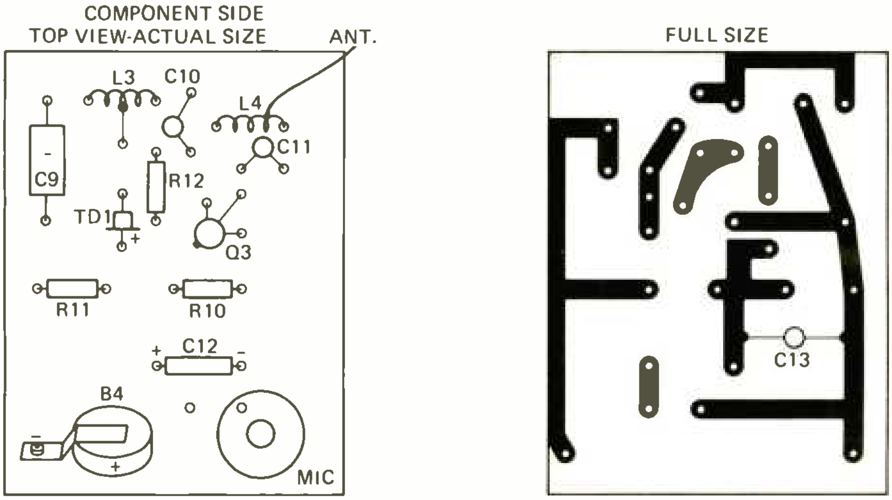


FIG. 7—WIRELESS MICROPHONE PC PATTERN and parts layout shown full-size. A similar layout using perforated board will work if you keep the rf circuit leads short.

Rf applications

It is as a high-frequency amplifier and oscillator that the tunnel diode really comes into its own as the following circuits show. The basic sinewave oscillator circuit will crank out rf very nicely with just a change in tuned circuits.

Figure 5 shows an rf signal generator suitable for testing and alignment purposes from 1 to 40 MHz. The FET buffer stage prevents loading of the tuned circuit and resulting instability and loss of Q. Applying an audio signal from a low impedance source at the junction of R5 and R6 will give a combination of amplitude and frequency modulation at the output if desired. The FM component results because changes in the bias on the tunnel diode (from the modulating signal) vary its negative resistance operating point. This tends to "pull" the resonant frequency of the tuned circuit up and down in step with the input signal amplitude. L2 may be a BC band Loopstick with C5 200—400 pF to cover the AM broadcast band. For the 27-MHz Citizens band, C5 is 20 pF and L2 is 11 turns of No. 22 enameled wire on a ⅜ in. slug tuned form. Tap at 3 turns.

Initial adjustment is easy. Break the circuit at the point marked "x" in the schematic and hook up the milliammeter as for the first experiment. Apply power and adjust R5 for a stable point in the middle of the negative resistance slope. R5 can be sealed in this spot if desired with a few drops of clear nail polish. It is also possible to measure the resistance of the Trimpot with an accurate bridge or ohmmeter and substitute a fixed 5% resistor of the nearest standard value.

Printed circuit construction or tight point-to-point wiring on Perfboard is a must for this circuit and the one following if reasonable stability is to be obtained.

One possible vhf application for a tunnel diode, a complete FM wireless mike, is shown in Fig. 6-a. Operation is the same as that of the rf signal generator, but the resonant frequency of the tank circuit has been altered. Again, a FET is employed as a buffer to reduce the instability that is usually a drawback of these circuits. A small speaker is used as a microphone to modulate the transmitter. If operation from a high-impedance source is desired, add the matching circuit of Fig. 6-b.

The author's model was constructed on a PC board as shown in the photograph and the etching pattern is given in Fig. 7. A stiff guitar pick makes a good, cheap tool for tuning C9 to a quiet spot on the FM band.

I hope you've enjoyed experimenting with these circuits; the basic principles can easily be adapted to your own special ideas and design problems. **R-E**

equipment report

Sound Technology Model 1000A FM Generator

Circle 87 on reader service card

TRADITIONALLY, FM DETECTOR ALIGNment has been done by generating a swept frequency in the rf or i.f. band, and displaying the detected FM output versus the original modulation signal on an oscilloscope. The modulating frequency is low to prevent a muddled display because of unwanted sidebands, and is usually a 60-cycle sine wave derived from the ac line. Conventional alignment using the S curve display is for best tuning symmetry. After such a procedure the distortion is sometimes found to be higher than specified by the manufacturer and is often higher than need be. One way to optimize the detector tuning is to feed the receiver with a single tone FM modulated signal and use a harmonic distortion analyzer to make detector adjustments to lower the distortion.

To say the least this is an unsophisticated, haphazard and time consuming procedure. Although you may indeed succeed in bringing the distortion with spec, it may be an unstable tuning point in that the particular tuning you have ended up with may be critical and soon drift out. (Newer FM detectors need no alignment, but to date, these tuners are found only in high-end equipment.—*Editor*

In recognition of these problems Sound Technology has a better idea and has introduced a unique FM alignment generator using a dual sweep signal generation scheme. It's their model 1000A. It produces an oscilloscope scan that directly indicates intermodulation distortion. While the generator includes a convenient array of other features such as stereo, SCA and clean CW signal generation this discussion is limited to the novel dual sweep method.

Figure 1 is an ideal S curve; so ideal, in

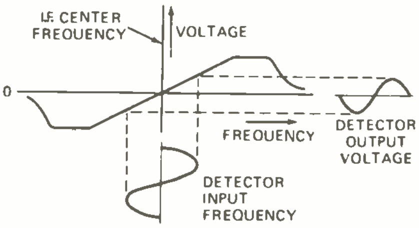


FIG. 1

fact, that it does not have an S shape at all but is perfectly straight or linear along its entire detection bandwidth. Assume the FM detector and i.f.-limiter have perfect characteristics giving perfectly horizontal segments at the S curve ends before the receiver filtering rolls off the response. An input signal detected along the perfectly linear portion of the curve will be reproduced distortion free. If the instantaneous input frequency to the discriminator is represented as the amplitude points on a sine wave, the recovered audio output can be constructed using the detection curve as a transfer characteristic as shown in the figure. The output sine wave is identical to the input waveform except that its amplitude is modified by the constant detector slope.

In Fig. 2 a less ideal S curve is shown, along with how a detected signal is rec-

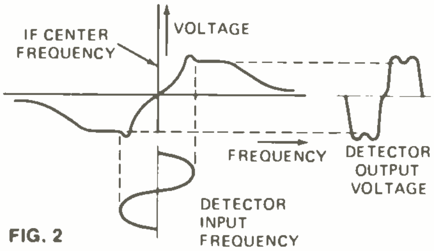


FIG. 2

overed distorted by the transfer operation. Changes in slope compress and stretch the sine wave as it is transferred resulting in non-linear distortion. The departure of the S curve from ideal straightness in second degree and higher power curvature is directly related to intermodulation and harmonic distortion.

In Fig. 3 the ideal S curve is redrawn with a point by point slope plot below. Notice

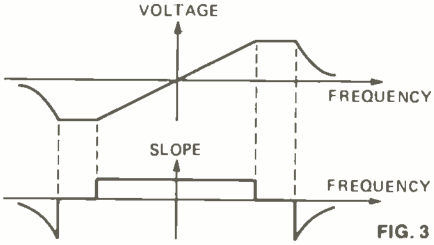


FIG. 3

that during the linear detection region the slope curve is perfectly level at some positive value above zero corresponding to the S curve's constant slope. The horizontal S curve extensions have zero slope and the slope plot returns to zero in these intervals. Fig. 4 is a similar display for a detector exhibiting non-linear distortion. In this case the center of the scope display is not flat but wiggles with the S curve slope variations. Intuitively it seems desireable to display the S curve slope characteristic as it is somehow related to distortion.

The question remains: How can a signal be generated and detected to produce a slope-dependent display and can the distortion be easily determined from it? Sound

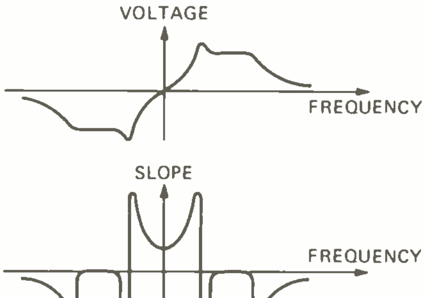


FIG. 4

Technology superimposes a small 10 KHz sine wave frequency modulation on top of their normal relatively high modulation basic 60 Hz sweep modulation. Since 10 KHz is more than 100 times the 60-HZ rate and since its amplitude is held to about 10% of the 60-Hz swing, each of a series of points on the S curve as in Fig. 5 can be considered to be stationary in time as the small 10-KHz

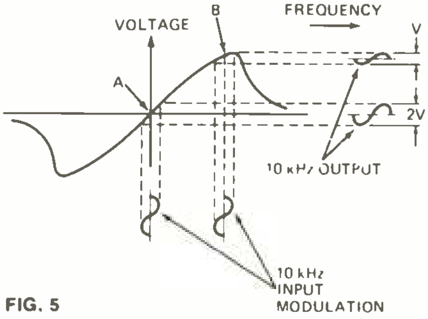


FIG. 5

secondary warble frequency sweeps over a single cycle. The detected voltage due to the warble is directly related to the slope at that particular point. The S curve shown has exagerated distortion with point A having twice the slope of point B. So by superimposing these two signals a display could be produced that has 60-KHz S-shape information and the higher 10-KHz slope information. If the 10 KHz is recovered by filtering, only the slope information remains and it can be displayed alone for lack of confusion.

It turns out that the deviation in flatness of the slope curve in relationship to the average height of the curve indeed can be calibrated to reveal the intermodulation distortion of the receiver. Total harmonic distortion can then be approximated from the IM figure. Actually either type of distortion can theoretically be determined exactly knowing the detector response behavior. However, without finding the mathematical power series which the S curve follows we cannot make the THD determination absolute. This is not a problem since a 25% error will not blur the distinct relative comparison this method offers.

When two arithmetically added tones are intermodulated on a non-linear slope in this way various mixing products result. For example assume there is only a linear or first

(continued on page 91)

TECHNICAL TOPICS

Here are five circuits for your approval. For hi-fi buffs there is a deluxe stereo headphones adapter; TV DX'ers might try the untuned TV booster; circuit enthusiasts have an unusual oscillator, power supply, and car lights-on reminder.

by **ROBERT F. SCOTT**
TECHNICAL EDITOR

OWNERS OF OLDER STEREO RECEIVERS, and amplifiers may want to use headphones, but don't because their set doesn't have a phone jack and they haven't found a headphone circuit that suits them. The headphone remote control unit in Fig. 1 was described by Mr. N. Pickles in *Practical Wireless*. It was developed for use with stereo amplifiers and receivers, and to provide —when desired—a controlled amount of crosstalk between right and left channels to provide a more realistic stereo image. A meter and BALANCE control are used to balance the signals fed to the right and left earphones.

The two 120-ohm resistors attenuate the signal from the amplifier output terminals before it reaches the phones. These can be reduced in value or eliminated, if the control box is connected to the amplifier through a stereo phone jack providing an attenuated signal.

When the double-pole switch, S1, is closed (in the NORMAL position), the attenuated right and left signals are applied to the phones directly through the BALANCE and RIGHT and LEFT VOLUME controls. When the switch is open, the signals are passed through the crosstalk network consisting of L1, L2-C3, R1-C1, and R2-C2. This network provides a "full-stage" effect by mixing some of the right and left signals around 1 kHz so as to "fill the hole in the middle" created by the stereo phones.

Unusual L-C oscillator

The novel oscillator circuit shown in Fig. 2 was designed for constant amplitude across its tuning range. The oscillator, described in *T.E.S.T.*, a magazine published in Paris, France for service technicians, was designed especially for use in test instruments, but can be used in receivers and other devices where its characteristics are needed.

Transistor Q1 is a FET, but a bipolar transistor can be used instead. Q2 and Q3 form the amplitude regulator. Q1's drain current is held constant at a level just high enough to sustain oscillations. This constant current is supplied through a split path consisting of L2-Q2 and R1-Q3. Path L2-Q2 forms the feedback loop needed for oscillation. D1 and D2 rectify a portion of the rf signal at Q2's collector, to develop a base bias for this transistor.

When power is first applied to the circuit, Q3 is blocked because its base-emitter voltage is at, or close to,

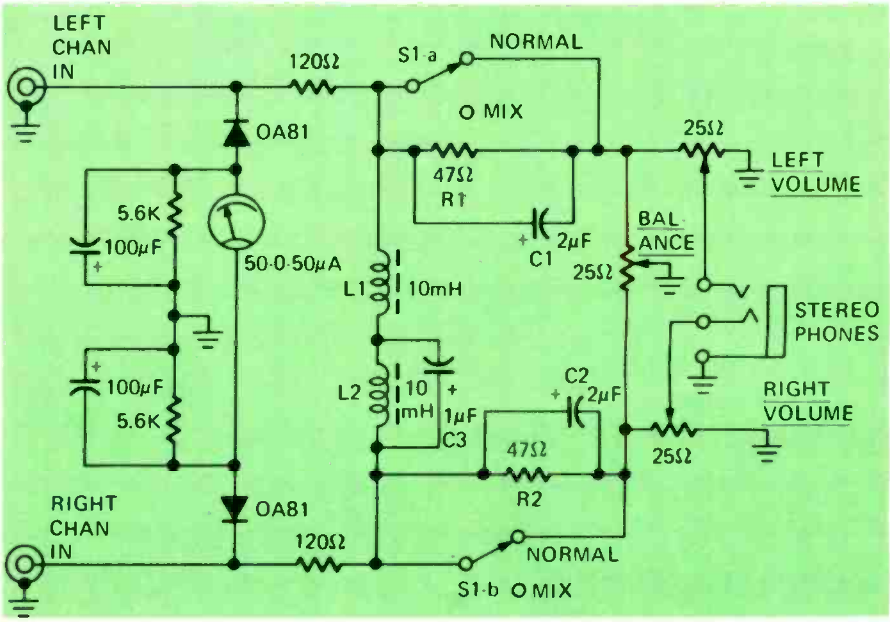


FIG. 1—STEREO HEADPHONE ADAPTER has meter and control for balancing the amplifiers' output and the signal to the phones. A mixing circuit can be used to "fill the hole in the middle."

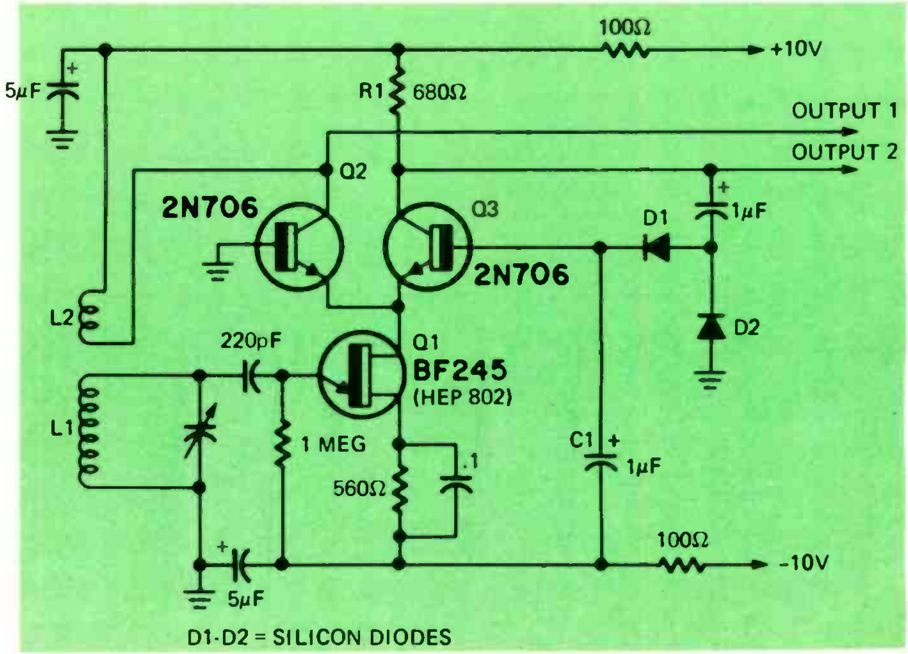


FIG. 2—UNUSUAL CONSTANT-AMPLITUDE OSCILLATOR. The FET is a tickler-feedback oscillator with feedback current taking paths through Q2 and Q3 for amplitude regulation.

zero. The full drain current for Q1 flows thorugh L2 and Q2. When the circuit starts oscillating, Q3 conducts sporadically. The voltage developed across R1 is rectified by D1-D2, filtered by C1, and used to bias Q3's positive.

The greater the voltage drop across R1, the more Q3's current increases. Since Q1's drain current is *constant*, any current drawn through R1 must be subtracted from that available through L2-Q2 to sustain oscillations. Thus, when Q1's output increases, Q2 draws more current, reducing the feedback, and therefore, the amplitude of the oscillator output.

The output voltage can be taken from the collector of Q2 or Q3. The regulation of the output voltage increases with the number of turns on the feedback (tickler) winding L2, and can be easily set to ±1/ over a 3.5:1 tuning range. A coil for 150 to 520 kHz consisted of 150 and 2 turns for L1 and L2, respectively, on a small ferrite cup core. A 30-MHz coil, wound on a 5/16-inch form, containing 7 turns for L1 and 4 turns for L2.

To use a single power supply source, make up a voltage divider with a center tap to provide an artificial ground. Connect Q3's base to this ground through D1 and D2.

Something for your car

A number of circuits designed to warn the driver to turn off his headlights before leaving the car have been described. In most cases, the alarm sounds as long as the lights are on and the ignition is off. Thus, they are a nuisance at times when you want to leave the lights on with the ignition off.

The headlights-reminder circuit in Fig. 3 (from *Electronics Today International*, Sydney, Australia) gets around this by interlocking the alarm through the door switches in the courtesy-light circuit. The circuit is activated by the taillights, so the alarm works whenever the driver opens a door to leave the car while either the headlights or parking lights are on.

When the car's ignition is turned ON, capacitor C1 is discharged with both its terminals going to +12 volts—the positive end through R2, and the negative end through the ACC terminal on the ignition switch. If the car's lights are on, emitter and collector voltages are applied to the transistor, which is held cut off by the lack of a forward (negative) base bias.

Now, if the ignition is turned OFF while the lights are ON, C1 charges and produces a negative-going pulse on the transistor base. The transistor is biased on, pulling in the relay. The transistor is locked on because its base is now returned to ground (negative) through R1 and R3 and contacts 3-4 on the relay. The alarm is now armed and will sound when either front door is opened, so the switch connects it to ground through its contacts.

To disable the alarm-assuming that you want the lights on and door open —first switch off the ignition, switch the lights off and then on again.

Simple TV booster

Most build-it-yourself TV boosters use L-C tuning circuits that limit tuning to a single channel, or require elaborate procedures for broadbanding the circuits. The booster in Fig. 4 is an untuned broadband amplifier (taken from *Television* magazine, Paris) covering channels 7 through 13. Gain is 25 dB at 180 MHz, and drops 3 dB at 150 and 210 MHz. Power supply can be +4.5 to +12 volts.

Parts layout is not critical, but you

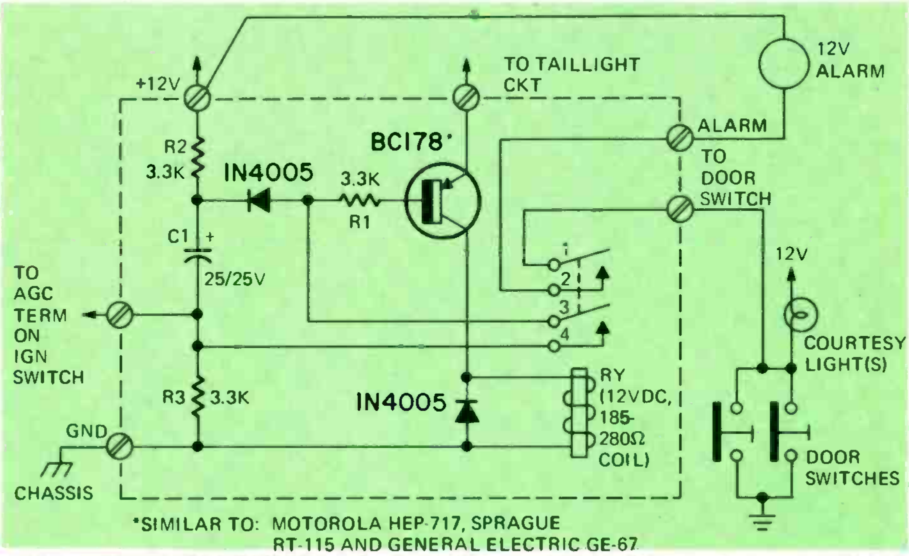


FIG. 3—HEADLIGHTS REMINDER can be disabled so you can leave lights on when you want to and warns you immediately when lights are left on inadvertently.

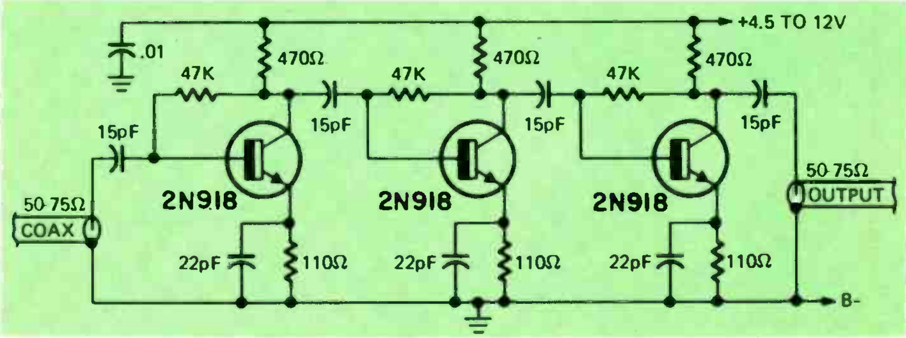


FIG. 4—A BOOSTER FOR HIGH-BAND VHF TV can be a useful receiving aid, particularly in fringe areas. This untuned broadband booster is easy to build.

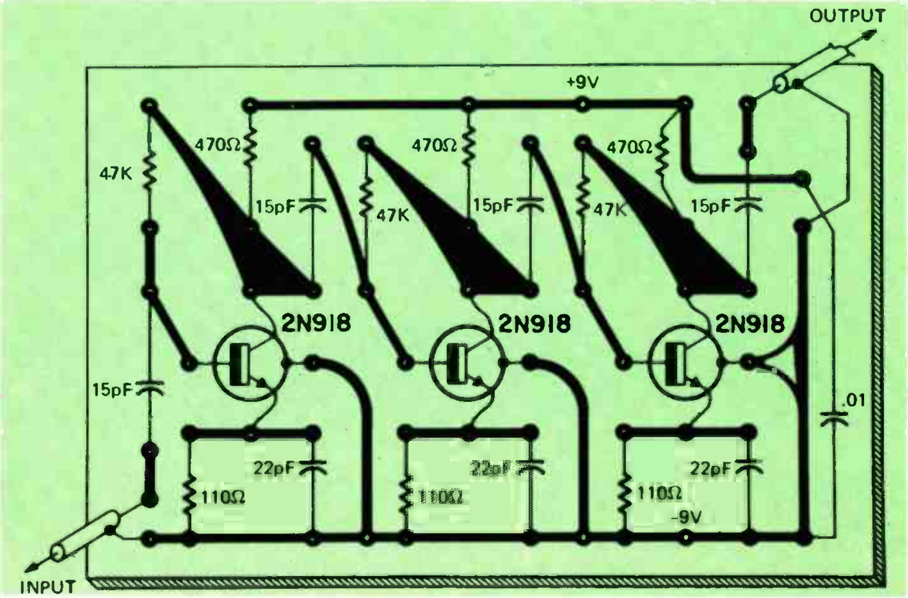


FIG. 5—PARTS ARE ASSEMBLED ON A BOARD approximately 2¼ by 2¾ inches. The circuit is easy to duplicate using perforated board and clips or etched and drilled PC board.

may want to use the pc layout in Fig. 5. The 75-ohm input and output impedances can be matched to 300-ohm twin lead by baluns. Gain can be controlled by inserting a 500-ohm pot in series with the output emitter resistor.

Transistor power supplies

There are lots of transistor radios, tape players, recorders, and similar devices that have been tossed aside because they operate solely from either 6- or 9-volt batteries. If you have similar devices you want to operate from power lines, see Figs. 6 and 7. They are combined schematics of 6- and 9-volt battery eliminators described in *Radio, Television and Hobbies* (now *Electronics Australia*).

The circuit in Fig. 6 delivers up to about 90 mA. The transformer is an ordinary filament variety delivering 500 mA or more. D1 and D2 (any silicon rectifier such as a 1N2858 or 1N3193) are connected as a voltage doubler. The transistor is a series regulator delivering an output voltage approximately equal to the Zener rating of D3. Use a 6-volt Zener diode for the 6-volt supply: 9-volt for a 9-volt source.

The solid-line resistors R1, R2, and R3 are used in the 9-volt supply, with R2 as 1.8K. In the 6-volt version, R1 is replaced by R1-a and R1-b with R4 connected at their junction.

Output ripple is less than 0.5 mV. R1 protects the transistor against overload by a short circuit. Short-circuit current is limited to about 150 mA.

Figure 7 shows similar essentials for a 6-9-volt supply delivering up to 1 ampere. Ripple voltage is less than 10 mV at 1 amp, and is much lower at lower currents. Effective dc resistance is about 0.4 ohm, and output impedance is that of the output capacitor.

In Fig. 7, Q1 is the current limiter that protects Q2 in the event of a short circuit. The circuit is set up so normal load currents develop a bias voltage that keeps Q1 saturated, so its effective resistance is very low. When the load current exceeds the preset level (1.1 ampere), Q1's forward bias is cancelled so the transistor cuts off, thus acting as an open switch in the current path.

The resistor in series with Q1's emitter sets the current limit. Increase it if the short-circuit current is greater than 1.25-1.30 amps. Shunting it with a resistor 150 to 200 times its value is a good way.

The rectifier used was a selenium bridge, but you can substitute low-voltage, 2-amp diodes. **R-E**

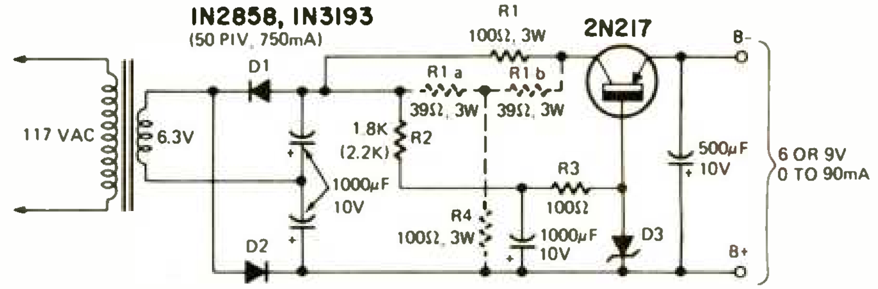


FIG. 6—BASIC CIRCUIT for 6- and 9-volt battery eliminators for small devices drawing up to 90 mA. Refer to text for values of the coded resistors and diode D3.

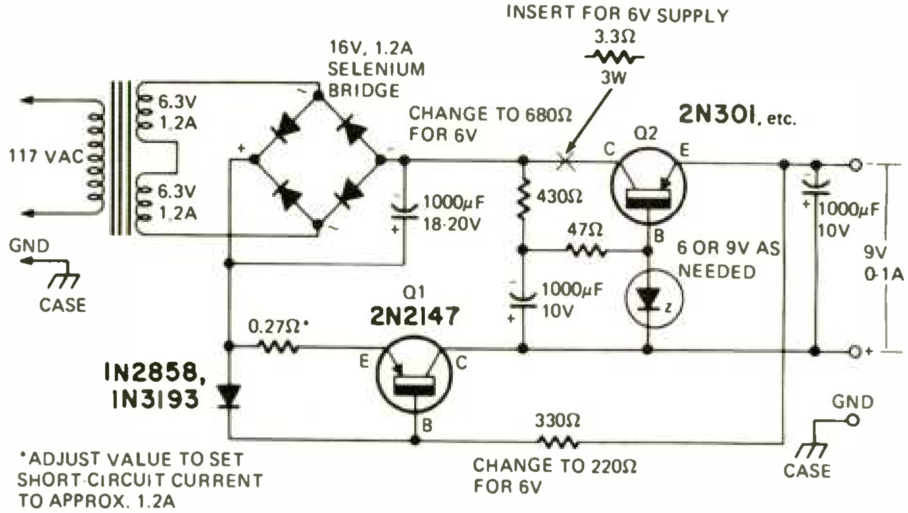


FIG. 7—BATTERY ELIMINATOR for loads up to 1 ampere. Select the Zener diode and the values of the resistors indicated for the desired 6- or 9-volt output.

R-E's Substitution guide for replacement transistors

PART XVIII

by ROBERT & ELIZABETH SCOTT

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores Allied Radio Shack. 2725 W 7th St, Ft Worth. Texas 76107

DM—D. M. Semiconductor Co. P.O Box 131. Melrose. Mass 02176

G-E—General Electric Co., Tube Product Div. Owensboro. Ky 42301

ICC—International Components. 10 Daniel Street. Farmingdale. N Y 11735

IR—International Rectifier. Semiconductor Div. 233 Kansas St., El Segundo. Calif. 90245

MAL—Mallory Distributor Products Co. 101 S. Parker. Indianapolis. Ind. 46201

MOT—Motorola Semiconductors. Box 2963. Phoenix. Ariz. 85036

RCA—RCA Electronic Components. Harrison. N.J. 07029

SPR—Sprague Products Co. 65 Marshall St., North Adams. Mass 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham. Mass. 02154

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota. Fla. 33578

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago. Ill. 60648

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible. however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

TSA NORTHEASTERN, N.Y. INSTALLATION DINNER

SMILING FACES AT THE INSTALLATION DINNER in Albany, N.Y. celebrate the 21st birthday of this active association. Those shown, from left to right are, Bob Plunzz, outgoing president; Mr. Paul Landor, the new president; Mrs. Landor; Larry Steckler, editor of Radio-Electronics Magazine; Mrs. Steckler; and Mrs. Warren Baker. Warren took this photo for us at the TSA dinner.

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N3734	NA	TS-3020	GE-28	ICC-S3020	NA	PTC 144	HEP-S3020	NA	NA	NA	WEP S3020	NA
2N3735	NA	TS-3020	NA	ICC-S3020	NA	PTC 144	HEP-S3020	NA	NA	NA	WEP S3020	NA
2N3736	NA	TS-3020	GE-20	ICC-S3020	NA	PTC 144	HEP-S3020	NA	NA	NA	WEP S3020	NA
2N3737	NA	TS-3020	NA	ICC-S3020	NA	PTC 144	HEP-S3020	NA	NA	NA	WEP S3020	NA
2N3738	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP 240	ZEN 200
2N3739	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP 240	ZEN 200
2N3740	RS276-2025	T-702	GE-69	ICC-702	IRTR-58	PTC 113	HEP-702	NA	RT-133	ECG 218	WEP 700	NA
2N3741	RS276-2025	T-702	NA	ICC-702	IRTR-58	PTC 113	HEP-702	NA	NA	ECG 218	WEP 700	NA
2N3742	NA	T-706	GE-27	ICC-706	NA	PTC 117	HEP-706	NA	NA	NA	WEP 244	NA
2N3744	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3745	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3747	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3748	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3753	NA	SR-1301	NA	ICC-R1301	NA	NA	HEP-R1301	NA	NA	ECG 5491	NA	NA
2N3754	NA	SR-1302	NA	ICC-R1302	NA	NA	HEP-R1302	NA	NA	NA	NA	NA
2N3755	NA	SR-1304	NA	ICC-R1304	NA	NA	HEP-R1304	NA	NA	NA	NA	NA
2N3756	NA	SR-1306	NA	ICC-R1306	NA	NA	HEP-R1306	NA	NA	NA	NA	NA
2N3757	NA	SR-1307	NA	ICC-R1307	NA	NA	HEP-R1307	NA	NA	NA	NA	NA
2N3758	NA	SR-1246	NA	ICC-R1246	NA	NA	HEP-R1246	NA	NA	NA	NA	NA
2N3759	NA	SR-1247	NA	ICC-R1247	NA	NA	HEP-R1247	NA	NA	NA	NA	NA
2N3762	RS276-2025	T-242	GE-29	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3763	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3764	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3765	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3766	RS276-2017	T-703	NA	ICC-703	NA	PTC 112	HEP-703	NA	NA	ECG 175	WEP 703	NA
2N3767	NA	T-241	NA	ICC-241	NA	NA	HEP-241	NA	NA	ECG 175	WEP 241	NA
2N3770	RS276-2003	T-3	GE-51	ICC-3	NA	PTC 107	HEP-3	NA	NA	ECG 160	WEP 3	ZEN 301
2N3771	NA	TS-7000	GE-75	ICC-S7000	TR-36	NA	HEP-S7000	SK 3036	RT-149	ECG 181	WEP-WS7000	NA
2N3772	NA	T-704	GE-75	ICC-704	TR-36	PTC 140	HEP-704	SK 3036	RT-149	ECG 181	WEP 704	NA
2N3773	NA	TS-7000	NA	ICC-S7000	NA	NA	HEP-S7000	NA	NA	NA	WEP S7000	NA
2N3774	RS276-2025	T-242	NA	ICC-242	NA	PTC 111	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3775	RS276-2025	T-242	NA	ICC-242	NA	PTC 111	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3776	NA	TS-3031	NA	ICC-S3031	NA	PTC 111	HEP-S3031	SK 3025	RT-115	ECG 129	WEP S3031	NA
2N3777	NA	TS-3031	NA	ICC-S3031	NA	NA	HEP-S3031	NA	NA	NA	WEP S3021	NA
2N3778	RS276-2025	T-242	NA	ICC-242	NA	PTC 111	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3779	RS276-2025	T-242	NA	ICC-242	NA	PTC 111	HEP-242	NA	NA	ECG 175	WEP 242	NA
2N3780	NA	TS-3031	NA	ICC-S3031	NA	PTC 111	HEP-S3031	SK 3025	RT-115	ECG 129	WEP S3031	NA
2N3781	NA	TS-3031	NA	ICC-S3031	NA	NA	HEP-S3031	SK 3025	RT-115	ECG 129	WEP S3031	NA
2N3782	RS276-2025	T-242	NA	ICC-242	NA	PTC 110	HEP-242	SK 3025	RT 115	ECG 129	WEP 242	NA
2N3783	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP 3	ZEN 301
2N3784	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP 3	ZEN 301
2N3785	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP 3	ZEN 301
2N3788	NA	T-707	GE-36	ICC-707	IRTR-67	PTC 129	HEP-707	NA	NA	NA	WEP 707	ZEN 204
2N3789	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	ECG 219	WEP S7001	NA
2N3790	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	NA	WEP S7001	NA
2N3791	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	ECG 219	WEP S7001	NA
2N3792	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	NA	WEP S7001	NA
2N3793	RS276-2011	T-56	GE-20	ICC-56	TR-25	PTC 123	HEP-56	SK 3124	RT-102	ECG 123A	WEP 56	ZEN 104
2N3794	RS276-2009	T-55	GE-63	ICC-55	NA	PTC 123	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3798	RS276-2024	T-57	GE-67	ICC-57	NA	PTC 141	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3799	RS276-2024	T-57	GE-21	ICC-57	NA	PTC 127	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3800*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3802*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3804*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3806*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3808*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3810*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	NA	NA	WEP 715	ZEN 106
2N3812*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	SK 3114	NA	NA	WEP 715	ZEN 106
2N3813*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	SK 3114	NA	NA	WEP 715	NA
2N3814*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	SK 3114	NA	NA	WEP 715	ZEN 106
2N3815	NA	NA	NA	NA	NA	PTC 127	NA	SK 3114	NA	NA	NA	NA
2N3816*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	SK 3114	NA	NA	WEP 715	ZEN 106
2N3818	NA	NA	GE-66	NA	IRTR-66	NA	NA	NA	NA	NA	WEP 701	NA
2N3819	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3118	RT-175	ECG 132	WEP 802	ZEN 123
2N3820	NA	T-803	NA	ICC-803	NA	PTC 151	HEP-803	SK 3116	RT-175	ECG 132	NA	NA
2N3821	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3822	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3823	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3116	NA	NA	WEP 802	ZEN 123
2N3825	RS276-2009	T-50	GE-17	ICC-50	NA	PTC 115	HEP-50	SK 3039	RT-108	ECG 107	WEP 50	ZEN 100
2N3826	NA	T-56	GE-61	NA	TR-24	PTC 121	HEP-S0007	SK 3018	RT-108	ECG 107	WEP 720	NA
2N3827	NA	NA	GE-63	NA	NA	PTC 121	HEP-S0007	SK 3018	RT-108	ECG 107	WEP 720	NA
2N3828	RS276-2009	T-55	GE-20	ICC-55	TR-24	PTC 121	HEP-55	SK 3122	RT-102	ECG 123A	WEP 55	ZEN 103
2N3829	RS276-2023	T-52	GE-21	ICC-52	IRTR-54	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP 52	NA
2N3830	NA	TS-3001	NA	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N3831	NA	TS-3001	GE-28	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N3832	RS276-2011	T-56	NA	ICC-56	TR-17	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP 56	ZEN 104
2N3840	RS276-2023	T-52	GE-21	ICC-52	IRTR-52	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 52	NA
2N3841	NA	NA	NA	NA	NA	PTC 127	NA	NA	NA	NA	NA	NA
2N3843	RS276-2009	T-50	GE-62	ICC-50	TR-24	PTC 139	HEP-50	SK 3122	RT-102	ECG 123A	WEP 50	ZEN 100
2N3844	RS276-2009	T-723	GE-62	ICC-723	TR-24	PTC 139	HEP-723	SK 3122	RT-102	ECG 123A	WEP 723	ZEN 111
2N3845	RS276-2009	T-723	GE-62	ICC-723	NA	PTC 139	HEP-723	SK 3039	RT-108	ECG 107	WEP 723	ZEN 111
2N3846	NA	T-56	GE-17	NA	NA	PTC 133	NA	SK 3039	RT-108	ECG 107	WEP 720	NA
2N3852	NA	NA	GE-28	NA	NA	NA	NA	NA	NA	NA	WEP S3023	NA
2N3853	NA	NA	GE-28	NA	NA	PTC 110	NA	NA	NA	NA	WEP S3023	NA
2N3854	RS276-2009	T-723	GE-62	ICC-723	TR-33	PTC 139	HEP-723	SK 3039	RT-113	ECG 108	WEP 723	ZEN 111
2N3855	RS276-2009	T-723	GE-62	ICC-723	TR-33	PTC 139	HEP-723	SK 3039	RT-108	ECG 107	WEP 723	ZEN 111
2N3856	RS276-2009	T-723	GE-62	ICC-723	NA	PTC 139	HEP-723	SK 3039	RT-108	ECG 107	WEP 723	ZEN 111
2N3857	RS276-2021	T-51	GE-21	ICC-51	NA	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	WEP 51	ZEN 101
2N3858	RS276-2009	T-723	GE-62	ICC-723	TR-24	PTC 139	HEP-723	SK 3122	RT-102	ECG 123A	WEP 723	ZEN 111
2N3859	RS276-2009	T-723	GE-62	ICC-723	TR-24	PTC 139	HEP-723	SK 3124	RT-102	ECG 123A	WEP 723	ZEN 111
2N3860	RS276-2009	T-50	GE-62	ICC-50	IRTR-52	PTC 139	HEP-50	SK 3039	RT-108	ECG 107	WEP 50	ZEN 100
2N3862	NA	TS-0004	GE-20	ICC-S0004	NA	PTC 136	HEP-S0004	SK 3122	RT-102	ECG 123A	WEP 56	ZEN 127
2N3863	NA	T-247	NA	ICC-247	IRTR-61	PTC 118	HEP-247	SK 3036	RT-131	ECG 130	WEP 247	NA
2N3864	NA	T-704	GE-75	ICC-704	IRTR-61	PTC 118	HEP-704	SK 3036	RT-131	ECG 130	WEP 704	NA
2N3865	NA	T-707	NA	ICC-707	IRTR-61	PTC 118	HEP-707	NA	NA	NA	WEP 707	ZEN 204
2N3866	RS276-2009	TS-3008	GE-28	ICC-S3008	IRTR-87	PTC 144	HEP-S3008	SK 3024	RT-114	ECG 128	WEP 242	NA
2N3867	RS276-2025	T-242	GE-29	ICC-242	IRTR-88	PTC 141	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3868	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 141	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3869	NA	TS-3001	GE-28	ICC-S3001	IRTR-64	PTC 123	HEP-S3001	NA	RT-100	ECG 123	WEP 53	NA
2N3877	NA	TS-0007	GE-17	ICC-S0007	NA	PTC 123	HEP-S0007	SK 3024	RT-114	ECG 128	WEP 735	ZEN 205
2N3878	NA	T-241	GE-66	ICC-241	NA	NA	HEP-241	SK 3021	NA	NA	WEP 241	NA
2N3879	NA	T-241	NA	ICC-241	NA	NA	HEP-241	SK 3021	NA	NA	WEP 241	NA
2N3880	RS276-2009	T-50	NA	ICC-50	NA	NA	HEP-50	SK 3122	RT-102	ECG 123A	WEP 50	ZEN 100
2N3881	NA	TS-3001	GE-63	ICC-S3001	IRTR-87	PTC 144	HEP-S3001	NA	NA	NA	NA	NA
2N3882	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3883	NA	T-253	NA	ICC-253	NA	PTC 135	HEP-253	NA	NA	ECG 160	WEP 253	ZEN 304
2N3885	NA	NA	GE-20	NA	NA	PTC 136	NA	NA	NA	NA	WEP 735	NA
2N3896	NA	SR-1472	GEMR-3	ICC-R1472	NA	NA	HEP-R1472	SK 3505	NA	ECG 5522	NA	NA
2N3897	NA	SR-1473	GEMR-3	ICC-R1473	NA	NA	HEP-R1473	SK 3505	NA	ECG 5524	NA	NA
2N3898	NA	SR-1475	GEMR-3	ICC-R1475	NA	NA	HEP-R1475	SK 3505	NA	ECG 5527	NA	NA
2N3899	NA	NA	NA	NA	NA	NA	NA	SK 3505	NA	ECG 5547	NA	NA
2N3900	RS276-2009	NA	GE-62	ICC-724	TR-51	PTC 139	HEP-724	SK 3124	RT-102	ECG 123A	WEP 724	ZEN 112
2N3901	RS276-2009	T-55	GE-10	ICC-55	TR-51	PTC 123	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3902	NA	T-740	NA	ICC-740	IRTR-62	PTC 118	HEP-740	NA	NA	ECG 163	WEP 740	ZEN 206
2N3903	RS276-2009	T-736	GE-20	ICC-736	IRTR-53	PTC 136	HEP-736	NA	NA	NA	WEP 736	ZEN 120
2N3904	RS276-2009	T-736	GE-20	ICC-736	TR-24	PTC 136	HEP-736	SK 3024	RT-102	ECG 128	WEP 736	ZEN 120
2N3905	RS276-2021	T-715	GE-21	ICC-715	IRTR-54	PTC 103	HEP-715	SK 3114	RT-115	ECG 159	WEP 715	ZEN 106
2N3906	RS276-2021	T-715	GE-21	ICC-715	TR-30	PTC 103	HEP-715	SK 3025	RT-115	ECG 159	WEP 715	ZEN 106
2N3907*	NA	T-729	NA	ICC-729	NA	PTC 121	HEP-729	NA	NA	NA	WEP 729	ZEN 115
2N3908*	NA	TS-0007	NA	ICC-S0007	NA	PTC 144	HEP-S0007	NA	NA	NA	WEP 735	NA
2N3908	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3909	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3910	NA	NA	GE-21	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3911	NA	T-739	GE-21	ICC-739	NA	PTC 103	HEP-739	SK 3911	RT-115	ECG 159	WEP 717	ZEN 122
2N3912	NA	T-739	GE-47	ICC-739	NA	PTC 127	HEP-739	SK 3114	RT-115	ECG 159	WEP 717	ZEN 122
2N3913	NA	NA	GE-21	NA	NA	PTC 103	NA	NA	NA	NA	NA	NA
2N3914	NA	T-739	GE-21	ICC-739	NA	PTC 103	HEP-739	SK 3114	RT-115	ECG 159	WEP 717	ZEN 122
2N3915	NA	T-739	GE-47	ICC-739	NA	PTC 127	HEP-739	NA	RT-126	ECG 106	WEP 52	ZEN 122
2N3916	NA	T-714	GE-32	ICC-714	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N3917	NA	TS-5000	GE-19	ICC-S5000	NA	PTC 116	HEP-S5000	NA	NA	NA	NA	NA
2N3918	NA	TS-5000	GE-19	ICC-S5000	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N3919	NA	T-704	GE-28	ICC-704	NA	NA	HEP-704	NA	NA	NA	NA	NA
2N3920	NA	T-704	NA	ICC-704	NA	NA	HEP-704	NA	NA	NA	NA	NA
2N3922	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3923	NA	T-706	GE-27	ICC-706	NA	PTC 117	HEP 706	SK 3045	RT-110	ECG 154	WEP 712	NA
2N3924	RS276-2009	T-75	GE-28	ICC-75	NA	NA	HEP-75	NA	RT-100	ECG 123	WEP 53	NA
2N3925	NA	NA	GE-28	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3926	NA	NA	GE-28	NA	IRTR-66	PTC 128	NA	NA	NA	NA	NA	NA
2N3927	NA	NA	GE-66	NA	IRTR-66	PTC 128	NA	NA	NA	NA	NA	NA
2N3928	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	NA	NA
2N3932	RS276-2011	T-56	NA	ICC-56	NA	NA	HEP-56	NA	RT-113	ECG 108	WEP 56	ZEN 104
2N3933	RS276-2011	T-56	NA	ICC-56	NA	NA	HEP-56	SK 3039	RT-113	ECG 108	WEP 56	ZEN 104
2N3936	NA	SR-1242	NA	ICC-R1242	NA	NA	HEP-R1242	NA	NA	NA	NA	NA
2N3937	NA	SR-1243	NA	ICC-R1243	NA	NA	HEP-R1243	NA	NA	NA	NA	NA
2N3938	NA	SR-1244	NA	ICC-R1244	NA	NA	HEP-R1244	NA	NA	NA	NA	NA

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve tracer or lab-type transistor checker.

(continued next month)

NA=NOT AVAILABLE

R-E's Service Clinic

Upgrading the technician

It's time to stop talking and start doing

by **JACK DARR**
SERVICE EDITOR

THERE'S A GREAT DEAL OF TALK ABOUT THE need for upgrading technicians. It's quite true. Many people have stated the problem; now let's take a look at some of the nuts and bolts of the situation; what and how.

A technical education, especially in electronics, has a half-life of about five years! In plainer words, a technician who finished his schooling in 1963, and hasn't kept up to date, is right now unable to earn a living. He's still thinking tubes; he doesn't know solid-state circuitry. In 1983, if George Orwell doesn't beat us to it, today's technicians who can work with discrete solid-state circuits, won't know what it's all about either, in an "IC-ized" world!

There's a message here. I can attest to its validity from much personal experience. The profession of electronics technician is, and always has been, a "Red Queen's Race", right out of Alice in Wonderland, where the contestants have to run as hard as they can just to stay where they were. Plainly speaking, this means that the typical technician must study *continually*, to keep pace with the fast-paced development of new circuits, components and materials. I'd say that I average an hour a day of study, sometimes more. Even then, something new is always jumping out at me.

Now we've stated the problem. OK, what can we do about it? As I said—study. Study what? Fortunately, there is no lack of material. Not in the order of importance, for each is equally important, we have magazines such as **Radio-Electronics**; the detailed literature put out by set and component manufacturers, and many books, plus the service meetings conducted by manufacturers for technicians.

There is the normal hassle among "educators" as to which way is best. We have many different ways of conveying technical data to the technicians; audio-visual presentations, lectures, magazines, books, service manuals. Each of these has its place. I don't think there is a single "best way". Most effective is a combination of methods. For example, a service meeting is a lecture by a factory field engineer. Technicians listen attentively to him, and try to get the details. Unfortunately, many studies have proven that material heard once at a lecture is very poorly *retained*. After only a short time, they retain only about *10%* of the data. So; to complement the lecture, the technicians should be given exact copies of all material covered in the lecture, with diagrams and illustrations. These can be re-read whenever needed, and will serve as a very useful part of the reference library.

In my opinion, this is the best way. Most of the concepts in our profession are so complex that it is simply not possible for the technician to assimilate them in one sitting, at a lecture. To understand and *retain* these concepts, he must have the data available in the form of the printed word, so it can be read and re-read until it has, quite literally "soaked in" to his mind, and he can use it.

To get this down to a finer point, there are two ways of studying. One is the "cram"; studying full-time for several weeks, or months. The second could be called the "bite-size" method; taking a short period of time each day and studying only one small section of the material at a time until it is perfectly plain.

Personally, I prefer the second way. A small bite of knowledge acquired each day is far more apt to be retained than massive doses crammed into the brain. Here again, the key word is "retention". If huge bites are taken, only a small fraction stays with him. The rest must be "re-learned" later. So a lot of the original study-time is wasted.

A personal viewpoint

One reason that I can speak with some authority in this area is that "I've been there". The vast majority of my technical education has been gotten in just that way—from reading textbooks, magazines service manuals, and anything else I could get my hands on. I have also had the opportunity to set up experiments in training young technicians, and find out exactly what methods of teaching got the best results, where retention of the data was concerned.

In my early days, it was really rough to understand this stuff. This was due to one simple cause—*the way it was written*. "By engineers FOR engineers", not for students. So at that time, you could read the book, but then you had to go hunt up someone who could explain it to you. This is doing it the hard way, believe me.

If you'll pardon a short ride on my favorite hobby-horse, I'd like to say a few words about technical writers. They bear a great responsibility in our highly scientific society. It's their mission to make complex and obscure concepts *plain*, to someone who does not know them. If the writer will take pains to *explain* his circuits, in detail, and using very plain language, the reader will have a far easier time comprehending it. After all, the whole purpose of writing a technical article or book is to explain something to a reader who doesn't know anything about it.

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

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

I was very fortunate, when I began writing, in being associated with a very wise old gentleman, who taught me a great deal. When I sent in an article (on horizontal sweep, I think it was), saying that I thought it was really just a little bit *too* simple, and "written-out", he said something that I've remembered to this day. "If they already *know* all about this circuit, they don't have to *read* your damned article. Your reader doesn't, so always explain it as plainly as you can." So please, men, don't write to engineers unless you're writing for an engineering publication.

The two sections of knowledge

The "education" of an electronics technician can be divided into two sections. One is a thorough knowledge of the basic circuitry, and how all components work. The second is the ability to USE this knowledge to find and repair faults in existing circuitry. In other words, DIAGNOSIS.

In this area, we need more effort, in my opinion. This is based on many years of corresponding with working technicians, in the Service Clinic. I've answered thousands of letters from men, who already *had* all of the data needed to make the diagnosis! They simply had not had sufficient training in the art of *applying* the knowledge. In other words, they're ignorant.

Right now let me pause and make a very definite distinction between two words. I get a lot of answers from men who say "Gee, I was stupid! Why didn't I see that?" I reply, "There is a vast difference between stupidity and ignorance!" If you're just *ignorant* of something, this means that you haven't learned it YET. If you're really stupid, this means that you *can't* learn it." Frankly; very, very few electronics technicians are stupid. Everyone is ignorant, including me, in certain areas. (Unfortunately, *I* can offer written proof where I'm concerned.)

Diagnosis *is* an art. It consists of learning all of the easily-available facts about the problem. For instance, by looking at the TV screen. From this preliminary data, you make a stochastic analysis of the most likely cause. Stochastic is a word with a Greek root, which means "A rough guess!". That's all you've got, at this point.

After making the first guess, the expert technician makes further, more detailed tests, to prove or *disprove*, the validity of his initial guess. If these show that the first guess wasn't correct, he calmly eliminates that stage or parts from his list of suspects, and makes another guess. This process is repeated until he finds the cause of the trouble.

Working technicians are familiar with failure-modes and symptoms in older sets. However, in solid-state circuitry, failure-modes, symptoms and faulty operation often look differently. So we must learn a new set of concepts to be able to make diagnoses as quickly and accurately as we did on the other types. On this subject, I'm a believer in the value of "lab work" at service meetings. Some manufacturers use sets with faults placed in them. The technician must locate and identify the troubles. This makes them *use* the new knowledge they have just been taught, which makes the retention a lot easier.

Back to the writers

I'm going back and hammer on the technical writers again, for a minute. This kind of thing is what we have to teach the technicians. If they learn the basic principles and applications of diagnosis, they'll be successful in repairing any kind of electronic apparatus, no matter how complex, in the least possible time. We must *teach* them how to do this. It is a purely *mental* function.

This is where the technical writer gets back into the act. It is his job to *explain* this and its uses, in language plain enough so that it will not be a barrier. Language can be a channel between minds, or a *barrier* to effective communications. Using strange words or very long, unfamiliar words, breaks the fragile link between writer and reader. I'm not saying that this material should be written in slang, or jive-talk. It simply menas that it must be written in the plain, high-information-content language spoken by the technicians.

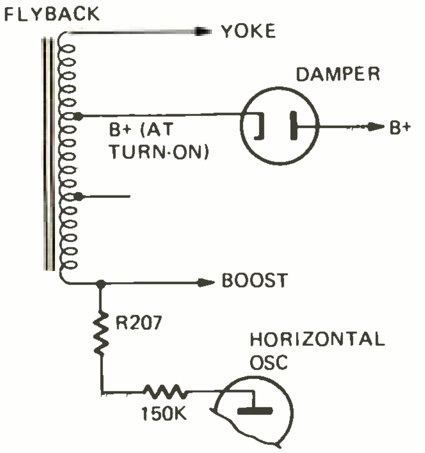
If a new word must be used, the writer should explain it very carefully, the *first time* it appears. This should be repeated, later, if necessary. Studies have shown that new words should be "redefined" if they appear more than 2.1 pages of text after the first usage. After this much time, there's a chance that the reader has forgotten the first definition, at least temporarily. He doesn't want to turn back to its first appearance, and he shouldn't be made to, if the writer is sufficiently skillful!

In conclusion, great efforts are being made, by many people, to provide technicians with materials for upgrading their skills. Now we come to the most important point in the whole thing. This upgrading is the responsibility of *the technician himself*. No one is going to *make* him study; it's entirely up to him. He must have the desire and the incentive, and the patience, to devote a part of each day to the study of new circuits, parts and uses. We can provide the materials for study, but it's entirely up to the man (person) himself to put them to use. Fortunately for all of us, the actual benefits of such upgrading are pretty easy to demonstrate. They take the form of increased productivity, and increased *income*. We'll help out in every way we can, but it's really up to YOU, gentlemen. Take it from here. **R-E**

reader questions

PLATE VOLTAGE MISSING

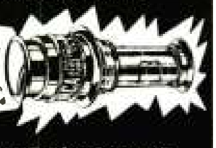
I'm stumped! I have no plate voltage on the horizontal oscillator of this Admiral HI-IX, so, nothing else. I can't "see" the path that the dc voltage takes to get to it. After the oscillator starts, it's fed from the

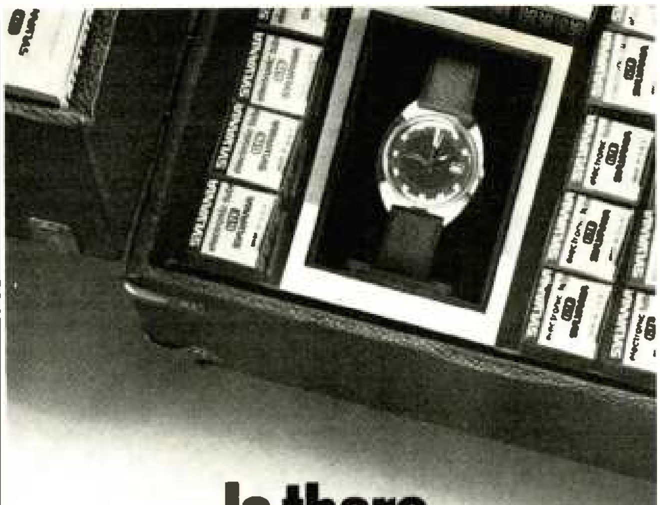


boost, but what starts it?—S.J., Scarborough, Ont.

This looks complex, and sounds complex, but it isn't. You'll find this or equivalent circuits in a lot of sets. Here's how it goes.

Start at the B+ supply, on the damper plate. When the set's turned on, current flows through the damper tube and the B+ appears on the cathode. This flows through R207, to





the bottom of the 150K plate load resistor, to the plate of the horizontal oscillator. This supply is actually used only for *starting* the oscillator. Once it has started, the boost voltage builds up, and supplies, the oscillator through another resistor network, not shown here for clarity.

60-HZ HUM BAR

After much digging and chasing, I have finally located the cause of the 60-Hz hum-bar in this Philco 16M91. I checked out all of the things you suggested (in the first letter) and finally pinned it down to the cathodes of the color-difference amplifiers! The cathodes of these three tubes (common) read shorted to ground. The tubes are good, the 270-ohm resistor is good, and I've even pulled the tube sockets. Still read the short. I can't get a new PC board from the factory! Any more ideas?—J.V., Elmhurst, N.Y.

A couple. While the sockets are out, locate the cathode conductor(s). Clean the board thoroughly, and examine this conductor with a good-sized magnifying glass. Look for tiny solder-spikes, solder bridges, or discolored place which might indicate that an arc had taken place, causing a short through the board. There is a wire jumper close to these sockets; this can be taken out to isolate this circuit.

I don't think this is really a "ground" or short to ground. From the symptoms, it's probably a leakage from the cathode conductor to the hot side of the *heater* conductor to the color diff-amp tubes! This would read zero to ground, of course, with an ohmmeter. If need be, leave the tubes out, and turn the set on. See if you can read any ac voltage on the cathode conductor. Look for places where the 6-volt ac conductor goes near the cathode conductor.

Last resort: since this is really a pretty simple circuit, with only 3 connections, cut the PC board conductors completely out with a razor blade, etc. Then, *wire* the three cathodes together with hookup wire, and connect this to the bias resistor! That should get it.

BROADCAST BARS

(Preface: the original complaint on an RCA CTC-40 was "horizontal bars in the picture." Eventually, it was discovered that the set was *radiating* these bars! Other sets operating nearby would pick them up, with an identical display. Several letters were exchanged on possible causes for this, and finally the reader, Rob Purtzer of Bob's TV Service wrote.)

"I cured it! Just as soon as I did, I got your letter suggesting the same thing! (Comment: mental telepathy?) At any rate, I noted that the thing was certainly acting like one of the old spark-gap transmitters. Where could I have a spark-gap like this?

The answer wasn't too hard to find. When the top of the HV cage had been closed, with the new HV rectifier tube in its socket, the plate-cap of the tube had *missed* the "socket" on top of the flyback and was arcing madly!"

NO HV, REGULATOR PROBLEM

This Sylvania D-11 has no high voltage. I can't get the −40 volts on the grid of the 35LR6. The plate voltage of the 6CL8 horizontal regulator is off, too; only −0.6 volt instead of −40. Checked resistors, capacitors, tried new tubes. R123 was off: this is 270 ohms, so I replaced it with a new one. Can you help out?—J.V. Santa Clara, Calif.

For the first step, take that 270-ohm resistor out (R123) and replace it with the right value. Someone has evidently changed it before. This is *not* a 270-ohm unit; it should be 47K, and it's the plate-load resistor of the horizontal oscillator! No wonder you're not getting any grid-drive on the 35LR6.

The plate voltage of the horizontal regulator tube (6CL8) is developed exactly like that of a keyed agc tube; from a pulse taken from the flyback. With no drive, no pulse; this should straighten out when you get the horizontal drive back.

LOW GAIN, INTERCOM

I've got to install an intercom system for a lumber company. They want two speakers in large warehouses, some distance from the office. The system is an old one, with a 35W4, 12AU6 and 50B5. I tried this in one of the warehouses. I got very little volume and a lot of hum on Talk. What can I do to match the speakers better and get more volume?—G.R., Greensboro, N.C.

Without a lot of trouble, not very much! This system does not have much gain, and only about 1 watt of audio output. Your best bet would be to use two more master stations in the warehouses, instead of the normal remote units. This will get rid of the hum problem.

IGNITION NOISE

My problem is heavy ignition noise in a high-traffic area. Customers often think that this is in the set. Is there anything that can be used on the set to stop this?—L.P., Detroit, Mich.

No. (Not to give you a short answer!) This is due to the clods who have taken the resistive ignition wiring off their cars. There's no way of filtering this out of the TV signal. About all you can do is move your antenna back as far from the street as possible, use an antenna booster to raise the signal level, and *possibly*, use shielded 300-ohm twin lead. Most of the noise is picked up by the antenna itself, but shielded lead-in may help to get it to the shop in better condition. (The signal, I mean; not the noise!)

INTERMITTENT DARK SPOT

The raster in this Admiral 15E1 has an odd symptom. At first, it comes on with a 3-inch dark spot in the center; 15 to 20 minutes later, this disappears, and I have a good picture! Do you know what I should look for?—J.C. Providence, R.I.

If I said I *knew*, I'd be lying. However, the crystal ball tells me that this kind of weird symptom *could* be caused by a defective filter capacitor. Probably one with high power factor or an intermittent open connection. Scope all filters while the symptom is still present.

MOTORBOATING, TRANSISTOR RADIO

With a brand new battery, this Motorola 8X26E transistor radio works perfectly. However, as soon as the battery ages just a little (internal resistance rises) the thing motorboats. If I bridge a 100-µF capacitor across the battery, it works fine. Battery voltage doesn't have to drop; it acts up with the full 6 volts applied! What should I do?—M.B. Spartanburg S.C.

Leave that 100-µF capacitor in there. There is no battery bypass in this set. "Motorboating" is a low-frequency oscillation that is practically always caused by feedback through the dc power supply. A 100-µF capacitor at 25 volts shouldn't be too big to tuck away somewhere in the case.

WET CAR IGNITION SYSTEM

I accidentally splashed some anti-freeze into my Mark Ten C-D ignition system. Now it doesn't work. What's the most likely thing to have "gone," from this?—A.L., Detroit, Mich.

The SCR. I'm enclosing a copy of the schematic. Check to see if the SCR is shorted. If so, replace it, and be sure to clean the PC board very thoroughly, and dry it out. That ought to do it.

NO BOOST, NO HV

There is no boost voltage, and no high voltage on an Admiral H1 chassis. All dc voltage supplies check out. Tubes OK. I checked the yoke with an ohmmeter, and it shows a pretty good balance. So, here I sit! What is it?—A.J., Pawtucket, R.I.

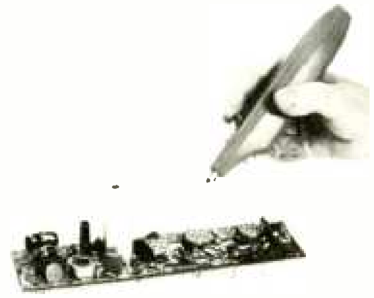
It doesn't take much of a short in the horizontal winding of the deflection yoke to cause trouble. An ohmmeter test isn't *too* reliable, because of the possibility of a very small short; one or two turns. This is enough to load down the supply and kill the boost.

Check the yoke on a "Flybacker" type tester (reads resonance of coils) or: substitute another horizontal winding, of about the same inductance. If the boost comes back, that was it. R-E

new products

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

CORDLESS SOLDERING IRON has built-in spotlight for working in dark areas. Operates on a rechargeable nickel-cadmium battery and heats in about five seconds. A UL listed recharger is included with the unit, which can be



recharged overnight; just plug into a 100—120-volt 60-cycle ac outlet.

Tip temperature is over 700°F. Approximately 100 joints can be soldered from each charge depending on wire size; iron can be used while recharging. An off-on button provides finger-touch control; small tip permits pinpoint work; extra tips are available. 8 inches long with tip; 6 oz. — **Wall-Lenk Manufacturing Co.,** P.O. Box 3349. Kinston, N.C. 28501.

Circle 31 on reader service card

4-CHANNEL HEADPHONES, *model TEL-101F* use Fixler Effect patents, under license, to create discrete 4-channel listening. Each phone contains two high-velocity, acoustically placed and phased, wide-frequency range dynamic drivers. Sound-coupling system uses open cell urethane foam that permits each ear to hear in

normal direction-sensing manner without feel of excessive encapsulation. Integral electrical network can be adjusted by listener for both channel separation and "room size" to suit his personal taste.

Compatible with all standard amplifier headphone jack impedances. Frequency range of from 20 Hz to 20 kHz. 20 oz.; $75.00 — **Telephonics,** 770 Park Avenue, Huntington, N.Y. 11743.

Circle 32 on reader service card

SILICONE HEAT SINK, *SL-1*, for use on solid-state electronic equipment. Zinc-oxide filled silicone compound is suited to heat transfer applications. Good for mounting power transistors because thermal conductivity is 0.428

BTU/ft.2°F/ft. High dielectric strength (500 volts/mil), low dissipation factor (less than .005) and good storage stability (won't separate even under centrifugal force of 20,000 gravities). Compound can withstand temperatures between −65°F and +400°F. Available in 1 oz. squeeze tubes mounted on pegboard display cards; $2.15 — **Chemtronics Inc.,** 1260 Ralph Avenue, Brooklyn, N.Y. 11236.

Circle 33 on reader service card

SPEAKER SYSTEMS. Two-way bookshelf system *T-200;* three-way bookshelf system *T-300;* four-way five-driver floor-standing system *T-400:* four-way seven-driver floor-standing system *T-500*. *T-400* contains a pair of wide-dispersion supertweeters angled to propagate the high end over a full 180°. A 3½-inch cone-low-tweeter high-midrange delivers well-dispersed, low-distortion sound with its range limited to 3000 to 7500 Hz. A 5-inch midrange cone goes down to 700 Hz that leaves only the lowest frequencies to be handled by the 12-inch woofer. Frequency response: 38 - 20,000 Hz ±3 dB (down 10 dB at 28 Hz, free field); power requirements: 10 watts recommended for amplifier, 100 watts maximum speech /music with-

out fusing; sensitivity: 10 watts = 92 dB SPL in medium-large room (3000 cu. ft.). 27 x 15 x 13-¼ in. (includes removable base); 53 lbs; $279-95.—**Technics by Panasonic,** 200 Park Avenue, New York, N.Y. 10017.

Circle 34 on reader service card

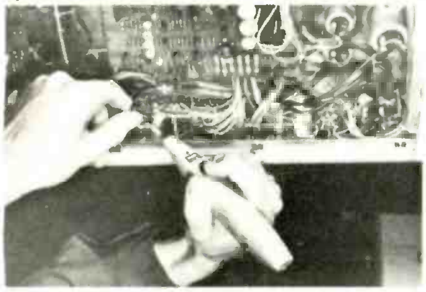
ELECTRONIC CALCULATOR, *model EC-250* not only adds, subtracts, divides and multiplies, but performs mixed and chain calculations and features an automatic percentage key. Has "auto-constant" capability that allows multiplication or division of a long series of numbers without having to re-enter the constant figure. Also has a full-floating decimal that automatically positions itself correctly and a clear-entry

key that erases only the last number entered without clearing previous entries.

Hooded display allows readability of the eight digits and an overflow indicator on the panel lights if the answer exceeds eight digits. Three-way power allows operation on ac. rechargeable or regular penlight cells. 5-⅞ x 3 x 1-¼ in.; 8 oz.; $69.95 with carrying case, ac adapter /charger and instruction booklet.—**Radio Shack,** 2617 West Seventh Street, Fort Worth, Tex. 76107.

Circle 35 on reader service card

CORDLESS SOLDERING IRON, *Quick Charge model 7700*. Decrease in recharging time is due to long-life nickel cadmium batteries. Lower base stand (with slot for spare tip) will return a partially discharged battery to full capacity in an hour or two. A completely discharged battery can be fully recharged and used again in about four hours, giving tip performance equivalent to up to 50 watts and over 700° temperature. Same



low voltage and isolated-tip construction as original *Iso-Tip* which eliminates electrical leakage and need for grounding, reducing risk of heat damage to sensitive components. Tip is easily replaceable with any of the four completely different tip sizes from heavy duty to fine (manufacturer does caution against interchanging standard *Iso-Tip* with a *Quick Charge* stand) as units are not interchangeable.

Pressing the button gives you soldering heat in five seconds plus a built-in work light on working area; pilot light, too, Lick-off switch prevents accidental heating of tip. Carries enough power to make up to 125 electronic joints per charge; automatically begins recharging when replaced in its stand; no wires to connect; no positioning of iron in its stand. 8 inches long with tip; 6 oz.; kit consists of cordless *Quick Charge* soldering iron, separate recharging stand, one No. *7545* fine tip, one No. *7546* heavy duty tip and instruction booklet.—**Wahl Clipper Corp.,** 2902 Locust Street, Sterling, Ill. 610811

Circle 36 on reader service card

DIGITAL VOM, *model 460-2* has both LED and analog displays. Primary readout is a 0.33" high, non-blinking 3½ digit LED display with automatic blanking of non-significant zeros. Analog readout is a dual-scale rotating drum meter; upper analog scale provides dB readings.

Twenty-six ranges are provided: 5 each for ac and dc voltage and current, 6 for resistance

measurements. Accuracy on dc ranges is ±0.1% of reading ±1 digit for voltage, ±0.2% ±1 digit for current. Overrange indication is automatic and linear to 500 counts beyond maximum indication. Single LSI module for counting, storage and display logic. Operates either from ac line voltage or automatically recharging internal batteries; portable. 115 Vac (50/60/400 Hz) version $375.00 less nickel-cadmium batteries; 230 Vac version $380.00 less batteries.—**Simpson Electric Co.,** 853 Dundee Avenue, Elgin, Ill. 60120.

Circle 37 on reader service card

CASSETTE RECORDER, *Sony model TC-152SD.* Built into unit is a Dolby noise reduction system that reduces audible hiss inherent in magnetic tape, providing the high signal-to-noise ratio. Features ferrite-and-ferrite (F & F) head which has life span up to 200 times that of standard permalloy head. Other features include peak limiter which automatic shut-off operates at end-of-tape in record and play modes to save battery life and avoid strain on mechanism; tape select switch is provided for selecting proper record equalization when using either standard or chromium dioxide tape.

Also features line in/line out facilities for stereo deck operation; playback can be heard in mono through its built-in single monitor power amplifier and speaker; separate playback volume and tone controls. Two large Vu meters

with illuminated on/off switch, straight-line record level controls, input selector switch, 3-digit tape counter, locking pause control, stereo headphone jack and two front panel microphone inputs. $299.95 with two patch cords, four "D" cell batteries and shoulder carrying strap.—**Superscope,** 8150 Vineland Avenue, Sun Valley, Calif. 91352.

Circle 38 on reader service card

VOM, *model 615-K* Maintenance Tester Kit for appliance, industrial, commercial and residential maintenance. A multi-purpose, multi-range tester and accessories for most maintenance tasks, including trouble-shooting circuits, thermocouples, cooling and heating equipment and controls and machinery of all kinds.

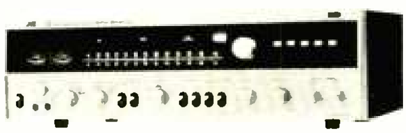
Comes in protective black molded carrying case with the model *615* vom that measures

volts, ohms, ac current leakage (ac mA); temperature and thermocouples, model *20-A* clamp-on ac ammeter adapter, model *101* ac line separator, 48-inch leads, 6-foot thermocouple probe, alligator clips, batteries and instruction manual. Kit $180.00; model *615* by itself $130.00—**Triplett Corp.,** Dept. PR, Bluffton, Ohio 45818.

Circle 39 on reader service card

4-CHANNEL RECEIVER, *model JVC 5446-X* features built-in CD-4 demodulator for Quadradisc records, low-distortion matrix decoders and automatic switching between CD-4 and matrix stereo.

Also features a special 5-zone S.E.A. super tone control system that allows the user to re-



cord and re-equalize older tapes and records. Features new noise reduction inputs and outputs, remote control/balance provision, tape monitor and full speaker selection. The four direct-coupled amplifiers deliver a total of 120 watts rms with low distortion and wide bandwidth. $649.95. — **JVC America, Inc.,** 50-35 56th Road, Maspeth, N.Y. 11378. R-E

Circle 40 on reader service card

new lit

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

TAPE RECORDER CLINIC PROCEDURES. 21-page catalog describes step-by-step test methods for conducting a tape recorder clinic using the Ferrograph Ferrotester. Includes playback test, record/playback test, harmonic distortion test, erase, channel separation, signal-to-noise, wow/flutter and drift. Test tapes are listed on last page. — **Elpa Marketing Industries, Inc.,** Thorens & Atlantic Avenues, New Hyde Park, N.Y. 11040.

Circle 41 on reader service card

CREATIVE POWER TOOLS. 12-page catalog includes Moto-Tools, Moto-Shop, engraver. kits, attachments and accessories that include cutters, points, bits, wheels, sanding discs and drums, collects, mandrels, replacement motor brushes and safety goggles. Four-color cover and many photographs. — **Dremel Manufacturing,** Dept. P.O. Box 518, Racine, Wisc. 53401.

Circle 42 on reader service card

PUBLICATION CATALOGS, Spring-Summer 1974. 16-page brochure covers full line of computer technology books available from the IEEE Computer Society. Included are outlines of the topics covered in *COMPCON Digests*, selected IEEE Press books as well as proceedings from some of symposia in the computer field: DataComm, Fault Tolerant Computing, Switching and Automata Theory and others. — **Computer Society** Publications Offices, 5855 Naples Plaza, Suite 301, Long Beach, Calif. 90803.

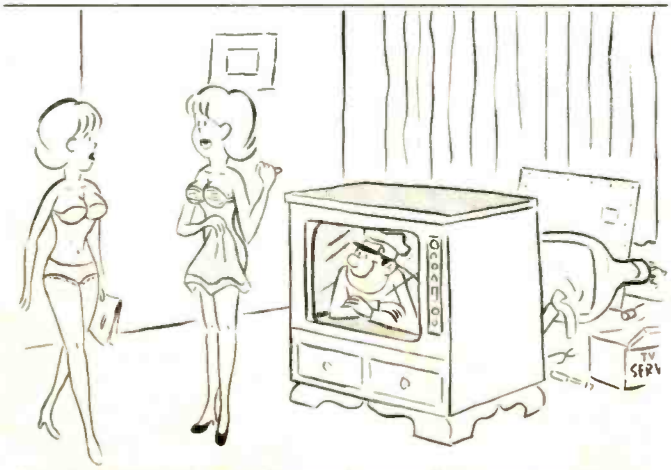
Circle 43 on reader service card

PROFESSIONAL CRT'S. Short-form catalog is designed for ready reference; gives electrical and mechanical specifications for 40 different CRT types. Mono-accelerator and post-deflection accelerator types are two largest categories. Other categories include monitor tubes that offer resolution up to 1100 TV lines, multiple-trace types (including both dual-beam and split-trace tubes) and high-frequency CRT's. Also listed are flying-spot scanners and storage and projection CRT's. — **Amperex Electronic Corp.,** Electro-Optical Devices Div., Slatersville, R.I. 02876.

Circle 44 on reader service card

GLOSSARY OF METRIC CONVERSIONS. We inadvertently omitted the price from this item in our May issue and that it is mainly available as promotional literature with your company's name printed on the back. Prices range from 55c — $1.50 each (without printing) depending on quantity. — **Henry Lavin Associates, Inc.,** 12 Promontory Drive, Cheshire, Conn. 06410.

R-E



"Call the TV Shop and cancel our call for service. The set seems to be working OK now."

Circle 27 on reader service card

CONVERGENCE PROBLEM

I've never seen a convergence problem like this one. When I move the red static magnet, the green moves, and vice versa. The whole screen is a mess. Nothing works right. Can't be the picture tube; I just put it in. What is this?—J.G., Crystal City, Ark.

Take the convergence yoke off, turn it around, and put it back on with the white-plastic side to the back. It's apparently reversed. Double-check; the red gun should be on the lower right, as you look at the back of the set.

NOISY ELECTRIC RANGE

How could I make a filter for an old electric range? This one has CalRod heating elements, but it's about 15 years old. Makes popping noises, and upsets radio reception.—A.B., Rochester.

I don't believe I would, not yet. If this range is making noise, you have a dirty connection somewhere. The heating elements are most apt to be plug-in types. At this age, it's quite likely that they're not making a good contact. Take each one out, and check the tips. If you see "arc-marks" or burnt spots, clean up the sockets and element pins until they make good tight contact. This should stop it.

The only other thing that could do this would be a dirty switch, and the elements are the most likely. Get all contacts clean and tight, and the noise will stop.

VDR PROBLEM

We had vertical hold problems in this Zenith 16K30 chassis. Found the VDR on pin 7 of the 6BU8 was cracked. Can't find an exact schematic of this chassis. Any dope on that VDR?—E.W. Orlando Fla.

Not much! Zenith's service data shows it as a Part No. 63-5058. It *is* different from the one used in 16K20 and others. Someone seems to have been doing a bit of tube-swapping. The sync separator, etc. tube in this chassis should be a 6HS8. Base-interchangeable with 6BU8. VDR feeds voltage to the 6HS8 control grid, coming from the 6GN8 screen grid. R-E

next month

SEPTEMBER 1974

■ **Put The Time On Your TV Screen**

If you've got an electronic digital clock that has a BCD output, you can put that time, in numbers, on the screen of almost any TV. Build this Don Lancaster circuit and add it to your set.

■ **40 COSMOS IC Projects**

First installment in a new series of articles. They will show how this new family of micropower IC's work and will then go on to give you 40 circuits to build and use.

■ **New Opportunities For Technicians**

There's a lot more than TV sets that need the ministrations of an electronics service technician. Just take a look at this total world of electronic repairs and got in on some of those service dollars.

■ **Build An IC Op-Amp Tester**

It's a simple device and it does test IC op-amps quickly and accurately. It can double as an IC breadboard too.

■ **What Is An RAM?**

Random Access Memory, of course. You knew that! But here's your chance to find out how these IC's work.

PLUS:
Appliance Clinic
Jack Darr's Service Clinic
Equipment Reports
Step-By-Step Troubleshooting
R-E's Transistor Replacement Guide

try this

CONNECTORS GALORE

Snap-on battery connectors for TV, radio and loudspeaker use can be had by saving exhausted 9V dry batteries. Break them apart and save the snap-on connector heads which are mounted on plastic strips with pigtails attached. Each transistor battery has a male and female connector. These can be paired with another set for extensions, testing purposes or experimentation. — *Glen F. Stillwell*

TOPLESS

Do you have a coffee can full of miscellaneous nuts, bolts, and washers in your work area? Ever notice that the particular piece of hardware you want is *always* on the bottom? Well, why not have a can with two bottoms . . . one of which is always going to be up? Take one of the new one-pound

coffee cans with a plastic reusable lid, cut out both metal ends, obtain a second lid from another can, and install a plastic lid over each end as covers. Presto . . . less digging and dumping of the can on the bench. — *Kent Mitchell, W3WTO*

HEAT SHRINKABLE TUBING ELIMINATES SHOCK HAZARD

It's easy to make up tests leads when the wire is secured in the plug or test prod by a set screw, but this means that whatever voltage you plug into is waiting there, on the screw hidden in the insulator, for your fingers! A small piece of

¼-inch heat shrinkable tubing around the plug's insulator over the exposed screw will eliminate this shock hazard and yet let you, later, remove the tubing and reuse the plug again. Use different colors of tubing and you will also color code your test lead sets. — *Gene Cabot* R-E

Build it yourself!

Build this exciting color TV as part of Bell & Howell Schools' fascinating learn-at-home program employing digital electronics!

Digital clock that flashes on the screen!

Channel numbers that flash on the screen!

Automatic pre-set channel selector!

Simulated TV picture

"Electro-Lab" is a registered trademark of the Bell & Howell Company.

Simulated TV picture

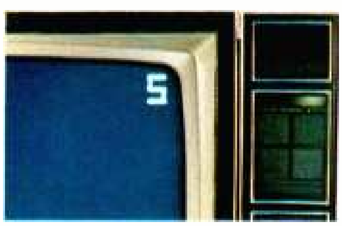
You get valuable "hands on" experience right from the very start . . . it makes learning faster and all the more enjoyable!

Digital electronics is a fascinating world to explore! It's an expanding technology that's changing not only our clocks, wristwatches and pocket calculators, but now, color TV!

By building Bell & Howell's big-screen color TV with digital features, you'll learn about this exciting field first hand. And you'll take special pride in this remarkable TV because you built it yourself!

You work with a color TV that's ahead of its time . . . and learn about these exciting features:

Digital channel numbers that flash on the screen



Press the instant-on button and the channel number flashes big and clear, right on the screen – and stays there as long as you want!

Automatic pre-set channel selector

Just a push of the forward or reverse channel buttons and instantly the VHF and UHF channels come on in a pre-set sequence. All "dead" channels are skipped over.

Digital clock that flashes on screen

With just the push of a button, this TV tells the correct time. The hours, minutes and seconds appear in clear, easy-to-read digital numbers.

You need no prior electronics background . . . we help you every step of the way!

We start you off with the basics and help you work your way up, one step at a time.

With your first lesson, you'll receive a special Lab Starter Kit that aids your understanding of electronics fundamentals . . . gives you immediate "hands on" experience. If there's a "snag," call one of our expert instructors toll-free. You can also talk shop with instructors and fellow students at our "help-sessions" scheduled in 50 cities at various times throughout the year.

Perform fascinating experiments with the exclusive Electro-Lab® electronics training system. It's yours to build.

Your program includes professional testing equipment to give you valuable "hands on" experience. You'll build and use a *digital multimeter*, a *solid-state oscilloscope* with "triggered sweep," and a modular *design console*. You will have the most up-to-date tools of the trade, including instruments you can use professionally after you finish the program.

The valuable skills you learn in digital electronics could lead to new income opportunities, full or part-time . . . perhaps a business of your own!

Once you've completed this learn-at-home program, you'll have the skills to service color TV's, plus repair a variety of home electronics equipment.

While many of our students do not ask for employment assistance, it is available. Of course, no assurance of income opportunities can be offered. No better or more practical at-home training in electronics is available anywhere!

Mail the postage-free card today!

This Bell & Howell Schools' program is approved by the state approval agency for Veterans' Benefits. Please check the appropriate box on the card for free information.

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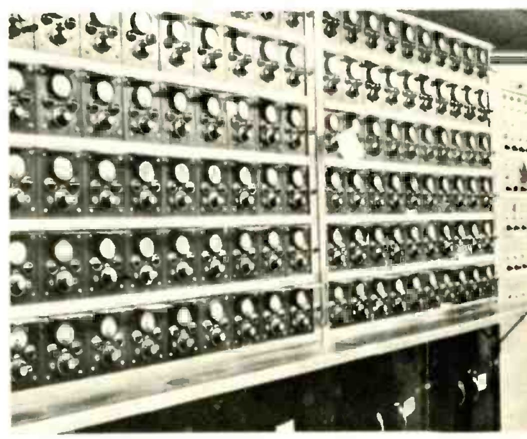
664R1

SECURITY INSTALLATIONS
(continued from page 35)

comers to the security field. "Don't think you can run out and paste a few strips of foil on a window and plug in an ultrasonic detector and call it a protection system. There's a lot more to it. You'll have a big investment of time, effort, and money before you can put systems together right.

"You'll have to learn to lay foil neatly and so it really does protect. You'll need know what's meant by supervised door and window switching You'll have to recognize which situations are best served by wired protection; by spot protection; by motion sensing with low-frequency sonic, high- frequency sonic, ultrasonic, and microwave equipment. There's a lot to it. You're just not going to learn in a few weeks of throwing installations in, or even a year."

The national security companies echo Bowman's cautions and add some advice. An official of the Automatic Fire Alarm Association points out that small operators flounder from lack of financial backing, business acumen, and technical knowledge. Some fail because they install equipment that hasn't been sufficiently field-tested; when equipment can't do the job, or a marginal equipment-maker goes under, guess who's left holding the bag.



False alarms generated by poor systems, no matter where the fault lies, give the entire industry a black eye. The problem has driven some cities to consider legislation outlawing alarms that call police or fire departments directly. Committees of national associations (includng some law enforcement and fire fighter groups) are working to draft a "model statute" for cities, counties, or states that decide to regulate alarm companies. The hope within the industry is to keep such laws from becoming overrestrictive.

But almost all agree that the problem of false alarms must be dealt with one way or another. Industry spokesmen feel such laws should require some level of proven expertise, perhaps by licensing installers or security companies. Regulations might logically designate quality for equipment and set standards for installations. Large cities such as Los Angeles already have statutes in the works. Texas plans statewide regulation of the alarm business.

Where from here?

The burglar and fire protection business may get tougher. It's already no snap. One Midwest survey disclosed that barely half the alarm companies in business four years ago have remained open. Of companies in business at the start of this year (1974), 15% are defunct at this writing. Consider well before you launch into this enterprise.

One partial answer to the false-alarm problem lies in central monitoring. That is, instead of signaling police or fire department directly, the alarm goes by leased telephone line to a central sensing board owned by the security firm. Company personnel check out the alarm and alert authorities. If the alarm is real, the proper authorities respond and the owner is notified.

Guaradian Alarm Co., Inc. is headed in that direction. "It's for better service to our customers, though, not to circumvent false alarm problems," Bowman points out. "We won't be sending out investigators, but will notify police or fire departments directly. Through a central monitor, our customers can be more certain of continuous surveillance and dependable response to any alarms that do occur."

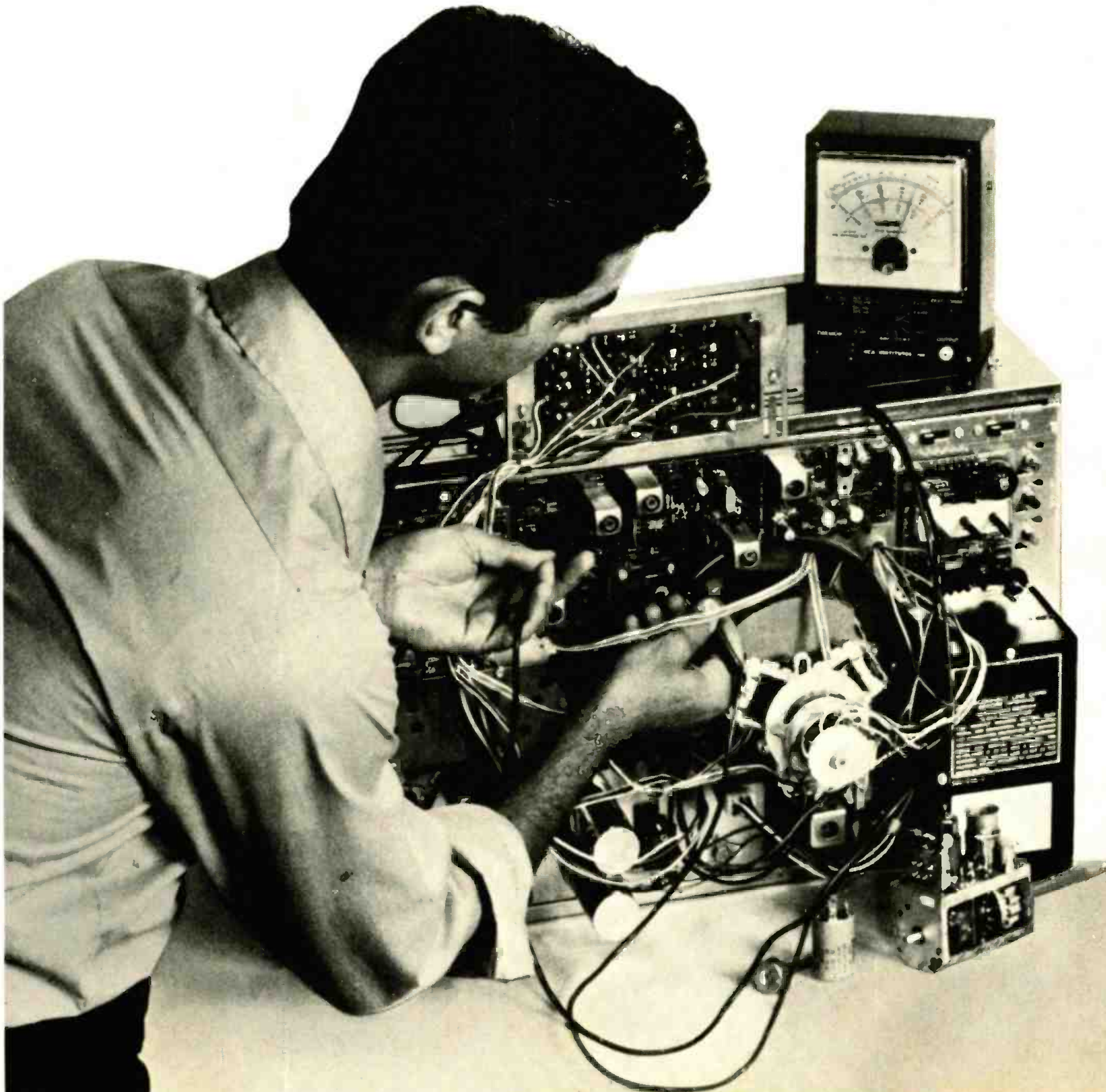
CENTRAL MONITORING SERVICE KEEPS TABS ON ALARMS in customers' premises via leased direct telephone lines. Constantly checks condition of each security system as well as reporting an intrusion or fire. Monitoring service appeals mainly to commercial business clients, seldom to residential alarm users.

A central monitoring system is in no way a necessity for anyone entering the security business. It's very, very costly to install and operate. But a company that has grown to that size and financial stability can be considered in the business for real.

That's about the way the burglary and fire protection field adds up today. Bowman advises the average electronics man to go into the TV business or "something else easy." But for the above-average guy . . . well, he just might have a chance selling and installing alarms. **R-E**

Why a Sylvania home training program may be

your best investment for a rewarding career in electronics



1 LEADER IN ELECTRONICS TRAINING

Over the years, Sylvania Resident Schools have trained thousands of men and women for key positions in the electronics field. Now, through Sylvania Home Training, you can receive the same high-quality career training at home. In your spare time. While you hold your present job. Remember, this training is designed with one purpose in mind — to give you the background you need to land the electronics job you really want!

2 AUTOTEXT TEACHES YOU ELECTRONICS RAPIDLY, EASILY.

AUTOTEXT, offered exclusively by Sylvania, is the proven step-by-step method of home training that can help you learn the basics of electronics quickly and easily.

3 CASSETTE SYSTEM

This innovative learning-by-hearing approach is a special option that adds an extra dimension to AUTOTEXT. It's almost like having an instructor in your own home. As you play the cassette tapes, you'll have an instructor guiding you through your AUTOTEXT lessons. Explaining the material as you read it. Going over schematics with you, reinforcing the basic electricity and electronics study materials with you. Everything you need to know to get you started towards a highly regarded position as an electronics technician — all in an easy-to-understand, conversational tone.

4 SPECIALIZED ADVANCED TRAINING

For those already working in electronics or with previous training, Sylvania offers advanced courses. You can start on a higher level without wasting time on work you already know.

5 PERSONAL SUPERVISION THROUGHOUT

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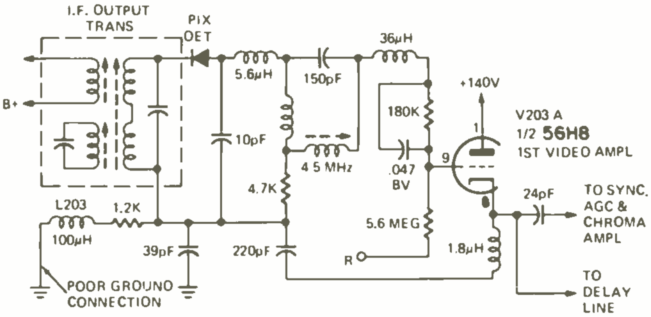
technotes

INTERMITTENT NEGATIVE PICTURE

After 15 minutes the picture on an RCA CTC22 color chassis would cut out, pull horizontal and vertically and then go negative. When the set operated for over an hour the picture would return to normal. Tube replacement and voltage measurements did not solve the intermittent picture.



The picture would act up when pushing around upon the circuit board. A poor ground connection was found at one end of L203.—*Homer L. Davidson*

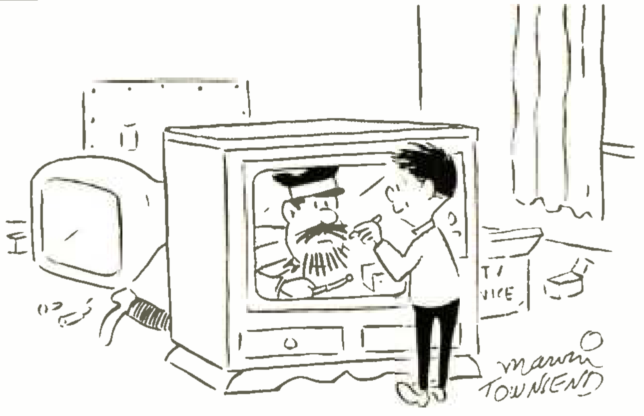
HOT-SPOT CIRCUIT TROUBLE-SHOOTING

All service technicians are familiar with circuit-cooler sprays which help locate faulty parts by cooling them to normal temperature and thus restoring normal circuit operation. Circuit coolers won't help much if the set only acts up with the cabinet on, but operates normally uncovered.

One easy answer is to wrap ⅛-inch diameter copper tubing on the barrel of a 100-watt soldering iron and then flow air through the tubing. By varying the soldering iron temperature with a variable transformer, you can govern the air temperature. With the air flow rate set so only a small area is heated in the set, it is possible to heat individual components in the trouble area until the faulty unit is located. — *Ralph Tenny*

HEATHKIT GR-371MX

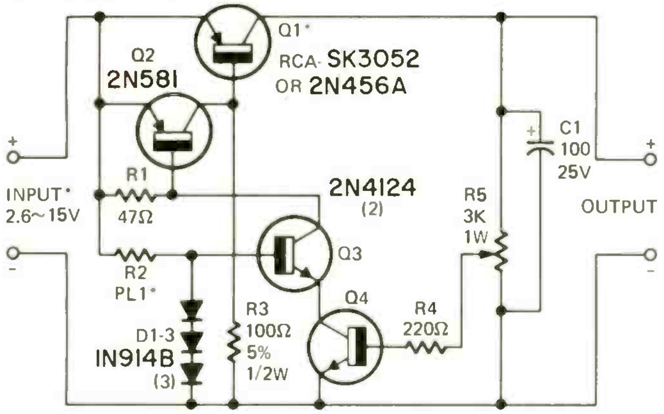
The symptom was a bright *vertical* line. The owner was stumped because his trouble-shooting manual doesn't cover this condition. The problem was traced to a broken connection at the horizontal yoke. After making the repair, a plastic cable tie was installed as shown to prevent recurrence. — *Donald R. Hicke* R-E



circuits

MUSCULAR LOW-VOLTAGE HIGH-CURRENT REGULATOR

Need a regulator with up to 5 amps capacity with less than 25 millivolts output variation for low voltages? I did, and here's the circuit I developed to regulate the heater of a touchy, hazardous-gas sensing device — I needed precisely 1.1 volts at 500 MA. The regulator shown uses two RCA entertainment-replacement type germanium transistors, and holds its output constant to within 10 millivolts of whatever it is set at from 2.6 to 5 volts input (assuming an output of 1 to 2 volts). Its operating range is actually from 2.6 to 24 volts at 7 amps maximum if the series transistor (Q1) is a 2N456A on an adequate heat radiator, and R2 is replaced by a 28-volt-lamp, type 1764.



*SEE TEXT

NOTE: IF PL1 IS USED, INSERT A TYPE 1764, 28V, 40mA LAMP.

Here's how it works: Pass transistor Q1 is connected with the output load on its collector. Q2 shunts Q1 base and emitter, controlling Q1 operating current. Sensing transistor Q4 amplifies any output voltage variation and causes common-base-connected Q3 to draw more or less current via R1 and Q2 emitter-base diode. If Q3 draws more current than established by reference diodes D1—D3, Q2 also draws more collector current, causing Q1 to pass less collector current to the load. If the output drops so that cascode-coupled transistors Q3 and Q4 draw less current, Q2 conduction drops, allowing Q1 base bias to increase, and Q1 draws more current through the load, reestablishing the output level.

Regulator output load variations are bypassed to some extent by C1 so that the regulator will not oscillate. The three 1N914-B diodes are operated in a partially-saturated mode and provide a very good reference for Q3. Using the pilot lamp in place of R2 limits both diode and Q3 base current to safe values at higher input levels, and, if better regulation is required at any input level between 2.6 and 10 volts, use of the lamp brings the output's variation below 5 millivolts shift for every 1-volt input shift. Excluding power transformer, rectifier and filter capacitor, the circuit shown here can be built for less than $10.00. — *L.E. Geisler* **R-E**

NEXT MONTH

The electonic service technician is **not** a vanishing breed. There's more for him to fix than ever before. In the September issue **Radio-Electronics** looks at the potential. Don't miss this special report.

VIDEO DISCS

(continued from page 44)

The playback system scans the recording with laser light through lenses in the revolving-disc scanning system. The record needn't even be round—since it doesn't spin—but merely a flat piece of film placed in a slot. The recreated digital program data is fed to a digital-to-analog converter for restoration to TV-signal format. Digital's aim is a $200 player.

RCA electrostatic-capacitance system

RCA has been heavily involved in videodisc development since the mid-1960's, probably longer than any other company. Its efforts have been in a different direction—toward a needle-in-groove videoplayer which looks and operates as much like a standard phonograph as possible. Part of the family of "SelectaVision" devices, RCA's system uses a rigid 12-inch plastic record which is metallized on one side. It is scanned by a metallic-element pickup. The plastic layer of the disc is, in effect, the dielectric of a capacitor (or group of capacitors) with the metallic layer one plate and the pickup the other. The television picture information is stored in the disc as a series of varying capacitances.

The 12-inch RCA disc revolves at 450 rpm and plays for up to 30 minutes. RCA has announced no timetable for commercialization, but it's understood the system is nearly ready for production engineering.

MDR magnetic system

This is the only disc system announced so far which is designed for home recording and therefore is more aptly described as a substitute for a VTR than as a home playback device. MDR, which stands for magnetic disc recorder, is the invention of audio record manufacturing engineer Erich Rabe of Nuernber, Germany, in collaboration with recording-head maker Wolfgang Bogen Co. of West Berlin.

The 12-inch MDR disc is divided into two sections. The outer half is coated with a smooth magnetic material (chromium dioxide is currently being used). The center section looks like a conventional small phonograph record. The player used in recent demonstrations was a modified Dual turntable geared up to play at 156 rpm to twice the 78-rpm speed. The pickup head, which rides on the outside section of the disc, is modified with a sort of outrigger attachment containing a sapphire stylus which rides in the grooved center disc to guide the magnetic outer head in a spiral path.

The heart of the system is a magnetic recording-playback head with a gap of 50 μm, providing extremely high information-storage capacity on the magnetic portion of the disc. A low-noise preamp is mounted in the pickup housing. Although the system currently records at 156 rpm, its developers think new magnetic materials and further head refinement will provide up to 15 minutes of color programming on each side of the record at 78 rpm. The player is targeted to sell for less than $400, blank discs $5 to $6 each.

That's the current starting line in the Great Videodisc Derby. One or two, or perhaps three, could finish in the money. Or the winner could be a dark horse not even in this lineup. Although most of the systems are "targeted" for production next year, don't hold your breath. Many of them had 1974 targets last year. Don't take the target prices too seriously either. Costs—particularly of new and untried products—have a way of creeping up.

But it does now appear that some form of video-on-demand system—most likely a disc player—will soon be on the way to American homes. **R-E**

MDR MAGNETIC VIDEODISC player looks very much like a conventional audio record player; but, of course, it isn't.

Electronics helps blind to pour coffee safely

A little device that may be more important than it looks is the electronic liquid level sensor made to hang on the side of a coffee cup or other liquid container. It was invented at the General Electric Research and Development Center, Schnectady, by Dr. Richard W. Roberts—now Director of the Bureau of Standards — and George Jernakoff, GE project engineer.

The battery operated liquid level detector, which looks a little like a lapel microphone buzzes when the beverage rises to a half inch from the brim. General Electric does not intend to make or market it, but offers a free license to any responsible firm who may wish to do so.

The creative minds of the inventors and their friends already have turned up a new and unplanned use of the sensor — alcohol testing. Most liquids are conductors of electricity, but pure alcohol is not. Thus, the stronger the alcoholic content of a beverage, the weaker the buzz emitted by the liquid level detector. •

OTL DESIGN

(continued from page 51)

ment should be used for both halves of the circuit. The two arrangements are shown in Fig. 8.

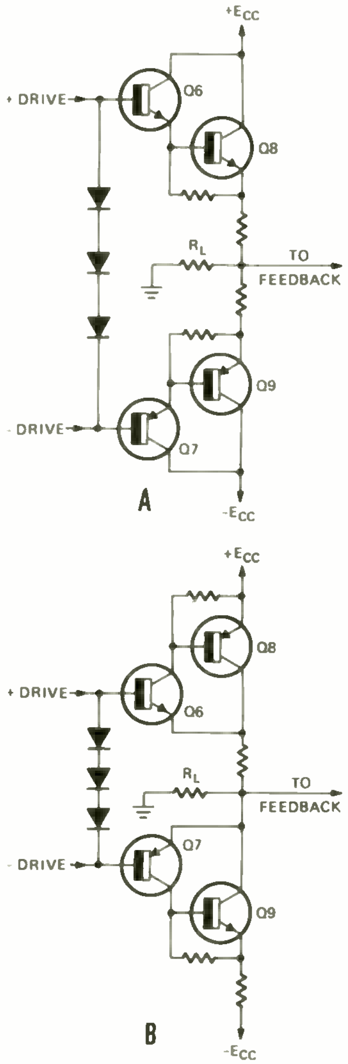


FIG. 8—TWO OUTPUT CIRCUITS used to replace the transistor counterparts in Fig. 5. a—A dual Darlington. b—A dual beta multiplier.

Either circuit can be substituted directly into any of the quasi-complementary arrangements. Either circuit can be used to replace transistors Q6 through Q8 in the arrangement discussed with respect to Fig. 5. Design requirements are not unlike those described above.

Protecting the output devices

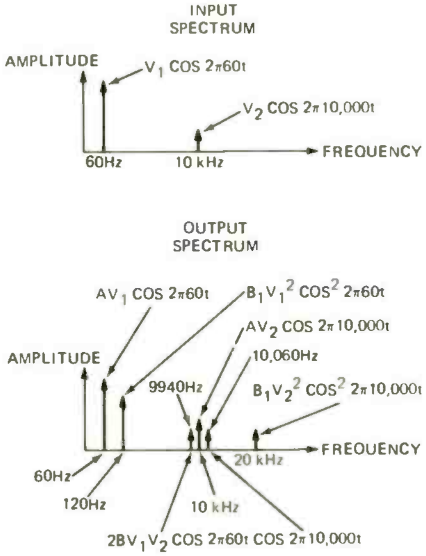
The output transistor can be easily destroyed due to overdissipation. A short at the output is a common cause of this. Various methods have been devised to protect the devices without deteriorating the performance. These circuits will be discussed in a future article. **R-E**

DID YOU MISS?

If you like this story on OTL amplifier design, you will also want to read Len Feldman's report on a new pay TV system that offers high-fidelity stereo sound. The story starts on page 45.

(continued from page 59)

order and a parabolic or second order component shape in the detector characteristic. Fig. 6 shows that the 60 Hz and 10-KHz signals interact to give frequency components at 60 Hz, 120 Hz, 20 KHz and an AM modulated 10-KHz signal. The depth of modulation of the AM signal is equal to the intermodulation distortion. The 60-Hz and 120-Hz terms are the normal S-curve components. For those interested the generation of these products are shown mathematically in Fig. 6. This explanation is somewhat simplified but essentially correct because the 60-Hz waveform used is not truely a



$$E_o = AE_m + BE_m^2$$

$$E_m = V_1 \cos 2\pi 60t + V_2 \cos 2\pi 10{,}000t$$

$$E_o = AV_1 \cos 2\pi 60t + AV_2 \cos 2\pi 10{,}000t + B_1V_1^2 \cos^2 2\pi 60t + B_1V_2^2 \cos^2 2\pi 10{,}000t + 2BV_1V_2 \cos 2\pi 60t \cos 2\pi 10{,}000t$$

FIG. 6

sine, but is sawtooth shaped with its own series of initial harmonics.

As suggested above, a built in active bandpass filter is used to discard the unwanted products from the detected baseband leaving only the desired 10-KHz intermodulation product and the 10-KHz linear term. This cross product is now displayed as in Fig. 7. It differs from the theoretical slope plots of Figs. 4 and 5 in

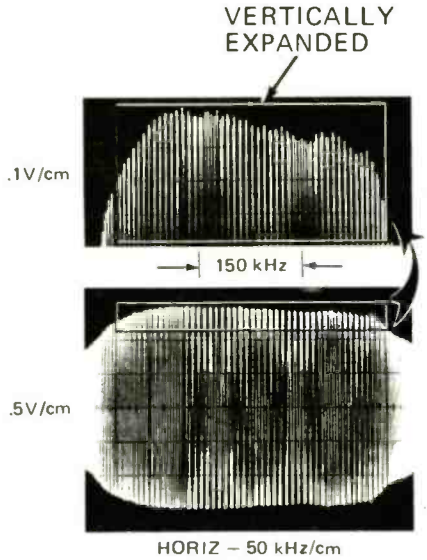


FIG. 7

that due to the 10-KHz modulation technique that produces it the display has both positive and negative excursions as opposed to the relatively constant positively oriented theoretical display. You can simply observe one half of the display, for example the top half and only consider the voltage variation of the signal peaks.

The oscilloscope gain can be increased to permit a more accurate determination of the p/p expanded envelope variation in the top of the pattern to be able to use the relationship:

(continued on page 96)

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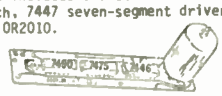

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74H51	.35
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☐ SLA-1*	.33 h.	Opcoa

* Pin-for-pin MAN-1. ** Pin-for-pin MAN-4, elec. char. same

9 "MINI" DIGITS ON A SUBSTRATE Only $6.95

☐ 3 for $18

With spec sheets

Made by ANTEX No. DA1099. This Numarray is a GAASP numeric LED DISPLAY designed for calculators, miniature equipment — it's the latest in calculator construction. MEASURES ONLY: ¾ x 2⅜ x 1/32" on a ceramic substrate. Internally multiplexed, providing 8 .110 character digits each with its own decimal point and an extra-digit located in left hand position displaying a minus sign or overflow. All anode segments of each digit are connected in parallel reducing number of connections to 17 for a 9-digit display. Each digit contains its own BUBBLE MAGNIFIER! MAX. SPECS: 80mw, 10 mils per segment, 3 volts, brightness 125-ft.L. With spec sheet.

"AEROSPACE" BABCOCK & LEACH CRYSTAL CAN RELAYS

All hermetically sealed. Submini, 1/6, half, and full crystal can types in 6-12-24V in asst contacts up to 4PDT, 1 amp up 10 amps. Such types as BR40, 41, 10, 44, 16, 24, etc.

☐ **12 for $3.50**

Sorry, no choosing voltages or types. From factory mixtures . . . to you! Good asst, if you are space-minded, at low prices.

KRONOS WITH "TIME BASE"*

Cabinet is 6" x 5½" x 6".

$39 Any Type Clock less time-base — NEW FOR 1974!

• with TIME BASE **$54.95**

CHOOSE YOUR READOUT

☐ Type	LED	Charac.
☐ KR-101	MAN-3	.12
☐ KR-103	MAN-4	.19
☐ KR-105	707†	.33
☐ KR-106	704†	.33
☐ KR-107	SLA-1†	.33
☐ KR-108	Same as SLA-1 but GREEN, add $12.	

• 12 or 24-hr clock

† "MAN" LED readouts are "all LEDs" but the Litronix 707 and Opcoa SLA-1, like the MAN-1, are of the reflective bar segment technique. the 704 is the reflective bar version of the MAN-4.

- Now two clocks in one!
- For 12VDC* 110VAC!
- Now adaptable to boats, planes & cars too!
- One price for any LED!
- The only clock of its kind in USA today!
- Compare and see!

Scientific Devices introduces the new any LED Kronos digital clock. That's right, you can choose the "ALL-LED" Man-1, Man-3, and Man-4, and the new reflective bar types with the larger digits, at only one price, $39. This is a Scientific Device first! We even hav the GREEN LED readouts at a slightly extra cost. We have more . . . for $19.95 we have available as an (*) extra option to Naval Observatory your clock, or making it an all-purpose all-duty unit. For indoor and outdoor activity. This "TIME BASE" is the simplest on the market today with the help of one of the largest time base manufacturers for the famous digital wrist watches. Therefore, current drain is negligible, not like other cumbersome types. It's easy to construct, easy to slip into the Kronos of your choice and connect with easy instructions. Its overall design is simple and easy to construct. The kit is complete with famous black-and-white TEN-TEC cabinet, plus all accessories with booklets. Features include 3 setting controls, 1-hour per second, 1-minute per second, and hold button. KR100 series is a Scientific Device exclusive!

CRYSTAL TIME BASE FOR ANY KRONOS*

☐ **$19.95**

Includes precision crystal, time-base IC, pc board & accessories with info.

WRIST WATCH LIQUID CRYSTAL DISPLAY

Only ☐ **$19.95**

- *3-1/2 digit. 7 segment
- *Only 1-1/16 x 11/16 x 1/4"

See POPULAR ELECTRONICS (Jan., 1974) for building your own electronic digital wristwatch using the Liquid Crystal Display (LCD) as its basic. Easy to see. 3½ digit display, requires less than 1/1000 of power as LED'S. Visibility increases with ambient light. Difficult reading of LED'S in light. Pulsates SECONDS in center of display. NO NEED OF TRANSISTOR-RESISTOR interface, as LED'S, thus smaller package. Chip contains holder, tiny connecting terminals, and "slide-in-place chrome spring face plate". Size of display in holder: 1-1/16 x 11/16 x ¼". Operating freq. 32 hertz. 45-microwatts of power. Operates from 1.5V hearing aid cell. Uses the new and latest C MOS micro-circuitry. We include copy of write up from PE magazine.

Calculator Basics

MAKE YOUR OWN CALCULATORS WITH OUR LOW PRICED

☐ **6 & 8 DIGIT POCKET CALCULATOR BASIC KITS** Your Choice **$16.95**

BASIC KIT #1 — includes case, all-function Flex Key Keyboard, Cal Tech CT5002 calculator chip, 9-digit Antex LED display with built-on individual magnifiers, plus sheets.

BASIC KIT #2 — same as Basic #1 except calculator chip is National 8-digit MM5725.

BASIC KIT #3 — same as Basic #1 except calculator chip is National 6-digit MM5736 and 75492.

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MUX'D DIGITAL CLOCK PC BOARD

Your choice **$2.50**

- ☐ MAN-1 ☐ Litronics 707 (MAN-1*)
- ☐ MAN-3 ☐ Litronics 704 (MAN-4**)
- ☐ MAN-4 ☐ Opcoa SLA-1 (MAN-1*)
- ☐ 6-MAN-3A's for above board. $6.00

* Elec char. same as MAN-1 or 4.

Each board properly multiplexed for 6 digits, to hold MAN-1's, MAN-3's, MAN-4's, Litronics 707 (MAN-1) and 704 (MAN-4), and Opcoa's SLA-1 (MAN-1). Board 6⅞" long with spec sheets.

LOWEST PRICES ON NATIONAL "CALCULATOR CHIPS"

CALCULATOR CHIPS ON A "DIP"

☐ CT5001	12-Digits, 40 Pin	$6.50	3 for $18.
☐ CT5002	9-Volt version of 5001	8.50	3 for $24.
☐ CT5005	12-Digits, 28-Pin with 3-function memory.	9.95	3 for $27.
☐ MM5725	8-Digits, 4-Funct. LED	6.95	3 for $18.
☐ MM5736	6-Digits, 28-Pin, 9V	4.95	3 for $12.

Similar to Mostek 5001. Outperforms Texas 8-digit TM1802. A 40-pin DIP. Adds, multiplies, subtracts, and divides. Use with 7-segment readouts, Nixies, and LED's. DATA SHEETS.

PLASTIC VOLTAGE REGULATORS

*TO-136 Package

Buy 3 — Take 10%

☐ L-129	5V	600ma	$2.10
☐ L-130	12V	500ma	2.10
☐ L-131	15V	450ma	2.10

POCKET CALCULATOR KEYBOARD

For hand-held units, properly multiplexed for chip CT-5001, 2, 12 or Mostek 5010-12. 18 feather-touch keys, by FLEX-KEY.

☐ Only **$6.95** 3 for $18.

OAK FEATHER-TOUCH SWITCHES

4 for $1 **29¢ ea**

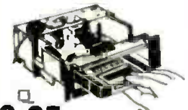
- *For RTTY
- *Printed Circuits
- *For Unique Panel Switches

Mfd. by OAK (Ham's note, RTTY, too) data systems, same as used in Keyboard Calculator, SPST. Normally Open, 24V 1 amp contacts. Characters and letters easily changed. ⅜" high. Printed circuit.

†Blue top, white characters. •White top, black numbers.

NO.	
☐ 0•	☐ 8•
☐ 1•	☐ 9•
☐ 2•	☐ CE†
☐ 3•	☐ CL†
☐ 4•	☐ −†
☐ 5•	☐ + =†
☐ 6•	☐ ÷†
☐ 7•	☐ ×†
	☐ ••

8-TRACK CAR RADIO STEREO TAPE TRANSPORT



☐ **9.95** 3 for $27

8-Track tape transport with complete stereo playback system less audio amplifier. Operates off 12 VDC Wow & flutter proof. Use 739 preamp & ready to go. Uses 8-track tape. Wt. 3-lbs.

CALCULATOR KEYBOARD SWITCH KITS

☐ **Kit of 17 for $3.95**

☐ 10-pc. kit, 0-to-9 only same type as above. **2.50**

Each switch made by Oak #415, SPST normally open, 24V 1 amp contacts. Kit includes 0-to-9 (10 switches white with black numerals) decimal, white with black dot, and CE, CL and 4 functions blue with white characters.

CLOCK CHIPS ON A "DIP" as low as 8.88 WITH DATA SHEETS

☐ MM5311	6-digit	28-Pin	$ 8.88
☐ MM5312	4-digit	24-Pin	8.88
☐ MM5313	6-digit	28-Pin	8.88
☐ MM5314	6-digit	24-Pin	8.88
☐ MM5316	4-digit	40-Pin, Alarm	12.50

☐ 1-MM5316, DIGITAL ALARM CLOCK FACTORY FALLOUT — $1.49 EA

FIRST TIME ANYWHERE!

SCRS! TRIACS! QUADRACS! SAME PRICE SALE!

10-Amp Power Tab Plastic Units

PRV	Sale
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☐ 100	.95
☐ 200	1.25
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4-FUNCTION MEMORY "CALCULATOR KIT" ☐

Pocket type, the lowest price 4-function memory with all arithmetic. Complete with all parts, instruction booklet.

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Terms: add postage **Rated:** net 30
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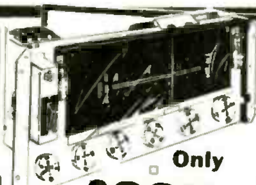
20-WATT STEREO AMP

Featuring solid state circuitry throughout, with printed circuit construction. 10 watts "peak" audio power per channel. Handsome walnut veneer grain with chrome trim escutcheon. With provisions for separate escutcheon mounting items as STEREO HEADPHONES, TREBLE, BASS, BALANCE, VOLUME controls, separate PHONO AND AUXILLIARY with separate OFF-ON POWER switches. Chassis size 11½ x 3 x 2". Separate rear plate has right and left speaker phono type jacks, with convenience power outlet for tape of phono and Auxilliary Inputs, for using amplifier with tape decks, and other equipment. Separate external cables for stereo phono connections, 6-ft. power cord, separate ON-OFF light indicator, and automatic turntable power plug with handsome set of knobs. Wt. 2 lbs. **16.95**



☐ Only **$39.95**

20-WATT STEREO AM-FM-MULTIPLEX

- 20-watt Solid State Amplifier!
- All Solid State, Printed Circuitry
- Slide Rule Dial
- All Purpose, All Family System!

WITH GLASS ESCUTCHEON

The most unusual HI-FI stereo buy of 1974. A unit that has so many unique and different functions, makes it the finest system of its kind at the usual Poly Pak economy prices. Features: built-in FM antenna, record player jacks on separate panel. Another external panel consists of provisions for "right" and "left" speaker jacks, for external FM ground, jacks for connecting a tape recorder to radio tuner or phono of systems to record. Lower inputs for connecting tape deck that will play back thru the internal amplifier for systems. Includes red indicator on front panel for STEREO indicator. Another jack for plugging in a pair of stereo headphones.

Has the following controls on front panel, PHONO-STEREO-AM-FM, MONO, FM STEREO, TAPE, master control switch. LOUDNESS, BALANCE, TREBLE, BASS controls, with power ON-OFF rocker switch. Designed for all audio-philes to use as wall unit in DEN or FAMILY ROOM, or control unit by easy chair in family room, or for those who wish to design their own console or modular system. With 6 ft. 115 VAC cord and plug. Only 13 x 7 x 3½, plus diagram. Shpg. wt. 3 lbs. With knobs.

60-WATT AM-FM-MULTIPLEX

☐ Same as above except amplifier heavy-duty stereo 60 watt unit. . . . $59.95 ☐ **$59.95**

☐ **$14.95**
☐ Same as Item #1 except reject, parts may be missing.

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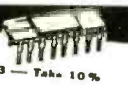

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10-AMP PLASTIC "POWER TAB" SCR'S

PRV	Sale
☐ 50	$.75
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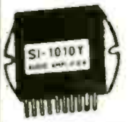
HIGH POWER TRANSISTOR WITH HEAT SINK

☐ **$1.49** 3 for $3

Removed from new equipment! Includes popular 2N174 'doorknob' transistor TO-36, germanium PNP. 150 watts. VCBO 80V, 15 amps, 40 hfe. For ignition, high power transmitters, etc. Mounted on heat sink 5 x 2¼ x 1¼".

BRAND NEW LOWEST PRICES
GENERAL ELECTRIC 3-WATT AUDIO AMP
3 FOR $6.00 ☐ **$2.50**

Delivers 3.5 watts continuous, 10 watts peak, with heat sinks; micro-mini size: ¾ x ½ x ½". 9 to 30V supply. High sensitivity. 8 to 16 ohms.



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Mfgr's Type	Watts	Sale
☐ SI-1010Y	10	$ 8.88
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Used extensively in hi-fi systems, tape decks, FM tuners, record players, stereo components, musical instruments, P.A., etc. All amplifiers, flat within ½ db from hz to 100,000. Each unit properly heat-sinked, with heavy-duty connecting tie lug connections. Single-ended pushpull output. Power supply required 24VDC. Output to 8 ohms. Order by Stock No.

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- ☐ 2 – MOS FETS, DUAL GATE, N chan. 3N187, TO-18, RCA $1.
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- ☐ 2-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red $1.
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- ☐ 10—FAIRCHILD-NATIONAL, 9000 Series ICs, dips, hobby $1.

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☐ LM-305	Pos. voltage Reg. TO-5	1.19
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☐ LM-309K	5V Volt.-Reg. 1 Amp TO-3	1.85
☐ LM-310	Voltage-Follower TO-5	1.25
☐ LM-311	Hi-perf. Volt. Comp. (A)	1.19
☐ LM-319	Hi-speed Dual Comp. DIP	1.50
☐ LM-320	MINUS 5, 12 or 24V V.R. TO-3	1.50
☐ LM-339	Quad Comparator, DIP	2.50
☐ LM-324	Quad (4-741's in DIP)	2.50
☐ LM-350	Dual peripheral driver	.41
☐ LM-370	AGC Squelch op amp, TO-5	1.19
☐ LM-373	AM-FM SSB I.A.D, TO-5	3.50
☐ LM-374	AM-FM SS IVAD TO-5	3.50
☐ LM-377	Dual 2-watt audio amp	3.00
☐ LM-380	2-watt audio amplifier TO-5	1.69
☐ LM-381	Low noise dual pre amp DIP	1.95
☐ LM-382	Low noise dual pre amp DIP	1.95
☐ LM-703	RF-IF amp, TO-5	.55
☐ LM-709	Operational amplifier (A)	.36
☐ LM-710	Differential amplifier (A)	.45
☐ LM-711	Dual Differential Amp (A)	.36
☐ LM-723	Voltage Regulator (A)	.69
☐ LM-725	Instrument Op Amp	.95
☐ LM-733	Differential Video	1.75
☐ LM-741	Freq. Comp. 709 (A)	.41
☐ LM-741CV	Mini DIP 741C	.45
☐ LM-747	Dual 741 (A)	.89
☐ LM-748	Freq. adjustable 741C (A)	.44
☐ LM-1303	Stereo pre amp DIP	.95
☐ LM-1304	FM Stereo Multiplexer	1.25
☐ LM-1307	FM Multi. Stereo Dem. DIP	.91
☐ LM-3028	Differential RF/IF amp	1.50
☐ LM-3900	Quad "current mirror" amp	.95
☐ LM-4250C	Programable op amp	2.50
☐ LM-75451	Dual peripheral driver	.44
☐ LM-75453	Dual peripheral driver	.44
☐ LM-75492	Hex digit driver, 250ma, DIP	1.85

(A) TO-5, Dip or mini Dip

LINEAR Op Amps

• FACTORY GUARANTEED • FACTORY TESTED • FACTORY MARKED

☐ 531	Hi slew rate op-amp (TO-5)	$2.50
☐ 532	Micro power 741 (TO-5)	2.50
☐ 533	Micro power 709 (TO-5)	2.50
☐ 536	FET input op amp (TO-5)	2.95
☐ 550	Precision 723 voltage reg. (DIP)	1.17
☐ 555	Timer 2 u Seconds to 1-hr. (A)	1.25
☐ 556	5 Times faster than 741C	2.10
☐ 558	Dual 741 (DIP)	1.00
☐ 560	Phase lock loops (DIP)	2.95
☐ 561	Phase lock loops (DIP)	2.95
☐ 562	Phase lock loops (DIP)	2.95
☐ 565	Phase lock loops (A)	2.95
☐ 566	Function generator (TO-5)	2.95
☐ 567	Tone decoder (A)	2.95
☐ 702C	Hi-grain, DC amp (TO-5)	.49
☐ 704	TV sound IF system	1.50
☐ 711C	Dual diff. comp (A)	.33
☐ 723C	Voltage regulator (A)	.69
☐ 741CV	Freq. comp 709 (Mini DIP)	.44
☐ 748C	Freq. adj. 741C (A)	.44
☐ 753	Gain Block	1.75
☐ 739-739	Dual stereo preamp	1.98
☐ 741-741	Dual 741C (TO-5)	.89
☐ PA265	5-Watt voltage regulator	1.00
☐ ULN2300M	Op amp with SCR	1.00
☐ CA3065	Video Audio system	1.00
☐ RC4195	Dual 15V Tracking V.R.	2.50
☐ 4136	Quad 741's (DIP)	1.95
☐ RC-2556	Dual 555's	2.25

(A) TO-5 or DIP Buy any 3 — Take 10%

EXPERIMENTAL op amps

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☐ 300	5 for $1.	☐ 558	4 for $1.
☐ 301	10 for $1.	☐ 565	4 for $1.
☐ 307	10 for $1.	☐ 567	4 for $1.
☐ 308	5 for $1.	☐ 592	5 for $1.
☐ 309K	4 for $1.	☐ 703	5 for $1.
☐ 380	3 for $1.	☐ 709	10 for $1.
☐ 381	3 for $1.	☐ 710	10 for $1.
☐ 516	5 for $1.	☐ 711	10 for $1.
☐ 556	4 for $1.	☐ 723	5 for $1.
		☐ 733	5 for $1.
		☐ 741	5 for $1.

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☐ SN7401	.30	☐ SN7437	.55	☐ SN7472	.50	☐ SN74112	.95	☐ SN74161	1.75
☐ SN7402	.30	☐ SN7438	.55	☐ SN7473	.55	☐ SN74113	.95	☐ SN74163	1.95
☐ SN7403	.30	☐ SN7440	.30	☐ SN7474	.55	☐ SN74114	.95	☐ SN74164	2.95
☐ SN7404	.35	☐ SN7441	1.40	☐ SN7475	1.00	☐ SN74121	.60	☐ SN74165	2.10
☐ SN7405	.35	☐ SN7442	1.50	☐ SN7476	.65	☐ SN74122	.95	☐ SN74166	2.08
☐ SN7406	.45	☐ SN7443	1.50	☐ SN7478	.95	☐ SN74123	1.20	☐ SN74173	2.50
☐ SN7407	.55	☐ SN7444	1.50	☐ SN7480	.65	☐ SN74125	.71	☐ SN74175	3.20
☐ SN7408	.35	☐ SN7445	1.50	☐ SN7481	1.25	☐ SN74126	.71	☐ SN74176	2.10
☐ SN7410	.30	☐ SN7446	1.65	☐ SN7482	.99	☐ SN74140	1.25	☐ SN74177	2.10
☐ SN7411	.35	☐ SN7447	1.45	☐ SN7483	1.25	☐ SN74141	1.95	☐ SN74180	1.20
☐ SN7413	.95	☐ SN7448	1.50	☐ SN7486	.55	☐ SN74145	1.55	☐ SN74181	3.95
☐ SN7416	.55	☐ SN7450	.30	☐ SN7489	3.50	☐ SN74148	4.50	☐ SN74182	1.20
☐ SN7420	.30	☐ SN7451	.30	☐ SN7490	1.49	☐ SN74150	1.61	☐ SN74185	2.50
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☐ SN7422	.35	☐ SN7455	.55	☐ SN7492	1.35	☐ SN74153	1.60	☐ SN74193	1.95
☐ SN7425	.50	☐ SN7462	.35	☐ SN7493	1.35	☐ SN74154	2.10	☐ SN74194	1.95
☐ SN7426	.55	☐ SN7464	.30	☐ SN7494	1.35	☐ SN74155	1.55	☐ SN74195	1.25
☐ SN7430	.30	☐ SN7465	.50	☐ SN7495	1.35	☐ SN74156	1.45	☐ SN74196	2.50
				☐ SN7496	1.35	☐ SN74157	1.55	☐ SN74197	2.80
				☐ SN74100	1.65	☐ SN74158	1.55	☐ SN74198	2.65
				☐ SN74107	.70			☐ SN74200	5.95

* "DIP" Packages

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☐ SN7441	5 for $1.	☐ SN74123	10 for $1.
☐ SN7442	5 for $1.	☐ SN74150	3 for $1.
☐ SN7444	5 for $1.	☐ SN74154	5 for $1.
☐ SN7445	5 for $1.	☐ SN74181	3 for $1.
☐ SN7446	5 for $1.	☐ SN74192	5 for $1.
☐ SN7447	5 for $1.	☐ SN74193	5 for $1.
☐ SN7448	5 for $1.	☐ SN74199	3 for $1.
☐ SN7472	10 for $1.		
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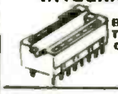

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Circle 83 on reader service card

SOUND TECHNOLOGY 1000A

(continued from page 91)

$$\text{Peak IM Distortion} = \frac{\text{p/p pattern variation}}{\text{average p/p pattern height}} \times 100\%$$

Total harmonic distortion is estimated within ± 25% by dividing the IM distortion figure by 5. The lost positive or negative slope sign information is not significant since the slope sign depends on the inversions within the receiver and the connections to the receiver and test equipment.

With the dual-sweep method, linearity is measured directly and as we have shown variations in the flatness of the curve represents distortion since the important cross modulation pattern is really being displayed. The method displays the distortion over the entire detector bandwidth dramatically pointing out critical tuning by sharp peaks or nulls on the dual sweep display.

Detector alignment proceeds using the setup of Fig. 8. The detector transformer primary is tuned for best flatness of the slope curve over a 250-KHz bandwidth. The transformer secondary is tuned to zero the receiver's tuning meter. It is also possible for the experienced technician involved in equipment design to see trends such as odd or the more common even order distortion by examining the display pattern. R-E

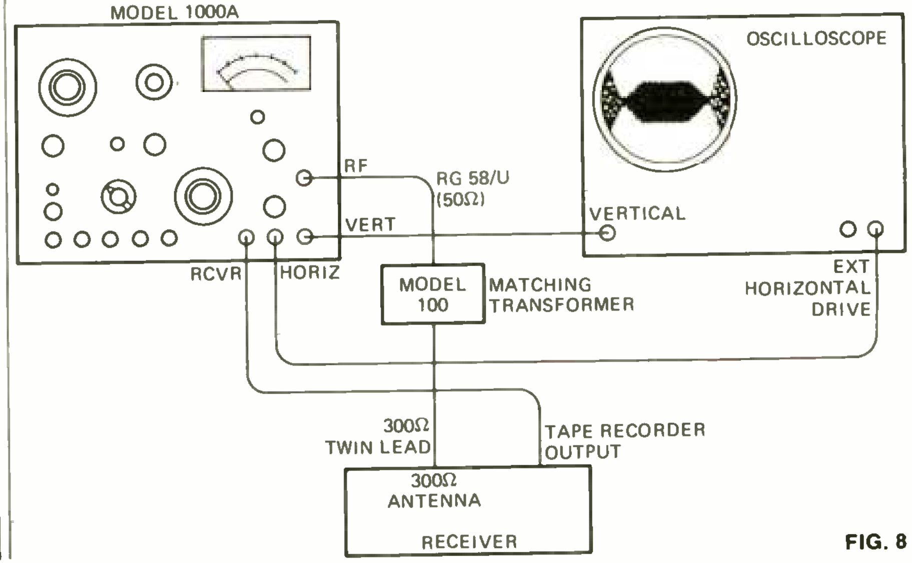

FIG. 8

INTERNATIONAL ELECTRONICS UNLIMITED

AUGUST SPECIALS

TTL

7400	Quad 2 input NAND gate	$.22 ea.
7404	Hex inverter	.25 ea.
7410	Triple 3 input NAND gate	.22 ea.
7420	Dual 4 input NAND gate	.22 ea.
7438	Quad 2 input NAND buffer O.C.	.35 ea.
7440	Dual 4 Input buffer	.22 ea.
7445	BCD-to-decml decoder/driv. O.C.	.89 ea.
7453	Expandable AND-OR INVERT gate	.25 ea.
7460	Dual 4 input expander	.20 ea.
74123	Retrig. monostable multivib w/clr	.89 ea.

LED DISPLAYS

MAN 2	type .32" Red Alpha Numeric	5.95 ea.
MAN 7	type .27" Red 7 Segment	1.95 ea.

LINEAR

324	Quad op amp (4-741's) DIP	$1.89 ea.
351	Dual peripheral driver mDIP	.39 ea.
380	2 watt audio amp DIP	1.49 ea.
565	Phase locked loop DIP	2.49 ea.
3900	Quad amp DIP	.65 ea.
8223	Programmable ROM TTL DIP	5.95 ea.
8038	Voltage controlled oscillator - sine-square-triangle output DIP	5.95 ea.
MCD2	Opto isolator - diode	1.19 ea.
MCT2	Opto isolator - transistor	.89 ea.

5001 LSI Calculator Chip (40 pin) add, subtract, multiply & divide
With data — $3.95 ea.

DIGITAL INTEGRATED CIRCUITS

7400	.25	7447	1.45	74141	1.25
7401	.25	7448	1.50	74145	1.25
7402	.25	7450	.29	74150	1.25
7403	.25	7451	.32	74151	1.05
7404	.29	7452	.32	74153	1.45
7405	.27	7453	.32	74154	1.75
7406	.55	7454	.45	74155	1.35
7407	.53	7460	.30	74156	1.50
7408	.29	7464	.45	74157	1.50
7409	.29	7465	.45	74161	1.65
7410	.25	7472	.45	74163	1.80
7411	.35	7473	.55	74164	2.95
7413	.95	7474	.55	74165	2.95
7415	.50	7475	.95	74166	1.95
7416	.50	7476	.55	74173	1.95
7417	.50	7483	1.25	74175	1.95
7420	.25	7486	.55	74176	.95
7422	.32	7489	3.25	74177	.95
7423	.37	7490	1.25	74180	1.15
7425	.39	7491	1.40	74181	4.25
7426	.35	7492	1.05	74182	1.10
7427	.39	7493	1.05	74185	2.50
7430	.25	7494	1.10	74190	1.65
7432	.30	7495	1.05	74191	1.65
7437	.50	7496	1.05	74192	1.65
7438	.55	74100	1.65	74193	1.65
7440	.25	74105	.55	74194	1.65
7441	1.25	74107	.55	74195	1.15
7442	1.15	74121	.65	74196	1.35
7443	1.25	74122	.55	74197	1.15
7444	1.30	74123	1.15	74198	2.50
7445	1.25	74125	.69	74199	2.50
7446	1.45	74126	.95		

LOW POWER TTL

74L00	.40	74L51	.40	74L90	1.75
74L02	.40	74L55	.60	74L91	1.50
74L03	.40	74L71	.60	74L93	1.75
74L04	.40	74L72	.60	74L95	1.75
74L06	.40	74L73	.80	74L164	2.95
74L10	.40	74L74	.80	74L165	2.95
74L20	.40	74L78	.80	74L98	2.95
74L30	.40	74L85	1.25		
74L42	1.75	74L86	.95		

HIGH SPEED TTL

74H00	.37	74H21	.37	74H55	.45
74H01	.37	74H22	.37	74H60	.45
74H04	.37	74H30	.37	74H61	.45
74H08	.37	74H40	.37	74H62	.45
74H10	.37	74H50	.37	74H72	.60
74H11	.37	74H52	.37	74H74	.70
74H20	.37	74H53	.45	74H76	.70

8000 SERIES TTL

8091	.69	8214	1.95	8810	.95
8092	.69	8220	1.95	8811	.75
8093	.69	8230	2.95	8812	1.25
8094	.69	8301	1.25	8822	2.95
8095	1.55	8309	1.05	8830	2.95
8121	1.05	8312	1.05	8831	2.95
8123	1.75	8520	1.45	8836	.69
8130	2.50	8551	1.95	8830	1.50
8200	2.95	8552	2.95		
8210	3.95	8554	2.95		

CMOS

74C00	.85	74C74	1.50	74C162	3.25
74C02	.85	74C76	1.70	74C163	3.25
74C04	.95	74C107	1.50	74C164	3.50
74C08	.95	74C151	2.90	74C173	2.90
74C10	.85	74C154	3.50	74C192	3.25
74C20	.85	74C157	2.25	74C195	3.00
74C42	2.15	74C160	3.30	80C97	1.50
74C73	1.70	74C161	3.25		

4000 SERIES RCA-EQUIVALENT

CD4001	.65	CD4013	1.50	CD4025	.65
CD4002	.65	CD4016	1.50	CD4027	1.35
CD4009	1.00	CD4017	2.95	CD4030	.65
CD4010	.65	CD4019	1.35	CD4035	2.85
CD4011	.65	CD4022	2.75		
CD4012	.65	CD4023	.65		

MEMORIES

1101	256 bit RAM MOS	2.50
1103	1024 bit RAM MOS	7.95
5260	1024 bit RAM Low Power	7.95
7489	64 bit RAM TTL	3.25
8223	Programmable ROM	6.95

CALCULATOR CHIPS

5001	LSI (40-Pin) Add, subtr., mult. & div., 12-dig. Data supplied with chip	$6.95 ea.
	Data only — Refundable with purchase	1.00
5002	LSI similar to 5001 exc. des. for battery operated - Data supplied with chip	8.95 ea.
—	Data only — Refundable with purchase	1.00
5005	LSI (28 pin) Full 4 funct. mem. 12-dig. displ. & calc. 7 seg. mltplx. outp. Data suppl. w/chip	10.95 ea.
	Data only — Refundable with purchase	1.00
MM5736	18 Pin, 6-dig., add, subtr., mult., div.	4.95 ea

DIGITAL CLOCK CHIPS

MM 5311	28-pin any readout 6-dig. BCD with spec. sheet	11.95 ea.
MM 5312	24-pin any readout 4 digit Ipps output BCD with spec. sheet	8.95 ea.
MM 5313	28-pin any readout 6 digit Ipps BCD with spec. sheet	10.95 ea.
MM 5314	24-pin LED-Incandescent readout 6-digit with spec. sheet	10.95 ea.
MM 5316	40-pin norm. alarm set snooze alarm-timer 12 or 24-hr. operat. with spec. sheet	15.95 ea.

LED's

MVIOB	Visible red TO 18		.25 ea.
MV50	Axial leads micromini dome	.25 ea	5/1.00
MV5020	Jumbo clear dome visible red	.35 ea	3/1.00
ME4	Infra red (invisible) diff. dome		.60 ea.

DISPLAYS

MAN1	Type red, 7 segment .270		3.95 ea
MAN3M	Type red 7 seg .127"	1.75 ea	4/4.85
MAN4	Type red, 7 seg .190"	2.35 ea	4/ 7.95
MAN5	Type grn. 7 seg. .270"	4.75 ea	4/15.75
MAN 7	Type (SLA1), red 7 seg	2.50 ea	4/ 7.95
MAN8	Type yel. 7 seg. .270"	5.50 ea	4/18.95
DL707	Type (MAN 1Repl.)	3.50 ea	4/13.00

OPTO ISOLATORS

MCA 2-30	Darlington	.95 ea
MCD 2	Diodes	1.95 ea.
MCT 2	Transistor	1.45 ea.

PHASE LOCKED LOOPS

560 Phase locked Loop	DIP	2.95 ea
561 Phase Locked Loop	DIP	2.95 ea
562 Phase Locked Loop	DIP	2.95 ea
565 Phase Locked Loop	DIP	2.95 ea
566 Function Generator	MINI-DIP	2.95 ea
567 Tone Generator	MINI-DIP	2.95 ea

LINEAR INTEGRATED CIRCUITS

300	Pos V Reg (super 723)	TO-5	$ .95 ea
301	Hi performance AMP	MINI-DIP, TO-5	.45 ea
302	Voltage Follower	TO-5	.95 ea
304	Negative Voltage Regul.	TO-5	1.25 ea
305	Positive Voltage Regul.	TO-5	1.25 ea
307	Op AMP (super 741)	MINI-DIP, TO-5	.45 ea
308	Micro Power Op Amp	MINI-DIP	1.25 ea
309H	5 V Regulator	TO-5	1.25 ea
309K	5 V 1A Regulator	TO-3	1.95 ea
310	Voltage Follwer Op Amp	TO-5	1.45 ea
311	He perf. Volt. Compartr.	MINI-DIP, TO-5	1.25 ea
319	Hi-Speed Dual Compartr.	DIP	1.65 ea
320	-5.2 V Neg. Regulator	TO-3	1.95 ea
320	-15 V Neg. Regulator	TO-3	1.95 ea
324	Quad Op Amp	DIP	2.25 ea
339	Quad Comparator	DIP	2.50 ea
340T	Pos. Volt. Reg. (6V-8V-12V-15V-18V-24V)	TO-220	2.25 ea
370	AGC/Squelch AMPL	TO-5 or DIP	1.65 ea
372	AF-IF Strip-detector	DIP	.85 ea
373	AM/FM/SSB Strip	DIP	3.60 ea
376	Pos. Volt. Regulator	MINI-DIP	.65 ea
377	2W Stereo amp	DIP	2.75 ea
380	2 Watt Audio amp	DIP	1.75 ea
380-8	.6W Audio amp	MINI-DIP	1.75 ea
381	Low-Noise Dual Pre-Amp	DIP	2.25 ea
382	Low-Noise Dual Pre-Amp	DIP	2.25 ea
550	Prec. Voltage Regulator	DIP	.95 ea
555	Timer	MINI-DIP	1.25 ea
703	RF-IF Amp	MINI-DIP	.59 ea
709	Operational AMPL	TO-5 or DIP	.45 ea
711	Dual Different. Compar.	DIP	.39 ea
723	Voltage Regulator	DIP	.75 ea
739	Dual Hi Perf. Op AMP	DIP	1.25 ea
741	Comp. Op AMP	MINI-DIP, TO-5	.45 ea
747	Dual 741 Op Amp	TO-5 or DIP	.95 ea
748	Freq. Adj. 741	MINI-DIP	.45 ea
1303	Stereo Pre-Amp	DIP	.95 ea
1304	FM Mulpx Stereo Demod	DIP	1.50 ea
1307	FM Mulpx Stereo Demod	DIP	.95 ea
1458	Dual Com. Op. Amp.	MINI-DIP	.75 ea
LH2111	Dual LM 211 Volt. Comp.	DIP	2.95 ea
3065	TV-FM Sound System	DIP	.75 ea
3075	FM Det.-LMTR & Audio Pre-Amp	DIP	.85 ea
3900	Quad Amplifier	DIP	.75 ea
3905	Precision Timer	DIP	.75 ea
7524	Core Mem Sense AMPL	DIP	1.95 ea
7525	Core Mem Sense AMPL	DIP	.95 ea
7534	Core Mem Sense Amp/	DIP	2.75 ea
7535	Core Mem Sense Amp	DIP	1.25 ea
8038	Function Generator	DIP	8.95 ea
9601	Retriggerable One-Shot	DIP	.95 ea
75451	Dual Peripheral Driver	MINI-DIP	.49 ea
75452	Dual Peripheral Driver	MINI-DIP	.49 ea
75453	(351) Dual Periph. Driver	MINI-DIP	.69 ea
75491	Quad. seg. driver for LED readout	DIP	1.60 ea
75492	Hex digit driver	DIP	1.75 ea

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Temp range: 40°C plus 85°C Tolerance -10 plus 50% (greater than 4.7 UFD) -10 plus 75% (4.7 UFD or less)

Value	1	10-90*	100-240*	Value	1	10-90*	100-240*
1 UFD/50V	14c	12c	11c	100 UFD/16V	19c	15c	14c
2.2 UFD/50V	14c	12c	11c	100 UFD/25V	24c	18c	17c
3.3 UFD/35V	14c	12c	11c	220 UFD/16V	24c	18c	17c
4.7 UFD/35V	14c	12c	11c	220 UFD/25V	35c	25c	24c
10 UFD/16V	14c	12c	11c	330 UFD/16V	35c	25c	24c
10 UFD/25V	14c	12c	11c	330 UFD/25V	44c	35c	32c
22 UFD/16V	14c	12c	11c	470 UFD/16V	37c	30c	27c
22 UFD/25V	15c	13c	12c	470 UFD/25V	49c	39c	35c
33 UFD/16V	15c	12c	11c	1000 UFD/16V	49c	39c	35c
33 UFD/25V	17c	13c	12c	1000 UFD/25V	75c	60c	55c
47 UFD/16V	17c	14c	13c	2200 UFD/16V	75c	60c	55c
47 UFD/25V	19c	15c	14c				

*** 10 pcs. per capacitance value**

DIGITAL TTL

	1-99*	100-999*		1-99*	100-999*		1-99	100*-999*
7400N	32c	28c	7446N	$1.30	$1.10	7496N	$1.20	$1.07
7401N	32c	28c	7447N	$1.30	$1.10	74107N	55c	50c
7402N	32c	28c	7448N	$1.35	$1.15	74121N	70c	60c
7403N	32c	28c	7450N	32c	28c	74122N	72c	62c
7404N	35c	31c	7451N	32c	28c	74123N	$1.11	99c
7405N	35c	31c	7453N	32c	28c	74141N	$1.61	$1.43
7406N	52c	46c	7454N	32c	28c	74150N	$1.56	$1.39
7407N	52c	46c	7459N	32c	28c	74151N	$1.20	$1.07
7408N	36c	32c	7460N	32c	28c	74153N	$1.58	$1.40
7409N	36c	32c	7470N	36c	32c	74154N	$2.25	$2.00
7410N	32c	28c	7472N	40c	35c	74155N	$1.46	$1.29
7411N	35c	31c	7473N	52c	45c	74156N	$1.17	$1.04
7413N	63c	56c	7474N	52c	45c	74157N	$1.56	$1.39
7416N	50c	44c	7475N	85c	72c	74158N	$1.56	$1.39
7417N	50c	44c	7476N	60c	55c	74160N	$1.95	$1.74
7418N	35c	31c	7480N	74c	65c	74161N	$1.95	$1.74
7420N	32c	28c	7482N	$1.02	91c	74162N	$1.95	$1.74
7423N	75c	67c	7483N	$1.58	$1.40	74163N	$1.95	$1.74
7426N	36c	32c	7486N	60c	55c	74164N	$1.95	$1.74
7430N	32c	28c	7489N	$4.50	$4.00	74165N	$2.48	$2.20
7437N	51c	46c	7490N	85c	72c	74166N	$2.03	$1.80
7438N	51c	46c	7491N	$1.37	$1.22	74180N	$1.20	$1.07
7440N	32c	28c	7492N	85c	72c	74181N	$3.38	$3.00
7441N	$1.45	$1.27	7493N	85c	72c	74182N	$1.17	$1.04
7442N	$1.20	$1.07	7494N	$1.20	$1.07	74192N	$1.80	$1.60
7445N	$1.62	$1.44	7495N	$1.20	$1.07	74193N	$1.80	$1.60
						74198N	$2.78	$2.47
						74199N	$2.78	$2.47

*** Any Quantity per Item (TTL only) Mixed**

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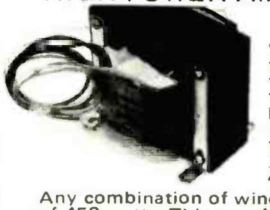

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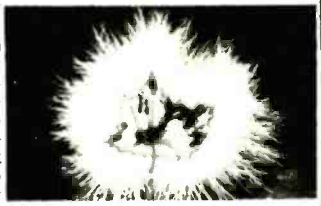

Experiment in the fascinating new field of "Kirlian" electrophotography — images obtained on film without camera or lens by direct recording of electric charge transmitted by animate & inaminate objects. Each "aura" differs — animate aura said to change corresponding to physical changes. Kit incls portable darkroom, double transformer isolated from power source; instrs.

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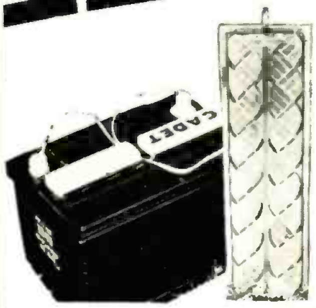

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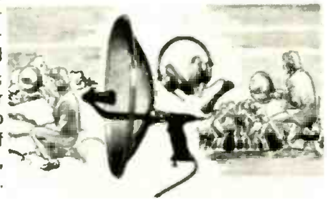

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Circle 75 on reader service card

The editors' choice: Heathkit Digital Design Color TV!

At **ELEMENTARY ELECTRONICS** they said: "The fact is, today's Heathkit GR-2000 is the color TV the rest of the industry will be making tomorrow ... there is no other TV available at any price which incorporates what Heath has built into their latest color TV."

The **FAMILY HANDYMAN** reviewer put it this way: "The picture quality of the GR-2000 is flawless, natural tints, excellent definition, and pictures are steady as a rock. It's better than any this writer has ever seen."

POPULAR SCIENCE pointed out "more linear IC's, improved vertical sweep, regulators that prevent power supply shorts, and an industry first: the permanently tuned I.F. filter."

The **RADIO-ELECTRONICS** editors said the Heathkit Digital Design TV has "features that are not to be found in any other production color TV being sold in the U.S.:

"*On-screen electronic digital channel readout*... numbers appear each time you switch channels or touch the RECALL button... *On-screen electronic digital clock*... an optional low cost feature... will display in 12- or 24-hour format... *Silent all-electronic tuning.* It's done with uhf and vhf varactor diode tuners... *Touch-to-tune, re-programmable, digital channel selection*... up to 16 channels, uhf or vhf... in whatever order you wish... there's no need to ever tune to an unused channel. *LC IF amplifier* with fixed ten-section *LC IF bandpass filter* in the IF strip... eliminates the need for critically adjusted traps for eliminating adjacent-channel and in-channel carrier beats. No IF alignment is needed ever. *Touch volume control*... when the remote control is used... touch switches raise or lower the volume in small steps."

POPULAR ELECTRONICS took a look at the 25-in. (diagonal) picture and said it "can only be described as superb. The Black (Negative) Matrix CRT, the tuner and IF strip, and the video amplifier provide a picture equal to that of many studio monitors ..."

To sum up, POPULAR ELECTRONICS concluded its study by stating, "In our view, the color TV of the future is here—and Heath's GR-2000 is it!"

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A Giant ... Steps Forward!

.....a truly fantastic, BRAND NEW, TV Service Instrument

More than two years in development.
Modular microcircuit construction.
Masterpiece of miniaturization.

MASTER SUBBER™ MARK V

The GIANT in a tiny package

Designed for servicing the ENTIRE signal circuit system of any Color or Black & White Television receiver . . . by signal substitution!

Substitutes the following signal stages:

- **VHF Tuner.**
- **Each video i.f. stage.**
- **Video detector stage.**
- **Video amplifier stage.** (Positive and negative going signals available simultaneously)
- **4.5 MHz sound i.f. amplifier stage.**
- **Sound limiter stage.**

Provides tests for:

- **UHF tuner.**
- **Antenna system.**
- **AGC system.**

Use on the bench or in the home. Equipped with wall plug-in transformer for 120-vac line, instrument automatically changes over to internal battery power when transformer is disconnected.

Inbuilt monopole antenna allows use without connection of outside antenna in prime signal areas.

Inbuilt monitor loudspeaker with separate level control.

Video carrier level meter may be calibrated against Master Gain Control for the area in which the instrument is used, to afford true field strength measurements.

Lightweight . . . and measures a mere 6.5"x 6.5"x 3.25" exclusive of knobs, handle and antenna.

Complete with connecting cables and instructions.

You get all this for $169.95 . . . at your stocking distributor.

. . . or write for more details and complete specifications.

CASTLE TV TUNER SERVICE, INC.

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In Canada: Len Finkler Ltd., Ontario

Circle 76 on reader service card