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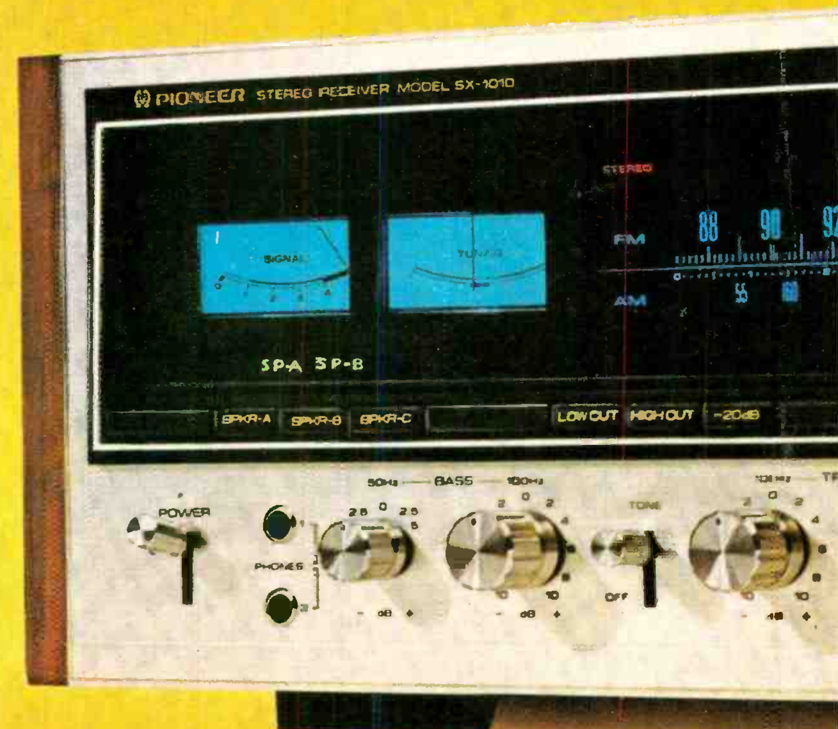

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Pioneer believes that any objective comparison of quality/performance/price between our new SX-1010, SX-939 and SX-838 AM-FM stereo receivers and any other fine receivers will overwhelmingly indicate Pioneer's outstanding superiority and value.

The most powerful ever

Pioneer uses the most conservative power rating standard: continuous power output per channel, with both channels driven into 8 ohm loads, across the full audio spectrum from 20Hz to 20,000 Hz. Despite this conservatism, the SX-1010 far surpasses any unit ever produced with an unprecedented 100 + 100 watts RMS at incredibly low 0.1% distortion. Closely following are the SX-939 (70 + 70 watts RMS) and the SX-838 (50 + 50 watts RMS) both with less than 0.3% distortion. Dual power supplies driving direct-coupled circuitry maintain consistent high power output with positive stability. A fail-safe circuit protects speakers and circuitry against damage from overloading.

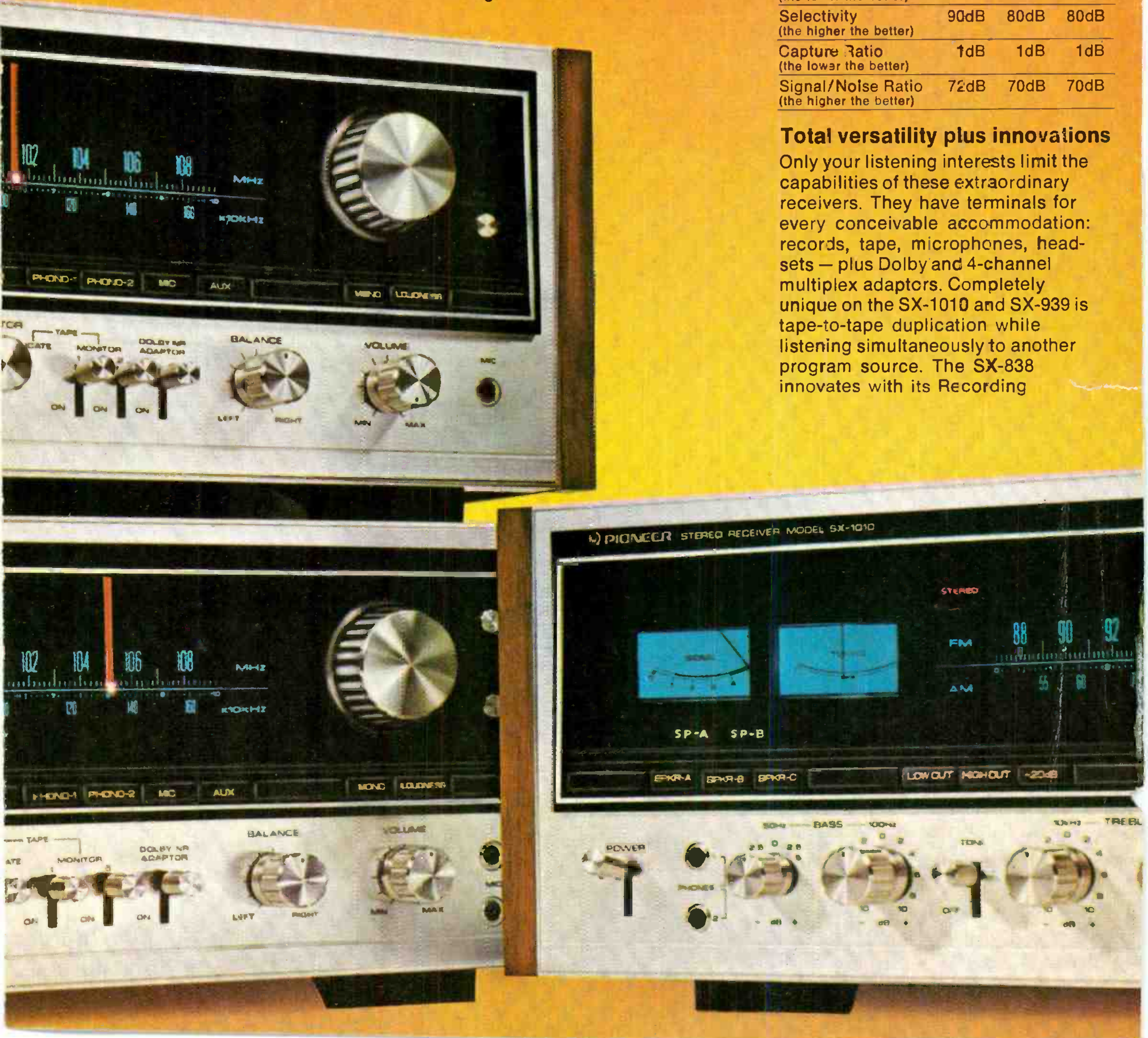
Outstanding specifications for flawless reception

FM reception poses no challenge to the exceptionally advanced circuitry of these fine instruments. Their FM tuner sections are designed with MOS FETs, ceramic filters and phase lock loop circuitry. The result is remarkable sensitivity, selectivity and capture ratio that brings in stations effortlessly, clearly and with maximum channel separation.

	SX-1010	SX-939	SX-838
FM Sensitivity (IHF) (the lower the better)	1.7uV	1.8uV	1.8uV
Selectivity (the higher the better)	90dB	80dB	80dB
Capture Ratio (the lower the better)	1dB	1dB	1dB
Signal/Noise Ratio (the higher the better)	72dB	70dB	70dB

Total versatility plus innovations

Only your listening interests limit the capabilities of these extraordinary receivers. They have terminals for every conceivable accommodation: records, tape, microphones, headsets — plus Dolby and 4-channel multiplex adaptors. Completely unique on the SX-1010 and SX-939 is tape-to-tape duplication while listening simultaneously to another program source. The SX-838 innovates with its Recording



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025 possible tonal compensations with unique twin stepped tone controls
(SX-1010, SX-939)

elector that permits FM recording hile listening to records and vice ersa. Up to three pairs of speakers ay be connected to each model.

IPUTS	SX-1010	SX-939	SX-838
ape monitor/4-ch. adaptor	3	2	2
hono	2	2	2
licrophone	2	2	1
uxiliary	1	1	1
oise reduction	1	1	1
UTPUTS			
peakers	3	3	3
ape Rec./4-ch. adaptor	3	2	2
leadsets	2	2	1
loise reduction	1	1	1
-channel MPX	1	1	1

Master control system capability

Pioneer's engineers have surpassed themselves with a combination of control features never before found in a single receiver. All three units include: pushbutton function selection with illuminated readouts on the ultra wide tuning dial, FM and audio muting, loudness contour, hi/low filters, dual tuning meters and a dial dimmer.

Never before used on a receiver are the twin stepped bass and treble tone controls found on the SX-1010 and SX-939. They offer over 3,000 tonal variations. A tone defeat switch provides flat response instantly throughout the audio spectrum. The SX-838 features switched turnover bass and treble controls for more precise tonal compensation for room acoustics and other program source characteristics.

In their respective price ranges, these are unquestionably the finest values in stereo receivers the world has ever known. Audition their uniqueness at your Pioneer dealer. SX-1010 — $699.95; SX-939 — $599.95, SX-838 — $499.95. Prices include walnut cabinets.

Also new and more moderately priced.

Pioneer's most complete and finest line of receivers ever, presents equally outstanding values starting at $239.95. Shown here are the SX-535 — $299.95, SX-636 — $349.95, SX-737 — $399.95. All with walnut cabinets.

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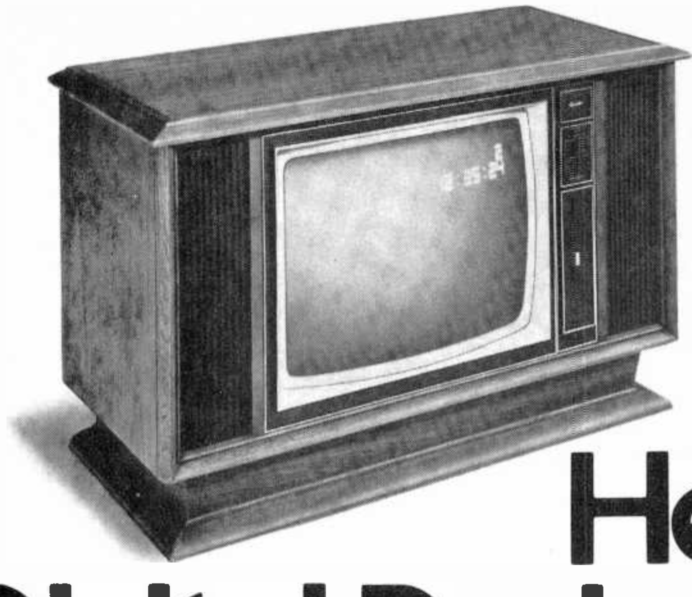


The editors' choice: Heathkit Digital Design Color TV!

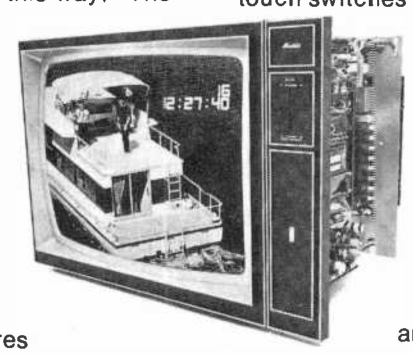
"At **ELEMENTARY ELECTRONICS** they said: "The fact is, today's Heathkit GR-2000 is the color TV the rest of the industry will be making tomorrow ... there is no other TV available at any price which incorporates what Heath has built into their latest color TV."

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, reprogrammable, 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!"

Why not see what the experts have seen? The Heathkit Digital Design Color TV—without question the most remarkable TV available today.

Mail order price for chassis and tube, $659.95. Remote Control, $89.95, mail order. Clock, $29.95 mail order. Cabinets start at $139.95. (Retail prices slightly higher)."

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AUGUST 1974 VOLUME 6, NUMBER 2

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ZIFF-DAVIS PUBLISHING COMPANY
Popular Electronics
Editorial and Executive Offices
One Park Avenue New York, New York 10016
212-725-3500
William Ziff, President
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Western Office
9025 Wilshire Boulevard,
Beverly Hills, California 90211
213 273-8050; BRadshaw 2-1161
Western Advertising Manager, BUD DEAN

Japan: James Yagi
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Editorial

OUR "NEW LOOK"

How sweet it is! After yearning over the years for an opportunity to work within the framework of a magazine of traditional size, here we are, at last, with a spanking new, big format. Would you believe the page size is about 59% larger than what we had before?

What does it mean to you, the reader? First, you will enjoy improved graphics and readability—schematics that are no longer disjointed due to page-size limitations, advertising cards (bless them) that don't act as manila dividers, and artistic effects (including color) that are more pleasing to the eye.

No doubt some ecologically oriented readers will wonder why we changed now, with the reputed paper shortage. The answer to that is simple. Most magazine paper today is produced for use with offset printing presses, which is what we are now using. Prior to this, POPULAR ELECTRONICS was printed by the letterpress process, which promises to go the way of the auk except for special purposes. Further, we recognized that a shift to a larger size was imminent as electronic circuits became increasingly complex, thereby requiring more page space to present larger schematics. As computer technology sifts down to consumer levels, with lower prices and increased availability of components, we anticipate the complexity of schematic diagrams to increase. In essence, we have looked into the future and POPULAR ELECTRONICS is ready for it!

But our new look is more than physical or visual. We've gathered together the most authoritative electronics columnists in the field to bring you exciting, useful information in specific areas. For example, you will soon be reading new columns on DX listening, ham radio, and TV servicing. These will be in addition to our regular columns on high fidelity, CB radio, test instruments and solid-state devices and circuits. Each columnist is expert in his respective field, deeply involved for many years in his specialty. Adding the new columns is a bonus for readers, made possible by the additional editorial space provided by the larger format.

We will welcome your comments on the change we have just made on this, our 239th monthly issue. Also, why not let us know which articles you liked best and what you'd like to see covered in future issues.

Art Salsberg

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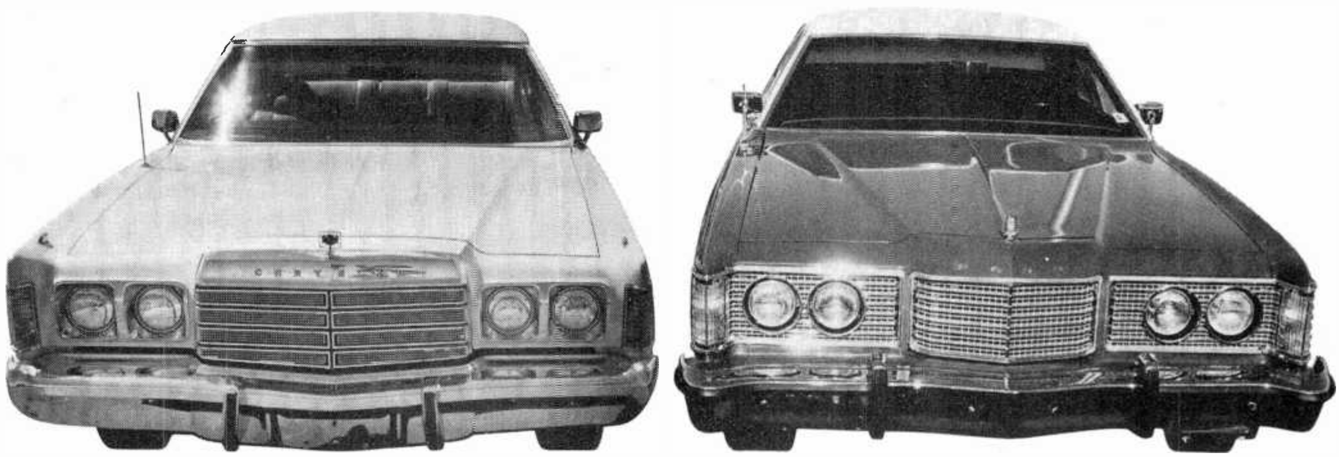
Fresh from the Factory. Yet These Cars Should Be Recalled.



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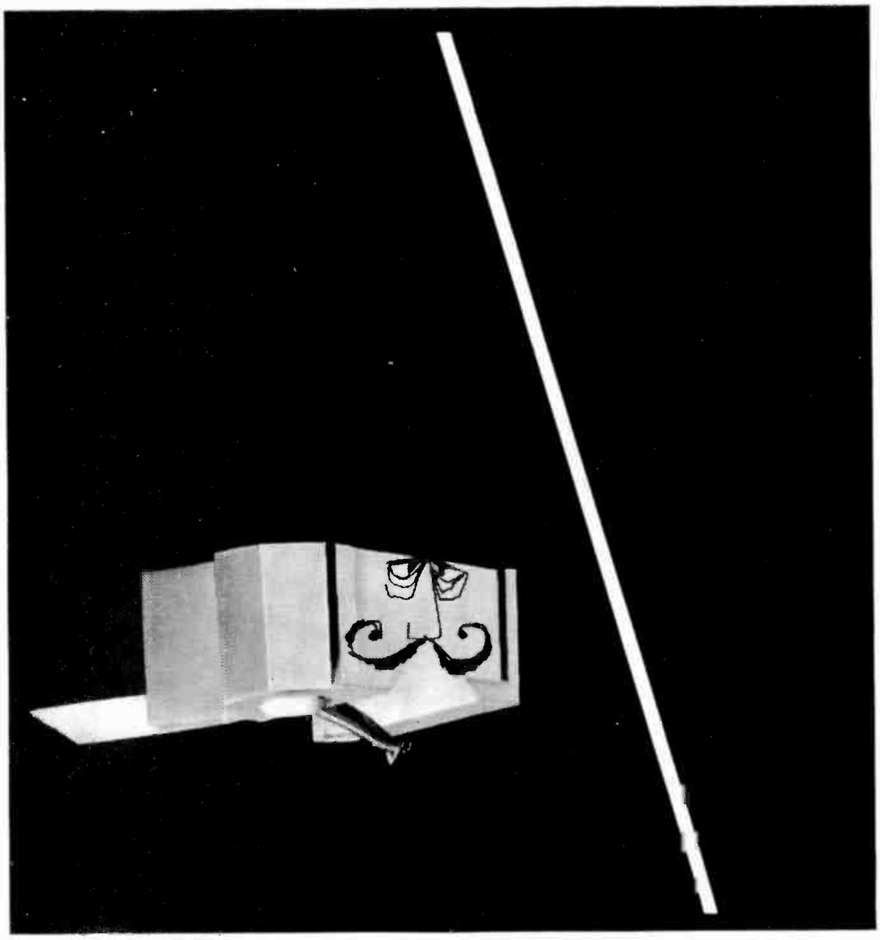

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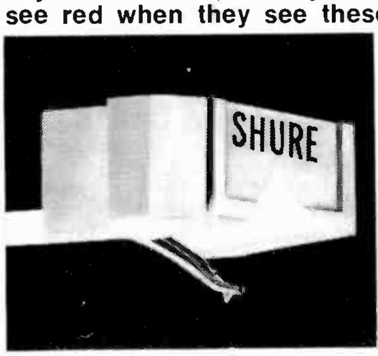

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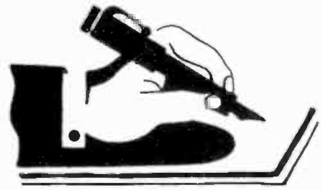

Letters

USING ASCII IN HAM RADIO

In "ASCII Keyboard and Encoder" (April 1974), it was stated that the ASCII system can be used for ham radio operation. However, it appears that the keyboard characters and layout and the necessary changes in the circuit would be different from the ASCII format normally used by hams. In addition, some simple series-parallel and parallel-series conversion circuits would be needed to interface with normal ham equipment.

Do you have any specific information we hams can use to alter the basic design to bring it closer to our requirements?

ROBERT A. LUFF, W3GAC
Gaithersburg, Md.

The author replies: You refer to a five-level Baudot code, not ASCII. The former is obsolete. There are two ways the keyboard could be used with Baudot: You could redefine the key matrix using the bottom three bits of the encoder for the least-significant two bits of the Baudot code and slightly rework the upper circuitry to generate the most significant two bits. The alternative is to add a code-converting ROM to the output of the keyboard. This is preferable because stock keytops and standard layout (with little reworking) can be used. Two ROM's might be needed.

Parallel-series conversion is an easy task. The simplest arrangement would be to use a 555 timer driving a 74165 shift register. A better method for both directions at once would be to use a UART, such as Signetics' 2536, Texas Instruments' TMS-6011, or Western Digital's TR1402A.

More information on the Baudot code and the conversion process using ROM's appears in my TTL Cookbook *available from Howard W. Sams & Co.—Don Lancaster.*

NEW "EARPHONE" LAW IN FLORIDA

Please advise your readers that, as of January 1, 1974, it is against the law in the State of Florida to drive with an earphone or other listening device covering or inserted in the ear. I would assume that this law also covers the single "boom" microphone combinations now becoming popular with CB'ers. The sole exception to the new Florida law is for an officer (police) while on duty and only when it is essential to the performance of his duty.

As an ambulance driver/attendant, I applaud this law. Drivers cannot hear our si-

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rens now with air conditioning going, windows closed, and radios blaring. Earphones and headsets only add to their deafness to our warning sirens.

R.A. HOLSTE
Orlando, Fla.

SOME WORDS ON REVERSE POLISH NOTATION

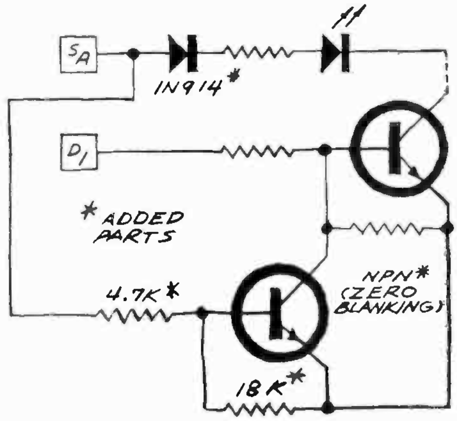
As an engineer and owner of an HP-35 pocket calculator, I was amazed that Mr. Frye failed to mention (in his "Buying and Using a Pocket Calculator," May 1974) the one important difference between the Hewlett-Packard calculators and all other pocket calculators currently available. The H-P's use Lukasiewicz (or "reverse Polish") notation and an operational stack, while other calculators use algebraic notation. Polish notation and an operational stack is the most efficient way to evaluate an expression.

KENNETH NOTT
Rensselaer Polytechnic Institute
Troy, N.Y.

You are correct. The H-P's are the only portable calculators to use Lukasiewicz notation, and this notation (plus the use of an operational stack) is the most efficient method of evaluating a mathematical expression.

HOW TO BLANK LEADING ZERO

The clock/calendar chip, CT-7001, sold



by several mail-order houses advertised in POPULAR ELECTRONICS is a very versatile device. Thus, it was disappointing to discover that the leading zero was not blanked, spoiling the appearance of the display. Having worked out an inexpensive addition to interface the circuit to blank out the leading zero, I thought your readers might be interested.

My add-on circuit (see schematic) consists of one transistor (the same as the driver) two resistors, and a 1N914 diode. Any segment output from the chip can be used except "B" and "C"—which would also blank out the "1"—and "G" (not used for the zero).

WILLIAM E. SCHOEN
Holland, Pa.

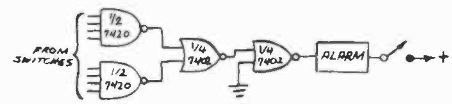
ASCII IS NOT A MACHINE LANGUAGE

As a computer science major, I read with interest "ASCII Keyboard and Encoder" (April 1974). However, I must take exception with the statement that ASCII is a machine language. Technically, ASCII is a bit representation of alphanumeric and control information. A machine language, by contrast, is either the internal representation of the opcodes or the external form of the machine's assembly language, depending on who is giving the definition.

DANIEL RUSSELL

MAKING FULL USE OF ALL THE GATES

In "Alarm System for the Popular Electronics Low Cost Digital Clock" (December 1973), the diagram shows one 7404 hex inverter, one 7402 quad 2-input NOR gate, and one 7430 8-input positive NAND gate.



Half of the 7402 is not used. To make full use of all gates, replace the 7430 with a 7420 dual 4-input positive NAND gate, and use the 7402 as shown in my diagram.

JEFF JOHNSON
Rochester, Minn.

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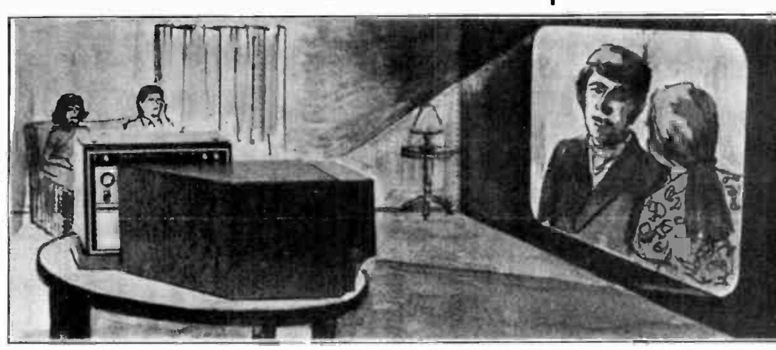

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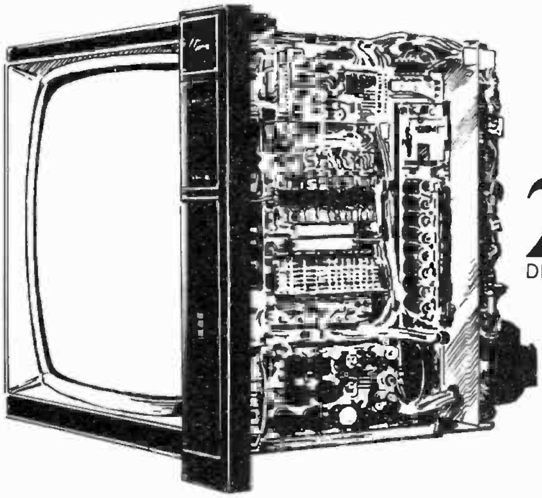

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Some of those "right" things are bite-size lessons to ease understanding and speed learning... personal grading of all tests, with comments or explanations where needed... a full-time staff of engineer/instructors to help if you need it... plenty of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

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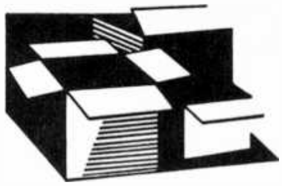


New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card or write to the manufacturer if the address is given.

3M INTRODUCES NEW LINE OF AUDIO TAPES

A line of audio tapes for the most discriminating audiophiles is now being marketed by the 3M Company under the Scotch brand "Classic" name. The new tapes are said to have more brilliant high-frequency response, excellent low-frequency response, and a higher overall output than previous 3M tapes. The line includes tapes in the popular open-reel, cassette, and 8-track cartridge formats. Each format is said to provide improved performance. The cassette's performance, it is claimed, will be particularly well received Recorders without a CrO_2 switch (and even those with it, but in the off position) will produce high frequencies superior to low-noise ferric-oxide tapes and low frequencies significantly superior to CrO_2 tapes, according to a company spokesman. Suggested retail prices are $4.35 for a C-60 cassette; $5.00 for an 8-track, 90-minute cartridge, and $12.45 for a 90-minute open-reel tape.

CIRCLE NO. 70 ON READERS SERVICE CARD

ONKYO AUTOMATIC 4-CHANNEL RECEIVER

The latest AM/stereo FM receiver in Onkyo's lineup, the Model TS-500, is described as a fully automatic 4-channel unit.

The heart of the receiver is a logic and analog computer-type circuit that automaticaly senses the CD-4, SQ, or QS signal coming from the tuner, turntable, or tape deck. The circuit analyzes the signal and automatically routes it to the built-in CD-4 demodulator or appropriate matrix decoder. The receiver is designed to accommodate 2-channel programs and programs in the SQ, QS (RM), and CD-4 (discrete) 4-channel formats. With all four channels driven simultaneously into 8-ohm loads, output power is specified at 20 watts/channel (rms) over a frequency range of 20 Hz to 20,000 Hz. In the strapped-stereo mode, the amplifier is rated at 50 watts/channel (rms) into 8-ohm loads, both channels driven. Distortion is rated at 0.5 percent, while IM distortion is 0.4 percent. Retail price is $749.95.

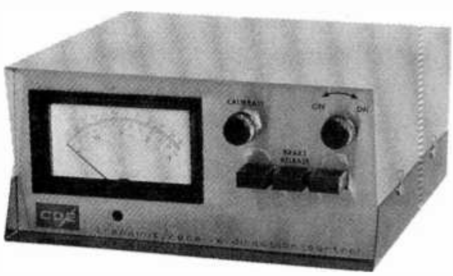
CIRCLE NO. 71 ON READERS SERVICE CARD

POMONA 36-kV CRT TEST PROBE

An advanced version of the self-contained CRT high-voltage test probe with built-in meter has been announced by Pomona Electronics. The model 4000 probe is designed to test all color and monochrome TV receivers with anode voltages up to 36 kV. Small enough to fit into a tube caddy, the probe can be used to make HV adjustments in the home without the need for extra test equipment. Simply connect the ground and touch the probe end to the anode connection; then read the voltage on the meter. Retail price is $24.95 at most electronics parts distributor outlets.

CDE HAM ANTENNA ROTOR SYSTEM

The Ham II amateur beam rotor system from Cornell Dubilier Electronics Corp. is designed to accommodate antennas and beams with a maximum of 7 sq ft (0.65 sq m) of wind area. The system provides a full



360° range of rotation, while a panel meter indicates accurate positioning. The Ham II has a wedge braking system that is operated independently of the CW and CCW directional controls. (The directional controls will not function until the brake is removed.) An independent brake release is specifically designed to minimize the effects of torsional forces caused by rapid deceleration of large antennas and beams. The bell housing containing the rotor's motor is of cast aluminum to provide complete weather protection. The high-torque motor has a stall-torque rating of 1000 in.-lb to turn the antenna even under severe wind and ice-loading conditions.

CIRCLE NO. 72 ON READERS SERVICE CARD

KINGS ELECTRONICS STRAIN-RELIEF BOOT FOR SMALL COAXIAL CONNECTORS

Junctions between coaxial cable and small, lightweight r-f connectors can now be made fatigue-resistant with a new elastometric boot developed by Kings Electronics Co., Inc. Specifically intended for use with Kings K-grip Jr. cable connectors when mated with RG- 174, 122, 58, and 59 cable, the "Flexiboot" protects the cable at the point where it enters the connector and acts as a strain relief. The Flexiboot comes in five different colors to simplify cable identification in multi-cable systems.

CIRCLE NO. 73 ON READERS SERVICE CARD

SANSUI INTEGRATED STEREO AMPLIFIER

The Sansui Electronics Corp. Model AU-6500 stereo amplifier can handle two sets of speaker systems simultaneously. It features high- and low-cut filters, a muting control, and a loudness compensation

switch. Total harmonic and IM distortion are stated at less than 0.1 percent. The equalized direct-coupled amplifier has a bandwidth of 5 Hz to 40,000 Hz and an input capacity of 300 mV rms. The AU-6500 amplifier permits independent operation of its preamplifier and power-amplifier sections. Power output is specified at 94 watts IHF. Retail price of the Sansui Model AU-6500 stereo amplifier is $259.95.

CIRCLE NO. 74 ON READERS SERVICE CARD

ROBINS BULK MAGNETIC TAPE ERASER

For erasing every type of magnetic tape, including digital cassettes up to ¼-in. (6.35-mm) wide, Robins Industries is marketing a new universal bulk eraser that carries UL and CSA approvals. The hand-held Model R24017 eraser is designed primarily for the consumer market for erasing open-reel, cassette, and 8-track cartridge recording tapes, but it is also suited to computer and other commercial applications. A convenient handle permits moving the eraser easily across any reel or cartridge, obliterating the recording in a matter of seconds and eliminating the need for winding and rewinding the tape. The eraser is 2.25 lb (about 1 kg), while retail price is $26.50.

CIRCLE NO. 75 ON READERS SERVICE CARD

MALLORY ULTRASONIC INTRUSION ALARM

A new ultrasonic intrusion alarm that is both an area and a perimeter protection device is currently being marketed by Mallory Distributor Products Co. as their Model CA3. The alarm employs such features as special circuitry that guards against false tripping by line transients and insects and the capability of using a variety of accessories for virtually any security need. The system features a horn alerting device, a selector switch that can be set for im-

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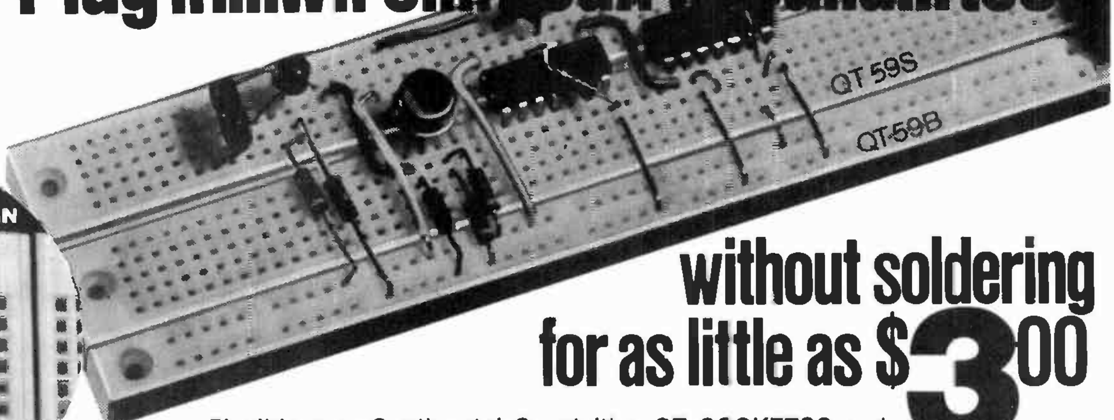

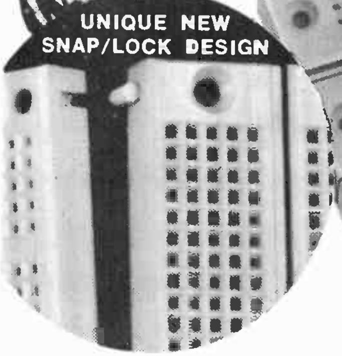

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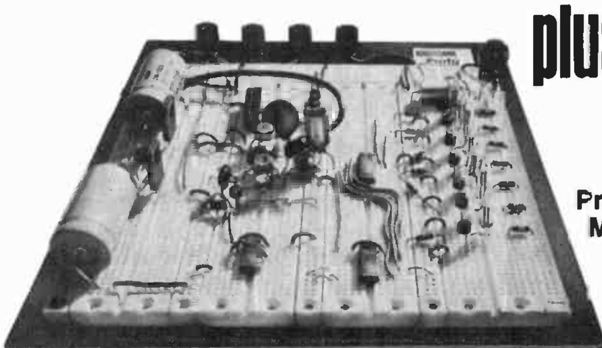

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103	24	9.0" x 6.0"	$59.95
104	32	9.5" x 8.0"	$79.95

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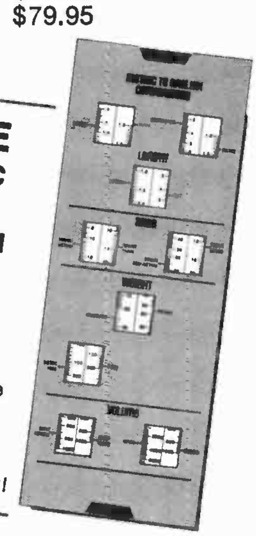

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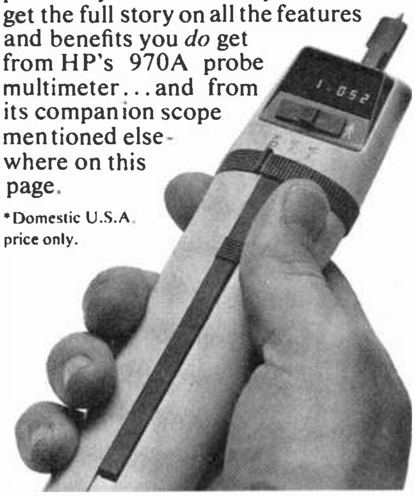
*Domestic U.S.A. price only.



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mediate sounding or delayed sounding, an on/off switch for horn alert or silent alarm, remote reset connections, loop connectors for perimeter protection, and a response control that can be adjusted for the length of time movement must occur before the alarm trips. These controls allow the owner to customize the intrusion warning system to his needs. For complete details regarding CA3 alarm system, contact your local Mallory distributor.

LISSON PORTABLE PROBE-TYPE TESTER

The new Versi-Probe multifunction tester from Lisson Electronics provides rapid fault analysis in both digital and analog circuits and is said to eliminate the need for costly test equipment. The compact battery-powered probe can perform many tests now requiring an expensive oscilloscope. It employs a combination of audio and LED indicators to test DTL and TTL circuits, RS232 and CCITT interfaces, communications loops and VF circuits, as well as for testing components. The Versi-Probe has a 1-megohm input impedance, 2-MHz bandwidth, and 50-volt (maximum) peak input specification. Retail price is $59.

CIRCLE NO. 76 ON READERS SERVICE CARD

SCOTT 70-WATT/CHANNEL STEREO RECEIVER

H.H. Scott's Model R77S is a new 70-watt/channel, AM/stereo FM receiver. An all-new MOSFET FM front end replaces the previous FET design to improve sensitivity at all signal levels. The i-f section employs double, 6-pole LC filters to steepen the limiting curve and increase selectivity from 40 to 70 dB, while a phase-locked-loop multiplex section provides a 60-dB S/N ratio in the stereo mode. The new phono preamp circuitry has a high overload threshold and is said to improve the S/N ratio of the phono stages with the cartridge in use. The 70-watt output rating per channel is continuous into 8 ohms from 20 to 20,000 Hz with less than 0.5 percent distortion (both channels driven). Power into 4 ohms is 110 watts/channel. Retail price is $599.90.

CIRCLE NO. 77 ON READERS SERVICE CARD

CHEMTRONICS SILICONE HEAT SINK GEL

A new heat sink compound for use on solid-state electronic equipment has been announced by Chemtronics. Designated the SL-1, the new zinc-oxide-filled silicone gel is said to be ideally suited to heat-transfer applications. Thermal conductivity is rated at 0.428 BTU/ft 2°F/ft. Other important characteristics of the compound include a high dielectric strength of 500 volts/mil a low dissipation factor of less than 0.005, and capability of withstanding temperatures between −65°. F (−53.8°. C) and 400° F (205° C). A 1-ounce (28.35 g) squeeze tube contains enough compound for several dozen transistors. Retail price is $2.15.

CIRCLE NO. 78 ON READERS SERVICE CARD

JVC 8-TRACK CARTRIDGE RECORDER FEATURES AUTOMATIC NOISE REDUCTION

JVC America, Inc., recently introduced what may well be the world's first 8-track record/playback deck with built-in automatic noise-reduction circuitry. In addition to

the noise reduction circuit, the deck has a special fast-forward switch, a pause control, two professional-style VU meters, and two record-level controls. The Model 1245 deck also has selectable automatic program repeat and permits the cartridge eject mechanism to be operated manually or automatically. Retail price of the deck is $249.95.

CIRCLE NO. 79 ON READERS SERVICE CARD

PANASONIC PUBLIC-SAFETY BAND RECEIVER

The model 1100 five-band portable receiver capable of tuning police, fire, continuous weather, and TV audio broadcasts tops Panasonic's new line of Tech Series portable receivers. The receiver is designed to operate mainly on batteries but has a built-

in power supply that permits it to be line powered. Its coverage includes the uhf/vhf high and vhf low PS bands. Featured are a battery-condition/tuning meter, band selector switch and band indicator, directional AM antenna, telescoping vhf/FM antenna, separate uhf antenna, and 2-hour timer that automatically shuts off the re-

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ceiver. Controls are provided for power, afc (for FM), squelch, separate bass and treble, loudness, and the timer. Jacks provided include outputs for external-speaker/earphone, multiplex, and recording. Supplied with the receiver are a detachable (adjustable) shoulder strap, earphone, ac power cord, and four D cells at a suggested retail price of $169.95.

CIRCLE NO. 80 ON READERS SERVICE CARD

PTS ELECTRONICS ALIGNMENT TOOL SET

Recently added to the PTS Electronics, Inc., line of TV-related products is the company's Dura-Seven alignment tool set. This seven-piece glass-filled polymer plastic set includes all the popular alignment tool sizes commonly needed for electronics work. The kit retails for $2.95.

CIRCLE NO. 81 ON READERS SERVICE CARD

SHURE VOICE-ACTIVATED GAIN CONTROLLER

The Shure Brothers Model M625 Voicegate can be used to combat most of the background noises that plague multiple-microphone tape recording and public address installations. This voice-activated gain controller installs between the microphone and mixer. It attenuates the microphone's output by about 16 dB until

the mike is excited by voice, when it almost instantaneously boosts the mike's output signal to unity gain. This allows all mikes to be on when needed, without ambient noise pickup, danger of feedback, and the need to continuously adjust gain. The circuit can distinguish between human voices and unwanted background noises; attenuate gain below unity until the input signal exceeds a predetermined trigger level; turn on virtually instantaneously without pops, clicks, or switching transients; and hold gain at unity for any predetermined time (from 0.5 to more than 30 seconds) following the final voice sound. Retail price is $120.

CIRCLE NO. 82 ON READERS SERVICE CARD

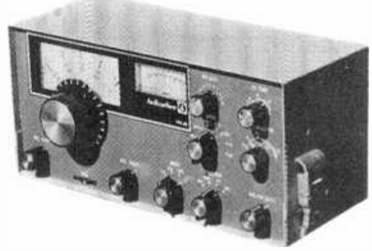
SHAKESPEARE CB ANTENNAS

Shakespeare Company's Style 4038 "Thundertwins" antennas offer Citizens Banders a bumper-mounting co-phased whip combination with three-section assembly. The fiberglass antennas are end-fed half-wave, center loaded. An exclusive Shakespeare Diplexer harness makes each 76-in (1.93-m) antenna act like it is 18-ft. (5.49-m) long. The Thundertwins sell for $74.50 complete with dual mounts and harness.

CIRCLE NO. 83 ON READERS SERVICE CARD

HALLICRAFTERS SSB/CW TRANSCEIVER

The new Hallicrafters Model FPM-300 Mark II transceiver provides complete coverage for SSB and CW operation on the 80-, 40-, 20-, 15-, and 10-11-meter domestic and international amateur radio bands. This is a complete fixed-station or mobile amateur radio system that can be operated from 12-volt dc or 117/234-volt ac power



sources. Only an antenna and key or microphone are needed to place the transceiver in operation. The single-conversion transmitter and receiver employs a 9-MHz i-f to insure superior image rejection. The transmitter's audio circuit levels are controlled by a compressor to handle a wide range of signal levels. The operator has a choice of VOX or PTT operation on SSB and semi-automatic break-in on CW. A built-in 25-kHz crystal-controlled oscillator provides an accurate frequency reference for dial calibration. Also featured are a six-pole, 2.1-kHz-wide, 9-MHz crystal lattice filter and product detector with crystal-controlled bfo for maximum stability. Price is $625.

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ESS BOOKSHELF SPEAKER SYSTEM

The ESS AMT 5 bookshelf speaker system employs a new Heil "power ring" tweeter that has a 16-fold miniaturized diaphragm mounted in a lighweight fiber holder. This driver operates with an air "squeezing" principle that is claimed to provide incredible sound purity. Frequencies beyond 1500 Hz are reproduced by the "power ring" air-motion transformer tweeter, while lower frequencies are reproduced by a 12-in. (30.5-cm) acoustic suspension cone-type woofer. A multi-stage crossover is said to assure virtually perfect blending in the critical midrange. A three-position brightness switch on the rear of the enclosure permits high-frequency adjustments to be made to suit different listening environments. Power-handling capability is rated at 150 watts peak. Frequency range of the system entends from 40 Hz to 24,000 Hz. Retail price of the system is $189.

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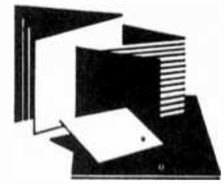

New Literature

SWAN AMATEUR RADIO CATALOG

The "World of Amateur Radio" is the title of a new 20-page catalog from Swan Electronics. The catalog gives features, specifications, and prices on the company's line of transceivers, linear amplifiers, fixed and mobile antennas, and compatible accessories for the ham radio enthusiast. Highlighted are three transceivers, 2-meter FM mobile and base transceivers, 6-meter units featuring SSB/AM/CW operation, and the company's line of High-Q fixed and mobile antennas. Address: Swan Electronics Corp., 305 Airport Rd., Oceanside, CA 92054.

IR TRANSISTOR SUBSTITUTION GUIDE

A handy pocket-sized universal transistor crossover chart is now available from the Semiconductor Division of IRC. Listed on the guide's chart are more than 250 IR and competitive part numbers, permitting the user to quickly select the proper IR transistor that replaces those made by other major manufacturers. The chart lists 48 Sylvania, 45 RCA, 45 GE, and 76 Motorola transistors and their IR replacements. Copies of Chart No. JD-608 can be obtained by writing to: Semiconductor Division, International Rectifier Corp., 233 Kansas St., El Segundo, CA 90245.

SHURE SOUND EQUIPMENT CATALOG

Titled "The Premier Family of Stereo Sound Reproducers," Shure Brothers; catalog No. AL210N fully describes and lists prices of the company's entire current line of phono cartridges. Also described are such accessories as cartridge styli, stylus force gauge, sound preamplifier, tonearms, headphone amplifier, and private-listening sound system. The 14-page catalog includes a two-page "Replacement Stylus Chart" foldout. Address: Shure Brothers Inc., 222 Hartrey Ave., Evanston, IL 60204.

BAYNTON TEST EQUIPMENT CATALOG

Listed in the new 64-page test equipment catalog (No. 38) from Baynton Electronics are specifications and prices for hundreds of test instruments. Oscilloscopes, pulse generators, multimeters, signal generators, Q meters, frequency converters, and dozens of other types of instruments are fully described. Address: Baynton Electronics, 2709 North Broad St., Philadelphia, PA 19132.

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Stereo Scene

By Ralph Hodges

SPEAKERS AND ROOMS

EVERYONE knows that a listening room and the speakers' placement in it are more than matters of looks and convenience. A speaker's acoustical surroundings (i.e., the room and its furnishings) profoundly affect the clarity, frequency balance, and even the overall loudness of its sound. Fortunately, few rooms of reasonable size are grossly unsuited for musical reproduction. (But then again, no room of an average dwelling is likely to be ideal for it either.) What's more to the point is that any room can be utilized for musical purposes poorly or successfully. Making the most of what's available is the key to the situation.

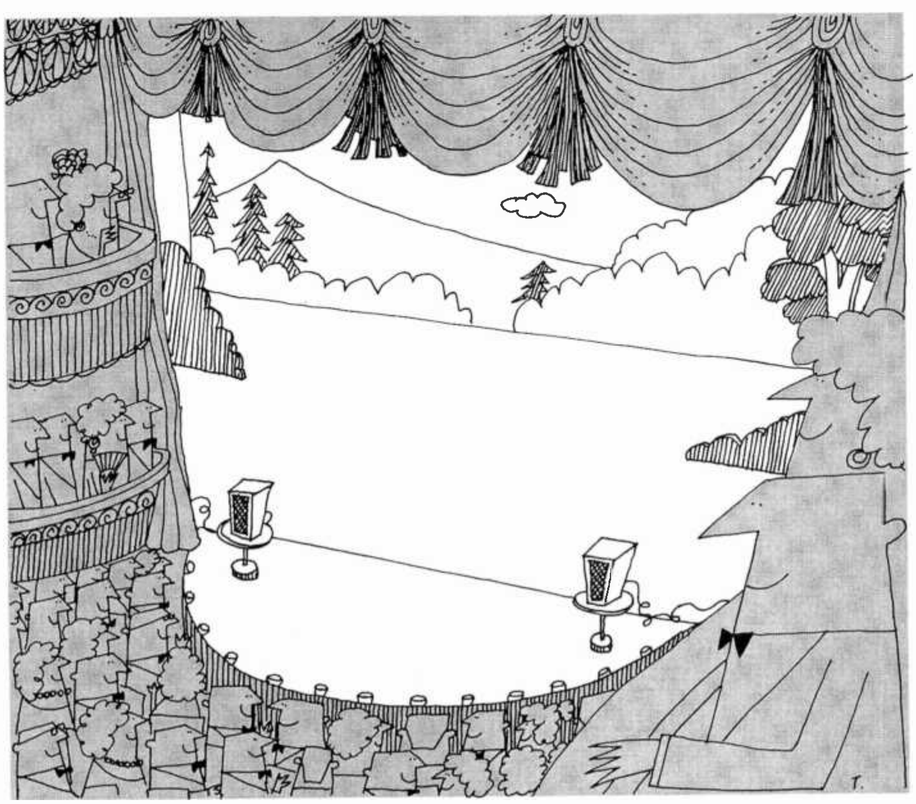
Too many people approach questions of room acoustics with the idea of somehow ferreting out the "perfect" spot for each speaker. This is rarely obvious, and sometimes it's impossible to determine with the information at hand. A better way is to start by eliminating the worst possibilities and then studying the remaining options more closely.

The Room Itself. In the interest of good bass response you want a room whose walls — or as many of them as possible — are particularly stiff and solid. Walls and other room boundaries serve as reflectors of sound energy, keeping it contained within the room where it has at least some chance of ultimately reaching your ears. Almost any wall can perform this important function for most audio frequencies. But under the onslaught of powerful low frequencies, a flimsy wall will actually begin to flex imperceptibly, thus partly absorbing instead of reflecting some of the energy, and permitting more of it to pass right through and escape to the outside.

Stiff walls are typically made of brick, concrete, cinder block, or stone. Plaster is rarely as good, and plasterboard and unbraced plywood are well down on the list. Homeowners with wood-frame houses may want to retreat to the basement, where conditions should be more than adequate. As for the apartment dweller, he should pick a room sharing at least one long wall with the exterior of the building, which is usually masonry. If this puts him in an interior room of the apartment, having no wall in common with the neighbors, then so much the better, for them and for him.

The dimensions of the room are important, for reasons we'll be discussing later. The general rule is to avoid any room with dimensions that are equal to or close multiples of one another, a cubical room (all three dimensions equal) being the worst possible case. This doesn't mean you should deliberately pick an irregular or odd-shaped space; this might cause as many problems as it cures. There is a mathematical expression for the theoretically ideal room. (The height, width, and length should be in the proportion of about 1 to 1.25 to 1.6.) If you have such a room, use it. But my experience is that most pleasantly rectangular rooms can be made to serve adequately.

It's customary to recommend using the largest room available as the listening room, presumably because it will give more acoustic support and smoothing to the lower frequencies. I have some reservations on this point. Should the room require some kind of acoustical treatment for mid- and high-frequency sound absorption, it's liable to become a complicated business. This is because a large room has a lot of surface area, and the effectiveness of the treatment will, in general, depend on the ratio of the areas of treated to untreated surface. For example, many older New York City apartments have unusually high ceilings — an architectural glory and a sonic disaster. The upper walls and ceiling of the larger rooms constitute hundreds of square feet of bare plaster almost impossible to cover in a way acceptable to the eye unless you happen to own the Unicorn tapestries. If



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you are fortunate enough to have such a room (I once did), you might be better off saving it for company and moving the speakers to a smaller space, where a few square yards of wall treatment (I used decorative scatter rugs, among other things) should suffice.

How small an acceptable room can be is another question. I feel that any room large enough to hold the equipment without impossible clutter is worth a try, especially if it fulfills the other conditions above. But there are no really hard and fast rules here.

Low Frequencies. At one time, the approved location for a speaker system was one of the corners of a room. This was because the intersecting walls and floor (or ceiling) formed a sort of crude megaphone that concentrated the output of the speaker (particularly the low frequencies) as it was projected into the listening area. Nowadays speaker placement is recognized as a more subtle problem involving considerations of sound quality as well as quantity. It is certainly worthy knowing that a speaker's bass output can be reinforced by moving it *closer* to a corner (it doesn't have to be right *in* the corner to benefit somewhat from this effect). But it's more important to realize that the overall best place for a speaker is where its output is least interfered with by local reverberant conditions and room resonances.

Simplest rules come first. Except for floor-standing designs, almost any good speaker will sound better raised up from the floor and away from the carpet. If you have any doubts about this, compare, using a couple of straight-backed chairs as speaker stands. If you feel the floor-wall intersection is needed for bass reinforcement, try the wall-ceiling intersection instead (provided the speakers can be hung), or move the speakers closer to the room corners.

Secondly, try to equalize the local acoustic environments of the speakers as much as possible. If one is near a corner, don't put the other close to an open doorway. If part of the room is carpeted or otherwise "padded," don't put one speaker inside that zone, and

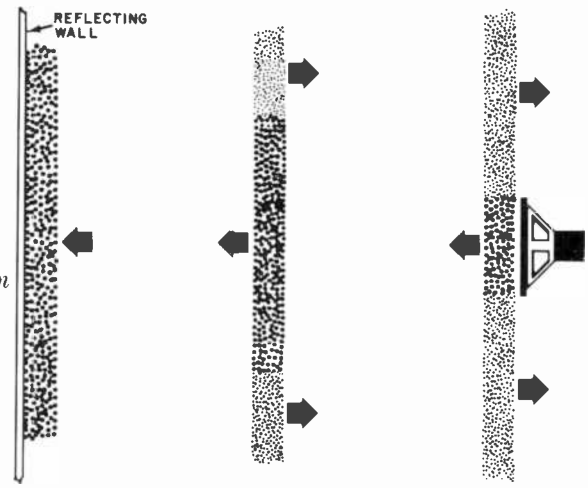

Fig. 1. Resonant mode being excited. Areas of high-pressure fluctuation exist where the reflected waves meet the direct waves from the speaker in phase.

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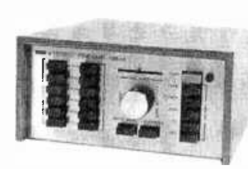

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the other one outside. Keep room furnishings from obstructing the speakers. If you've succeeded in all this, a mono signal switched from one to the other should sound much the same. If it doesn't, the mid- and high-frequency level controls on the speakers can sometimes be used to make effective adjustments.

Third, if one or more walls are stiffer than the others, always put the speakers against the stiffer walls. If this is impossible, use an adjacent wall. Try hard to avoid putting a speaker opposite (i.e., facing) a stiff wall, because this will inevitably give rise to the fierce resonant condition known variously as a "standing wave," *eigentone*, or simply "room mode."

The Eigentone Structure. Average-size rooms have dimensions corresponding to the wavelengths (and their multiples and fractions) of musical frequencies. For example, the frequency of 56.5 Hz has a wavelength (in air) of about 20 feet. When a speaker at one end of a 20-foot room emits that tone steadily, each wave races down the room, is reflected by the far wall, and arrives back at the speaker precisely in phase with the speaker's output a full cycle later. This serves to strengthen the loudness of the tone in the room considerably, at the expense of all other tones within that octave. If we drop the tone an octave in frequency, to about 28.2 Hz, essentially the same thing happens. (See Fig. 1 on previous page.)

The insidious thing about a room mode is that it reinforces only one tone of an octave. All other tones arrive back at the speaker out of phase, in varying degrees, with its immediate output, so a certain amount of *anti*-reinforcement (cancellation) occurs. The audible effect, with an organ pedal working its way steadily down the scale, might be something like: fine, okay, a noticeable weakening, almost nothing, a little stronger, a veritable sonic earthquake, and then a decline again.

Both the reinforcements and the cancellation are due to the same cause — a large, highly reflective surface at some distance from the speaker. This is the reason for the cautionary note about placing a speaker opposite a stiff wall. Such a wall will be an excellent reflector, whereas a flimsy wall might absorb or pass most of the sound energy, leaving little to make the return trip. On the other hand, putting the speaker against the stiff wall will reinforce (by the megaphone effect) *all* the bass frequencies without giving rise to serious resonances. (There will probably be at least one *measurable* resonance, however, occurring over the relatively short sound-path length between the woofer and the wall immediately behind. But if so, this would be unavoidable no matter which wall was used.)

Any of a room's dimensions—even the diagonals between corners—can give rise to an audible resonant mode, at specific frequencies. The sum total of all the modes of which a room is capable is sometimes called its "eigentone structure." A simple eigentone structure can actually be calculated by dividing 565 by each room dimension in feet. This will give the *lowest* frequency capable of exciting each dimension into resonance. Then multiplying that frequency by 2, 3, 4, etc., gives the higher harmonics, which might also be involved. Frequencies above about 200 Hz can safely be ignored. Wavelengths have then become so short that numerous resonant interactions constantly take place, resulting in a "clutter" of random phase interferences throughout the room.

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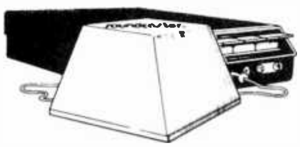

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And the clutter tends to average out in the end.

If all this seems very formidable, perhaps you can take heart from the following: (1) It's extremely unlikely that all the possible modes of a room will give audible trouble. The formation of a mode depends, among many other things, on the stiffness of the reflecting wall, the ability of the speaker to reproduce the offending tone in the first place, and even whether or not the tone corresponds closely to a note on the musical scale. (2) A resonant mode is a local condition that won't be heard everywhere in the room. Moving yourself or the speakers to another location often gets rid of it. (Although this can also, of course, create others). The most persistent modes are likely to be those occurring between parallel walls, and particularly between the speaker wall and the surface opposite, against which you'll probably be sitting. So if you follow the above rules in placing the speakers, you'll have given yourself the best chance of avoiding trouble. Other modes are probably not worth trying to predict in advance. Deal with them as they occur, walking around the room to locate the spots where they are least audible, and moving you listening position or the speakers as much as necessary in the direction of these quiet areas.

Incidentally, the rationale behind the "ideal" room proportions given earlier is that they will serve to distribute the resonant modes evenly throughout the low-frequency spectrum. If standing waves seem hopeless in a particular room, choosing another with proportions more closely approximating the ideal may very well help and could certainly be tried.

Mids And Highs. The effect of the listening room on mid and high frequencies has to do with the sound absorption — or lack of it — the room presents at those frequencies. The absorption usually comes from the furnishings. Bare plaster and uncarpeted floors absorb little sound; a totally empty room usually "rings" like a tile bathroom whenever a noise is made in it. The addition of carpets, drapes, upholstered furniture, and other soft, porous materials subdues the room by soaking up rather than reflecting the impinging sound energy. Shortly, the snarling, reverberant quality disappears, and speech and music become clearer and more intelligible. The highest frequencies are usually affected first. Thicker materials in greater quan-

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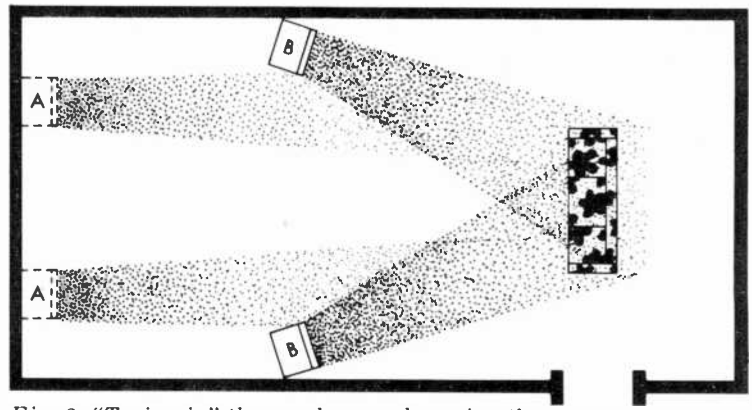

Fig. 2. "Toeing in" the speakers and moving them from locations A to locations B increases the level of high-frequency energy at the listening area. Precise positioning depends on room-mode activity.

tities begin to reach down into the mid-range, and may ultimately have some effect on the upper bass region.

Absorption problems generally come in two varieties. The first is that of the overly "live" room, which imparts a harsh, piercing, glaring quality to the sound. The usual diagnosis for this condition is too little absorption overall, and the cure is finding the time and money to install more "padding," with the greatest emphasis on large expanses of hitherto untreated surface (bare walls, for example).

The second problem involves an absence of the sparkle and "liveliness" contributed by the highest audible frequencies. The sound may be dull, and in extreme cases "murky." A room that exhibits these characteristics is frequently called "dead," and the trouble is usually attributed to too much high-frequency absorption. Actually, in more instances than not, the problem is too *little* mid-frequency absorption. (A truly "dead" room sounds extremely good with recorded music, although it is not very satisfactory for live performances.) A little explanation is in order here.

Room reflections appear to do very little in supporting frequencies from about 8,000 Hz up. These extreme highs are fragile. Even the molecular friction of their passage through air takes a surprisingly rapid toll. As a result, what we hear of them is largely the energy that has traveled *directly* from tweeter to ear. Whether the room is live or absorptive makes little difference—unless, of course, something has been done to obstruct the tweeter.

Mid-frequencies, of course, *are* augmented by room reflections. Should they get too much support, they'll simply mask the highs into unaudibility, which results in "muddy" sound. The best remedy, as in the case of any live room, is more absorption at the appropriate mid-frequencies.

Intelligent acoustical treatment involves a close study of materials and their absorptive properties at various frequencies. This will have to wait for a later column. But in the interim there are a couple of simple tricks that frequently help with murky sound. The first, especially effective when the speakers are directional at the high frequencies and tend to "beam" them straight forward, is simply to "toe" the speakers in—to angle them directly at your listening position, as in Fig. 2, instead of placing them flat against the wall. This arrangement is fairly popular in Europe for several reasons. In the U.S., however, it seems to violate some sanctified principle of decor.

Second, try getting yourself closer to the speakers, or the speakers closer to you. In long rooms where speakers and listeners face each other across the large dimension, it's often possible to bring the speakers forward along the side (long) walls (Fig. 2 again). This means that the sides of the cabinets will be against either wall, with the frequently unsightly backs exposed to view. This can't be helped, however. Besides, the scheme confers several other benefits. The woofer will now be right next to the wall, which often does away with the woofer-to-nearest-reflecting-wall resonance mentioned earlier. Also, the freedom of forward-and-back positioning sometimes provides a creative means of dealing with other persistent room modes.

I've had such good luck with side-wall placement of speakers that I'm tempted to recommend it to everyone. But the fact is that it just won't work in some rooms, either locating the speakers too far apart for good stereo, or involving other complications in some cases. ◈

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news HIGHLIGHTS

Color TV Anniversary

Just over twenty years ago commercial color television was born as an industry. The initial sets were bulky 15-inch console receivers with a suggested retail price of $1000. By the beginning of this year, the total color sets in use stood at an impressive 52.6 million. From practically zero in 1954, color TV grew to the point where two out of every three U.S. households in 1973 had at least one color set. By 1980, this penetration is expected to reach 90 per cent.

New Process for "Noiseless" Disc Recordings

A new disc-recording technique which is said to offer a solution to both tape-hiss carry-over and record surface noise has been announced by dbx, Inc. The decoding of the disc would be done at the point of playback either by an add-on decoder or by decode circuitry built into consumer preamps and receivers (as with the Dolby B system for tapes). Claimed advantages to the listener include: preservation of the full dynamic range of the original musical material, complete rejection of the inherent surface noise of the record medium, and substantial reduction of the perceived loudness of random clicks and pops in playback.

EIA to Furnish New Solid-State Color Sets to Schools

Schools participating in the 1974 EIA Service Technician Development Program will be supplied new solid-state color-TV sets to replace their older inventory of mostly tube-type sets. Sixteen schools geographically spaced across the U.S. will present 23 sessions in 1974, as part of the six-year-old Service Technician Development Program. Attending the schools will be more than 500 high school vocational and industrial arts teachers who will, in turn, present classes in consumer electronic servicing to more than 2500 students in the next school year.

An LSI Linear IC for CD-4 Demodulation

An LSI linear integrated circuit for the purpose of CD-4 discrete record demodulation has been announced by Quadracast Systems. This IC performs all the demodulation functions required as well as all the necessary circuits for a high-quality, low-noise phono preamp. The subsystems include: wide-range preamp, high-gain FM limiter, phase-locked loop FM detector, carrier detector, an indicator, expander system, front-to-back differencing circuit, output buffer amplifier, and internal reference supply. Two of these IC's together with a handful of discrete components make a low-cost, high-quality 4-channel demodulator. The devices are being distributed by the Industrial Division of Matsushita Electric Corp., 200 Park Ave., New York, N.Y. 10017.

Flameproof Resistors For Safety

A new line of flameproof film resistors has been introduced by RCA Parts and Accessories Division. The resistors won't flame or short under the most severe overloads, according to the company. There are 61 standard resistance values, ranging from 10 ohms through one megohm in ½-watt, 1-watt, and 2-watt ratings.

$1-Million Anti-Ham Lawsuit

A group of neighbors in Yorktown Heights, New York, filed suit against a radio amateur, charging interference with TV, radio and/or telephone receptions, invasion of privacy, mental anguish, et al. The defendant's system is said to have line filters in ac lines to both the exciter and linear to minimize r-f interference. It's estimated that the ham, who's retired on a police pension, will have to spend over $3,000 to defend himself. The Harmonic Hill Radio League, Box 73, Katonah, New York 10536, set up a bank account to accept donations to be used to offer financial assistance to W2OVC.

Overseas Tape "Letter" Mailing Requirements

Sound cassettes and three-inch open reels sent *overseas* in Post Office-approved plastic mailers must now be enclosed in an envelope. The 3-inch x 4¼-inch plastic mailers are still fine for domestic mailing, but fall short of the 3½ x 5½ minimum parcel size established recently for international mailing.

Will U.S. Recapture the Radio Market?

According to Lester Hogan, president of Fairchild Camera and Instrument, the U.S. will recapture the AM/FM radio market from Japan. Fairchild Camera and Instrument is currently working on a one-chip AM/FM radio to prove the feasibility of this type of device. This chip along with increased sales to eastern European countries should increase the use of U.S. IC's in the radio market.

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CIE graduate builds two-way radio service business into $1,000,000 electronics company!

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Edward J. Dulaney, Scottsbluff, Nebraska, (above and at right) earned his CIE Diploma in 1961, got his FCC License and moved from TV repairman to lab technician to radio station Chief Engineer. He then founded his own two-way radio business. Now, Mr. Dulaney is also President of D & A Manufacturing, Inc., a $1,000,000 company building and distributing two-way radio equipment of his own design. Several of his 25 employees are taking CIE courses. He says: "While studying with CIE, I learned the electronics theories that made my present business possible."

Two-way radio is booming. There are already nearly seven million two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc., and Citizens Band uses. And the number keeps growing by the thousands every month. Who is going to service them? You can – if you've got the know-how!

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There are other advantages, too. You can become your own boss – work entirely by yourself or gradually build your own fully staffed service company. Of course, we can't promise that you will be as successful as Ed Dulaney, or guarantee that you'll establish a successful two-way radio business of your own, but the opportunities for success are available to qualified, licensed men in this expanding field.

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3. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales.

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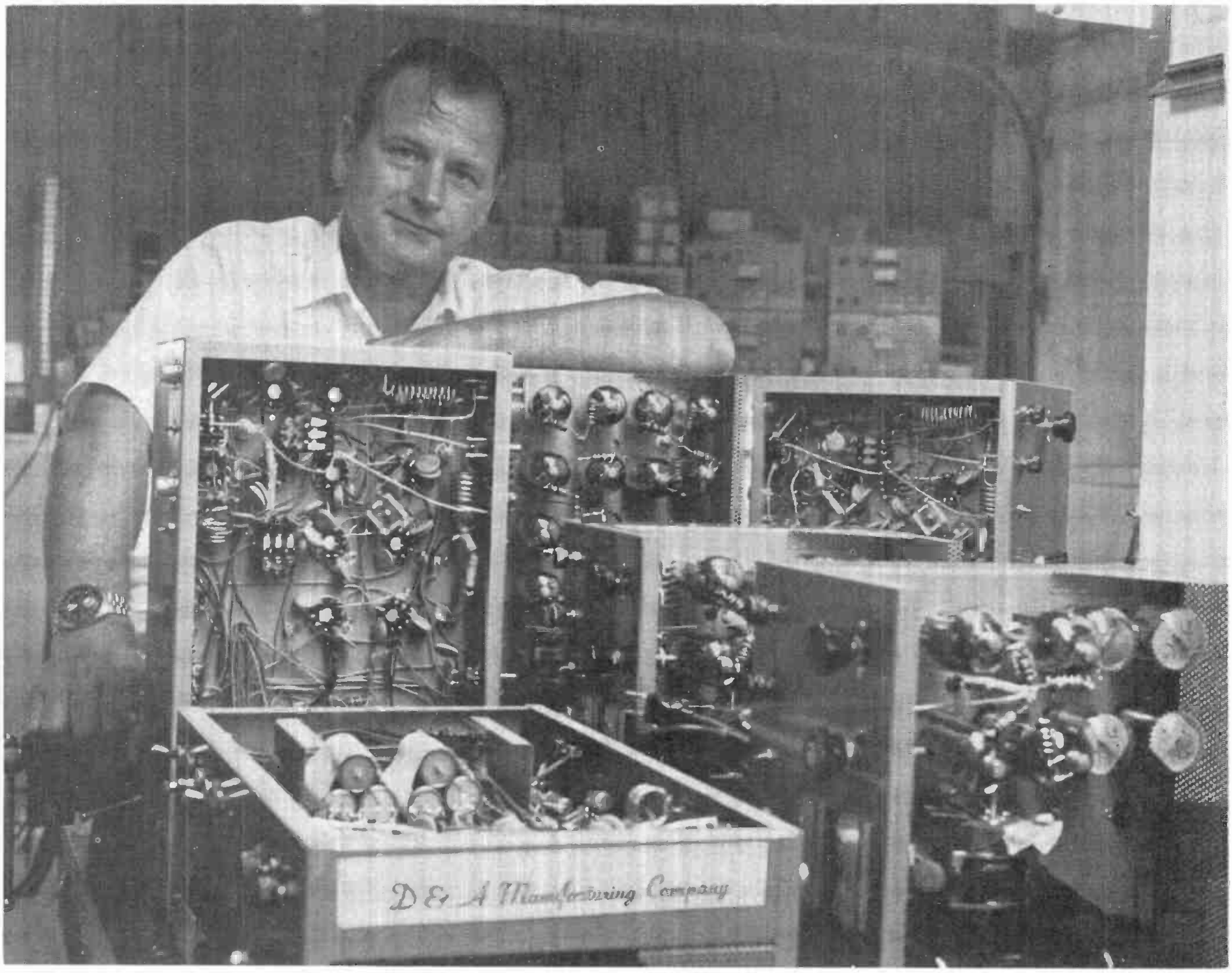

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Popular Electronics
AUGUST 1974

Breakthrough Project!

Now you can convert any oscilloscope to display alphanumerics with this unique under $50 character generator

the "Scopewriter"

BY GARY STEINBAUGH

WE HAVE all been fascinated, at one time or another, by those video displays in banks and airline offices that print out alphanumeric information received from a central computer. Now you can have your own character generation system at low cost. With it, you can communicate with a fellow hobbyist over the telephone lines. Your messages to each other can be printed out on a standard oscilloscope CRT. And, if you're a ham, character-coded messages can be sent and received over the air, with CRT printout. The system can also be an inexpensive boon for the deaf and mute, of course.

The "Scopewriter" will display any of 64 different characters in a message up to 32 characters long on a common CRT. (It can be used with a TV screen, but the application is somewhat more complex.) The Scopewriter uses large-scale integrated circuits so it is easy to build and it can be very simply connected to the scope's Y-axis input. Although it uses switch addressing, it will accept conventional ASCII keyboard inputs. (See "ASCII Keyboard and Encoder," April 1974.)

It is not necessary to use the Scope writer with special display oscilloscopes because of the sweep and blanking techniques employed. The scope's internal sweep supplies horizontal deflection while a ramp generation circuit supplies vertical deflection to form a raster. When the logic indicates a space, the ramp is disconnected and the scanning dot is rapidly deflected beyond the top of the screen. The resulting vertical traces are very

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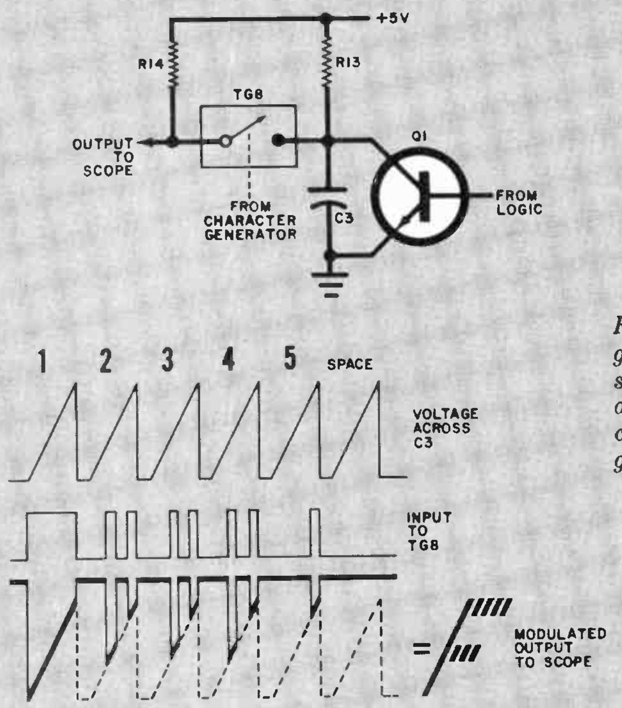

Fig. 1. Basic character generating circuit is shown above. Waveforms at left show how the capital letter F is generated.

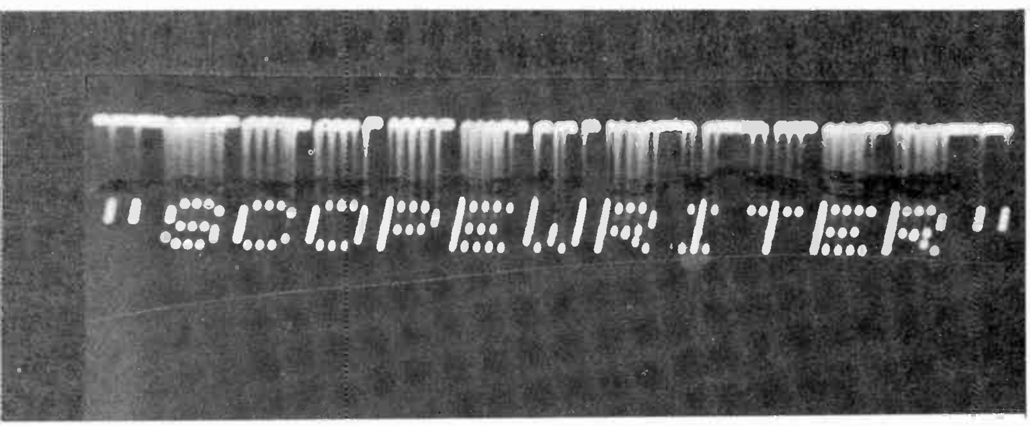

Photo of scope CRT shows letters as printed out by Scopewriter. During rapid transitions to the +5-volt level (at top), the trace is very dim.

dim and do not interfere with the character being formed. An internal memory, using a standard computer code, stores the character shapes and the line of alphanumerics selected.

Generating Characters. The basic modulator circuit is shown in Fig. 1. Also shown are waveforms describing how a character is generated on the CRT. Capacitor *C3* charges up through resistor *R13* to form the leading edge of a sawtooth waveform. Other logic circuits in the system turn on switching transistor *Q1* to short out the charge on *C3* and produce the rapid trailing edge of the sawtooth. The frequency of the sawtooth wave is selected to be about 25 kHz so that it will match the persistence of the phosphor found on most scope CRT's.

The sawtooth output is connected to the scope's vertical input through a high-speed electronic switch, which we call here a transmission gate (symbol *TG*). When this switch is open, the scope line is at +5 volts through *R14*. When the switch is closed, certain selected portions of the leading edge of the sawtooth are applied to the scope. The portions selected are determined by the closing of *TG8* to allow the signal to pass. The operation of *TG8* is determined by a signal from a digital generator whose synchronized output pulses look like the center waveform of Fig. 1. (The particular waveforms shown here are used to generate the capital letter F.) Note that six sawtooth signals are used to define one character—five for the character itself and one for the space after the character.

During the first sawtooth, the entire leading edge of the waveform is allowed to pass to the scope, thus producing the sloping left-hand line of the F. The next five intervals use digital pulses that allow different points on the slope to produce dots that define the horizontal elements of the character.

With the high speed of the scope's horizontal sweep, the dots appear close together to make the letter readable. Where the scope trace remains on to make long lines, the trace is bright; during rapid transitions (to the +5-volt level), the trace is dim. This gives the characters an appearance of "hanging" below a line.

The digital generator is actually a MOS read-only-memory (ROM) whose contents are permanently programmed at the time of manufacture

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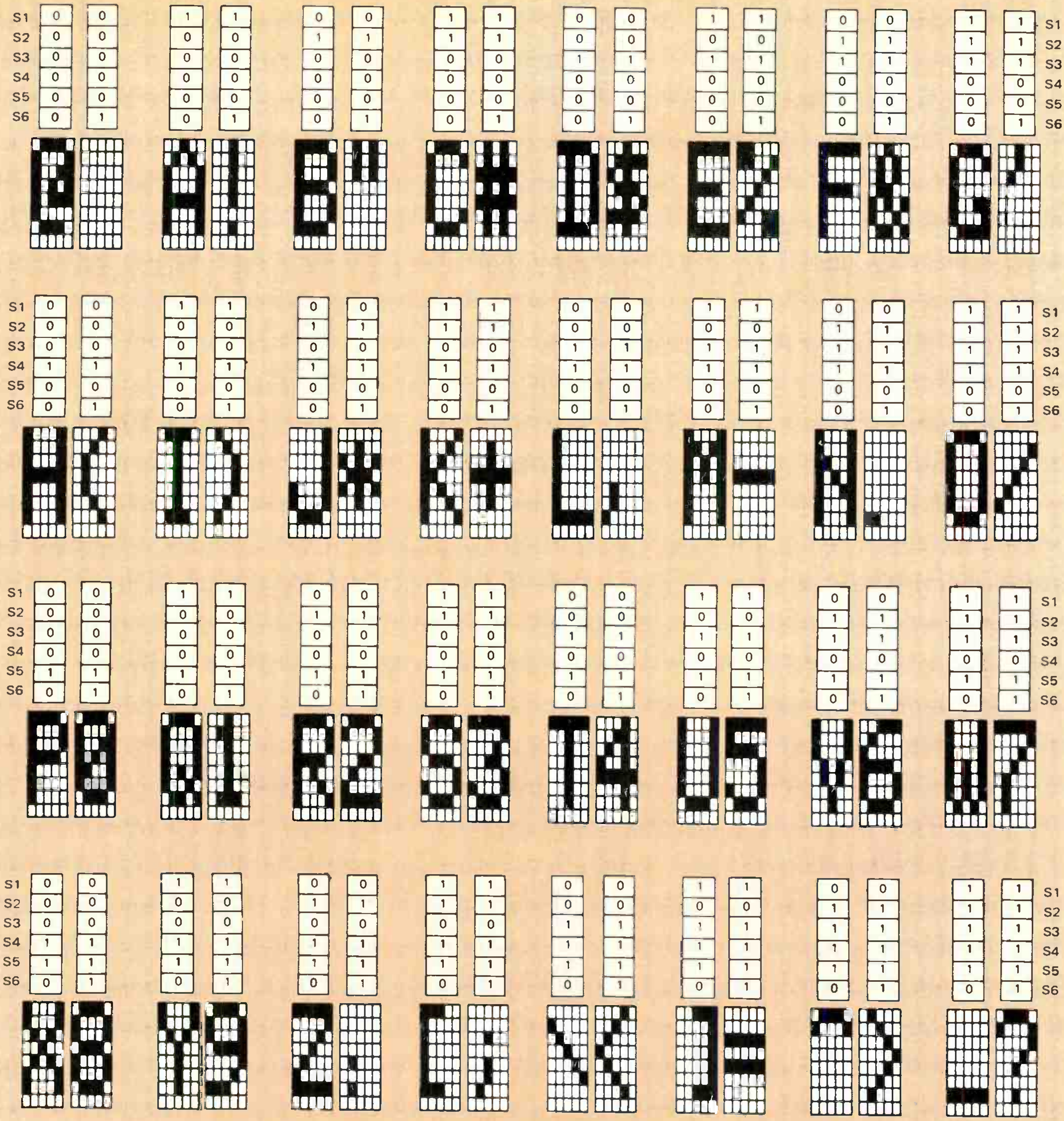

Fig. 2. The 64 characters that can be generated and the required ASCII inputs.

and can't be changed. However, they can be read out when desired. The 64 alphanumeric characters are stored in the form of a matrix of five columns and seven rows (an eighth row is not used). The columns appear as five output lines which are switched through their respective seven rows by three input lines and a row decoder. An additional six input lines and a character decoder select one of the 64 characters.

The 64 characters and the required ASCII inputs are shown in Fig. 2. Figure 3 shows the internal arrangement of the ROM.

Circuit Operation. The complete schematic of the Scopewriter is shown in Fig. 4. Two NOR gates (formed by portions of *IC1*), in conjunction with *C1, R3,* and *R4* form the 25-kHz oscillator. The oscillator output drives two flip-flops (*IC2*) to produce a 3-bit binary count. The latter is connected to the character generator (*IC6*, pins 21, 22, and 23) to run the ROM outputs through their seven rows in the proper sequence.

The sawtooth generator is made up of *Q1, C3,* and *R13.* The base of *Q1* is driven by a pair of transmission gates (*TG6* and *TG7*) arranged as an AND gate. (The transmission gates are in *IC4* and *IC5*.) The AND gate is driven by the 3-bit binary counter. The voltage across *C3* increases until it is shorted

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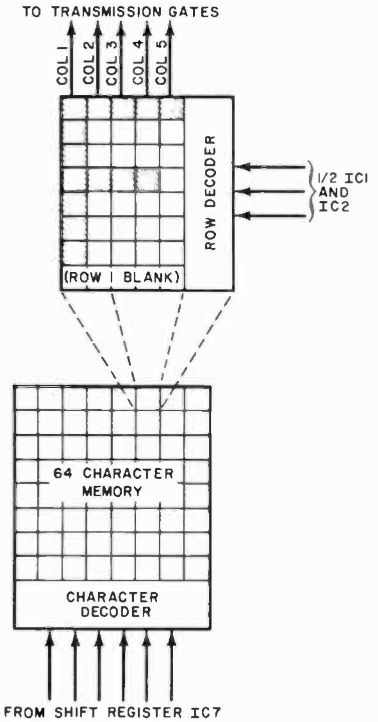


Fig. 3. Diagram showing internal arrangement of the character generator read only memory (IC6).

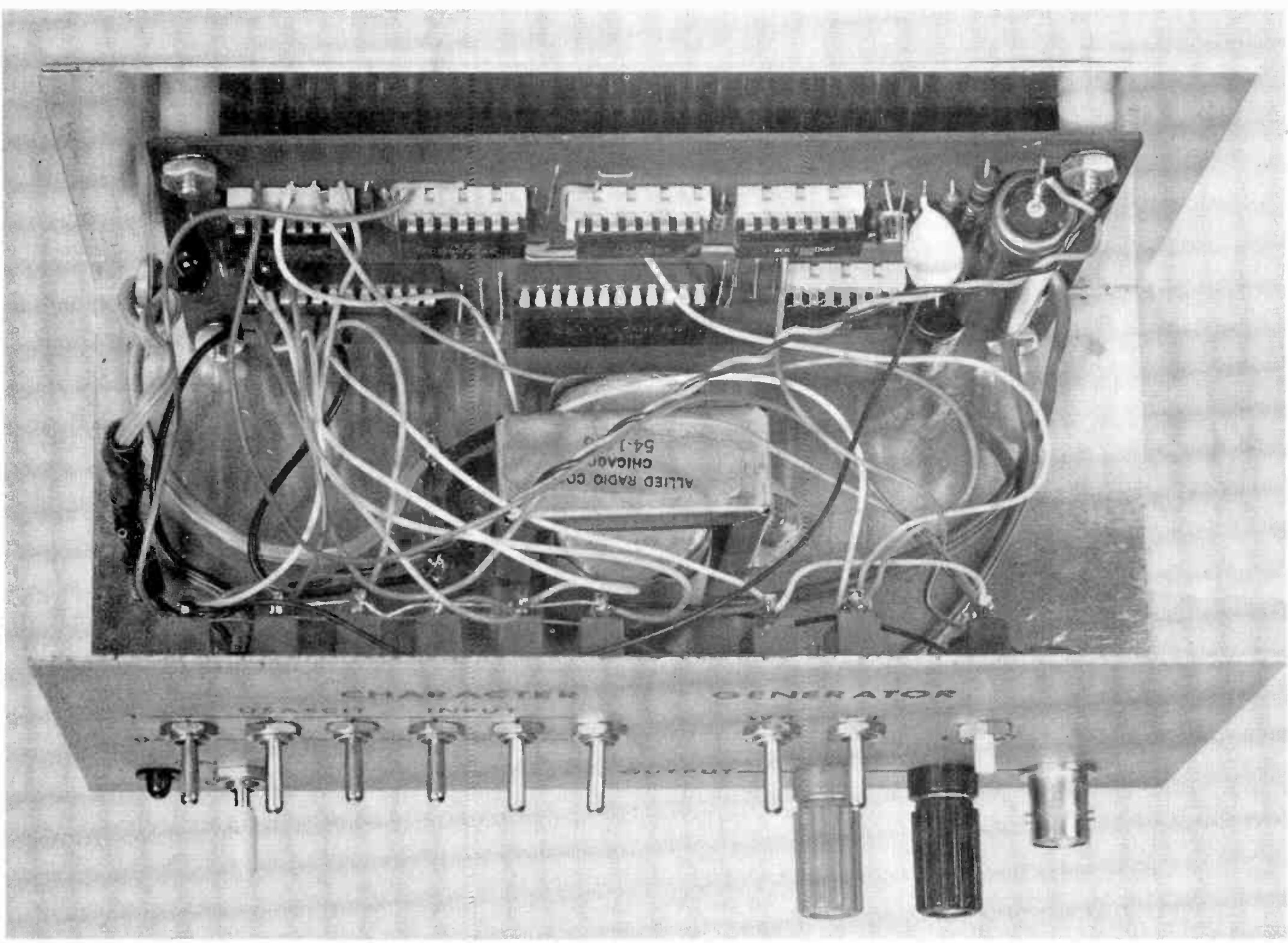
by *Q1* on the eighth binary count. The cycle then repeats to produce the sawtooth waveform.

The output of the last *IC2* flip-flop triggers a divide-by-8 counter (*IC3*) which is connected so that it resets itself on the seventh count, producing a divide-by-6 counter. The five outputs of *IC3* turn on *TG1* through *TG5*, which are connected to the five ROM outputs, to provide the output code one column at a time.

The six character inputs to the ROM are supplied by shift register *IC7*. Resistors *R5* and *R6* through *R11* and capacitor *C2* provide the correct conditions for the shift register. The latter is analogous to six long tubes, each capable of holding a string of 32 binary 1's and 0's. When triggered by a clock pulse, each tube takes in a new bit (either 1 or 0) while pushing one bit out the other end. A write recirculate switch (*S3*) connects the end of each tube to its input so that none of the bits is lost. Instead they flow around, forming a memory for the message.

The clock pulses come from the divide-by-6 counter (*IC3*) through *S1* and ¼ *IC1* when a character is completed. The clock pulse can also come from switch *S2* through the debounce circuit made up of two sections of *IC1*. Pushbutton switch *S2* is used to enter a message one character at a time.

Construction. Although the circuit can be assembled using point-to-point wiring, the use of a pc board, such as that shown in Fig. 5, is recommended. This illustration also shows the component layout. Use a low-power soldering iron and fine solder and be sure to install the jumpers where indicated. Observe the notch code for positioning IC's and the polarity markings on electrolytic capacitors. The use of sockets for the IC's is also recommended. Al-



This photo shows how the prototype of the character generator was assembled.

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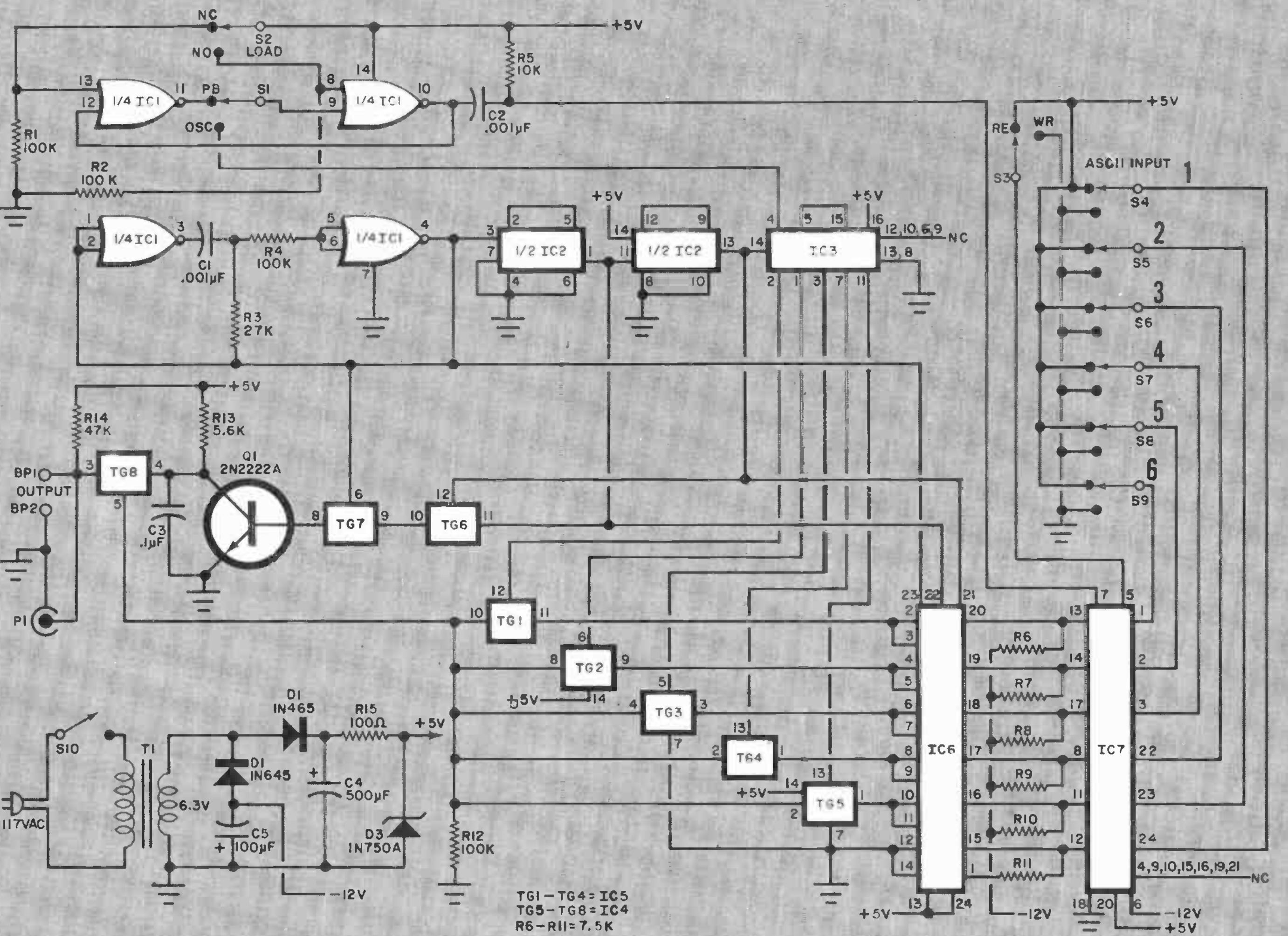

PARTS LIST

BP1, BP2—5-way binding post (red and black)
C1, C2—0.001-µF, 50-volt Mylar capacitor
C3—0.1-µF, 50-volt, Mylar capacitor
C4—500-µF (or larger), 15-volt electrolytic capacitor
C5—100-µF (or larger), 15-volt, electrolytic capacitor
D1, D2—1N645 silicon rectifier diode
D3—1N750A, 4.7-volt, ½-watt zener diode
IC1—4001 CMOS quad 2-input NOR gate
IC2—4013A CMOS dual D flip-flop
IC3—4022A CMOS divide-by-8 counter
IC4, IC5—4016A CMOS quad bilateral switch (transmission gate)
IC6—TMS2501NC ROM character generator (Texas Instruments)
IC7—TMS3112NC hex 32-bit static shift register (Texas Instruments)
P1—BNC connector (optional)
Q1—2N2222A transistor
R1, R2, R4, R12—100,000-ohm, ¼-watt resistor
R3—27,000-ohm, ¼-watt resistor
R5—10,000-ohm, ¼-watt resistor
R6-R11—7500-ohm, ¼-watt resistor
R13—5600-ohm, ¼-watt resistor
R14—47,000-ohm, ¼-watt resistor
R15—100-ohm, ½-watt resistor
S1, S3-S9—Dpst toggle switch (miniature)
S2—Spdt momentary-action pushbutton switch
S10—Spst switch
T1—Filament transformer; sec: 6.3 V, 0.6A (Allied Radio 6K32HF or similar)
Misc.—LED and current-limiting resistor (optional), suitable chassis, line cord, spacers, mounting hardware, press-on type, rubber feet (4), etc.
Note—The following are available from Systems West, Inc., 900 Dartmouth Dr., NE, Albuquerque, NM 87106: pc board (SWPC) at $4.95; electronics kit with pc board and semiconductors (SWE) at $49.95; complete kit including prepunched case at $79.95; assembled unit (1-year warranty) at $99.95; compatible ASCII keyboard at $39.95.

Fig. 4. This is complete schematic, including power supply, of the Scopewriter.

though they are protected against damage due to static buildup, it is good practice to handle them as little as possible and insert them as the last step in construction.

The photograph shows the front panel of the prototype. Mount the ASCII input switches (*S4-S9*) in a row, with the top positions marked 1 and the bottom position 0. An optional LED power-on indicator can be mounted on the front panel. (Use a current-limiting resistor for the LED.)

The transformer can be located in any convenient part of the enclosure.

Although both binding posts and a BNC connector were used for the output on the prototype, either one or some other type of terminal can be used.

Testing and Operation. Connect *BP1* to the scope vertical input and *BP2* to the scope ground. (If you use the BNC connector, the proper connections will be made automatically.) Turn on the scope and set the horizontal sweep for about 10 ms. When the Scopewriter is turned on, a line should appear on the CRT with random characters below it. Adjust the sweep

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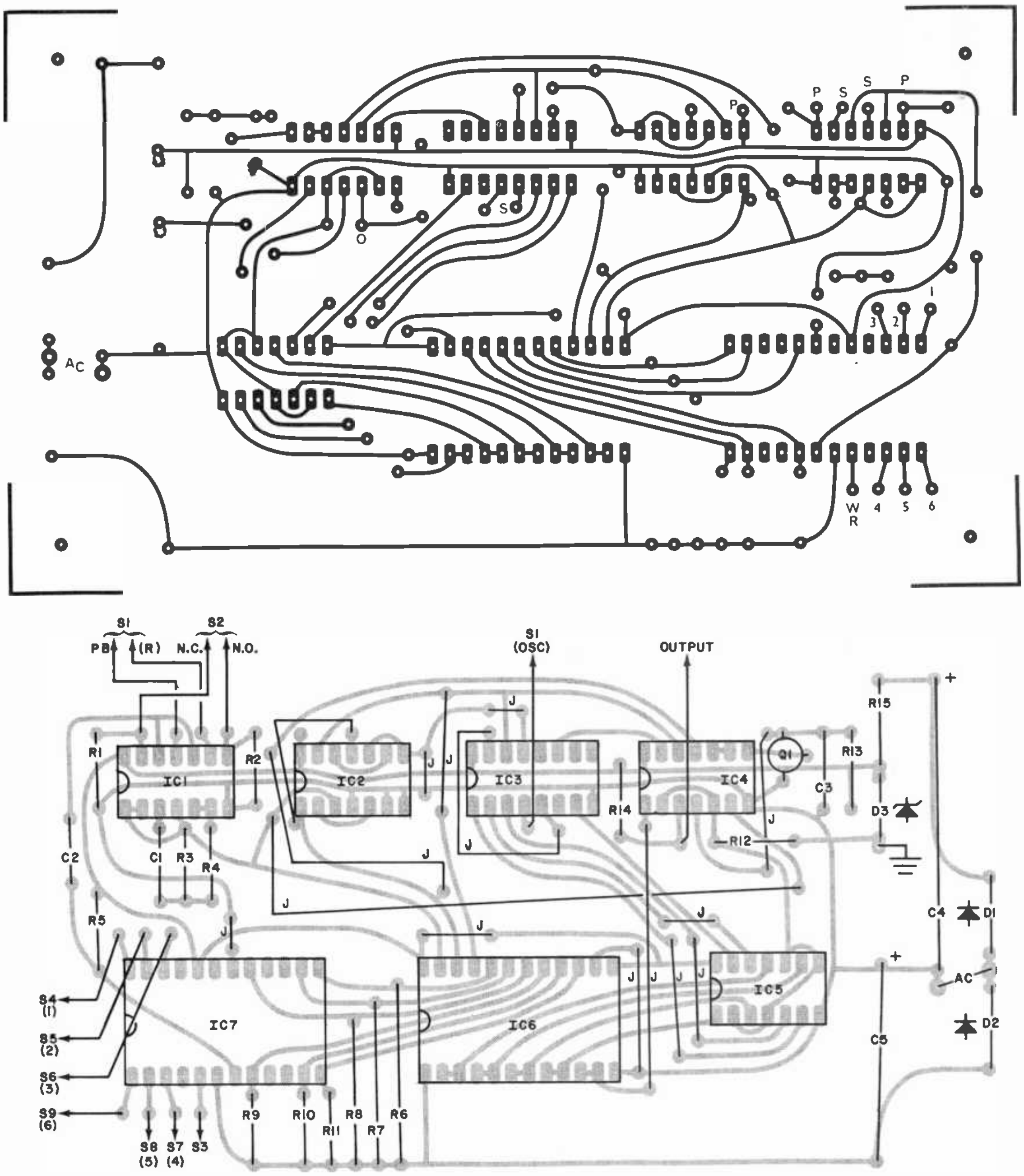

Fig. 5. Though the Scopewriter can be assembled on perforated board, a printed circuit board is recommended. Actual-size foil pattern is at top, component layout shown beneath it.

vernier so that the characters are stationary, and adjust the scope's intensity control so that the blanking lines are not too prominent. Use the scope's vertical gain to vary the character height.

To enter a message, perform the following steps, using the ASCII character coding shown in Fig. 2. Note that the six-element code starts with 6 (*S9*) on the left and proceeds to 1 (*S4*) on the right.

1. Place the switches in the 100000 position. This should produce a blank.
2. Set *S1* (PB/OSC) on OSC.
3. Set *S3* (WR/RE) on WR. This clears the memory.
4. Set *S1* to PB.
5. Insert a code on the ASCII switches for some specific character and press *S2* (LOAD) to enter the code into the memory. You can insert up to 32 characters, including blanks.
6. Place *S3* on RE.
7. Place *S1* on OSC. The message should appear on the CRT. Adjust the horizontal sweep/sync to position the message.

Should you notice a mistake in spelling within the message, perform the following steps to erase the wrong character and insert the correct one.

1. Set *S1* to PB. One of the characters (or spaces) will appear repeated across the face of the CRT.
2. Operate the LOAD switch to step through the message until the desired character appears.
3. Set the ASCII input switches for the correct character.
4. Set *S3* to WR.
5. Depress the LOAD switch to insert the correct character. Note that the next character in the message appears.
6. Set *S3* to RE.
7. Set *S1* to OSC. The entire corrected message should now appear.

Conclusion. The breakthrough project presented here is only the beginning of a variety of projects that POPULAR ELECTRONICS will present in this area, using read-only-memories for display purposes. ◈

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Hirsch-Houck Labs TESTS THE NEW 'PREMIUM' CASSETTE TAPES

By Julian D. Hirsch

A CASSETTE deck is no better than the tape used in it. Hence, it is not surprising that tape manufacturers are continually improving their products to keep pace with, or even get ahead of, the steady improvements made in the recorders themselves.

Currently, a number of "premium" cassette tapes are available to tape recordists. Since they are priced higher than "standard" tapes, it is normal to ask what practical sonic advantages they have.

To find an answer to the question, we tested several of these tapes, from different manufacturers, on a single high-quality cassette recorder. The relative performances of the tapes should be valid in any machine, though the specific results we obtained would probably not be duplicated on any other make of recorder.

Tapes Tested. We did not attempt to test every "high-evergy" or "low-noise" tape on the market. The ones we chose are representative of the available premium-grade cassettes. As a control, we used an Audio Magnetics cassette marketed for audio-visual applications in schools under the name "AV Educator." This tape is similar in its bias requirements to the few standard hi-fi tapes we have been able to identify.

The tapes arbitrarily chosen for testing were:

Brand	Model
Ampex	363
BASF	LHSM
Capitol	2
Memorex	MRX2
TDK	SD
TDK	ED

The Ampex 363 is a chromium-dioxide tape which was included to provide a second frame of reference (All American-made CrO_2 cassettes use Dupont Crolyn ® tape and have similar magnetic properties.) The other tapes are all ferric-oxide, high-output types, though the new TDK ED is modified with magnetite which is said to improve its magnetic qualities.

The recorder's "regular" bias was optimized for the test's control tape, while its CrO_2 bias was correct for the Ampex tape. The bias was not changed throughout the tests.

Our purpose was to find as many dif-

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ferences and similarities as possible between the vaious tapes when operated under identical conditions in the same tape deck. We measured the record/playback frequency response at a level of 0 dB on the recorder's meter and at levels of −10 dB, −20 dB, and −30 dB. The playback harmonic distortion was measured with recorded levels of −3 dB, 0 dB, and +3 dB and at frequencies of 100 Hz and 1000 Hz. (We also tested at 5000 Hz, but the results were so nearly alike that we discarded them.)

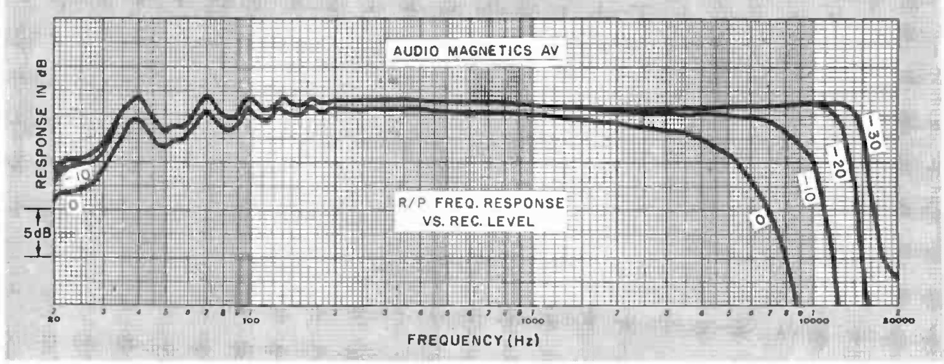
The S/N ratio, relative to the playback level of a 1000-Hz signal recorded at 0 dB, was measured with an IEC (ANSI "A") weighting characteristic to exclude the effects of hum and inaudible low-frequency noise. The recorder's Dolby noise-reduction system was not used during these tests.

The 1000-Hz recording level required for a 3-percent distortion in the playback signal was measured, since the final S/N ratio is determined by the 3-percent THD point rather than by the recorder's meter indications.

Finally, we measured the playback output from each tape after it had been recorded to a 0-dB level, comparing it to the output from a Dolby standard level tape (200 nanowebers/meter flux).

It should be emphasized that a cassette recorder must be biased specifically for the tape in use. A tape with different magnetic properties will generally not give the same frequency response. Therefore, we could not expect, nor did we obtain, a "flat" response from any of the tapes except the standard AV and CrO_2 tapes for which the machine was biased.

A high-energy tape will usually require more bias than a standard tape. It will also have an exaggerated high-frequency response if it is underbiased. We were looking for differences between tapes rather than their actual performance in the test tape deck. Hence, this did not unduly concern us.



What The Measurements Revealed. The frequency response curves clearly demonstrate that, with cassette recorders and tapes, there is no such thing as a frequency response. The actual response is a function of recorded level since the recording pre-emphasis leads eventually to tape saturation at low and high frequencies with increasing input level. This is seen principally as a rolloff of the highs at the higher recording levels. With most tapes, it also shows up as a slight desensitization at middle frequencies and a drop of several decibels at the lower frequencies at maximum recording level.

Cassette recorder frequency response is usually measured at −20dB, but the curves for every tape show a substantial improvement at the high end when the level is reduced to −30 dB. We did not go any lower because we wanted to avoid the influence of noise on the measurements.

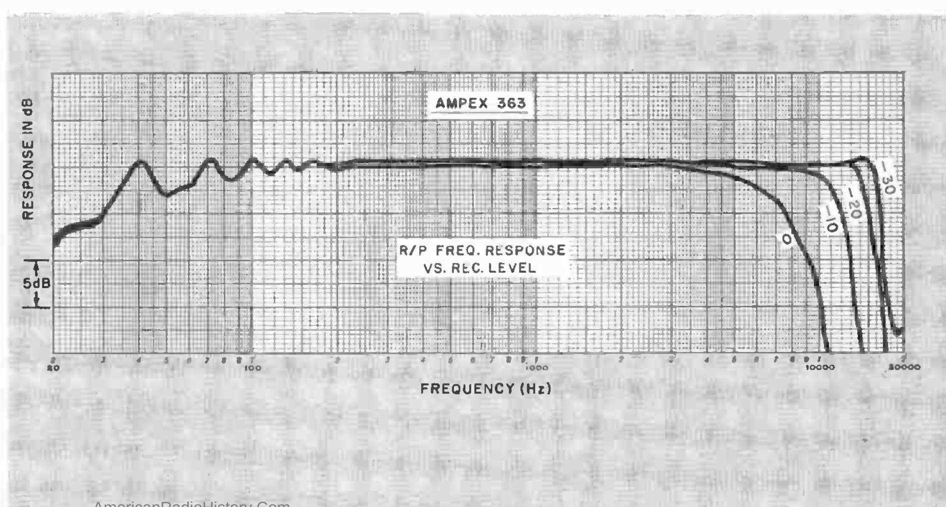
These curves suggest that the frequency response of a cassette deck varies continuously with program level. This is a startling concept for people who are accustomed to thinking of frequency response as a fixed characteristic. Nevertheless, this is exactly what happens. A good tape should preserve the dynamics and frequency response of the original program. Thus, the degree to which the frequency response is influenced by level should be one indicator of a tape's quality.

To compare the tapes, we listed the drop in response at 8000 Hz caused by a level shift from −10 dB to 0 dB, the drop at 12,000 Hz with an increase from −20 dB to −10 dB, and the drop at 15,000 Hz with an increase from −30 dB to −20 dB. By summing the decibel figures, we could draw some conclusions as to the high-frequency recording qualities of the tapes. Not surprisingly, the standard AV tape showed the greatest change, and the CrO_2 tape was the least affected. Although the other ferric-oxide tapes showed distinct differences and could be ranked in this test, we would hesitate to draw sweeping conclusions from the ranking order.

The TDK SD tape was somewhat better than the AV tape. The Capitol 2 and MRX2 were about equal to each other and slightly better than the SD tape. The BASF LH and TDK ED tapes headed the list.

The differences between tapes that rated close to each other were too small to be really significant, but there was no doubt that the TDK ED was the best of the ferric-oxide tapes in this respect; it also carries the highest price. However, the CrO_2 tape (which carries the highest price among tapes tested) out-pointed the TDK ED tape by about the same margin as the latter had over the bottom-ranking AV tape. This could have been because a different recording level was selected within the recorder in the CrO_2 mode. So the difference may not be as dramatic as it appears to be.

Adding the effect of the low-frequency response change over a level shift from −30 dB to 0 dB did not



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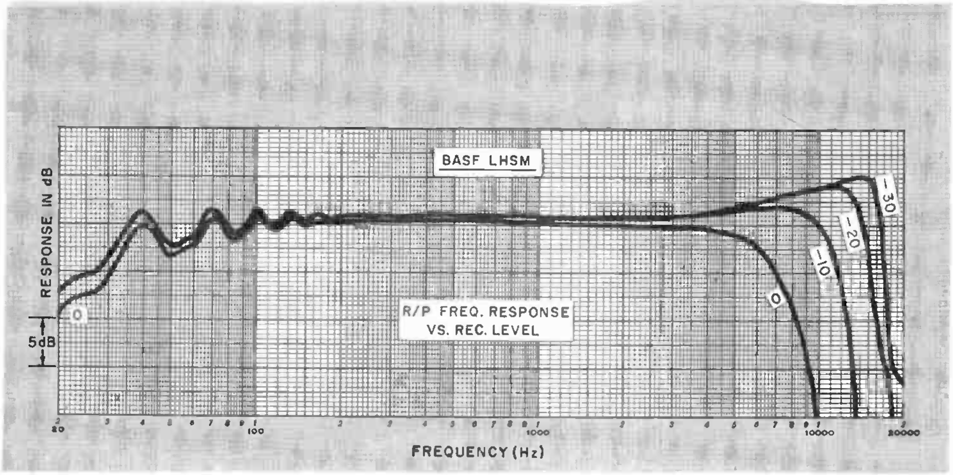


change the rank order of the tapes. The CrO_2 tape was the only one whose low and middle frequency responses were not affected by recording level. The AV and MRX2 displayed more change, while the other tapes were closely grouped between these extremes.

Another point of difference was the 100-Hz distortion at a +3-dB recording level. The Capitol 2 and BASF LH exhibited less distortion than the MRX2 and AV tapes, while the TDK SD and ED had the lowest distortion of the ferric-oxide tapes. The exception, again, was the CrO_2 tape, which had less than half the distortion of the TDK SD. The latter was the best of the ferric-oxide tapes used in this test.

The S/N ratio measurements revealed only minor differences in the tapes. The TDK and MRX2 tapes were slightly better than the AV, Capitol 2, and BASF LH tapes, but the difference from "best" to "worst" was only 2.5 dB. It is not fair to include CrO_2 tape in this comparison since the recording and playback equalization are switched with the bias to obtain the best S/N ratio. This gives it a 2.5-dB advantage over the best ferric-oxide tapes.

From the manufacturers' viewpoints, there are doubtlessly numerous weaknesses in this type of limited test program. This is why we caution against drawing unwarranted conclusions. For one thing, it is possible that, by optimizing the recording bias for each tape, the results might be affected. We would not expect any major shifts, but most of the tapes were so close in these measurements that even a minor change in high-frequency response could affect their standing. Possibly a different recorder, whose head required either more or less recording equalization than that of the tape deck used would also alter the standings. On the other hand, most consumers have no choice of recording bias (except as provided by a switch on some deck models) and would, therefore, be powerless to optimize their equipment for any particular tape.

How The Tapes Sounded. Since many of the measured differences between the tapes were so slight as to be inconclusive, or at least open to question, the next step was to record music on these tapes and listen for differences during playback. We used phonograph records with considerable energy in the highest octave, as well as in the middle and low-frequency ranges. For these tests, we used the recorder's Dolby noise reduction system, since we wished to minimize the effect of noise level on apparent frequency response.

A selection was recorded onto each tape without disturbing the setting of the recording level controls and played back for an A-B comparison with the disc. Average levels on the recorder's meter (about −3 dB) were used initially, followed by an increase to 0 dB. If the sound quality warranted it, we also recorded at +3 dB, which was the full-scale meter deflection.

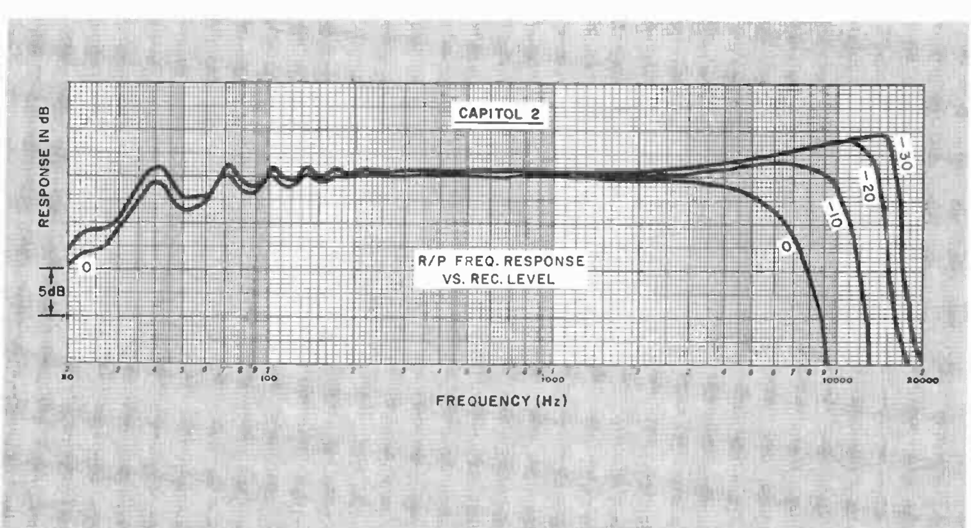
In this test, most of the tapes sounded slightly "bright" due to being underbiased. Interestingly, this effect was not nearly as prominent as the curves would suggest. Evidently, this was due to the rather high average program levels we were using. Most of the tapes rolled off appreciably at the top end, leaving a residual brightness in only the low-level passages.

This test produced no major surprises, although it tended to confirm our suspicion that the minor differences in tape ranking based on tape saturation effects were insignificant in practice. The AV tape (which, after all, is not represented as a "high-fidelity music" tape) had a hazy quality at −3 dB, with an obvious loss of definition on high-frequency transients. At 0 dB, the sound took on a blurred quality. However, by reducing the recording level to −10 dB, the sound was quite good.

Since the operating bias for the TDK SD is only slightly higher than for most standard tapes, it was operating nearly at its optimum point. The results were impressive, with essentially "perfect" sound quality at −3 dB and 0 dB. The only difference between the playback and the incoming signal was a minute dulling of the attack on high-frequency transients. Clearly attributable to tape saturation, this effect was audible to ome degree with all the test tapes at the levels we were using.

The other ferric-oxide tapes sounded surprisingly similar to each other. They were all bright sounding, but very clean, at −3 dB. With a slight correction from the amplifier's tone control, this could be converted to a virtually perfect sound. The correct approach, of course, would be to increase the tape recorder's bias to flatten out the response.

At 0 dB, there was no significant deterioration of quality. But at +3 dB, the change was marked. Our first impression was of a brighter sound, which seems contrary to expectations. Further listening revealed that a layer



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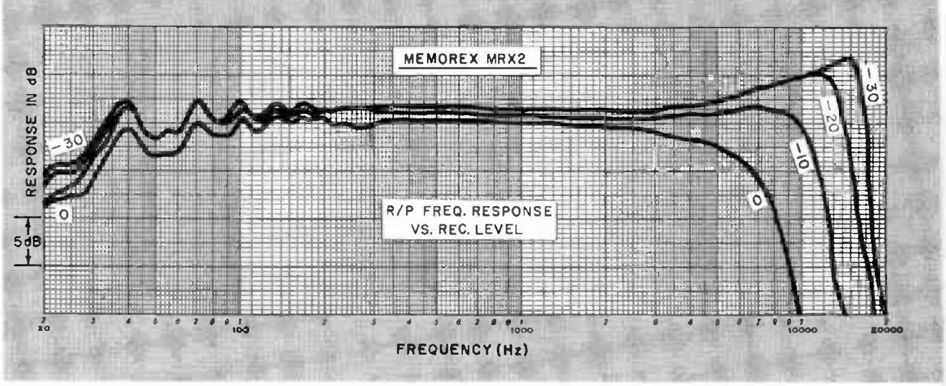
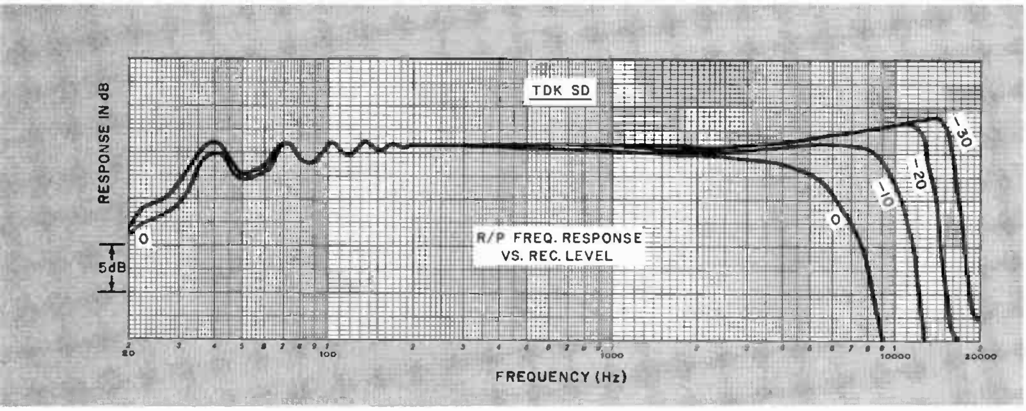
of sonic "fizz" (background noise) had been added to the music. This was the audible effect of high-frequency intermodulation products, which fell in the middle frequency range. The noise has the effect of making the overall sound appear to be bright.

The CrO_2 tape generally sounded much like the better ferric-oxide tapes. Any differences that existed were in its favor; but in this test, they were slight.



In Conclusion. Combining the results of our measurements and listening tests, we must conclude that CrO_2 tape used in a recorder designed to exploit the tape's qualities has clear advantages in distortion, S/N ratio, and resistance to tape saturation. The fact that this superiority is not always audible is a testimonial to the state of the art in cassette recorders and tapes, whose quality, in many cases, is better than the programs most people choose to record on those tapes.



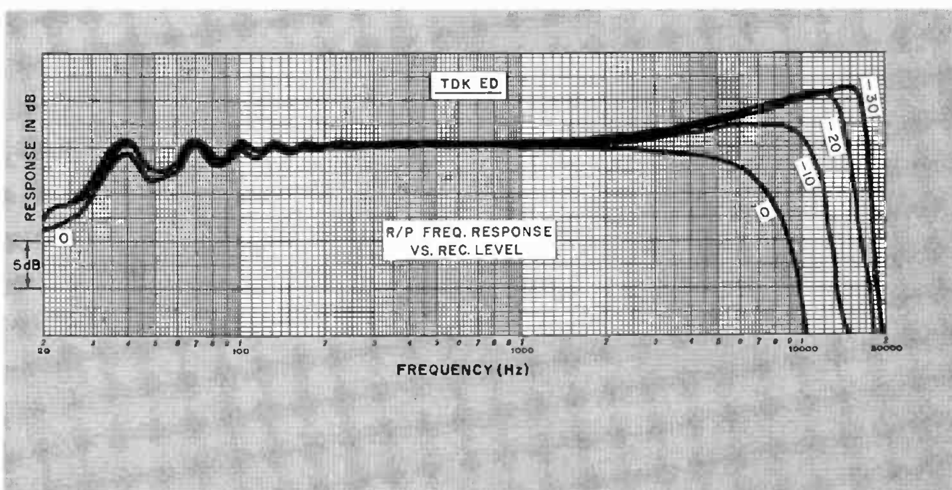
Among the ferric-oxide tapes, TDK ED and BASF LH seem to outperform the others, even if only slightly, in almost every respect. Previous experience with Maxell UD (not tested in this study) suggests that it would also rank with these two tapes with respect to the characteristics we evaluated. The other premium-grade tapes are very close to the top two or three. We would have difficulty justifying a ranking order because each tape had some points of superiority and others where it was somewhat inferior. Interestingly, the TDK SD tape was the only one of the premium tapes capable of delivering its best performance with standard bias levels.

Although the AV tape was included principally to show up the superiority of a premium tape for music recording, no apologies need be made for its performance. It was as good as any "standard" tape we have used. At lower recording levels, it came close to matching the sound of the other tapes.

There is an obvious lesson to be learned from our tests. To make the best recordings, use the best tape you can get. It is probably no coincidence that TDK ED and most CrO_2 tapes are relatively expensive. On the other hand, it is comforting to know that if your budget cannot accommodate them, you could use any of the other tapes and 99.9 percent of the time there would be no audible differences in the sound.

What about recording levels? Obviously, the tapes that are less easily saturated can be recorded at a higher level without unpleasant side effects. The manufacturers make a point of emphasizing this in their promotional literature. However, the extra "head room" of these tapes is not great (perhaps 3 dB or so), and our own preference would be to continue recording at a level that would be used with standard tapes. This must be determined for each recorder, since there is no standardization between their meter indications and the actual level recorded on the tape. Unless you are attempting to wring out the last decibel of S/N ratio, the true benefits of a high-energy tape can best be realized by letting its extra dynamic range accommodate those brief transients that might otherwise contribute to the background haze of an over-recorded cassette. This will also permit you to extract the greatest amount of the high-frequency response built into these tapes.

Since most tape decks cannot readily have their bias settings changed by the average recordist, we suggest that you follow the manufacturer's recommendations for suitable tapes, unless you find another kind more pleasing to your ears. The slight added brightness of a premium tape in a standard-biased deck is not unpleasant and may even help to compensate for some of the recorder's limitations. Since all CrO_2 tapes have the same bias requirements, you are less likely to go wrong in selecting a tape if you use chromium-dioxide tapes, assuming that your recorder has a CrO_2 switch to effect proper bias and equalization. ◈



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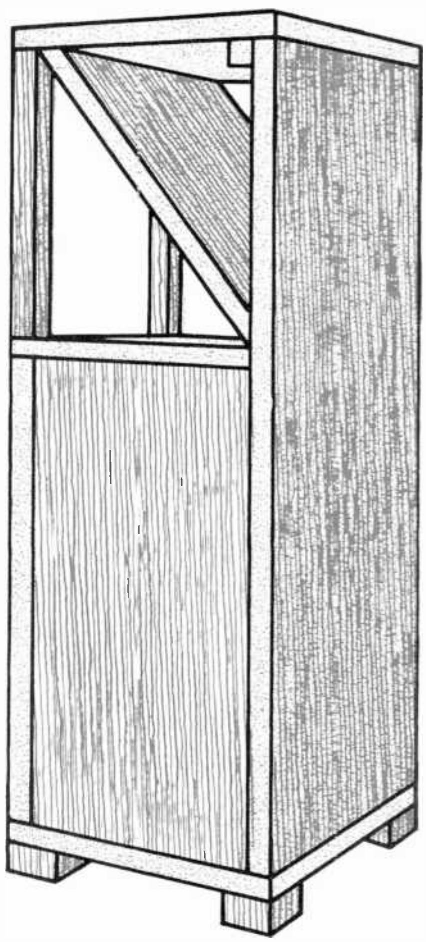
Build a Large-Port Speaker System

High-efficiency ported enclosure features novel high-frequency reflector system



BY DAVID B.WEEMS

IN 1971, an article in a British hi-fi magazine described a speaker enclosure called a "large-port reflex." Its most distinctive feature was the non-uniform cross-section of its port, formed in two parts by a pipe and a cavity. The dimensions of the latter were determined by the distance between the bottom of the cabinet and the floor, making the feet a functional part of the enclosure.

Another unusual feature of the system was the orientation of the speaker: it faced upward. Two kinds of reflectors were suggested: a diffuser for omnidirectional high frequencies, or a simple 45° reflector board. Especially recommended was the flat reflector for its stable stereo image.

American Version. The enclosure described in these pages is based on the British speaker system — with some important modifications. One questionable aspect of the 45° reflector board was that it, in common with most other small floor-standing speaker sys-

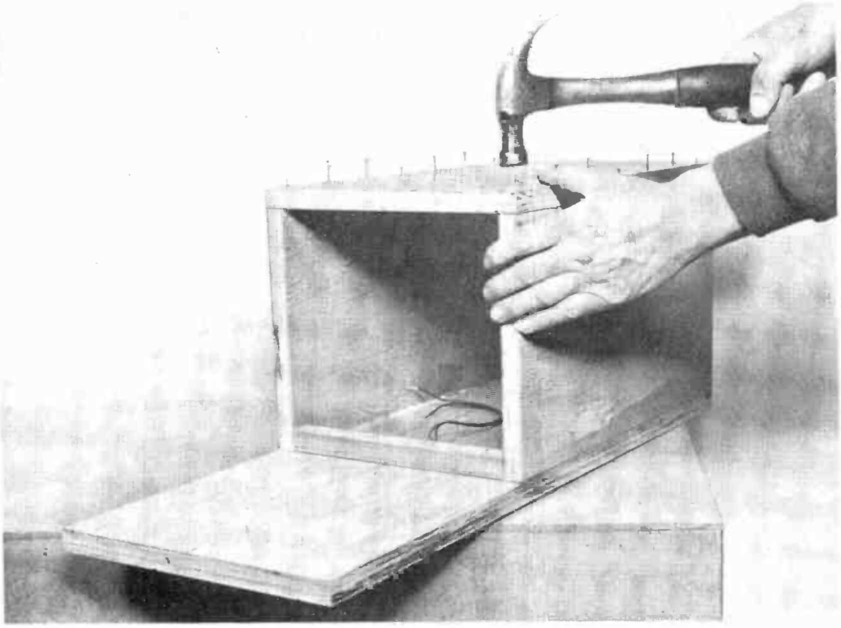


Fig. 2. Basic box is assembled with glue and nails. Don't skimp on the glue.

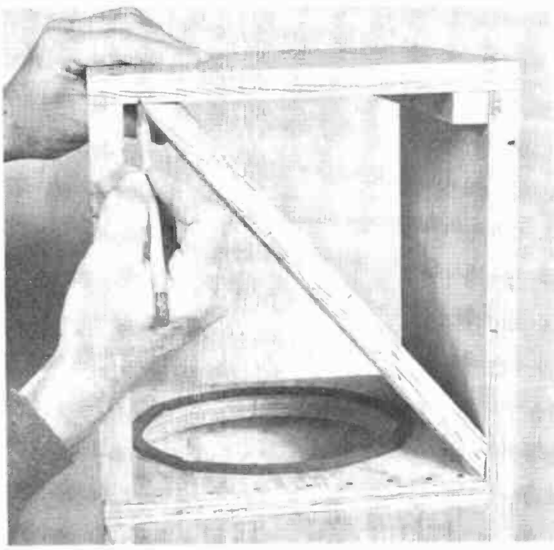


Fig. 3. With top panel temporarily in place, strike leading-edge line of reflector.

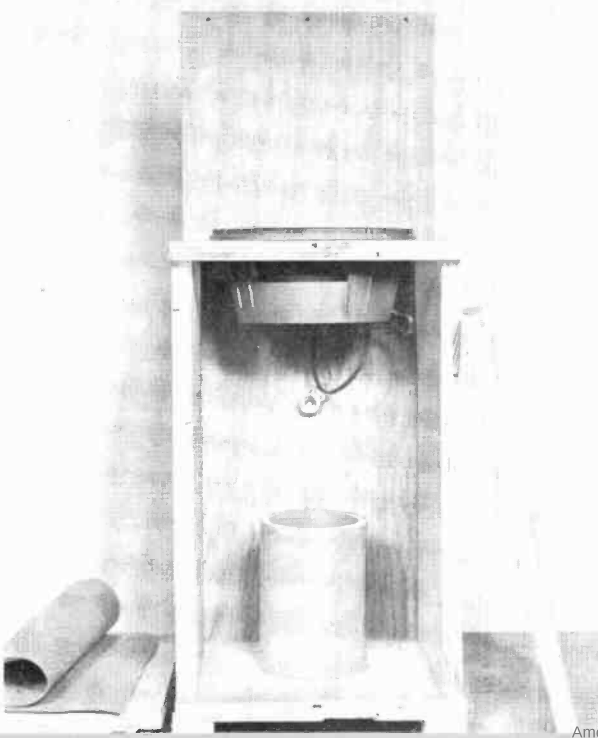


Fig. 4. Speaker faces upward. The terminal board and tweeter control are mounted on rear.

saw available and cannot get a lumberyard to make the cuts, you might want to substitute another kind of reflector, perhaps one suspended from the back or top panels of the enclosure.)

Attach the two front corner posts to the top panel with inside corner braces, and glue and nail the top cleat to the bottom of the top plate parallel to but ¾" (1.9 cm) from the rear edge. Set the top on the enclosure and hold the reflector panel in its proper position so that you can mark a line where the latter's leading edge meets the bottom surface of the top panel. (See Fig. 3.) Drill three or four shank holes through the reflector panel's top edge to permit screws to enter the top panel at a 90° angle. Glue the top edge of the reflector panel and use 1" (2.54 cm) flathead wood screws to fasten it to the top panel along the struck line.

While the glue is setting, prepare and install a gasket for the speaker. One of the easiest gaskets to use is a piece of ⅜"-wide by $^{3}/_{16}$-thick (0.92 cm-wide × 0.48 cm-thick) adhesive-backed foam weather stripping. Set the speaker in the opening, and mark the locations of the mounting screws. Drill pilot holes for the screws. Then, when you cut the weather stripping, make half-circle cutouts where the holes are so that the screws do not catch on the foam and damage the seal. Trim the gasket carefully so as to leave no gaps where the ends meet, else the tuning of the enclosure will be affected.

Tack 1" (2.54 cm) or thicker of acoustical damping material to the inside walls of the enclosure. Then cut some loose pieces and drop them around the pipe so they cover the bottom of the box. Next, solder the conductors at the free end of the lamp cord to the lugs on the speaker, and identify with paint or nail polish the terminal board screw that goes to the positive lug of the speaker. Install the tweeter control on the back panel, and mount the speaker in its cutout. (See Fig. 4 where the front panel is shown removed for clarity.) Use panhead sheet metal screws for fastening down the speaker.

Final Construction. At this time it is a good idea to check that everything is working properly. Then complete and install the reflector assembly as follows:

Glue a sheet of ⅛"-thick (0.32 cm-thick) resilient foam plastic to the reflector board and mount on this a 10" × 8" (25.4 cm × 20.32 cm) sheet of win-

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dow glass with the aid of four mirror clips and four 1" (2.54 cm) wood screws as shown in Fig. 5. Most mirror clips are designed to accommodate a ⅛"-thick (0.32 cm-thick) piece of glass; so, you might have to shim each clip with wood or hard plastic.

Temporarily mount the reflector assembly with a single screw in the middle of the back panel. Place the speaker system (or systems if you are assembling a stereo pair) in its permanent listening position and check the high-frequency coverage. If you want wider dispersion, you can unscrew the reflector assembly and replace the glass with a convex reflector as mentioned earlier. Look for a flattish dome that will not reflect the highs back onto the speaker.

When you mount the reflector assembly, use no glue. (You may need easy access to the speaker in the future.) Just sink three screws through the back panel into the top cleat, three more into the reflector panel, and eight more through the corner braces into the front corner posts and top of the speaker board. (See Fig. 6.)

In Fig. 7 are shown two views of the speaker system just prior to finishing. At this point, you should break all sharp edges with medium-grit sandpaper. Then sand and stain the top panel, after first attaching the trim around the raw exposed edges. Paint the front and side panels and the corner posts flat back. The enclosure's feet can be painted black or stained.

After the stain and paint have dried, stretch and staple the grille cloth around the enclosure. Finish up by attaching the bottom bumper, made from sanded and stained 1½" × ¾" (3.81 cm × 1.9 cm) pine, with finishing nails. This bumper should come flush with the bottom panel; under no circumstances should it extend to the floor.

In Use. Place the speaker system or systems on a carpeted floor for best results. If after a listening test you note a tendency toward boominess, try different room locations if possible. You might also try stuffing a small wad of fiberglass insulation into the pipe at the bottom of the enclosure. (No disassembly is necessary. Just tip back the enclosure and insert the insulation.) Theoretically, this is not the best place to put damping material, but in a finished system it is the most convenient. And it appears to be quite effective. ◈

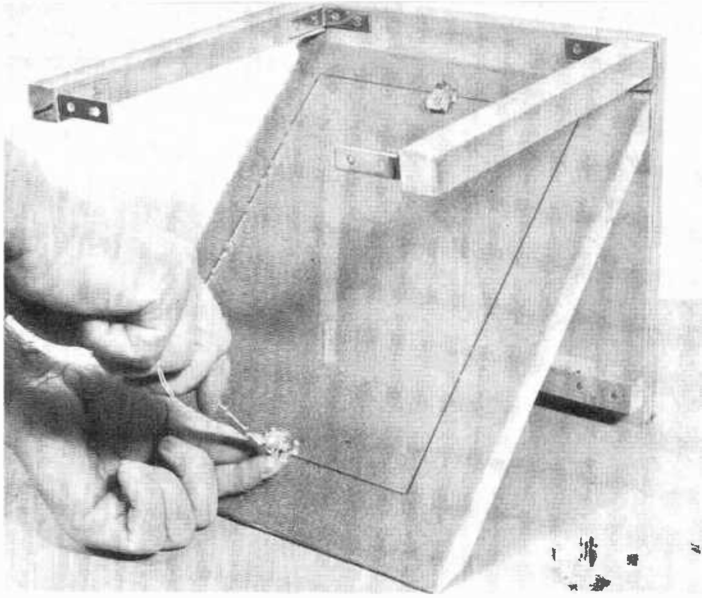

Fig. 5. After gluing foam padding, mount sheet glass reflector with mirror clips. Note weather stripping gasket around the speaker cutout.

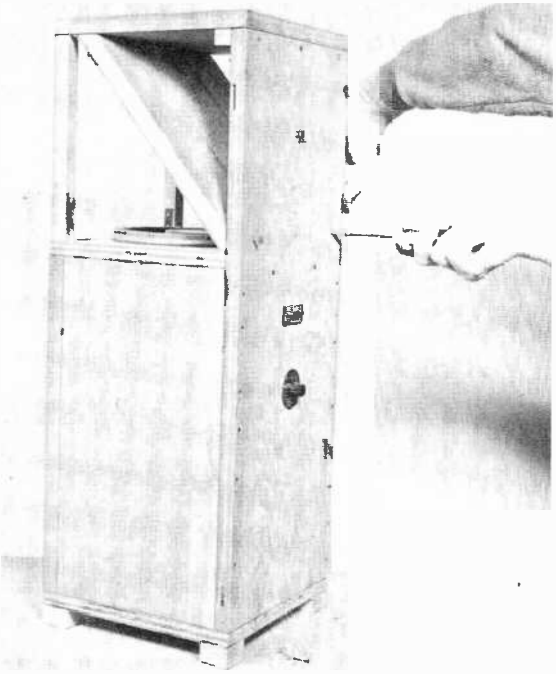

Fig. 6. Top and reflector assembly are fastened to enclosure with wood screw but no glue to provide access in the future.

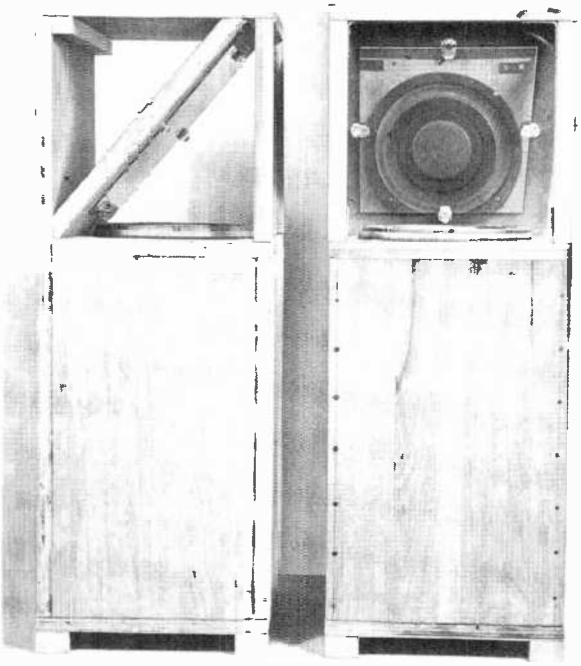

Fig. 7. Completely assembled but unfinished speaker system from front and side.

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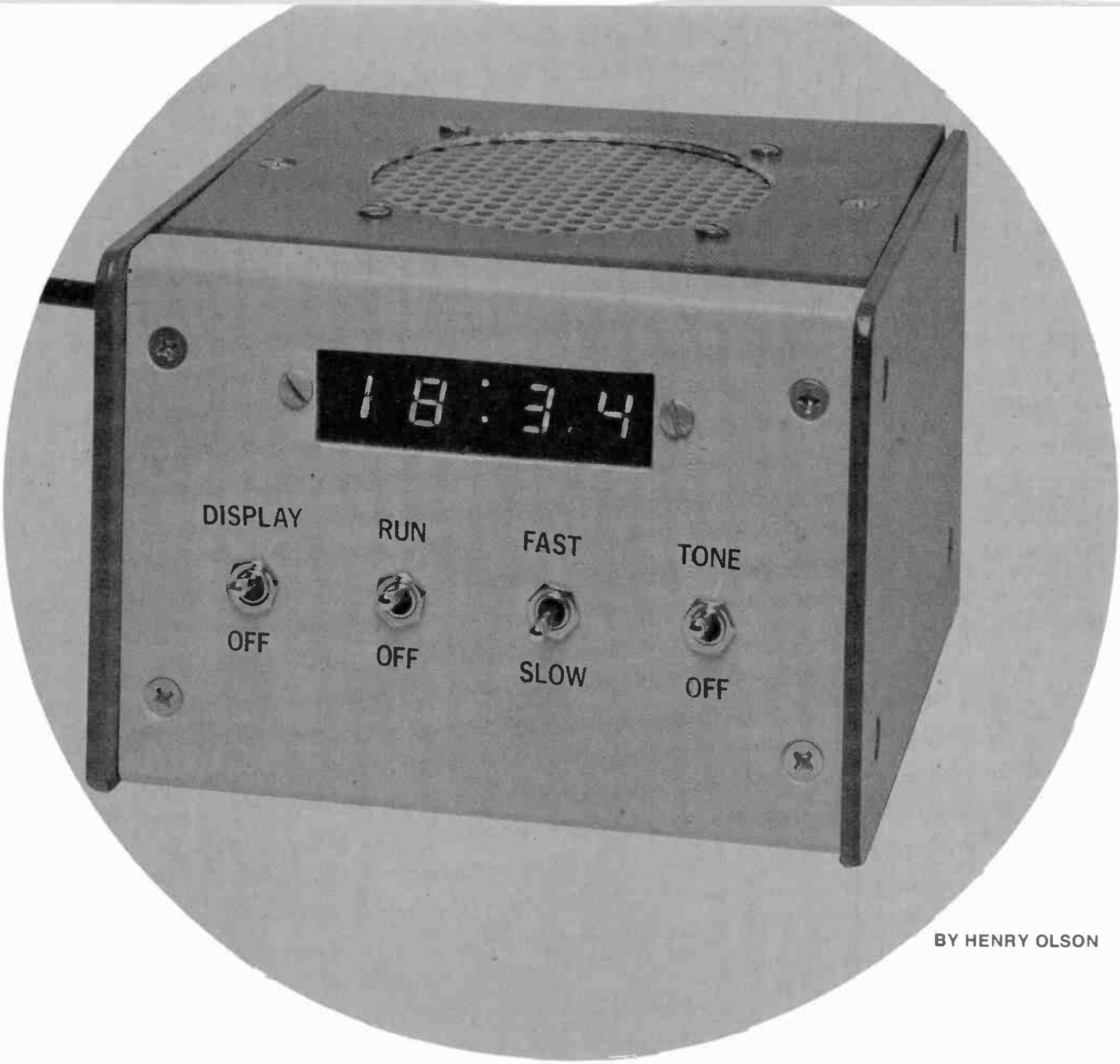

BY HENRY OLSON

"An amateur station shall be identified . . . at intervals not to exceed 10 minutes. . ." FCC Rules and Regulations, Part 97.87 (a)

ADD A 10-MINUTE "BEEPER" TO YOUR DIGITAL CLOCK

EVERY amateur radio operator knows that FCC rules require that he identify his station every 10 minutes. He also has to log the time of every contact he makes. Both requirements can be easily met if he has a clock with a beeper to give him an audible signal every 10 minutes.

With today's digital "clock-on-a-chip" IC's, building the clock is not difficult. A typical circuit (using an MM5314 IC which costs about $10) is shown in Fig. 1. The "Digital Clock-Calendar" project published in this magazine in November 1973 could also be used. These are 24-hour clocks, which can be set for GMT, normally used by hams.

With a suitable clock available, the ham operator then needs a way to obtain a 10-minute signal from the clock to drive a

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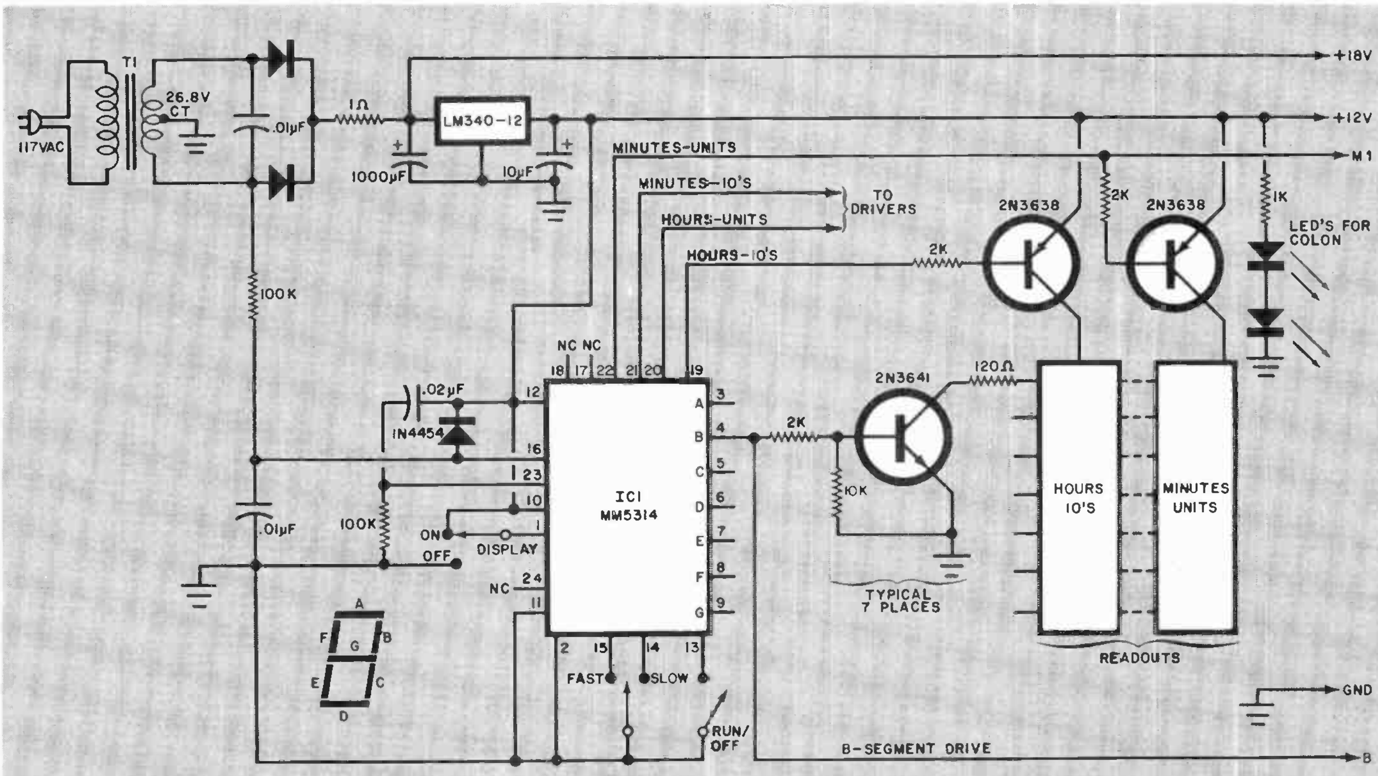

Fig. 1. A basic 24-hour digital clock circuit using an MM5314 IC. Other digital clock circuits could be used with the beeper. Note that only the units-of-minutes driver signal and the readout B-segment signal are used to drive the beeper circuit. If interference is too bad, an r-f decoupling filter can be used.

beeper at the proper identification intervals. Such a circuit is shown in Fig. 2.

How It Works. To understand how the beeper works, it is necessary to examine the way the clock generates the driving signals for a seven-segment readout. The logic that is required to operate the readout is shown in Fig. 3. Note that, in the column for the B segment, the signal changes from the high state to the low state at the count of five. It is that change in states that is used to drive the beeper.

Processing the signal for the beeper requires the use of three IC's because the output of the clock chip is multiplexed. (Drive signals for segments are actually on at all times but display is controlled by digit drivers.) The logic circuit for demultiplexing the signals (Fig. 2) is built up of CMOS IC's with the same pin configurations and functions as their 7400-TTL counterparts.

Elements G, H, I, J, and K form a latch circuit. To assure that the B segment of only the ones of minutes is clocked into the latch, two one-shot (delay) multivibrators (A with B and C with D) are used to

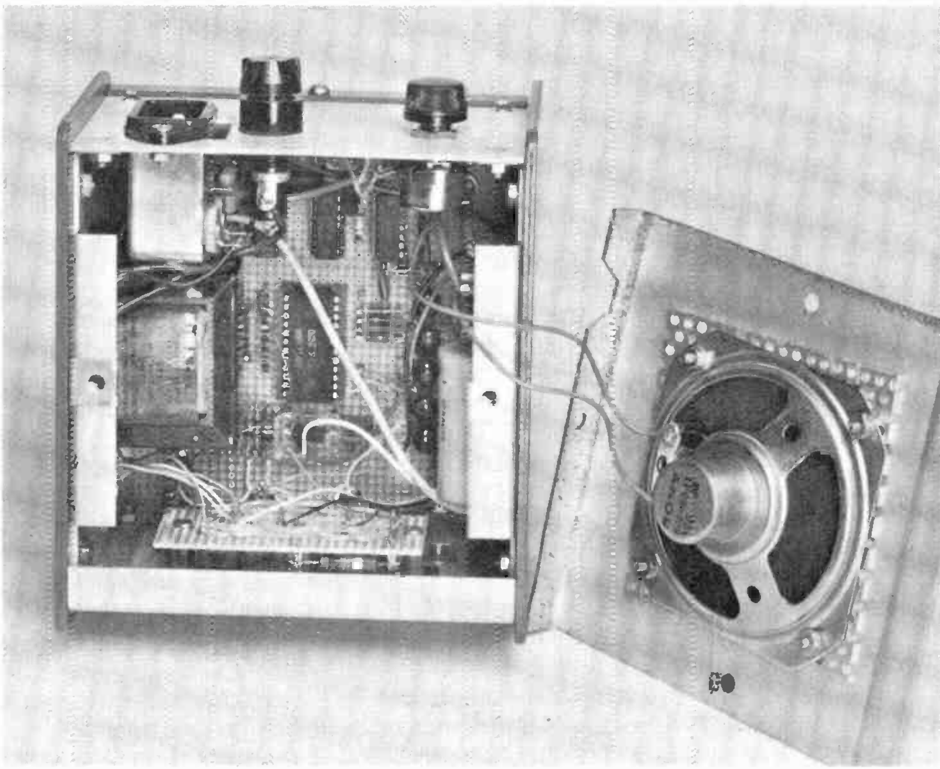

Photo shows internal arrangement of the prototype.

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PARTS LIST

C1, C3, C6—1000-pF capacitor
C2, C4—4700-pf capacitor
C5—0.47-μF capacitor
C7—470-pF capacitor
C8—1-μF capacitor
IC1, IC2—74C02 CMOS quad 2-input NOR
IC3—74C04 CMOS hex inverter
Q1—2N3638 transistor
Q2—2N3641 transistor
R1, R2, R4, R8, R11—10,000-ohm resistor
R3, R5—120,000-ohm resistor
R6—1.5-megohm resistor
R7—1000-ohm resistor
R9—1-megohm resistor
R10—100,000-ohm potentiometer
S1—Spst switch

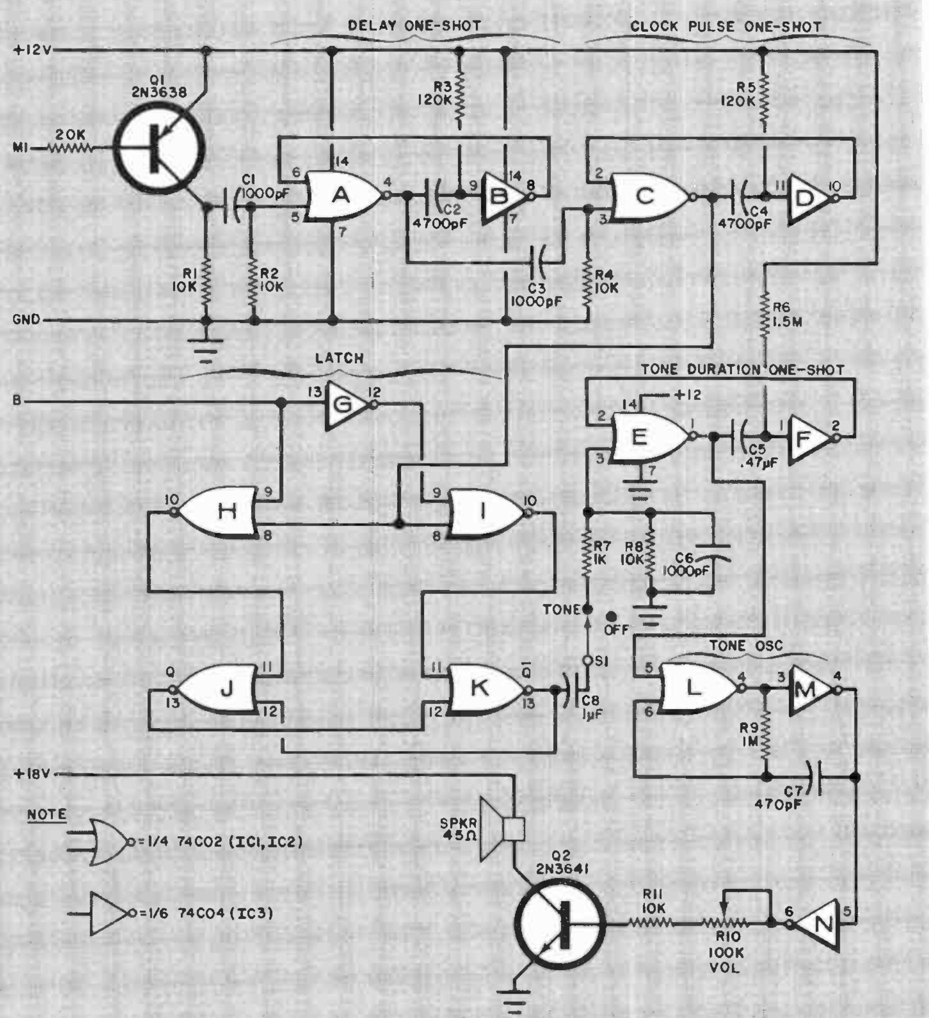


Fig. 2. The beeper circuit uses CMOS equivalents of conventional TTL chips. Inputs are units of minutes (M1), and minutes readout of B segment. The beep occurs on 4/5 transition.

shorten the width of the pulse wave form.

Since the latch is similar to a conventional flip-flop, it has both a Q and a not-Q output. That is, if a 1 is present on the B-data input (when the clock is at 0), then a 1 will be held on the Q output after the clock input changes to a 1. The not-Q output is held at 0.

By using the not-Q output of the latch, the level change when the minutes digit changes from 4 to 5 is from 0 to 1. This step output is differentiated by the following RC network and turns on the tone-duration one-shot (elements E and F). The output of the one-shot then activates the 1-kHz tone oscillator (elements L and M) for about one-half second. The tone burst is buffered and used to drive a small speaker through transistor *Q2*.

Construction. Since the clock is to be used in a ham station, with a high r-f environment, it should be enclosed in a metal case. For the prototype, the author used a Moduline P-355 case. If interference is too bad, an r-f decoupling filter (Corcom 6EF2) can be used in the power line where it enters the metal chassis. An equivalent job of line filtering can be obtained by using ferrite beads and feedthrough capacitors.

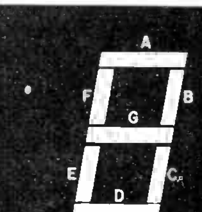
The composite digital clock and beeper can be assembled on perforated board using sockets for the IC's. In the clock circuit, six digits can be used by adding two more readouts and another pair of LED's for the extra colon.

Operation. Plug the clock into the power line and turn on the DISPLAY switch, the TONE switch, and the RUN switch. Leave the FAST/SLOW switch on the center position. The four readouts will indicate some time and the center colon should be lit.

Using the FAST/SLOW switch, cycle the clock through its 24-hour sequence, noting that the beeper works each time the minute readout goes from 4 to 5. Set the volume of the beeper as desired.

Again using the FAST/SLOW switch, set the clock one minute ahead of the correct time (preferably using WWV). When the clock just indicates the hour, turn it off, wait for the hour tone to sound on WVV and then turn the clock on.

When you are not using the clock to time ham transmissions, turn off the beeper. ◈



DECIMAL NUMBER	SEGMENTS A	B	C	D	E	F	G
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	0
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	0	0	1	1	1	1	1
7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	0	0	1	1

Fig. 3. Signals required for each digit of a 7-segment readout.

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A USER'S GUIDE TO MOBILE CB ANTENNAS

BY W.J. EVANZIA

Where to mount the antenna and how it performs

MANY CB'ERS are under the misguided impression that they can mount an antenna anywhere on a car and it will work to the best of its ability. But they soon become frustrated when they cannot reach their base stations or fellow mobiles just a mile or two down the road. Assuming the transmitter is performing properly, the problem in such a situation could very well be in the antenna.

Just about every CB'er knows that an antenna can be mounted on a vehicle's roof, trunk lid, fender, or bumper. However, many people do not realize that the antenna's physical location on the vehicle is often critical in maintaining station-to-station contact.

Some Technical Facts. Simply defined, an antenna is a device that radiates or receives electromagnetic energy known as radio waves. When designed for mobile work, all CB antennas are some multiple of one-quarter wave ($\lambda/4$) in length. For example, a 27-MHz, Class D CB antenna, if cut to one full wavelength, would be 36 feet. So, if λ is 36 ft, $\lambda/4$ would be 9 ft. or 108 in., which is exactly the length of the whips used by many CB'ers on their cars.

So far, we have discussed only half the antenna story. The basic antenna (of any type) is a $\lambda/2$ element. Therefore, for the $\lambda/4$ antenna to operate properly, a ground plane is required to serve as the missing quarter wavelength. In mobile applications, the vehicle's body becomes the ground plane and is the image of the $\lambda/4$ antenna (see Fig. 1).

Although it is a favorite topic among CB'ers, when they refer to "antenna gain" they are usually discussing beam antennas at fixed base stations rather than the vertical mobile whip. Antenna gain is defined by John Markus in his *Electronics and Neucleonics Dictionary* as "the effectiveness of a directional antenna compared to a standard non-directional antenna." The key word here is *directional*.

Theoretically, when an antenna is mounted in the center of a ground plane—such as an automobile's roof—it radiates equally well in all directions. In practice, however, this is not the case.

It is possible to mount two antennas one-quarter wavelength apart and feed power to them in such a way that their signals add to each other, and a directional beam will be obtained. This is so-called "co-phasing". Proper signal addition depends on the phase relationship between the two antennas. Hence, the type of coaxial cable feeding the antennas (which changes the impedance match) as well as physical spacing is critical.

Antenna Specialists Co. markets a phasing harness that does a creditable job of co-phasing antennas. It is made of combinations of RG59/U, RG11/U, and RG8/U coax. Pairing two types improves the impedance match. AS also makes a three-position control box

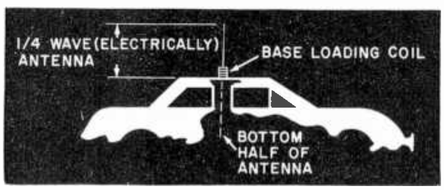

Fig. 1. Loading antenna improves impedance match and shortens length. Automobile provides ground plane and bottom half of the antenna.

that switches the phase of the feed signal to provide 2 dB gain in the forward and rear directions and 1 dB gain to both sides.

In mobile work, co-phased antennas operate best on large vans or motor homes where there is adequate room for the 9-ft spacing between antennas and the ground plane is large and flat.

Returning to the single whip, we find that these antennas are usually used in mobile installations because they require very little space and are easy to install. By using loading coils, the physical length of the whips is kept short, while their electrical lengths are optimized for resonance.

A number of manufacturers produce top-, center-, and base-loaded tunable and fixed-tuned antennas, as well as continuously tunable antennas for CB use. Naturally, you choose the one that gives the best performance for the type of vehicle on which you intend to use it. As a rule, top-loaded antennas provide the best radiation pattern in the plane of the vehicle. The center-loaded antenna is optimum for average ground resistance; by placing the loading coil at the center of the antenna instead of at the base, the radiation resistance is increased, although a larger coil must be used.

Bear in mind that any movement of the top- or center-loaded antenna that changes its position with relation to the ground plane, as when a vehicle is in motion, changes radiation efficiency. If the antenna is made stiff enough to remain upright at highway speeds, it becomes susceptible to severe damage from low-hanging tree branches and anything else that gets in its way. In general, the base-loaded antenna remains stable under most conditions and is less susceptible to damage.

Tuning the Antenna. Most antennas designed for a specific frequency are pretuned at the factory and little adjustment is necessary. But if tuning is required, an r-f wattmeter or VSWR bridge should be used.

To tune the antenna, first connect it to the transmitter through the VSWR bridge. Power the transmitter and observe the bridge to determine the for-

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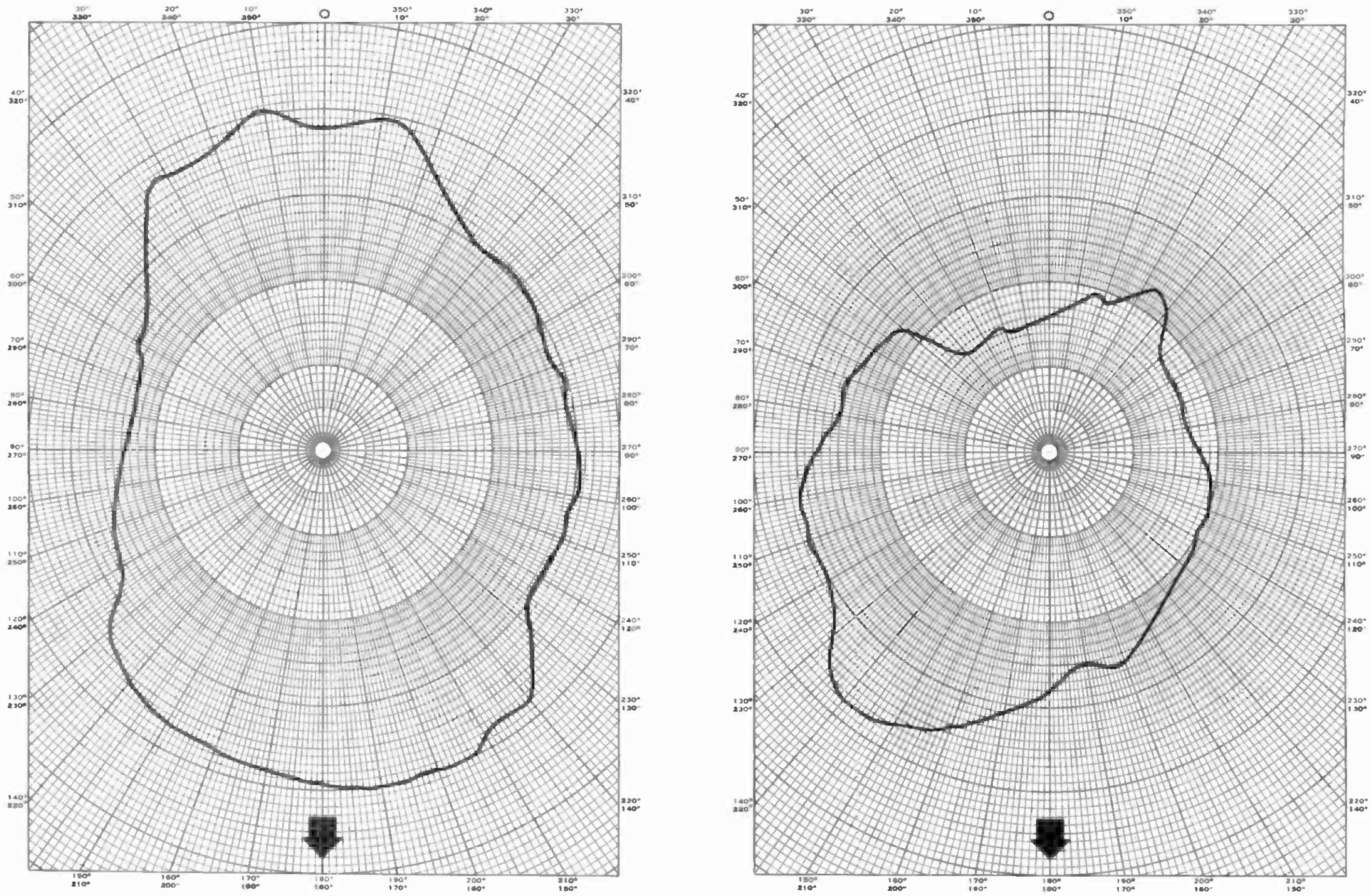


Fig. 2. Typical horizontal radiation patterns when a vertical whip antenna is mounted on the roof (at

ward and reverse power or SWR figures. If the VSWR is greater than 1.5:1, determine the direction of the required adjustment by moving the whip up or down in its mount or by changing taps on the tunable coil. Once you know how the adjustment must be made, adjust the antenna until the lowest SWR is obtained. (You can shorten stainless steel whips by scoring them with a file or grinding wheel and using heavy-duty pliers to snap off the unwanted pieces.)

Where to Put the Antenna. As mentioned earlier, the location of the antenna on a vehicle has considerable effect on performance because the vehicle's body influences the radiation and reception patterns. As Fig. 2 illustrates, the wave patterns for a λ/4 vertical whip mounted on a car's roof, rear deck, and rear bumpers are significantly different.

If a 9-ft unloaded whip and a base-loaded antenna are mounted in the center of a car's roof, the 9-ft whip will be the better performer. Also, a 9-ft whip mounted on the rear deck usually outperforms the roof-mounted base-loaded antenna. But a bumper-mounted 9-ft whip will come out second best because the roof-mounted antenna radiates evenly in all directions.

With a small drill, file, screwdriver, and silicone grease, almost any CB'er can install a mobile antenna. For example, to roof mount (or rear-deck mount) one of Hy-Gain's new "Hellcat" antennas, you need to drill only a ⅜-in. to ¾-in. hole. The base of this antenna is held firmly in place by taking up evenly on two adjustment screws (see Fig 3).

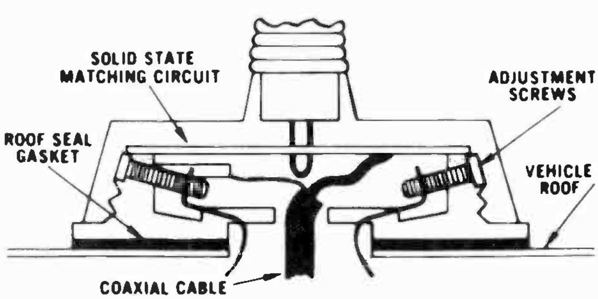
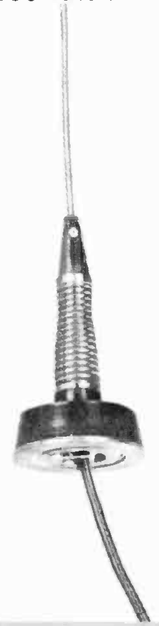


Fig. 3. Hy-Gain Electronics Corp.'s Hellcat 1 rooftop mount (right) is securely clamped to the automobile by two adjustment screws (above).



Trunk-lip mounts are even easier to handle; just two screws are required and no drilling is needed. The lip mount is connected to a clamp or strap that fastens around a bumper. For ball-type mobile antenna bases, the manufacturer usually provides easy-to-follow templates that give proper spacing and size of the bolt and cable connector holes.

The absence of a ground plane on non-metal vehicles and bikes is a pesky problem for the CB'er. A short marine-type antenna is recommended for

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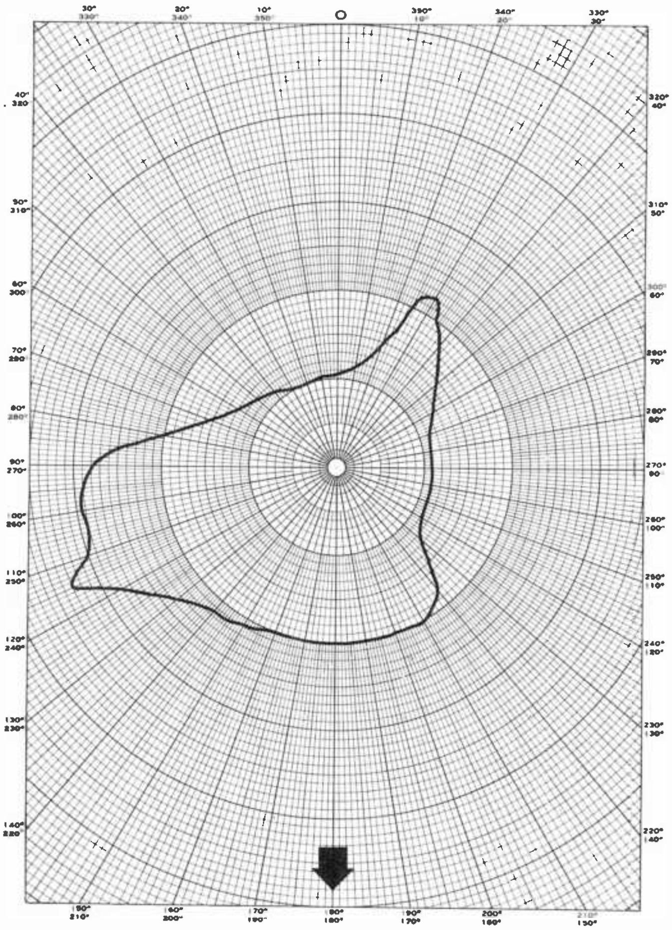

left), on rear deck (center), and on rear bumper (right).

motorcycles. Many are designed to work without a ground plane, and they are short enough not to interfere with bike operation. Special ground-plane kits, containing strips of self-adhering aluminized tape, are available for use in installations on fiberglass cars and campers.

One word about gutter mounts: they are available but are not recommended as permanent installations since the gutters on many new cars are not strong enough to hold an antenna. Magnetic mounts make superior temporary installations. They hold whips firmly at highway speeds and work equally well on roof tops and trunk decks. Of course, to use them, the vehicle must have a steel body.

Troubleshooting the Antenna. There are a few simple procedures CB'ers can use if antenna trouble is encountered. The quickest and best method of troubleshooting is to insert a VSWR bridge of the proper frequency and power range between the transmitter and the antenna. If the SWR is less than 1.5:1, the antenna is functioning properly, indicating that the trouble is in the transmitter.

If a bridge is not available, an ohmmeter can be used to troubleshoot the antenna. If you are using a base-loaded, shunt-fed (grounded) antenna, remove the coil from its mount and unplug the coax only at the transceiver end. Next, connect the ohmmeter across the cable connector. If you get an open-circuit indication, so far everything is fine. Now, short the cable at the antenna mount; the meter should read zero resistance. If either of these criteria is not met, the cable should be checked for breaks and/or shorts, and the mount should be checked for improper connections.

When you replace the coil in its mount, the meter should again indicate a short circuit (zero resistance). If it does not, the coil is either open and defective, or there is no connection at the base of the antenna.

For top- or center-loaded (ungrounded) $\lambda/4$ antennas, the cable and mount assembly test procedure is the same. However, when the antenna is replaced in the mount assembly, the meter should continue to indicate an open circuit until a deliberate short is made from whip to ground. An ohmmeter connected across the ends of any top- or center-loaded coil should indicate zero resistance (short). If it does not, the coil is defective.

Noisy Transceivers. Noise can seriously affect the range of a two-way radio system. So, antenna cables should be kept as short as possible and routed away from engines, gauges, electrical wiring, and other sources of interference. Local "noise" that emanates from alternators, spark plugs, ignition system, and other electrically operated devices can be significantly reduced by using suppression kits; by making sure all connections are tight; and by seeing to it that all metallic parts in the vehicle are positively bonded.

Noise from passing vehicles, or static caused by atmospheric conditions, can be removed by a preamplifier and noise eliminator installed in the antenna circuit. The noise pulses are amplified and blanking pulses are mixed with them to neutralize the noise. The preamp gives the receiver added selectivity and sensitivity which improves overall receiver performance.

Base-loaded antennas have better noise performance than the 9-ft whip or top-loaded types. Since one end of the loading coil is grounded, a direct path exists to ground for unwanted noise.

Communication Range. While communication between fixed stations separated by 20 miles or more is not uncommon, the range between base and mobile stations is usually 5 to 10 miles, and between mobiles it is 1 to 5 miles. It is important to understand that there are no absolute figures that specify just how far a CB radio signal will travel.

The groundwave range is governed primarily by terrain—hills, valleys, buildings, etc.—plus about 10 percent due to atmospheric diffraction. Other factors, such as weather, operating frequency, type of equipment, modulation percentage, noise, and the relative height of the transmitting antenna with respect to the receiving antenna, also affect the range.

Unusual weather, such as temperature inversions, often form tropospheric "ducts" that sometimes enable CB'ers to communicate over distances of up to 100 miles or so. When nature provides the conditions that permit it, such long-range communication is legal. However, using sky waves for DX'ing violates FCC regulations, which sets a 150-mile maximum range. ◈

MEASURE RPM OF ROTATING ELEMENTS WITH

THE IC PHOTO TACHOMETER

Battery-operated device gives accurate readings up to 50,000 rpm without physical contact.

BY ADOLPH A. MANGIERI

IF YOU service the numerous motor-driven appliances and tools found in the home, shop, or factory, consider building this photo tachometer. By recording normal rotational speeds for comparision with later measurements, you can easily detect the effect of worn gear trains or motor brushes and gauge improvement of performance after repairs. With no mechanical coupling required, the Photo-Tach measures the rpm of any type of rotating element, including miniature high-speed, low-power motors. You can also use the Photo-Tach as an analog frequency meter, useful for checking inverters and auxiliary ac generators.

Operated in either the incident or reflected light mode, the Photo-Tach includes five ranges up to 50,000 rpm. A plug-in light probe, using a high-speed photo-transistor, facilitates speed measurements. Using low-cost, high-performance IC's, the battery-operated tachometer features high accuracy and stability. The schematic diagram is shown in Fig. 1.

How It Works. Light pulses striking photo-transistor *Q1* produce voltage pulses at the input of operational amplifier *IC1*, connected as a Schmitt trigger which produces a sharply squared output pulse for each input pulse. Resistors *R3* and *R4* provide positive feedback and also determine the input voltage hysteresis or deadband. This prevents the tach from responding to noise components of the main signal and rejects the small 120-Hz modulation of 60-Hz incandescent light sources. Input high-pass filter, *C1-R2*, favors response to fast-changing light signals.

Output pulses from *IC1* are differentiated by *C6-R6* forming voltage spikes which are applied to the trigger input

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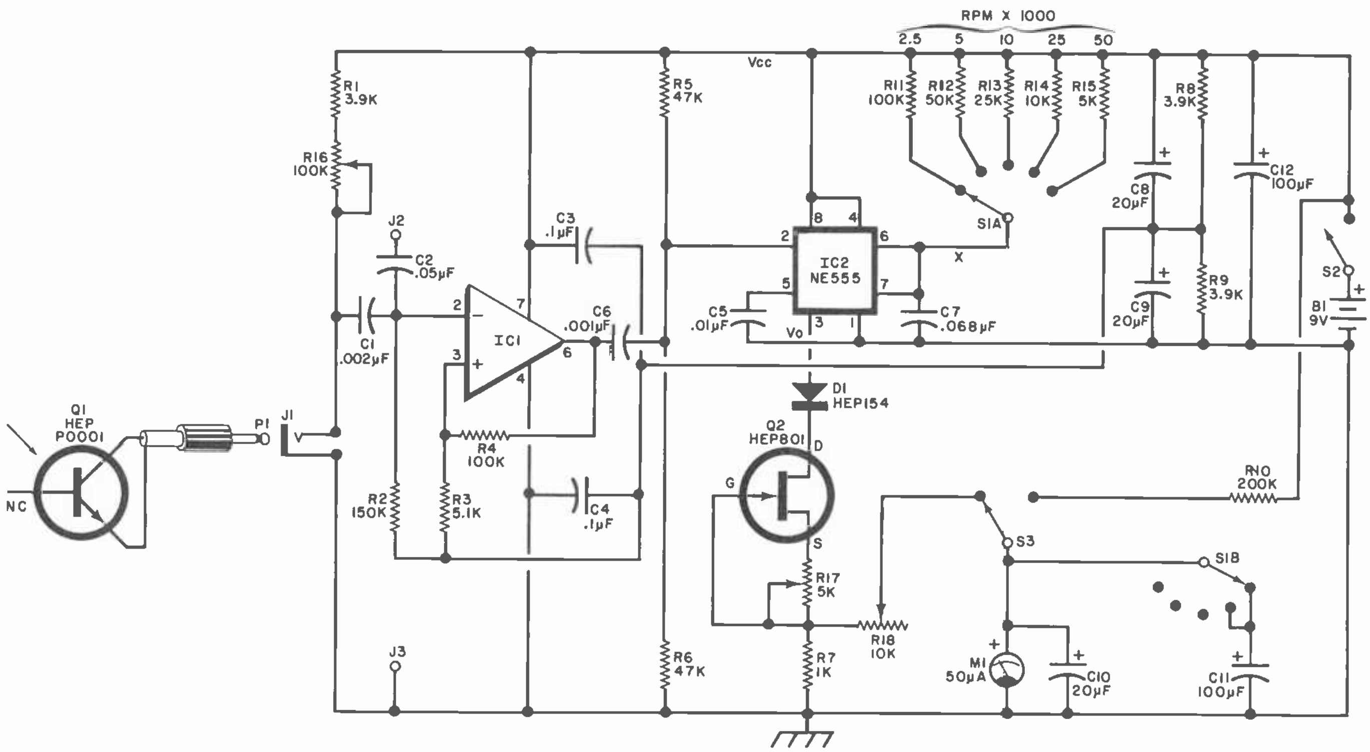
terminal (2) of timer *IC2*, connected as a monostable. When a negative-going trigger pulse drives pin 2 below one-third V_{cc}, the timer delivers a precise output pulse V_o at pin 3. Output pulse duration, independent of supply voltage, depends on timing capacitor *C7* and a timing resistor selected by range switch *S1*. Output pulses V_o pass through diode *D1* and energize FET constant-current source *Q2-R17*, producing constant-amplitude pulses across *R7*. Diode *D1* blocks the small residual voltage when V_o is low. Constant-duration pulses of constant amplitude are averaged by meter *M1* which responds linearly to the repetition rate of input light pulses.

Potentiometer *R16* adjusts the input sensitivity while capacitor *C11* dampens meter pointer vibration at low (2500) rpm. With a pulse duty cycle of near one-third at full scale, meter overrange is within safe limits.

Construction. Assemble the Photo-Tach in a 3″×4½″×6½″ metal case. In the prototype, perf board construction was used but you can make a printed circuit board using the foil pattern shown in Fig. 2. Use sockets for *IC1*, *IC2*, and *Q2*, and use short, heavy buses on the circuit board as common tie points to avoid ground loops. Install bypass capacitors *C3* and *C4* close to their *IC1* pins. Wire *R16* so that its resistance is zero with the control set counterclockwise. Voltage-range multipler resistor *R10* is, preferably 1% tolerance.

Connect the supply minus to case (ground). Tape over any unused pins of the IC sockets and carefuly observe correct installation of the IC's. Remove the meter dial card and mark the additional scales using dry transfers (see photograph). Otherwise, mark rpm range switch *S1* with multipliers



PARTS LIST

B1—9-volt battery (Burgess 2U6 or equiv.)
C1—0.002-µF 10% ceramic disc capacitor
C2—0.05-µF ceramic disc capacitor
C3, C4—0.1-µF ceramic disc capacitor
C5—0.01-µF ceramic disc capacitor
C6—0.001-µF 10% ceramic disc capacitor
C7—0.068-µF 10% Mylar capacitor
C8, C9, C10—20-µF 15-V electrolytic capacitor
C11, C12—100-µF, 15-V electrolytic capacitor
D1—Silicon diode (HEP 154 or equiv.)
IC1—Operational amplifier (HEP C6052P or 741C)
IC2—555 timer IC
J1—Miniature phone jack
J2, J3—Phone tip jack (one red, one black)
M1—0-50-microampere dc meter
P1—Miniature phone plug
Q1—Photo transistor (HEP P0001, HEP 312, or equiv.)
Q2—N-channel JFET (HEP 801 or equiv.)
R1, R8, R9—3900-ohm, ½-watt 5% resistor
R2—150,000-ohm, ½-watt 10% resistor
R3—5100-ohm, ½-watt 10% resistor
R4—100,000-ohm, ½-watt 10% resistor
R5, R6—47,000-ohm, ½-watt 5% resistor
R7—1000-ohm, ½-watt 5% resistor
R10—200,000-ohm, ½-watt 1% resistor
R11—100,000-ohm resistor, R12—50,000-ohm resistor, R13—25,000-ohm resistor, R14—10,000-ohm resistor, R15—5000-ohm resistor } 5% or better
R16—100,000-ohm audio taper potentiometer, with spst switch S2. (Radio Shack 271-1727 or equiv.)
R17—5000-ohm trimmer (Radio Shack 271-217)
R18—10,000-ohm trimmer (Radio Shack 271-218)
S1—Dp, 5-pos. shorting switch (Centralab PA-1002 or equiv.)
S2—Spst switch (on R16)
S3—Sp, 2-circuit momentary pushbutton switch
Misc.:—Transistor socket: DIP sockets (2); metal case 4½″×6½″×3″ (Vector W30-66-46B or equiv.); P-pattern perforated board; knobs (2); battery clip; miniature shielded cable; flea clips (Vector T42-1 or equiv.) hardware; etc.
Note: If you choose to use a printed circuit board, an etched, undrilled board (# Phototach 874) is available for $3.95, postpaid, from Techniques Inc., 235 Jackson St., Englewood, NJ 07631. New Jersey residents please add 5% sales tax.

Fig. 1. The light pulses at Q1 are squared up in IC1 and turn on precision monostable IC2. Constant-current output pulses through Q2 are averaged by the meter as rpm. Five ranges permit testing up to 50,000 rpm.

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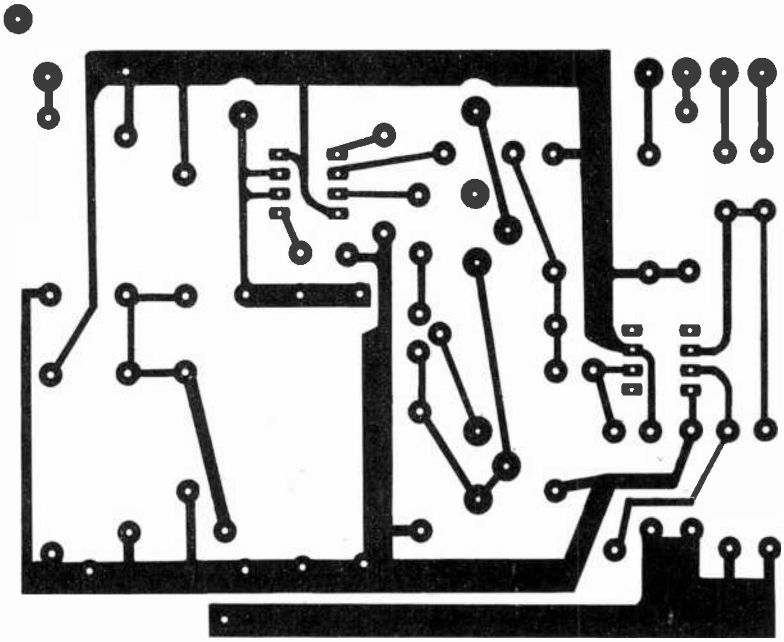

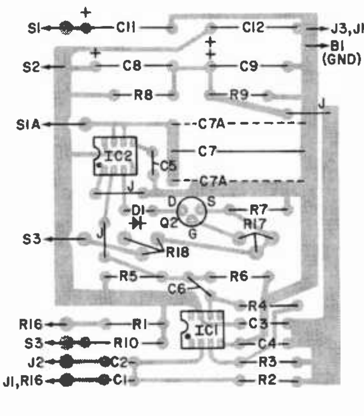

Fig. 2. Though the prototype of the tachometer was assembled on perforated board, it is convenient to use a printed circuit board. C7A is two 0.033 capacitors if this is preferred to one 0.068. (See Parts List to order board.)

of the 0-50 scale. Do not connect a meter protector across *M1*.

Mount the meter, range switch *S1*, sensitivity control *R16*, battery test switch *S3*, probe input jack *J1*, ac input connector *J2*, and the ground connector *J3* on the front panel as shown in the photographs.

For photo-transistor *Q1*, use either a glass lens (HEP P0001) or plastic lens (HEP 312). Clip off or insulate the unused base lead of the P0001 transistor. Connect the outer braid of a three- to four-foot length of miniature shielded cable to the emitter of *Q1* and center conductor to collector. Make sure the braid is connected to the grounding side of the P1-J1 combination. Install *Q1* within an opaque plastic tube, such as the barrel of a ballpoint pen. Position the lens about one-quarter inch from the tip of the probe. Install battery *B1* on the back plate of the cabinet.

Calibration and Checkout. Set *R17* and *R18* to mid-position and *S1* to 2500 rpm, then connect a dc voltmeter across *R7*. This test voltmeter input resistance should be at least 50,000 ohms on the selected voltage range. Disconnect wire "X" from the rotor of switch *S1A*. Operate sensitivity control *R16* to close *S2*. If *M1* is not pegged upscale, short *R6* momentarily, causing V_0 to go high. Adjust *R17* until the voltmeter indicates one volt. Remove the voltmeter, open *S2*, and reconnect wire "X" to *S1A*.

Breadboard the calibration circuit shown in Fig. 3, which supplies a 120-Hz signal (equivalent to 7200 rpm) and connect to jacks *J2* and *J3*. Set *S1* to 10,000 rpm, close *S2* and adjust *R18* until *M1* indicates 7200 rpm. With accurate range resistors, all ranges are simultaneously calibrated to high accuracy. You can use a signal generator to calibrate, check, or trim rpm ranges provided frequencies can be set to high accuracy, as with a frequency counter. Multiply frequency by sixty to obtain equivalent rpm.

Next, check rejection of the small 120-Hz modulation of incandescent light sources. Insert the probe in *J1* and aim the probe at a 50- or 75-watt lamp at distances of two inches to three feet while varying *R16* (sensitivity control) over its range. If *M1* does not remain at zero under all conditions, increase input hysteresis by increasing *R3* to 8200 or 12,000 ohms. If further remedy is required (not likely), reduce *R2* to 100,000 or 82,000 ohms and/or reduce *C1* to 0.001 µF.

Connect a 1500-ohm potentiometer (set for minimum resistance) in series with the plus lead of *B1*. Connect the calibrating signal to *J2* and *J3*. Increase the potentiometer resistance until *M1* drops to 7100 rpm or about 1% lower. Depress pushbutton switch *S3* and observe battery end-point voltage on *M1*, read as 0-10 volts dc. End-point voltage should be near 6.6 volts or less. If the voltage is above 7 volts, use a 12-volt battery for *B1* (made up of eight AA cells connected in series). The additional supply voltage accommodates a FET (*Q2*) having a pinch-off voltage above 3 volts.

Applications. In the incident-light mode of operation, the rotating element whose rpm is to be checked chops or gates the light traveling directly from a light source to the probe. This provides a noise-free, large-signal input to the tach. A reflectorized handy light with a 50- to 100-watt lamp proved a most convenient light source but you can use a desk lamp, drop cord, or a flashlight.

Position the light source about two feet behind the blades of an operating electric fan. Hold the probe near the front of the fan, aimed at the lamp. Advance *R16* until *M1* shows a steady and maximum indication. Observe that *R16* can be varied over much of its range while *M1* remains steady. For a fan with four blades, divide indicated rpm by four, etc.

To check the speed of a drill, construct a light chopper using a three-

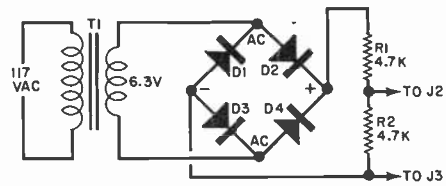

Fig. 3. Calibration circuit delivers a 120-Hz signal equivalent to 7200 rpm. Multiply frequency by 60 to obtain the equivalent speed.

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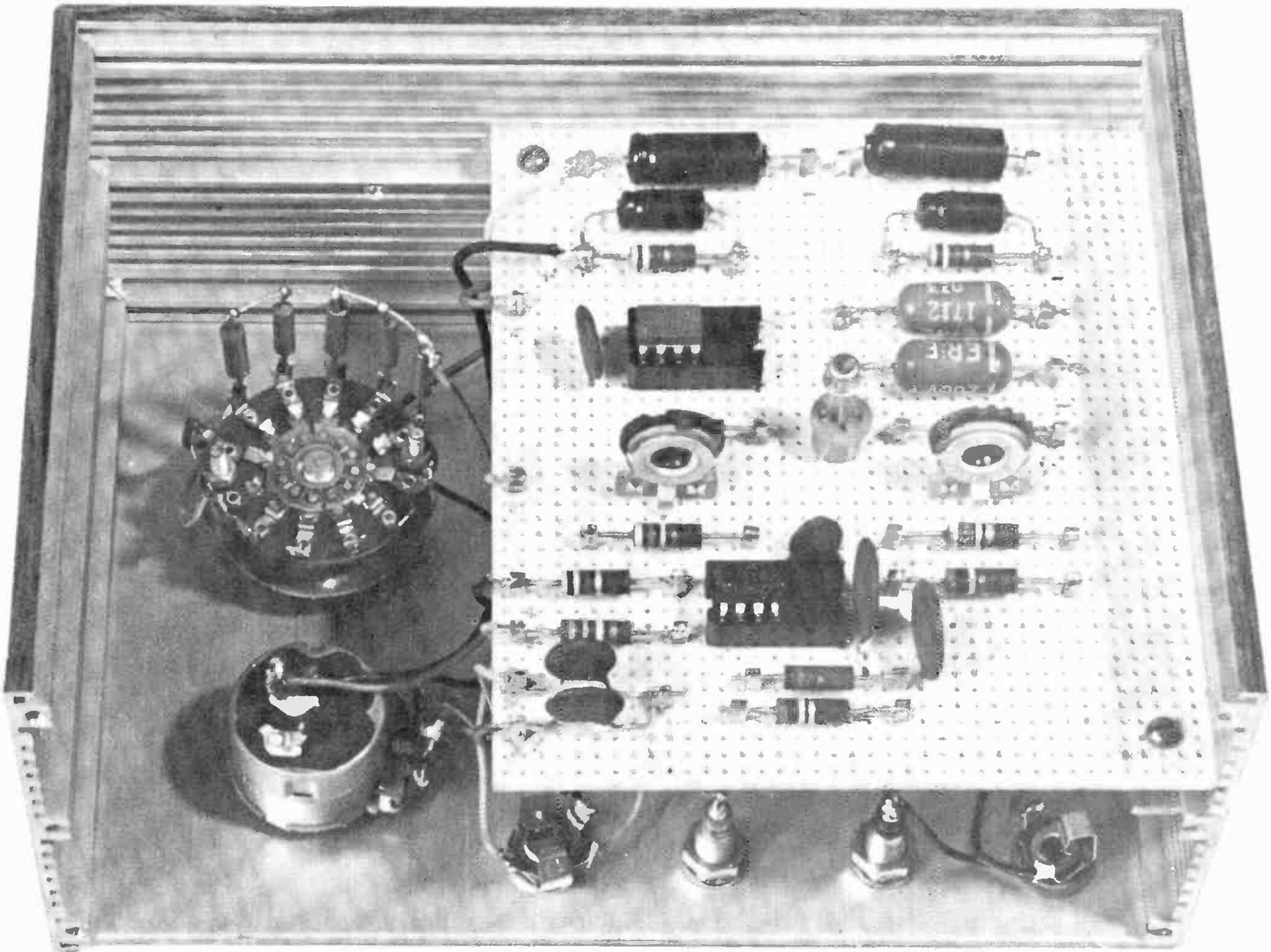

Photograph of prototype, assembled using a perforated board, shows how parts were assembled in chassis. The arrangement of the front panel is shown in the title photo.

inch diameter cardboard disc. Cut out a ¾"×¾" light gate at the edge and chuck the disc in the drill using a machine screw. To check motors having various shaft sizes, attach a light chopper disc to a suitable wheel, shaft collar, or knob. The spokes of a large pulley can serve as a light chopper.

In the reflected-light mode, the sensor views light reflected from contrasting surfaces. If surface reflectivity is excessively uneven due to rust spots, discolorations, or other irregularities, a reflected-light pulse may contain excessive noise. This will be recognized as a very high and erratic indication on the meter. Involving two directions of light travel, the reflected-light mode may require rigging of probe or light source, or both, to maintain steady indications.

To check the speed of a motor having a half-inch shaft or larger, wrap a strip of electrician's tape (cloth friction type, not glossy surface vinyl) around the shaft. Place the band on a shaft flat if possible. Place a strip of white surgical adhesive tape lengthwise across the band. Or, paint a white strip using fast-dry flat paint. Rig the probe horizontally about one inch from the shaft facing the band.

For the flatted shaft with white strip on the flat, hold the light source directly above the shaft at a distance of about 8 to 12 inches. For the round shaft, hold the lamp about 6 inches above the end of the probe handle. Advance *R16* and verify that the meter indication remains steady over some portion of pot rotation, proving adequate light input. For motors having smaller shafts, attach a reflective disc to a suitable wheel or knob. Paint half of the disc flat black and the balance flat white. Fan speed can be checked by this method provided the fan blades are clean and uniform in appearance. By sighting the running fan from several angles, you can pick a suitable direction to aim the probe. Particularly with very small fans, a slightly twisted blade can result in a missed light pulse.

Meter-pointer vibration becomes apparent below 400 rpm. In this case, include a second light gate or reflective surface and divide indicated rpm by two, etc. Position additional light gates or reflective surfaces in an approximately symmetrical pattern.

Keep tabs on the normal running speeds of appliances and tools for later comparisons. Use speed measurements to isolate problems between motor and drive train and observe effect of repairs. Speed measurements on major heavy-duty appliances such as washers and dryers can forewarn you of progressive wear which may lead to motor overload and possible fire hazards.

The tachometer can be used as a low-range frequency meter to check frequencies from about 10 to 800 Hz. Inject one or two volts ac into jacks *J2* and *J3* and divide indicated rpm by 60. Also, by connecting *J2* and *J3* to a scope, you can observe input to the tach as you vary lighting and sensitivity settings. ◈

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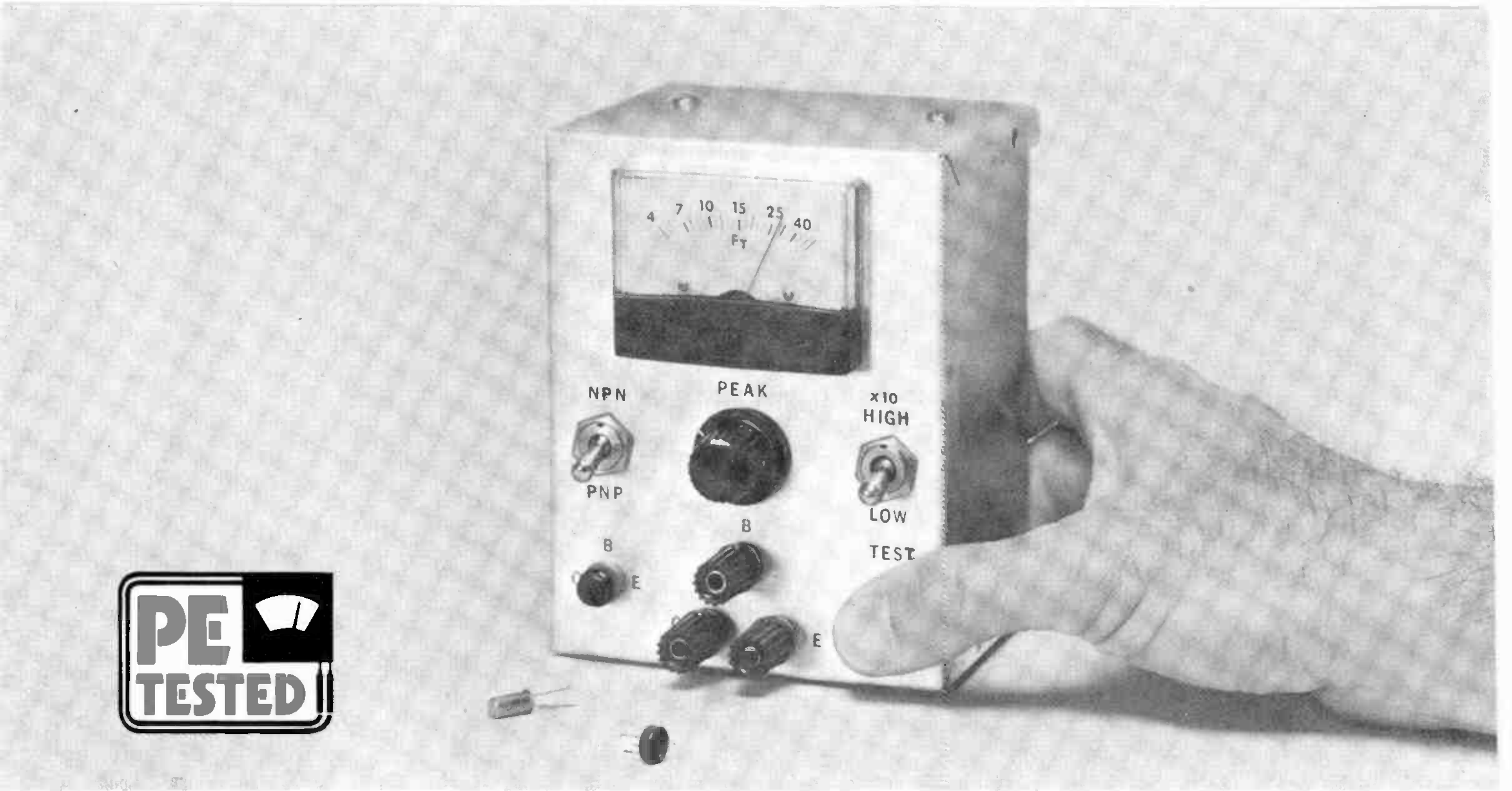

R-F TRANSISTOR TESTER

Checks upper frequency limit of bipolar transistors

BY DANIEL METZGER

CHECKING out an r-f transistor on a "standard" tester is as tricky as testing a high-voltage TV tube on the corner-drugstore machine. When the indicator reads "good," the device can still be bad.

Unfortunately, most transistor testers perform dc checks only. They indicate the device's beta (amplification) and, in some cases, leakage current. Few check performance at radio frequencies, however, which is an essential parameter if you're troubleshooting a transistorized front end.

The important characteristic here is the transistor's cutoff frequency, f_T. As the frequency increases, a transistor's amplifying capability drops rapidly. Above f_T, there is no gain at all, and the transistor just doesn't work. You can check your transistors' f_T to determine if they will operate satisfactorily at r-f by building the circuit shown in Fig. 1. (For more about the importance of f_T, see the box on page 59.)

How It Works. The circuit is essentially an emitter-follower amplifier whose input impedance varies with the f_T of the transistor. The input impedance is then used as one leg of a voltage divider, and the output voltage, as indicated on the meter, is a function of f_T.

The *Q1* circuit is a conventional Colpitts oscillator running at 1 MHz on the LOW range and 10 MHz on the HIGH range of *S1*. A signal of approximately 6 volts p-p is applied to the left end of resistor *R6*. Resistors *R4* and *R5* provide base bias for *Q2*, the transistor being tested. Either *L3* or *L4* forms a tuned circuit with *C6* and the input capacitance of the transistor being tested. With *C6* tuned to resonance, the reactance of the transistor's C_{in}, which would otherwise load the signal, is cancelled.

The input impedance of the base of *Q2* is essentially beta times the emitter resistance. This emitter resistance is *R7* in parallel with the effective resistance of the metering circuit. Emitter resistance varies with the setting of the calibrate control, but should be near 400 ohms. If a transistor having an f_T of 17 MHz is checked on the 1-MHz range, it will have a beta of $f_T/f = 17/1 = 17$. The base input resistance of the transistor will then be:

$$r_b = \beta\, r_e = 17(400) = 6800 \text{ ohms}$$

The 6-volt p-p input signal is the voltage divided by *R6* and r_b to produce a 3-volt p-p signal at the base (and also at the emitter) of *Q2*. Diodes *D1* and *D2* rectify this signal, but since each diode requires about 0.6 volt before it begins to conduct, only about 1.8 volts dc appears across *C10*.

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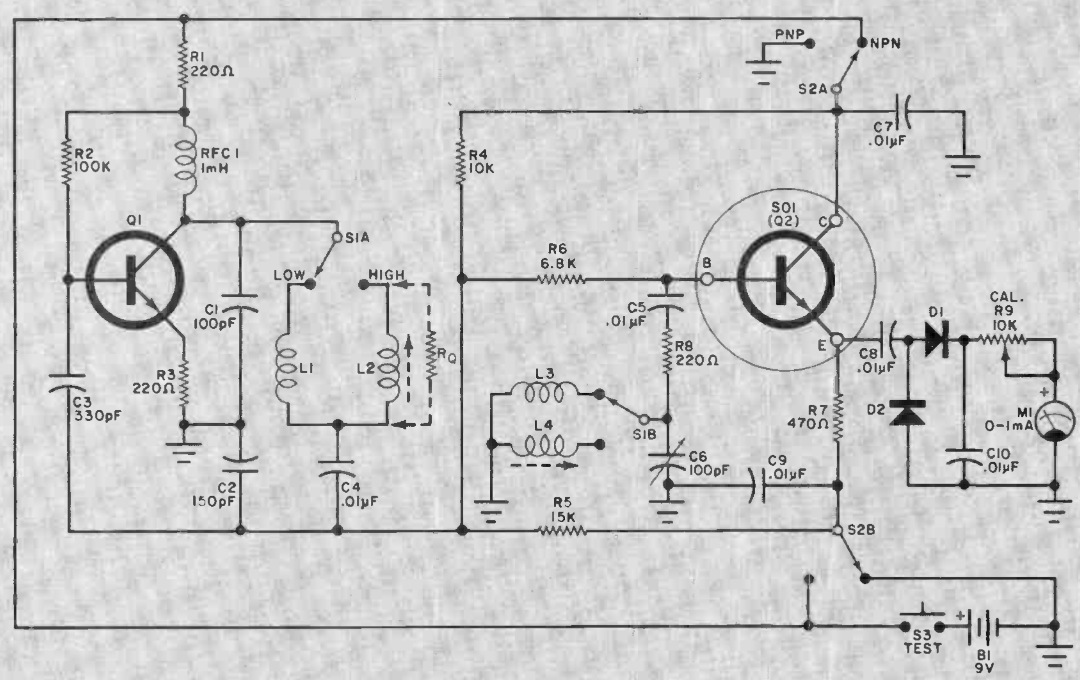


PARTS LIST

B1—9-volt battery
C1—100-pF disc capacitor
C2—150-pF disc capacitor
C3—330-pF disc capacitor
C4,C5,C7-C10—0.01-µF disc capacitor
C6—100-pF variable capacitor
D1,D2—Silicon signal diode (1N914 or similar)
L1,L3—400-µH inductor
L2,L4—25 turns No. 26 enamel wire, close-wound on ¼-in. slug-tuned form
M1—0-1-mA dc meter movement
Q1—Transistor (2N4124 or similar)
Q2—Transistor under test
R1,R3,R8—220-ohm, ½-watt resistor
R2—100,000-ohm, ½-watt resistor
R4—10,000-ohm, ½-watt resistor
R5—15,000-ohm, ½-watt resistor
R6—6800-ohm, ½-watt resistor
R7—470-ohm, ½-watt resistor
R9—10,000-ohm trimmer potentiometer
RQ—3300-to-33,000-ohm resistor (see text)
SO1—Transistor socket
S1,S2—Dpdt toggle switch
S3—Spst normally open pushbutton switch

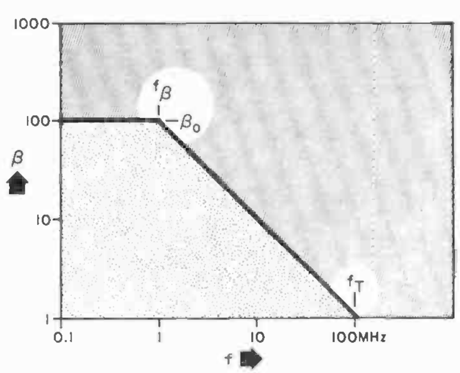
Fig. 1. The transistor being tested (Q2) is connected to socket SO1. Transistor Q1 is an r-f oscillator which supplies a signal to Q2. Frequency is changed by switching reactances.

Construction. Almost any type of construction can be used. The prototype was built up on a small piece of perforated board. However, keep in mind that the tester operates in the r-f range, so all leads must be as short as possible.

The test socket (*SO1*) and all controls and switches (except for *R9*) are mounted on the front panel. The battery is supported by a mounting clip. Coils *L2* and *L4* are mounted on a small metal bracket so that their screwdriver adjustments can be easily reached.

On the prototype, three five-way binding posts were connected to *SO1* and mounted on the front panel to facilitate testing using clip leads to connect to the transistor.

Calibration. Calculations such as those given above and in the box can be extended to apply to a range of f_T values and a calibration chart for the low range of the meter can be constructed as shown in Fig. 2. Other values of *R6*, *R7*, and signal frequency can be used to alter the range of the instrument, but care should be taken to ensure that betas higher than 50 will



WHAT IS f_T?

The cutoff frequency (sometimes also called gain-bandwidth product) is the frequency at which the current gain (h_{fe}) drops to unity. For frequencies lower than f_T, h_{fe} increases linearly at a rate of 6 dB per octave. (The beta doubles as the frequency is halved.) The rise in beta continues until the low-frequency beta (β_0) is reached at the beta cutoff frequency (f_β) as shown in the diagram. Notice that, for any frequency above f_β, the product of current gain and operating frequency is constant and equal to f_T. Hence, the name gain-bandwidth product for f_T.

Calculating h_{fe} at any frequency when f_T is known is a simple matter if this relationship is kept in mind. For example, if a transistor having an f_T of 200 MHz is to be used in a 27-MHz amplifier, its effective beta is f_T divided by f or 200/27 = 7.4.

To find the frequency at which beta will begin to drop below its full low-frequency value, the procedure is reversed. Thus, in the example above, if the transistor has a low-frequency beta of 150, it will begin to drop at 200/150 = 1.33 MHz.

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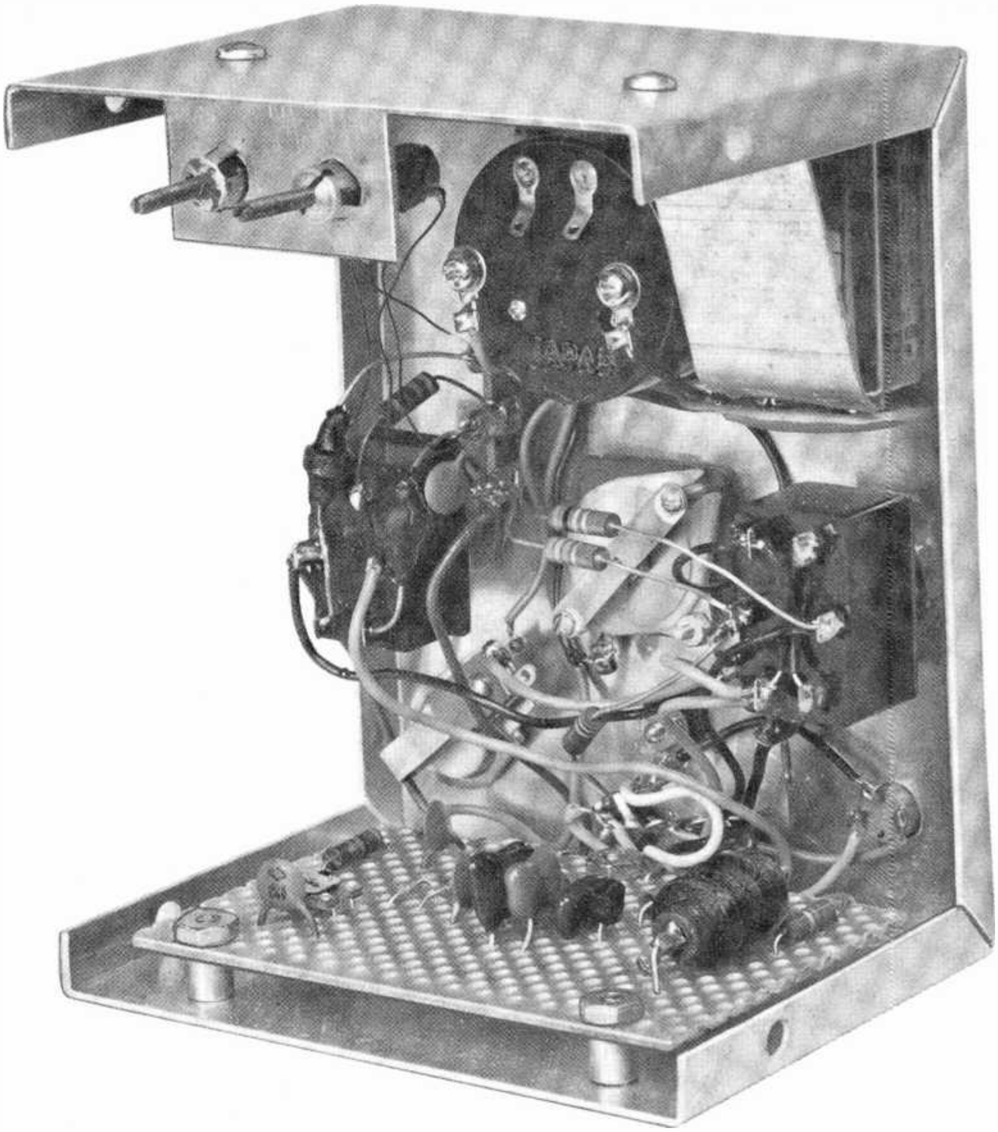

This photograph shows how prototype was assembled. Be sure to use short lead lengths to avoid r-f interference.

always drive the meter above full scale. This is because many transistors have a low-frequency beta not much higher than 50 and they would otherwise read low on the f_T scale.

To calibrate the instrument, a high-beta transistor with an f_T specification above 250 MHz is inserted in test socket *SO1* with range switch *S1* on LOW. The author used a 2N4124 with a measured low-frequency beta of 200. The beta of the transistor is known to be 200 at 1 MHz, giving an I_m of 1.3 mA as shown in the last line of Fig. 2. A 3-mA meter is then inserted in series with the instrument's meter, and *R9* is adjusted for 1.3 mA. The low range of *S1* is now calibrated. Use *C6* to set the meter pointer at maximum.

To calibrate the high range, it is necessary to insure that *Q1* is really oscillating at 10 times the low frequency (10 MHz in this case). This can be determined by using a grid-dip meter, a high-frequency oscilloscope, or a frequency counter.

Finally, the output of the oscillator (junction of *R4* and *R6*) must be checked with an r-f voltmeter and trimmed if necessary to keep the r-f output constant in both the high and low ranges. The trimming is accomplished by placing a resistor (*RQ*) across *L1* or *L2* and choosing its value so that the r-f voltmeter reads the same on both ranges. The resistor effectively lowers the Q of the coil and reduces the oscillator output on the range for which it is inserted. The value of *RQ* may be from 3300 to 33,000 ohms, depending on the difference in Q between the two coils. The calibration for the high range is simply 10 times the low range. ◈

FIG. 2. SAMPLE CALIBRATION CHART

f_T MHz	β	r_b Ohms	v_e Volts (p-p)	V_{C10} Volts	I_m mA
4.2	4.2	1.67 K	1.2	0	0
7.0	7	2.8 K	1.7	0.5	0.15
10	10	4.0 K	2.2	1.0	0.30
17	17	6.8 K	3.0	1.8	0.55
30	30	12 K	3.8	2.6	0.79
50	50	20 K	4.5	3.3	1.00
>250	200	80 K	5.5	4.3	1.30

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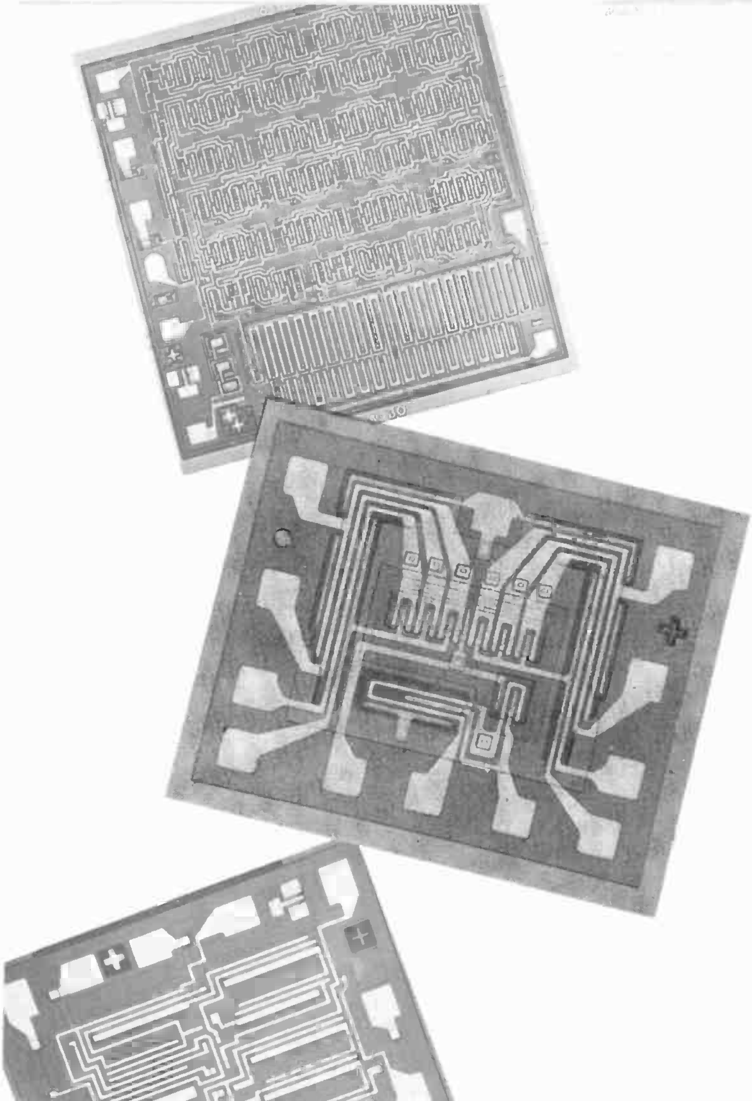

A GUIDE TO CMOS OPERATION

How CMOS devices are used in linear applications

BY WALTER G. JUNG
Contributing Editor

WHAT are the important characteristics of the basic CMOS inverting stage (amplifier)? First, it has the inherent simplicity of consisting essentially of just two transistors. It has a high input impedance; its output swing goes to the limits of the supply; and the stage can be biased so that the output is centered at half of the supply when the input is half of the supply ($\frac{1}{2}V_{DD}$). These characteristics make the CMOS amplifier ideal for use in digital circuits, where it is widely used, operating in the switching mode. But, how about using it in linear applications?

Actually, the same characteristics make CMOS equally usable in linear circuits. It is only necessary to add a biasing resistor and an input capacitor, as shown in Fig 1. The CMOS then becomes a class A linear amplifier.

How does this stage bias itself? The answer lies in the $\frac{1}{2}V_{DD}$ balance point. Resister *Rb* forms a direct dc feedback path from output to input. Any tendency for the output to drift high or low is fed back to the input, and the amplifier automatically corrects the drift. The stage then stabilizes its own bias point with the output at the same potential as the input balance threshold. Since the gate does not draw any appreciable current, there is no drop in *Rb*. This effect of a zero gate current permits the use of a very high resistance for *Rb* (22 megohms or higher). As a straightforward block of gain without ac feedback, the circuit of Fig. 1 has many uses.

The characteristics of this stage of gain are shown in Fig. 2. Although these curves are for a CA3600E, other CMOS inverters behave in a similar fashion. Note that the stage gain increases as the supply voltage is lowered, but the bandwidth is reduced. With higher supply voltages, the gain decreases and the bandwidth increases. To get high gain and wide bandwidth, cascaded stages must be operated at the higher supply.

Linearity Considerations. While the CMOS amplifying stage has the unique property of providing an output swing to the limits of the supply, this feature requires special consideration in linear applications. The transfer characteristic of a CMOS stage becomes quite nonlinear (compressed) at the extremes of the output swing. For digital use, this is not too important; but for linear amplifiers it is, if high-level outputs are desired. Plainly speaking, the best linearity is obtained at about the center third of the swing. Beyond that, distortion rises rapidly.

While high-level nonlinearity does limit the usefulness of the basic stage, the problem can be overcome by using negative feedback as shown in Fig. 3. Here, an input resistor, *Ri*, is used in addition to the biasing resistor, *Rf*. The stage then becomes a feedback amplifier. Gain is set by the ratio of the values of *Rf* and *Ri*, which can be varied to obtain different gains. The benefits of feedback are most evident at low gains, where feedback is greatest (as in Fig. 3, where the gain is unity).

This stage no longer has high input impedance. It is, in fact, the same as the value chosen for *Ri*. Capacitor *Ci* provides input coupling and *Co* is for output coupling. A feedback such as this can provide gains up to 10 with distortion less than 1% near full output. For higher gains, stages can be cascaded, with the overall gain being the product of the gains of individual stages.

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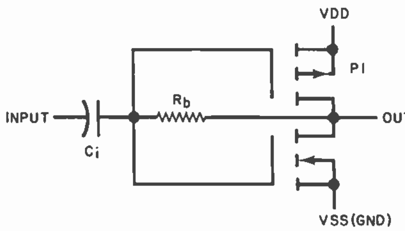

Fig. 1. A CMOS inverter biased for linear operation.

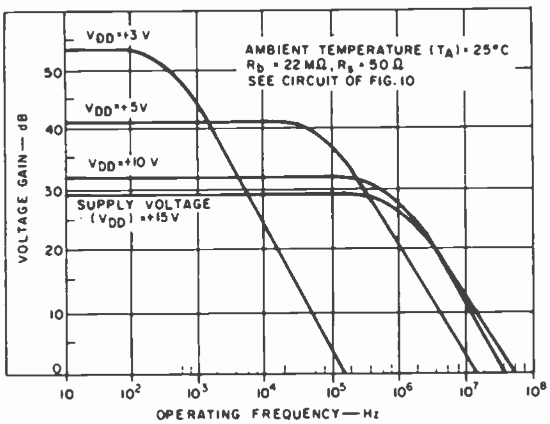

Fig. 2. Gain and bandwidth of RCA CMOS inverter vary with supply voltage.

Oscillator Circuits. Amplifier stages are an integral part of various types of oscillators. With the multiple stages of CMOS inverters available in the CD4007AE and CA3600E types, or in the hex inverters, a wide range of different types of oscillators can be built.

For example, the sine-wave oscillator shown in Fig. 4 is easy and economical to build. This is a Wien-bridge type of oscillator which uses two inverting stages cascaded to give overall positive feedback. The *R1C1* and *R2C2* combinations (with *A1*) form the "bridge". Stage *A2* provides gain to overcome the loss in the Wien network. Diodes *D1* and *D2* provide agc action to stabilize the output level. Since *A2* has a gain of 3, the circuit has both a high- and a low-level output. Ideally, the resistors and capacitors should be matched, but 5% components will usually work. When possible, use low-value capacitors and high-value resistors. This allows the use of mica capacitors (with their excellent characteristics) for the timing capacitors. The circuit will work over a fairly broad range of supply voltage, but the optimum is a supply of about 10 volts. Trim *R5* for lowest distortion, but don't go too low or the circuit may fail to start reliably.

An oscillator circuit that is even more attractive in performance and simplicity is the triangle/square-wave oscillator shown in Fig. 5. It uses three CMOS inverters. The first, *A1* is an integrator, and the other two are for a Schmitt-type level sensor. When two inverters such as *A2* and *A3* are cascaded, they have a very high gain. Therefore, it doesn't take much change in the input to *A2* to drive *A3* either full on or full off. This small level change is centered about *A2*'s $\frac{1}{2}V_{DD}$ threshold. Resistors *R1* and *R2* divide the input at *R2* so that *A2* switches at a fraction of the output. So the resistors actually set upper and lower thresholds, between which the circuit can be made to oscillate.

Stage *A1* is an integrator whose time constant is set by *R3* and *C1*. When the output at square-wave 1 is high, the output of *A1* decreases on a ramp pattern to form the triangle wave. At the lower threshold, the Schmitt trigger reverses states and the output of *A1* increases on the upward ramp. Thus, the *A1* integrator is made to oscillate between the two thresholds, generating a very linear triangle wave due to the negative feedback. The triangle waveform is also buffered by the gain in *A1*. The two square-wave outputs are 180° out of phase.

For simplicity, *R1* is made twice the value of *R2*. This makes the time of one oscillation period twice *R3C1*. Due to the extremely low CMOS input current, the value of *R3* can be very high. Consequently, the value of *C1* can be very small and it can be of good quality (such as a Mylar type). The capacitor should be nonpolar.

The circuit in Fig. 5 makes an excellent source of stable waveforms and its period is independent of supply voltage. Timing periods into the minutes range can be obtained with reasonable component values. It makes a good fixed-frequency oscillator, but it can also be tuned by varying *C1* in decades and using a potentiometer in series with a fixed resistor for *R3*. The ratio of the values of the fixed and variable resistances will determine the frequency range.

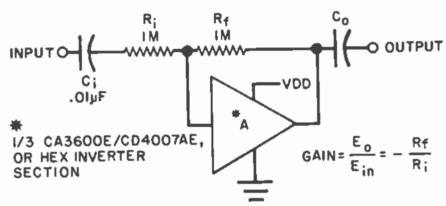

Fig. 3. Adding four components makes a simple feedback amplifier.

Function Generators. The schematic of a CMOS function generator is shown in Fig. 6. This circuit generates triangle, sawtooth, square, and pulse waveforms. By adding a pair of rectifiers (*D1, D2*) in series with the timing resistors, control of the duty cycle is achieved by making the up (t_1) and down (t_2) times of the

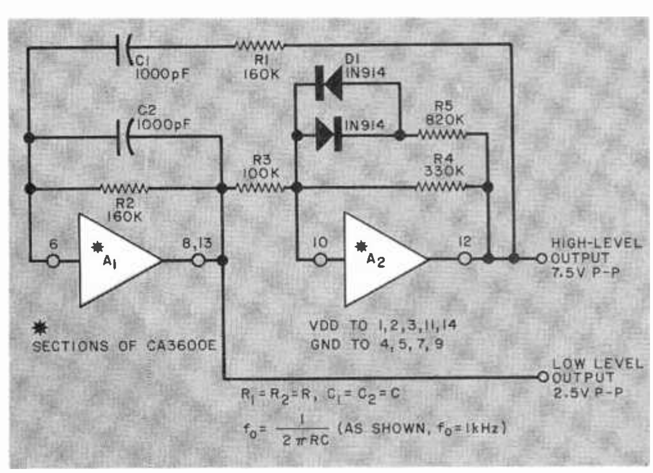

Fig. 4. Wien bridge sine-wave oscillator uses a pair of conventional CMOS inverters.

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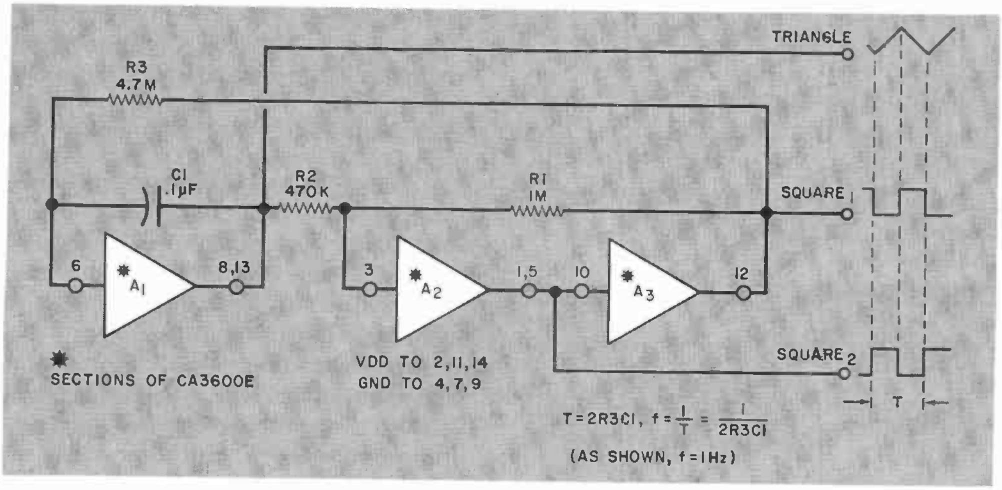

Fig. 5. Three CMOS inverters are used to create a triangle/ square-wave oscillator.

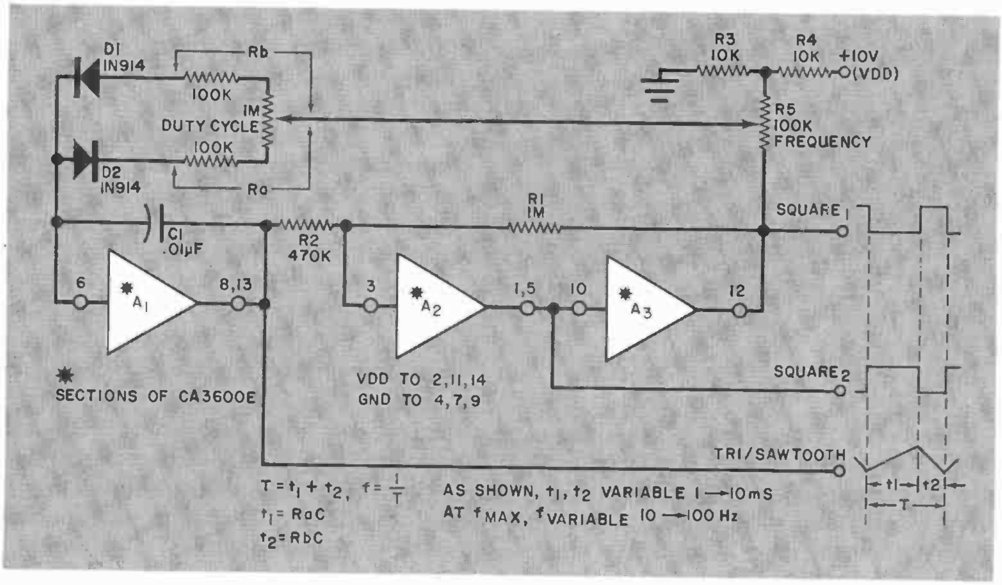

Fig. 6. CMOS function generator for triangle, sawtooth, pulse, and square waves.

ramp unequal. Time t_1 is *RaC1*, while t_2 is *RbC1*. In this case, the timing resistor is a fixed 100 kilohms plus the portion of the duty-cycle potentiometer which is connected to both legs of the circuit. he potentiometer can be used to ad- ust the *Ra*-to-*Rb* ratio over a range of 0 to 1, yielding a 10-to-1 variation in he duty cycle. To vary the frequency, nly a portion of the square-wave out- ut is fed back. The amount is varied by and the frequency can be varied er a 10:1 range.

here are many other oscillator and ing circuts that can be designed ng CMOS, but we haven't space to w them all here. We suggest you sult the manufacturer's literature details.

e transistors in the CD4007AE and 600E CMOS arrays can, of course, sed individually or in combination uild many custom circuits. In the 00E, there are three sets of hed complementary transistors. are also matched so that all p match one another—as do the n For example, in the CA3600E, *P1* and *P2* are matched for offset voltage to within ±4 mV. The n units are matched within ±30 mV. This matching can be used to advantage in various types of circuits.

FET-Input Op Amp. If you've experimented with op amps, you may have been stymied by the requirements for "input bias current." The literature says that it is ideally zero, but getting the input down to the picoampere range can be a pretty complicated and expensive process. One solution is to use a matched pair from a CA3600E as the input to any standard op amp, as shown in Fig. 7. The matched p-type units are used as source followers, buffering the differential inputs to the op amp. This reduces the input current to the 15-picoampere level. Since the matched pair adds an additional input offset voltage, it may be necessary to use the offset adjustment of the 741 to trim the net offset. Resistors *R1* and *R2* should be matched for best results. Other general characteristics of the 741 remain unchanged.

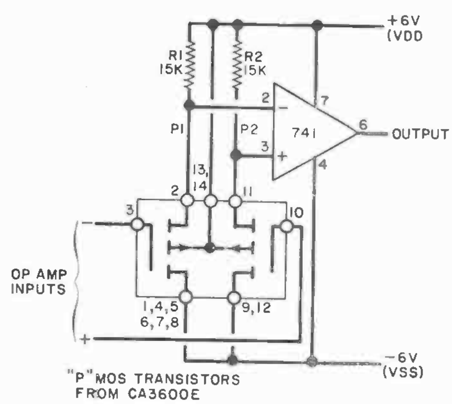

Fig. 7. Converting an op amp to a FET input using a CMOS array.

This circuit must be used with total supply voltages equal to or less than the CA3600E's 15-volt maximum. Also, if the gate input leads can ever see voltages in excess of V_{DD} or V_{SS}, some series resistance (10 k) must be added for protection.

Zero-input-current op amps can be used as long-period timers, sample-and-hold circuits, or anywhere that an absolute minimum of loading is required on the signal source.

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Product Test Reports

KENWOOD MODEL KR-5340 4-CHANNEL RECEIVER
(A Hirsch-Houck Labs Report)

Ten watts per channel—less than 0.8% distortion

THE Model KR-5340 is the lowest priced 4-channel receiver in the Kenwood Electronics line. The AM/stereo FM receiver's amplifiers are rated at 10 watts/channel with less than 0.8 percent distortion into 8 ohms, all channels driven simultaneously. Flipping a switch "straps" the amplifiers to provide 25 watts/channel into 8-ohm loads in the 2-channel mode.

Built into the receiver are RM and SQ decoding matrices, while the four AUX inputs can be used with an accessory CD-4 demodulator for playing discrete 4-channel records.

The FM tuner section features Kenwood's "DSD" (Double Switching Demodulator) for improved stereo performance and has a detector output. The output anticipates a 4-channel discrete FM broadcasting system — if the FCC ever gets around to approving one.

This is a fairly large receiver, measuring 21 7/8 in. by 14 3/16 in. by 6 5/16 in. It weighs 32 pounds.

The retail price of the Model KR-5340 receiver is $420.

Laboratory Measurements. With all four channels driven simultaneously at 1000 Hz into 8-ohm loads, the outputs of the amplifiers clipped at 16.5 watts/channel. Driving only the two front channels brought the output power up to 18.7 watts/channel. This increased to 22.5 watts into 4 ohms and decreased to 11.9 watts into 16 ohms. When the front and rear channels were strapped in the 2-channel mode, the maximum output was 41.5 watts/channel into 8 ohms.

Our distortion measurements were made in the 4-channel mode, with only two channels driven. From 20 Hz to 20,000 Hz, and for outputs between 1 watt and 10 watts/channel, the distortion varied only slightly with power or frequency. It was typically less than 0.1 percent, measuring about 0.06 percent in the midrange at 1 watt and reaching a maximum of 0.25 percent at 20,000 Hz and 10 watts output. At 1000 Hz, THD was less than 0.15 percent, and typically 0.06 percent, from 0.1 to 17 watts, while IM distortion was 0.3 percent over a power range of 0.1 watt to 10 watts.

The input sensitivity for 10 watts output was 96 volts (AUX) and 1.6 mV (PHONO). Hum and noise level was 72.5 dB down through each input. The phono preamplifiers overloaded at a very high 145-mV input.

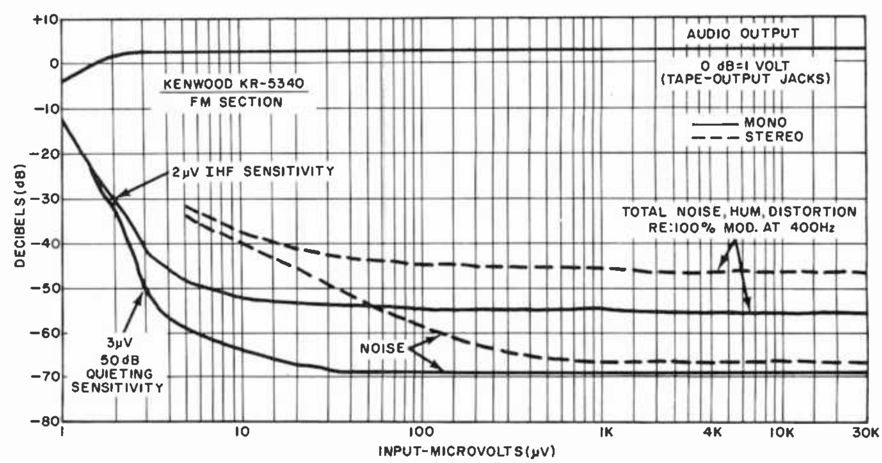
The tone controls had a maximum boost or cut of about 8 dB. This represents good design for a low-powered amplifier that could easily be driven into distortion if large amounts of tone control boost were available. The loudness compensation boosted both the low and high frequencies at reduced volume settings.

The RIAA phono equalization was extremely accurate, within ±0.25 dB from 30 Hz to 15,000 Hz. Unlike most amplifiers and receivers, the phono equalization in the KR-5340 was affected only slightly by the inductance of the cartridge. Only a 2- to 3-dB reduction in output at 15,000 Hz was observed with the popular cartridges we used.

The FM tuner had an IHF usable sensitivity of 2.0 µV in mono and attained 50 dB of quieting with an input of only 3.0 µV. The automatic stereo switching threshold was 5 µV, and a 50-dB S/N ratio in stereo required 32 µV of input signal.

The FM distortion at 1000 µV, rated at 0.5 percent in mono and 0.8 percent in stereo, tested out considerably better than these figures. At 1000 µV, the S/N ratio also surpassed the 63-dB specified rating, measuring 69.5 dB in mono and 67 dB in stereo.

The capture ratio was 1.4 dB, and AM rejection was 60 dB. Image rejection was 54 dB, while alternate-channel selectivity was 60 dB. The



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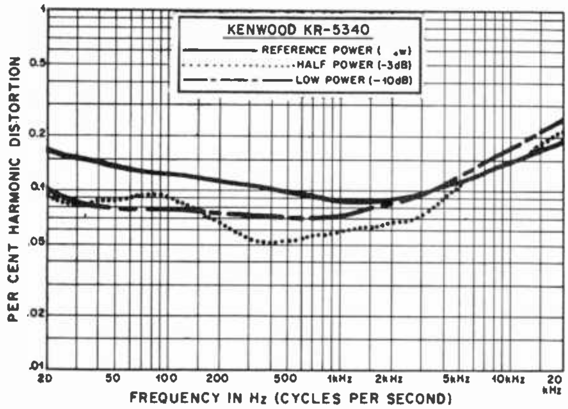
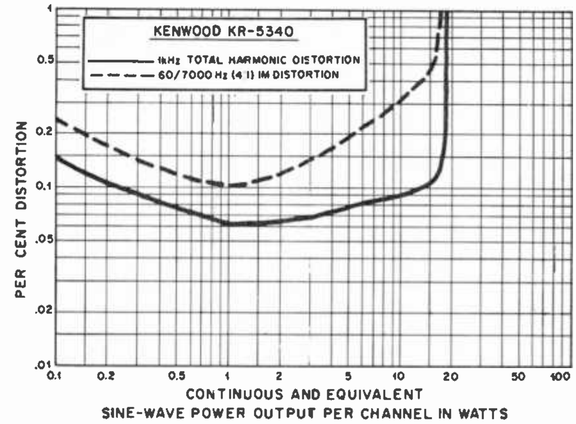


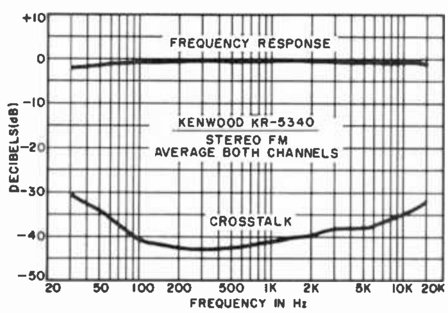


19-kHz pilot carrier suppression was a good 61 dB.

In stereo FM, the frequency response was exceptionally flat, down only 1 dB at 30 Hz and 15,000 Hz. Channel separation was also outstanding, averaging 40 dB over most of the audible frequency range and better than 30 dB over the full measurement range of 30-15,000 Hz. (The FM section of this receiver has no interstation-noise muting circuit.)

The AM frequency response was down 6 dB at 70 Hz and 3700 Hz.

User Comment. By concentrating on the essentials and leaving out some of the "frills" (such as interstation noise muting and multiple speaker outputs), Kenwood has been able to produce a 4-channel receiver at a price that is competitive with medium-priced stereo receivers. Even better, it has retained the traditional Kenwood quality, evidenced by the overall finish of the receiver, the smoothness of its controls, and the



excellent electrical performance of its tuner and amplifier sections.

As with almost all 4-channel receivers with decoding matrices, the KR-5340 has no form of "logic" to enhance the rather limited separation of a basic matrix decoder. Nevertheless, it manages to produce an excellent "surround sound" effect with practically any quadraphonic disc. (The RM and SQ characteristics are able to decode any commercially produced 4-channel matrixed disc.) The receiver does a fine job of synthesizing four channels of sound from 2-channel programs.

Upgrading the KR-5340 with an external accessory "logic" SQ decoder or a CD-4 demodulator is as simple as plugging in a couple of cables. Hence, obsolescence is not built in. Even considered as just a stereo receiver, the KR-5340 manages to hold its own quite well against competitively priced receivers with its clean and ample audio system.

CIRCLE NO. 65 ON READERS SERVICE CARD

TANDBERG MODEL 3341X STEREO TAPE DECK (A Hirsch-Houck Labs Report)

Single-motor transport with three speeds

AMONG open-reel stereo tape decks, the Series 3300X may well be the finest single-motor recorders available, as well as the least expensive in the Tandberg line. The Model 3341X, the quarter-track version most widely distributed in the U.S., operates at speeds of 7½, 3¾, and 1⅞ ips and can handle reels of up to 7 in. diameter. (Each spindle has an integral reel lock.)

The retail price of the Tandberg Model 3341X stereo tape deck is $430.

General Description. Tape motion in the 3341X is controlled by a single operating lever, a Tandberg feature for many years. For fast forward or rewind, the lever is moved to the right or left. Pulling it toward the front of the deck places the tape in normal forward motion, while pushing it toward the rear releases the reel brakes for easier tape loading. There is also a separate instantaneous STOP/START lever, sometimes called a "pause" control.

The RECORD interlock button is located at some distance from the tape transport's lever, making it virtually impossible to go into the recording mode accidentally. In addition, individual recording buttons for the two channels allow quarter-track mono recording or a "flying-start" transition from playback to record, without going through STOP.

The two INPUT LEVEL slide controls affect both LINE and MIC inputs. The microphones plug into front-panel jacks and mix with the LINE inputs (on the rear of the deck). However, the level control is common to both sources.

The two level meters are illuminated during record. They do not monitor the playback level, which is fixed. A small "S-ON-S" switch connects the playback output of either channel to the recording input of the other channel for making sound-on-sound recordings. Individual buttons connect either line output to the source or

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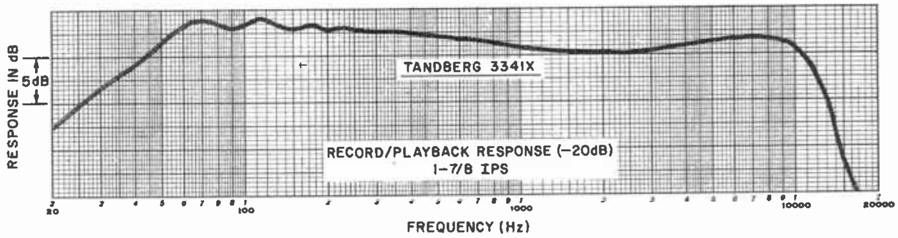
playback signal for off-the-tape monitoring. If only one button is pressed, a quarter-track mono playback signal appears at both outputs.

Laboratory Measurements. The playback response, with Ampex standard-alignment tapes, was ±1 dB from 50 Hz to 15,000 Hz at 7½ ips and ±2 dB from 50 Hz to 7500 Hz at 3¾ ips. With Maxell UD tape, for which the deck is biased, the overall record/playback frequency response at 7½ ips was 32 to 22,500 Hz. At 3¾ ips, it was still an impressive ±2 dB from 32 to 20,000 Hz. And at 1⅞ ips, traditionally relegated to voice recording, the response was flat within ±2 dB from 42 to 11,000 Hz.



At the LINE inputs, 140 mV was needed for a 0-dB recording level. The MIC input gain automatically adjusts itself to the impedance of the microphone over a very wide range to maintain optimum S/N and overload characteristics. With a 600-ohm source, about 0.5 mV was needed for a 0-dB level. (The meters are fast-acting peak-reading types.) Playback output from a 0-dB recording was 1.43 volts.

The reference 3-percent THD level was attained at 0 dB with the two higher speeds, and at −3 dB at 1⅞ ips. Applying IEC weighting (similar to the ANSI "A" characteristic) for a better correlation with subjective effects, the corresponding S/N figures were 65.6 dB, 64.0 dB, and 52.5 dB. There was no measurable increase in noise through the MIC inputs at 600 ohms.

Resistance to flutter at the two higher speeds was excellent, comparable to many of the better three-motor transports. At 7½ ips, it was only 0.075 percent, including wow. It increased to 0.09 percent at 3¾ ips. And at 1⅞ ips, it was 0.17 percent, which is comparable to that of a good cassette deck.

Tape handling was smooth and gentle, although like all single-motor transports, the "fast" speeds were not impressively fast (about 110 seconds for 1800-ft reels).

User Comment. The sonic performance of the Tandberg Model 3341X deck was virtually flawless. With FM tuner interstation hiss as a test signal, we listened for changes between the input and output signals. At 7½ ips, the only difference was a slight bass alteration. (Most of the response variation at that speed occurs below 300 Hz.) At 3¾ ips, there was a trace of added brightness, corresponding to the broad emphasis of 2 or 3 dB in the 15,000-Hz region. At 1⅞ ips, the loss of response above 11,000 Hz could be heard as a dulling of the noise. The same bass alteration could be heard at all three speeds.

With FM music programs, even the lowest speed generally gave perfect results. Playback was indistinguishable from the incoming signal. The STOP/START function, we were pleased to note, was free of the transient "wow" that afflicts many tape-recorder "pause" controls.

Summarizing, this is an outstanding tape deck. With the 3341X, it would seem to us that Tandberg has carried the single-motor transport to its peak of refinement. Further improvements would include, we expect, a change to three motors.

CIRCLE NO. 66 ON READERS SERVICE CARD

ROYCE MODEL 1-408 HAND-HELD CB TRANSCEIVER

Five watts and six channels in hand-held package

HAND-HELD CB transceivers — often referred to as "walkie-talkies" — have become popular communication devices in the field where external power is not available and where complete portability is desired. In addition to their conventional rigs, Royce Electronics has a wide variety of walkie-talkies, ranging in power from 100 mW to 5 watts and varying in features and the number of channels available.

The top of the Royce Line of walkie-talkies is the Model 1-408, a six-channel rig. Power is obtained from eight AA cells. The transmitter has an input power rating of 5 watts. A special battery-saving feature allows the power to be reduced to 2 watts merely by flipping a switch. This lower power in most cases will be adequate for short-range communication.

If rechargeable batteries are installed in the transceiver, a connector on the side of the unit's case will accommodate a battery charger. Also, the transceiver can be externally powered from any 12- to 14-volt dc source capable of delivering the required current. (Royce makes an accessory ac power supply, the Model 2-048, for line-powering the walkie-talkie. This optional supply retails for $40.)

Other features include a call-alert setup that is keyed by a tone from another transmitter to get the attention of the unit's operator; adjustable squelch; external speaker jack for receiver and PA use; built-in speaker that doubles as a microphone; jack for an external mike; and a 60-in. telescoping antenna (with provision for an external 50-ohm antenna).

The Model 1-408 retails for $110, including crystals for only Channel 11, carrying case, shoulder strap, and earphone. The unit measures 9¼" × 3⅛" × 2½" and weighs just slightly more than 2 pounds.

The Receiver. The receiver is a superheterodyne, single-conversion design. It employs an r-f stage that converts the incoming signal for driv-

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ing the 455-kHz, two-stage i-f strip. Selectivity is obtained from three i-f transformers and a ceramic bandpass filter, the latter located in the emitter circuit of the first i-f stage.

Adjacent-channel rejection was 20 dB on the low and 40 dB on the high sides of the selected channel. The overall bandpass at the 6-dB points was 400 to 2500 Hz. The sensitivity, rated at 1 μV for 10 dB (S+N)/N, checked out to be closer to 0.5 μV with 30 percent modulation at 1000 Hz. Image rejection was 20 dB — better than usually obtained with single conversion.

The squelch threshold range was 0.7 to 35 μV. The agc had little effect below 10 μV. Above that, the a-f output held to within 2 dB with a 60-dB (10 to 10,000 μV) r-f input change. A 100-μV signal was required to produce an S9 meter deflection.

A full-time automatic noise limiter (anl) is included, but it was not too effective. This is not necessarily a bad thing inasmuch as the signal levels encountered under usual operating conditions will override the noise.

With PA operation, the a-f output from a class-B stage was 3 watts (7 percent distortion at the start of clipping) at 1000 Hz into an 8-ohm load. Distortion on receive was slightly greater.

Transmitter. Separate crystals are required for each transmit and receive channel. The transmit crystal-oscillator signal is applied to the driver for the r-f output-power amplifier. The output of this amplifier is coupled to the antenna through a multi-section network and a loading coil. The external-antenna connection is made at the output of the network from which the power meter's reading is obtained. As usual, the driver and power amplifier are collector-modulated.

The automatic modulation control (amc) system is an amplified feedback affair that controls the bias — and thus the gain — of the first speech amplifier. R-f power reduction is accomplished by decreasing the collector voltage of the driver stage.

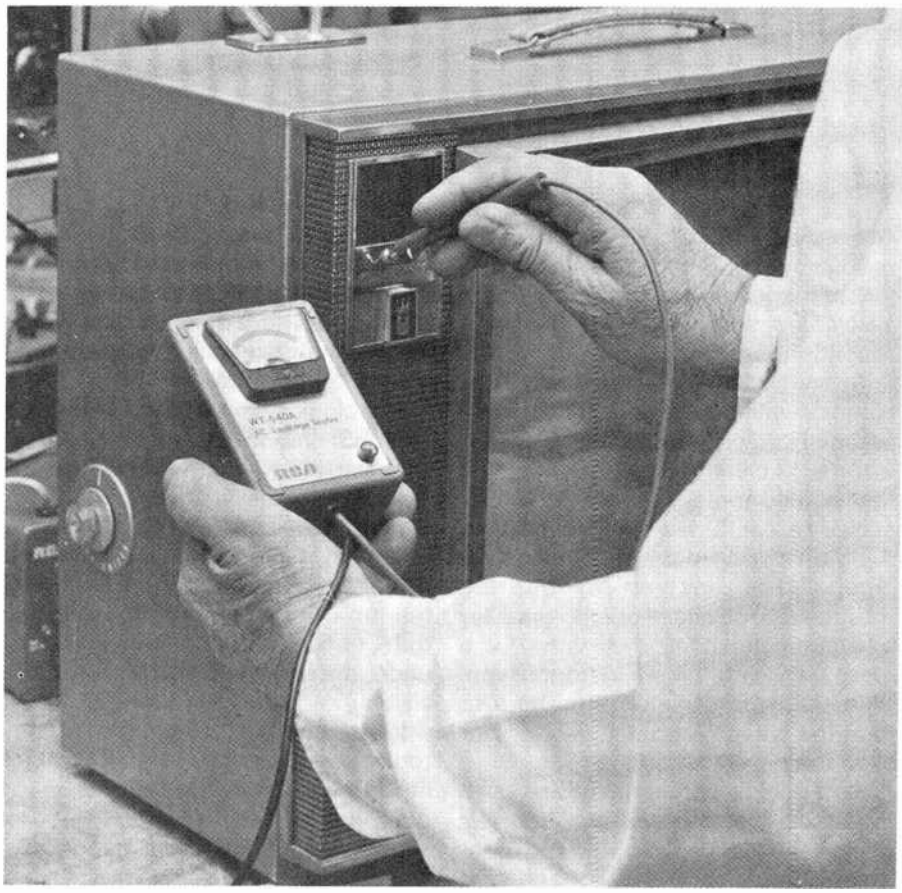
Operating at the 5-watt input level, the carrier output into a 50-ohm dummy load was just slightly less than 3 watts at a total transceiver current drain of 400 mA with a supply voltage of 12 volts. Peak current with modulation was 600 mA. On receive, the drain was only 50 mA. Using a 13.8-volt supply, as would be the case if the walkie-talkie were used in a car, the output was 4 watts. Operating on "battery save," the output was slightly less than 1.5 watts at 12 volts. (The transceiver can also be operated at 9 volts, in which case, the output becomes 0.5 watt and receiver sensitivity is down somewhat.

Modulation was excellent, with exceptional performance by the amc, which limited the modulation to 100 percent on the positive-going and about 90 percent on the negative-going peaks (no carrier breakup). Good waveform was observed, and distortion held to within 10 percent. Splatter at the adjacent channel with 10 dB of compression was better than 40 dB down. Otherwise, the response was 600 to 5500 Hz at the 6-dB points.

CIRCLE NO. 67 ON READERS SERVICE CARD

RCA MODEL WT-540A LEAKAGE CURRENT TESTER

Checks appliances and equipment for ground faults



THE THREE-WIRE ac line cord on electrical appliances must be credited with saving many lives, even if the possible "victims" were never aware of the fact. When a three-wire system is used in an electrical appliance, the third, or green, wire is connected to the metal case or chassis of the appliance and electrical ground at the wall outlet. In the event that the "hot" lead from the power line comes adrift and makes contact with the metal chassis, the presence of the third wire trips the circuit breaker or pops the ac line fuse, removing the potential hazard.

To be sure, there are still a considerable number of two-wire appliances in use, including kitchen aids, power tools, electrical fixtures, TV and radio receivers and even some industrial equipment. Those that are "double-insulated" can be considered safe, but other two-wire appliances that are not double-nsulated are potential hazards.

To protect appliance users from accidential electrocution, Underwriters Laboratories (UL) and American National Standards Institute (ANSI) have established the maximum leakage current permitted between an appliance and ground. Using a circuit having a 1500-ohm noninductive impedance, shunted by a 0.14-μF capacitance, the recommended maximum

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leakage current is 0.5 mA (0.75 mA in certain cases).

The RCA Model WT-540 ac leakage tester, available from RCA dealers for $29.50, is just the device needed for making leakage measurements. This easy-to-use instrument has no batteries, switches, or other controls. All you do is connect the test leads between the frame of the appliance and ground. One probe has a needle-sharp tip to permit it to penetrate through dirt, grease, oxide, paint, or other coating to make a good electrical contact with the metal frame.

There is only one meter scale. It is color-coded to provide at-a-glance indications of safe and unsafe leakage currents. The recommended maximum leakage points are clearly indicated on the scale.

A special test clip is provided for making the one simple check that insures that the meter is operating properly. This test clip also provides a means for determining which of the two socket connectors is hot and which is ground.

As an added safety feature, an internal fuse is provided to protect the instrument from damage should the leads contact an appliance that is either shorted or has extremely high leakage. If the fuse should blow, a front-panel lamp indicates that an unsafe level exists.

User Report. After confirming that the leakage tester was operating correctly, we first checked the washer and dryer in our cement-floored basement. It showed that leakage in these appliances was nonexistent. (Both are on three-wire circuits.)

We next checked all of the test instruments and power tools on our workbench and all the power tools in our garage, especially any that had metal knobs or metal control setscrews. We then proceeded to check every electrical appliance in our home, paying careful attention to such items as hi-fi gear, TV receivers, and kitchen appliances. Everything checked out fine.

As a final test, we inserted a deliberate short circuit in an old communications receiver. The leakage tester immediately registered the existence of an electrical hazard.

After using the leakage tester for a couple of weeks, we are convinced that it is one of the most important pieces of test equipment that has come along in recent years. We recommend that every service technician and electronics experimenter add one to his inventory of test gear.

CIRCLE NO. 68 ON READERS SERVICE CARD

DIGITAL CONCEPTS MODEL CK-100 ELECTRONIC CLOCK KIT

Tells time and date at a glance

HAVING assembled a number of digital electronic clocks from kits, we were not exactly enthusiastic about building another when the $68 (plus $18 for the C-31 cabinet) Digital Concepts Model CK-100 clock kit arrived. However, after opening the carton and spending a couple of hours assembling this kit, we have had some second thoughts.

To start with, Digital Concepts has come up with a different concept in kit assembly. Each step in their excellent manual is clearly explained, and the few components that are to be installed in each step are packaged in their own individual envelope. This means that, instead of hunting through a large pile of components for one particular item, everything for a given step is right there in front of you. With this type of setup, it is hard to imagine anyone going wrong, not even the novice kit builder.

High-quality components are used in this clock kit. The display consists of six large seven-segment gas-discharge readouts whose bright orange glow can be clearly seen from quite a distance away. The ends of each readout segment appear to be joined to the adjacent segments. Hence, the display is almost continuous.

The clock's circuit employs a single MOS/LSI chip with transistor interface between the IC and high-voltage gas readouts. The system is designed to display date and time separately, or time with date on demand (the latter by pressing a pushbutton switch on the top of the cabinet). The time and date setting switches are hidden under the rear of the clock and are not visible.

In assembling the clock, the only tools needed are a low-wattage soldering iron, a screwdriver, and a pair of diagonal cutters. Digital Concepts supplies everything else needed.

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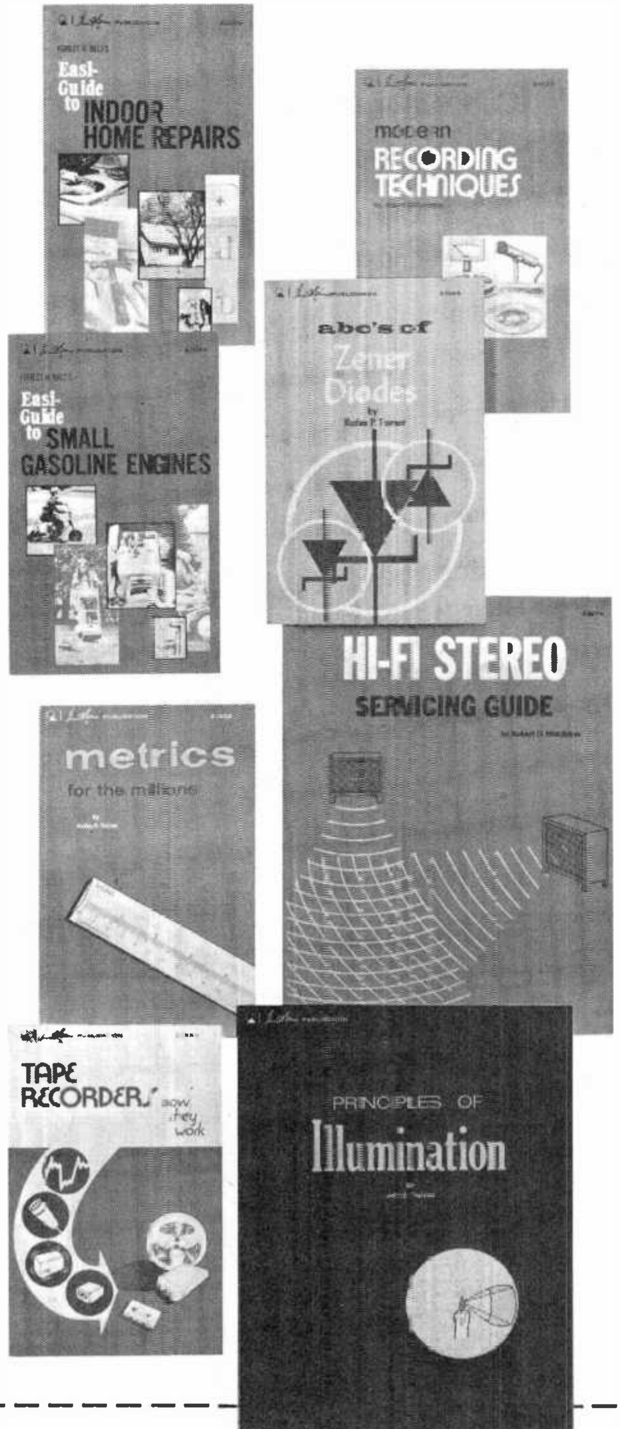

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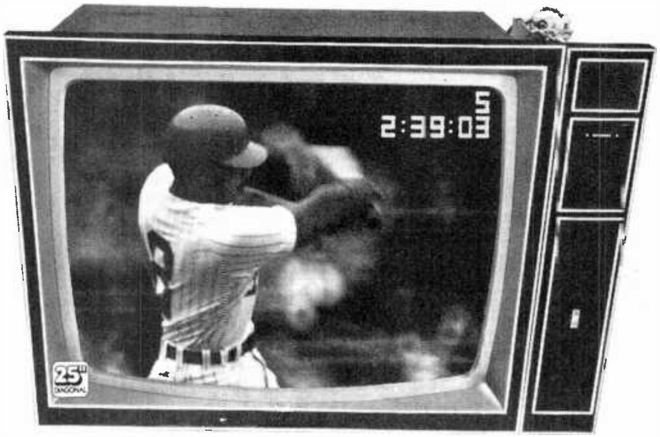

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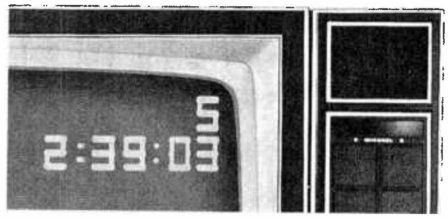
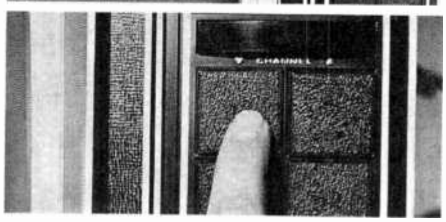
Channel numbers that flash on the screen

Digital clock that flashes on the screen



Automatic pre-set channel selector



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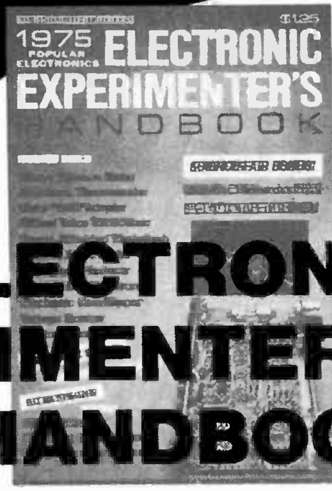

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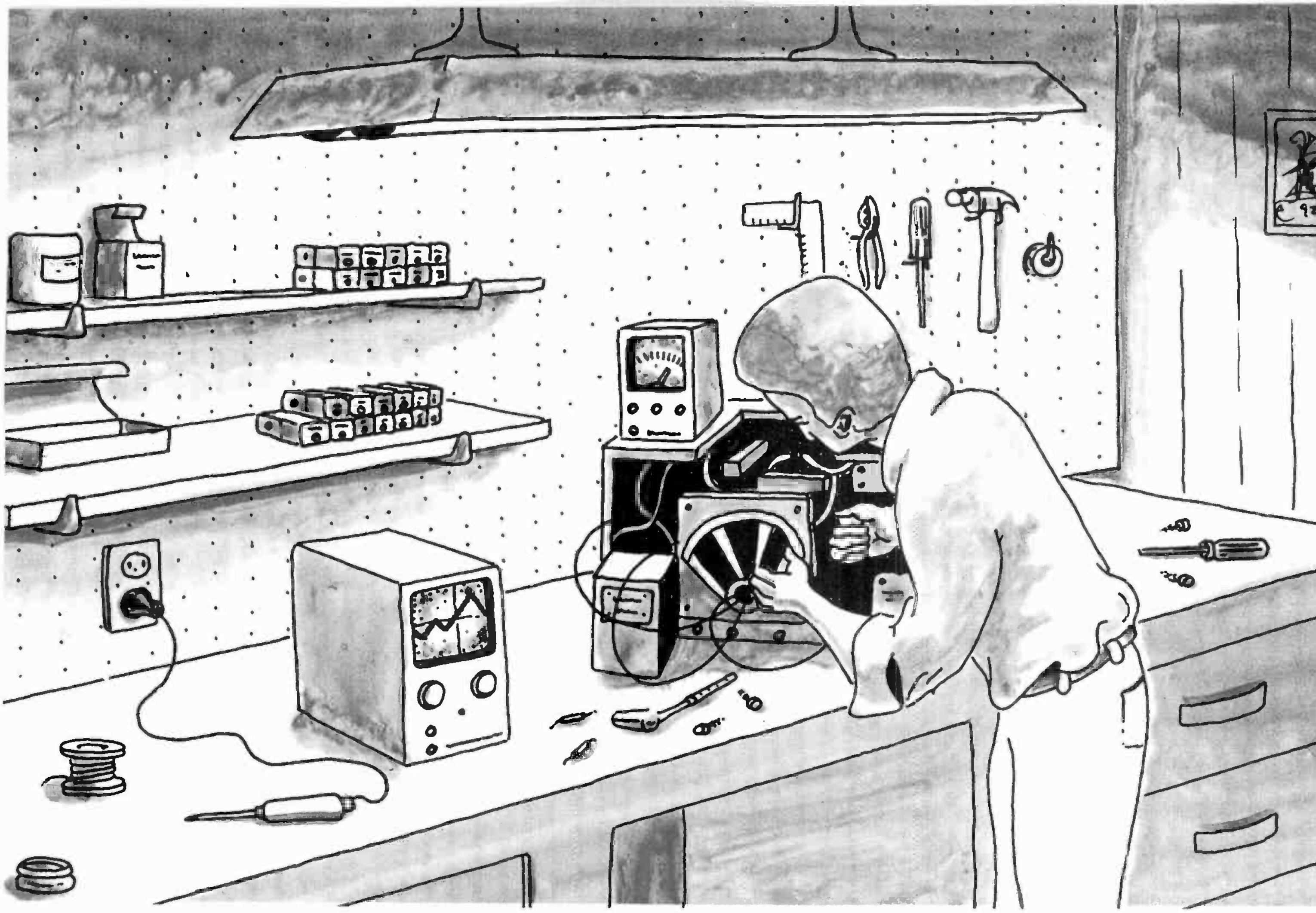

How to set up a HOME TV SERVICE SHOP

BY ART MARGOLIS

Helpful hints on getting started and the equipment you will need

EVERY year, thousands of electronics technicians and hobbyists get into part-time TV receiver servicing. Many quickly build up a business that justifies opening their own service shops on a full-time basis, and new careers are launched. Perhaps you can become one of the success stories.

You might start out in part-time servicing by working for a full-service shop, in which case, you will not have to make a capital investment. But if you are more ambitious and plan to go it alone, you will most certainly need a minimum number of parts, tools, and test equipment. Even so, the initial investment is surprisingly small—in the neighborhood of $50—for starting a business in these times.

Before you embark on part-time TV servicing, bear three things in mind. First, in some localities you need a licence to repair TV receivers; comply with the law. Next, a TV receiver operates on potentially hazardous voltages and has a high vacuum in its picture tube; use your head and follow sensible service precautions. Finally, a small percentage of TV troubles requires great technical skill and lots of

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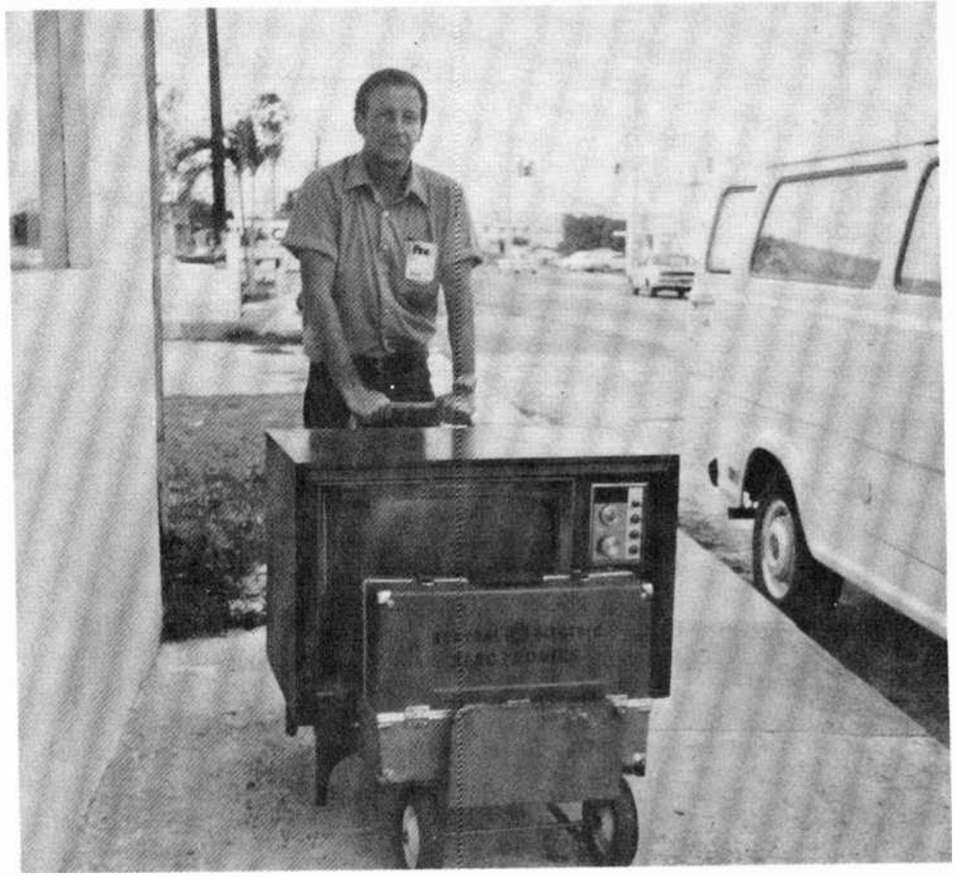

Here is how the author, equipped with a four-wheel dolly, easily carries a large color TV and his tube caddy from the house to the service van.

expensive test equipment to repair. If you can, make a deal with a full-time service shop that is equipped to tackle the jobs you cannot handle.

Your workshop requires replacement tubes, tools, chemicals, assorted parts, and test equipment if you are to work effectively. Let us discuss the minimum requirements that will help you fix a healthy percentage of TV repair jobs you might be called upon to perform.

WEEKEND WORKSHOP INVENTORY LIST

The following items, in addition to a high-impedance multimeter, will see the weekend serviceman through a great majority of TV receiver repairs.

Vacuum Tubes: 3A3C/3AW2/3B2; 6BK4/6CJ3/6CL3; 6DW4; 6CG7/6FQ7; 6GH8A; 6JE6/6LQ6

Hand Tools: Diagonal cutters; longnose pliers; 30-watt soldering iron; long thin screwdriver; Phillips screwdriver; socket wrenches; flashlight; jumper wire with alligator clips at both ends

Chemicals: Tuner/contact cleaner; corona dope

Assorted Parts: Rosin-core (60/40) solder; cheater cord; 4-ampere circuit breaker; fuses; #47 pilot lamps; 1-ampere silicon diode; 20-µF, 450-volt electrolytic capacitor; electrical tape

Test Equipment: Heavy-duty degaussing coil; hand mirror; incandescent-lamp continuity tester; neon-lamp tester

Replacement Tubes. Before color TV and solid-state electronics arrived on the scene, almost any electronics man could look at a tube-type receiver, analyze the symptoms, pull out the indicated tubes, check them at his local drug store, and identify the bad ones. Once identified, the bad tubes were quickly replaced. The receiver worked again.

In many cases, you can still do the same thing, although now it would be advisable to buy replacement tubes at a supply house and save at least 50 percent of the list price.

If you are doing a few calls a week, it is worth your while to carry some tubes with you. As time goes by and demands increase, you can add to your tube list until you have a satisfactory caddy of the most often needed tubes in your area. As shown in the Weekend Workshop Inventory List, only six vacuum tubes are listed. These are the most often needed tubes for the beginning serviceman. Their suggested list prices add up to about twice what they should cost you if purchased from a supply house.

Hand Tools. The main hand tools you must have for TV servicing and repair are the eight listed. You must be able to take apart a TV chassis and reassemble it, and you must also be able to remove and replace soldered-in components and adjust powdered iron cores without damaging them.

Only the most basic tools are mentioned in the Inventory List. Most of these you probably already have from your experimenting and hobby days.

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1. *A Lazy Susan tool holder on the service bench makes a place to hold a lot of things and also keeps them in their proper places.*

2. *Conventional, Philips-head, and hex-head drivers are all needed for the common job of removing the back of the television set.*

3. *A can of freezing solution sprays suspect capacitors and transistors as a test. If suspect heals during the freeze, the symptom will disappear temporarily.*

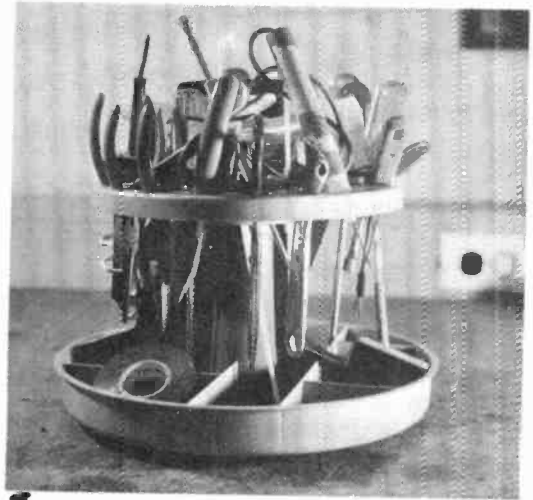
4. *To test resistances and voltages in hard-to-manage places, tube socket adapters are handy. They are made for every conceivable socket including those for CRT's.*

5. *A low-wattage iron is a must when working on a printed circuit board. A large iron gives too much heat and can loosen foil, burn holes, or damage semiconductors.*

6. *Ordinary neon tester allows you to check ac line voltage and r-f voltage around the HV cage.*

7. *A quick way to check out a dead heater string is with a filament checker. It also tests odd tubes like CRT's.*

8. *Fuses come in many shapes and sizes, including these chemical fuses. Try to have a representative set of fuses on hand at all times.*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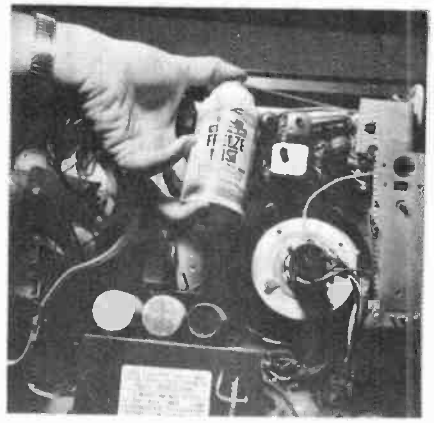
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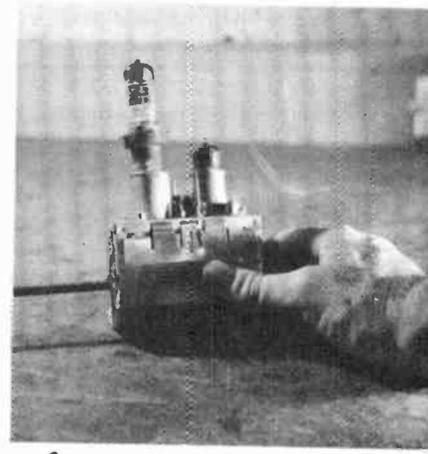
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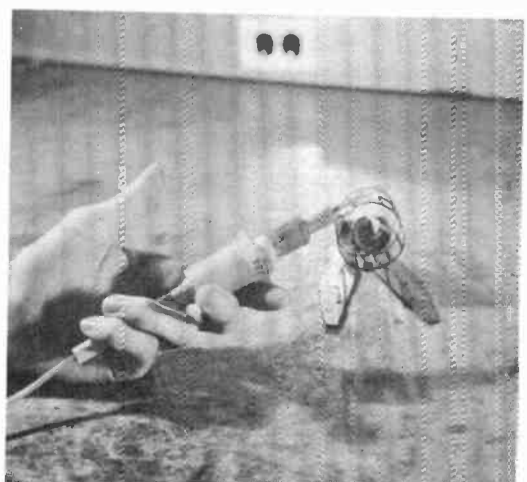
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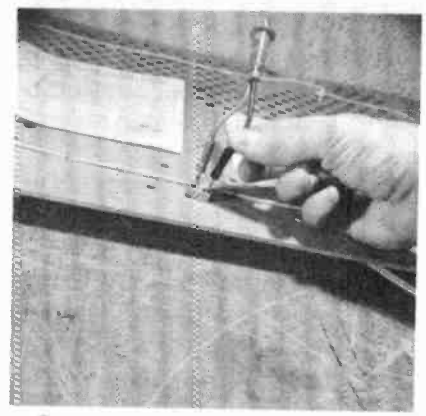
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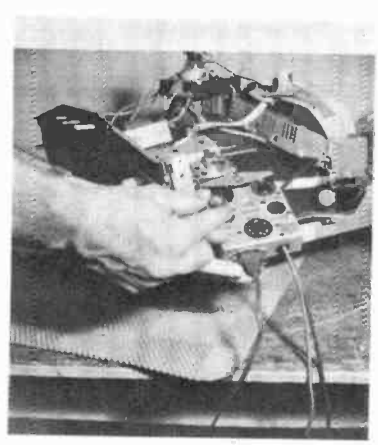
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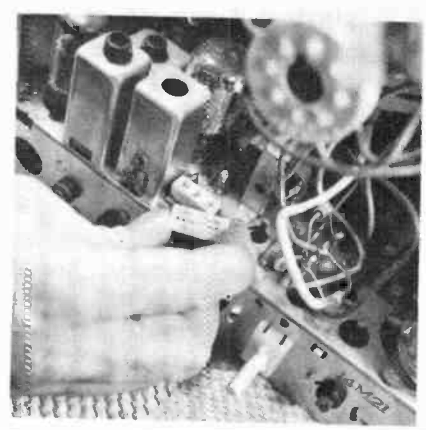
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Chemicals & Assorted Parts. Most of the time, you need only two chemicals in TV servicing work. These are tuner cleaner and high-voltage dope, the latter to reinsulate sections where the high voltage has begun to leak.

There are many types of chemicals available to aid in TV repair work, but you can manage without them. However, if you do any appreciable amount of work, each item has a definite time-saving purpose. So, you might consider adding them to your inventory as you begin to show a profit in your servicing.

Although it is not on our list, a can of aerosol freezing spray is the first "extra" chemical you should consider. It is excellent for tracking down capacitor and transistor troubles resulting from heat buildup. Simply spray the suspected component; if normal service is resumed, the cooled component is bad and must be replaced.

In the assorted parts category, the only three you must have are a cheater cord, a roll of solder, and electrical tape. Should-have items include a 1-ampere silicon rectifier, 4-ampere circuit breaker, fuses, several #47 pilot lamps, and a 20-microfarad/450-volt electrolytic capacitor. These are all common failure items that you will find get consumed quickly during servicing.

Test Equipment. It would be nice to own all of the test equipment a full-time service shop has, but you can get by with just a few basic items. While it is true that all the fancy gear will save a lot of time on the job, you will have to weigh this against the hundreds of dollars needed for the fancy gear.

Aside from your high-impedance VOM, you need a heavy-duty degaussing coil for color TV servicing, a simple neon-lamp tester for line and high voltages, a continuity tester, and a hand mirror.

The degaussing coil is a must when working on color-TV receivers for making purity adjustments and setting up for convergence adjustments. Degaussing coils are inexpensive items that are well worth the few dollars investment.

A tube tester is an important test instrument in TV servicing. But you do not have to own one. Most drug stores and electronics parts supply houses have tube testers that can be used free of charge. Testing transistors is another matter. Testers are not available in the places you would ordinarily find tube testers. However, you need not have an elaborate tester at your disposal. Since junction condition of transistors and diodes is a good indication of the device's operating condition, an ohmmeter can be used to check transistors and other solid-state devices. Make sure to use a current-limiting resistor in series with the meter's "hot" test lead.

Service Library. One of the most important tools a TV serviceman can have is a library consisting of schematics and manufacturer service manuals. The

MAKING THE JUMP TO FULL-TIME SERVICING

You may find that after a period of time servicing TV receivers on weekends, you can earn more money and have a large enough clientele to go into the business full-time. If you find yourself in this condition, you will undoubtedly want to know what types of parts and equipment you will need for full-time servicing. So, we have provided the following list to get you started:

TUBES FOR CADDY

1G3/1B3	6EJ7/EF184	10CW5
1V2	6EM7/6EA7	10GN8
1X2/1X2A	6EW6	11KV8
(3)3A3C/3AW2/3B2	(2)6FQ7/6CG7	12AT7/ECC81
3AT2	6GF7A	12AU7/ECC82
5U4GB/5AS4	(3)6GH8A	12AX7/ECC83
6AQ5/6HG5	6GU7	12BH7A
6AU6A	6GY6/6GX6	12BX7/12BV7/ 12DQ7
6AW8A	6HM5/6HA5	
6AX4GTB	(2)6JE6/6LQ6	13GF7A
(2)6BK4C/6EL4A	6JC6A	15KY8A
6BL8/ECF80	6JS6C	17AY3
6BZ6	6JU8A	17BE3/17BZ3
6BZ7/6BQ7A	6JW8/ECF802	17BF11
6CB6A/6CF6	6KT8	17JZ8
6CD6GA	6KZ8	21GY5
6CG8A	6LB6	22BW3
6CJ3/6DW4/6CL3	6SN7GTB	24JE6C
6DQ6/6GW6	6U8/6AX8/	33GY7A
6DX8/ECL84	6KD8/5KD8	38HE7
6EA8	8AW8A	42KN6
	8FQ7/8CG7	

Note: Numbers in parentheses indicate quantity required. No parenthetical numbers indicate only one required.

RESISTORS

Ohms/Watts	Ohms/Watts	Ohms/Watts
10/a,b,c,d	500/d	22k/a,b,c
15/a	1k/a,b,c,d	22k/a,c
22/c	1.5k/a,c,d	33k/a,b
27/a	2.2k/a,b,c	39k/b
47/a,b,c	2.5k/d	47k/a,b,c
50/d	2.7k/a,b	68k/a,b
75/d	3k/d	100k/a,b,c
82/c	3.3k/a,b,c	150k/a,b
100/a,b,c,d	4k/d	220k/a
150/a,c	4.7k/a,b,c	270k/a,b
175/d	5k/d	330k/a
220/a,b,c	5.6k/d	470k/a,b
250/d	6.8k/a,c,d	1M/a,b
270/c	7.5k/d	2.2M/a
330/a,c	8.2k/a,c,d	3.3M/a
400/d	10k/a,b,c,d	4.7M/a
470/a,b,c	15k/a,b,c,d	10M/a

Note: k=1000; M=1,000,000; a=½ watt; b=1 watt; c=2 watts; d=10 watts.

NON-POLARIZED CAPACITORS

600-V Mylar Paper	500-V Silver Mica
0.001 µF	10 pF
0.002 µF	33 pF
0.003 µF	47 pF
0.004 µF	68 pF

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0.01 μF	100 pF
0.02 μF	220 pF
0.047 μF	270 pF
0.1 μF	330 pF
0.25 μF	470 pF
	560 pF
	0.001 μF

50-V Ceramic Disc	**1000-V Ceramic Disc**
0.001 μF	220 pF
0.002 μF	330 pF
0.005 μF	470 pF
0.01 μF	680 pF
0.02 μF	0.001 μF
0.05 μF	0.005 μF
0.1 μF	0.01 μF

ELECTROLYTIC CAPACITORS

10-V	**25-V**	**50-V**	**150-V**	**450-V**
4.7 μF	2 μF	10 μF	10 μF	2 μF
10 μF	4.7 μF	22 μF	20 μF	4 μF
33 μF	10 μF	47 μF	40 μF	10 μF
47 μF	22 μF	100 μF	60 μF	20 μF
100 μF	47 μF	220 μF	50/30 μF	40 μF
220 μF	100 μF	470 μF	80/50 μF	60 μF
	220 μF	1000 μF		
	470 μF	2200 μF		
	1000 μF			
	2200 μF			

Note: All capacitors are axial-lead type.

MISCELLANEOUS ITEMS

Solder (rosin core)
Freezing solution
Yoke loosening solution
Tuner/contact cleaner
Heat sink compound
Plastic repair kit
Cabinet repair kit
Cements and glues
Corona dope
Plastic and glass cleaner
Alligator clips
Fish paper
Insulating spaghetti
Focus rectifier
Interlock receptacles
"S" type fuse clips
Assorted hardware
Rabbit-ears antenna & replacement elements
Silicon power rectifiers
Circuit breakers
Pilot lamps
Assorted transistors
Fuses
Ac plugs & line cords
Cheater cords
Soldering iron tips
High-voltage tape
Plastic tape
300-ohm twin lead
Coaxial cable

TOOLS

Diagonal cutters
Longnose pliers
Soldering aid
Soldering iron
Soldering gun
Wire stripper
Assorted screwdrivers
Tweezers
Spintites
Reamer
Socket wrenches
Hot-tube puller
File
Adjustable wrench
Slip-jaw pliers
Heat sink
Flashlight
Tube socket adapter
Tube pin straightener
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Control knobs
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Hammer
Cold chisel
Center punch
Allen wrenches
3-to-2 ac plug adapter
Extension cord
Alignment tools
Long pickup tool
Cheater cords
Adjustable light
Equipment dolly
Mirror with stand
Staple gun
Pop riveter
Crimping tool and connectors
Lazy Susan Tool caddy
Magnifying glass
Inspection mirror (dental type, preferably illuminated)
Electric drill
C clamps
Vise
Workbench

TEST EQUIPMENT

Tube tester
In-circuit transistor tester
CRT tester
Continuity tester
Neon-lamp tester for HV & r-f tests
Filament tester
High-impedance multimeter & HV probe
R-f/i-f/video/audio signal injector
B & K Analyst or Sencore Sweep Analyzer
Oscilloscope & high-impedance probe
Bias power supply
Color bar/pattern generator
Sweep-marker generator
Heavy-duty degaussing coil

investment for these items is very small when equated with the amount of time and effort they can save on a service call. When you attempt to repair a receiver and get stuck, it is time to get out the appropriate schematic and use it like a road-map to trace out circuitry.

The manufacturer is the least expensive source of service notes for his TV receivers. Most of the time, manufacturers will be happy to supply schematics for a fee of 50¢ or $1. There are other sources from which schematics and service notes can be obtained. Two of them are Howard W. Sams and Tab Books.

After each call, file the schematic in a service library near your workbench. Chances are that you will be called upon to repair this same model receiver in the future.

A good schematic is a well-marked diagram. Every time you find a trouble, circle the component or connection that is the cause of it. Do not be afraid to write on the schematic peculiar symptoms and other pertinent information that will save you time in the future where the symptoms are the same.

You can build up your service library gradually, starting with the service manuals for the most common manufacturer models and series in your service area. If you have to resort to buying $2 or $3 worth of schematics to get the one you want for a given receiver, add the cost onto the repair bill. ◈

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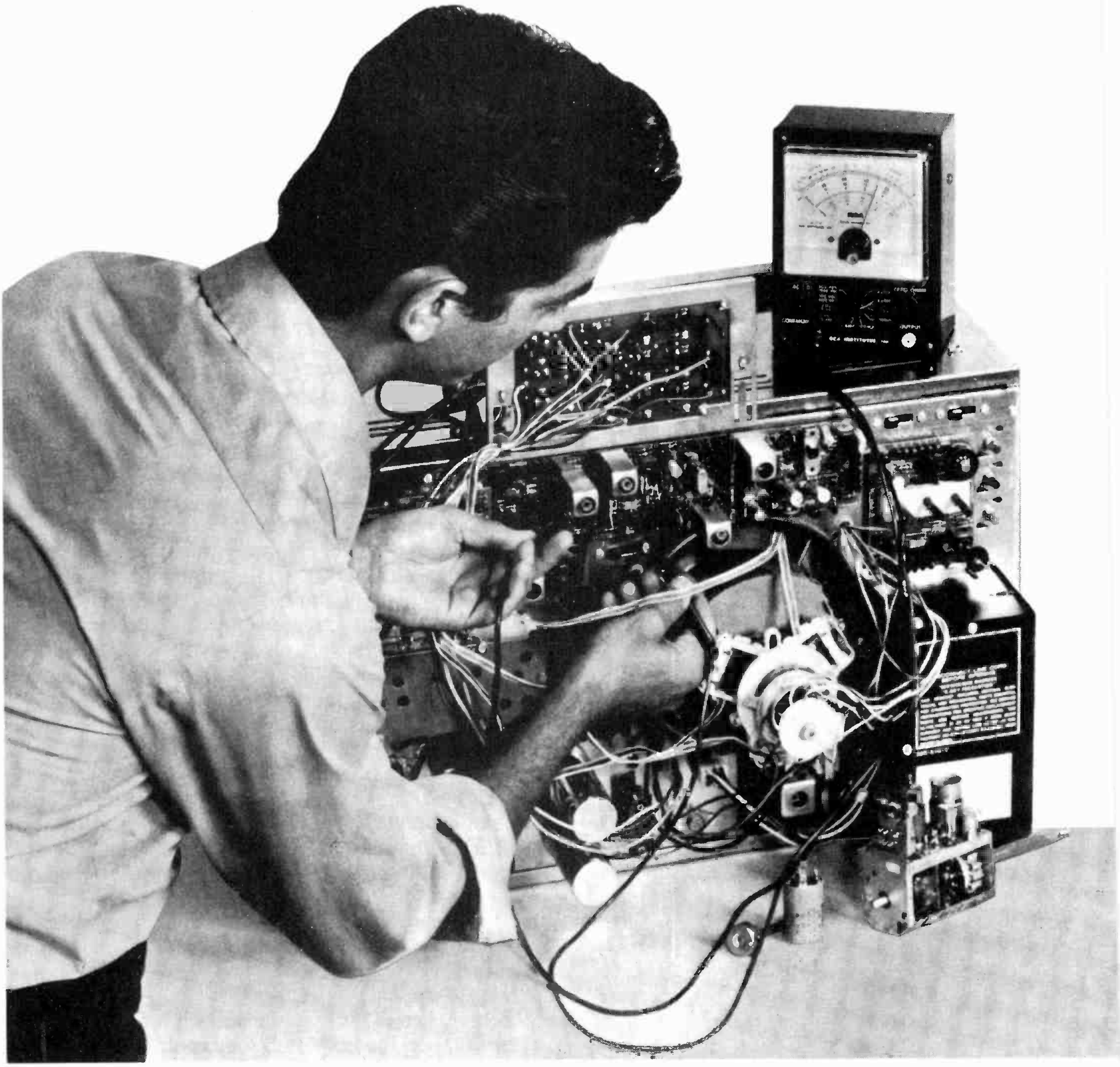

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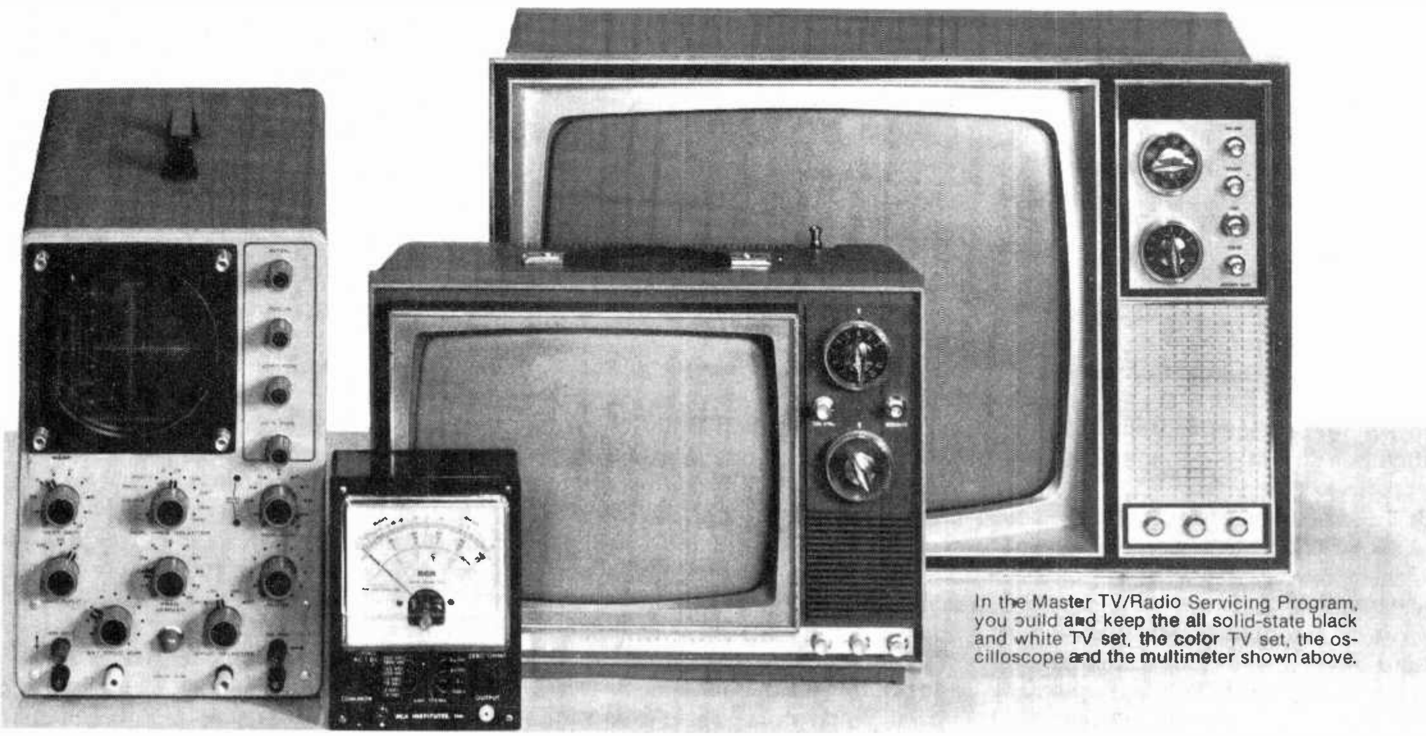

In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

CIRCLE NO. 16 ON READERS SERVICE CARD

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MAC'S SERVICE SHOP

Tips On Kit Building

By John T. Frye, W9EGV, KHD4167

SUMMER was bustin' out all over, and Barney's pursed lips were chirping a merry imitation of a robin as he entered the service department, where he found Mac, his employer, placing a kit-type frequency counter back in its case.

"There," Mac said with grim satisfaction, "that's another abused kit straightened out. Kit manufacturers spend countless hours of time and hundreds of thousands of dollars trying to make the assembly of their kits foolproof, but it's impossible to turn out anything some clod can't foul up by ignoring instructions."

"You've put together a bunch of them, haven't you?"

"I estimate that, from the time I ordered that first 5" oscillosope kit from a tiny Heath ad in *Radio News,* I've put together well over a hundred kits. They were made by such manufacturers as Heath, Eico, Knight, Archer, and ranged in complexity from simple resistance boxes to color TV receivers, laboratory oscilloscopes, and SSB transceivers."

"I notice the kits you put together almost always seem to work the first time you turn them on. They exceed the advertised specs in performance, and they keep working without trouble for many years. You got a secret?"

"No secret, just a fair amount of savvy I've acquired from my own mistakes. Believe me, I've made lots of them, and I've also learned from straightening out botched-up kits like that counter over there on the bench. From this painfully acquired experience, I've distilled a set of rules for myself that I follow faithfully in putting together any kit, large or small."

A Set of Rules. "Wouldst share your wisdom with your miserable slave, O Master?"

"I wouldst. *First, plan the assembly location carefully.* Ideally it should insure privacy, but at least it should be out of the traffic pattern and especially away from the patter of little feet. Kids and kits don't mix. Have lots of good light available. One light source should be movable so you can direct it into hard-to-see spots from various angles. If you don't have an adjustable bench light or a swiveling high-intensity lamp, you can make do with a good flashlight. At least a couple of ac outlets should be near at hand for your soldering iron and the lamps. Keep in mind you're going to drop some of the small parts or they will slip from your pliers and sail clear across the room. That's why working over a shag carpet is strictly a no-no. If you need convincing, you'll get it the firt time you try to find a tiny germanium diode or a ⅛" setscrew in the pile. A bare floor or a short-napped rug is best.

"Remember most kits will require several sessions to complete, and you don't want to have to pack everything away between sessions. So you need a large portable working surface that can be shoved back in a corner, with everything left on top just as it is, at the end of each session. A large square of hardboard on top of a card table works fine for all but the heaviest kits. The hardboard protects the top of the table from scratches and soldering iron burns; and, if the card table is needed, you can carefully lift off the hardboard and contents and slide it under the bed — if your wife will let you!

"*Next, open the kit carefully, find the manual, and study it.* Is the kit unit-packaged, with all the parts for a single portion packaged together, or are the parts packaged simply by types: resistors, capacitors, hardware, etc.? Are there any parts that require special care in handling? What is the general plan of construction? Do you do the pc boards first and then assemble them onto a mainframe and do the final wiring, or must some of the mainframe wiring be done before the boards are mounted? Will auxiliary equipment be needed in alignment and calibration: batteries, VTVM's, signal generators, short reset-time pulse generators, 'scopes? If so, you can be arranging ahead of time to secure those you do not have.

"*Locate, identify, and — if the kit is not unit-packaged — store in separate, easily accessible containers each group of parts.* Even if the kit is unit packaged, I go through each unit and locate and identify the parts and then put them back in their individual cartons until the assembly of that unit is called for. I prefer 7-oz. insulated disposable cups over the conventional muffin pans for storing the parts. Costing less than one cent each, these cups are lighter, deeper, easily labelled, and reusable. If you knock over a single cup, you simply scoop up the parts and put them back; but if you knock over a muffin pan, you've got 'pied' parts!"

"All that takes a lot of time," Barney objected. "I'm always in a hurry to get started."

"I know," Mac nodded his understanding, "but in the long run it saves both time and mistakes. You can often order a missing part and have it there by the time you need it. If the time you can devote to the kit is very limited and it is a large kit (such as a color TV), your warranty may well run out before you miss a part needed in final assembly. But the chief advantage of this checkoff is that it makes you thoroughly familiar with the appearance of all the parts you'll be using. Some will be like nothing you've ever seen before. Others will be distinguished from each other by subtle, but important differences. For example, you may have screws identical in size, length and threads but with different head types.

"I use a different cup for each category of screw, even though I have only two or three of one type. I do the same with nuts and lockwashers, and I label, with a pencil, each cup as to its contents. I separate capacitors by type, voltage, and capacitance when there is any danger of getting them mixed up. Quite often you will have a great many of the same type and voltage but a different capacitance. I may place all of these in a single cup. I like to use a block of molded plastic to hold resistors that I separate by wattage, tolerance, and resistance value. Once you've separated the high wattage and close tolerance resistors from the rest, you usually have a great many ½-watt, 10% tolerance units left. I've found it helps to cluster these by decimal resistance values: I stick all

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those up to 100 ohms in one group, those from 100 to 1000 ohms in another group, those from 1000 to 10000 ohms in another group, and so on. This allows me to select the proper resistor in a hurry. Let me hasten to add that after I have selected a resistor by banding, I always check it with an ohmmeter just before I install it. Rarely do I find a resistor out of its indicated tolerance, but it has happened. Quite often I find — in time — that I've made a mistake in reading the color coding.

"Finally, I'm especially careful with such parts as IC's, transistors, meters, and coils. The less you handle coils, the better, especially if they are pretuned. IC's and transistors never have their leads stuck into the plastic holding the resistors, even though they have apparently been shipped in this fashion. That shipping material is a special conductive type free of the static electrical charges that lurk in many plastics — charges that can easily destroy an IC or transistor.

"*Follow instructions to the letter.* Strangely enough, the tyro is much less likely to sin in this regard than is the experienced technician. The latter seems to think following step-by-step instructions is somehow beneath him and that he can wire a kit faster and more expertly just by following the diagram. That's the kind of mistake I used to make. Now I do precisely as I'm told, and I get along much better. I try to cut component leads and wires as close to specified lengths as possible, and I've made up a couple of simple little gadgets that help. One is just a plastic card, such as a discarded credit card, that I've cut in stairstep notches so that the distance from each notch to the opposite side of the card is a distance often needed in measuring lead length. The other is a portion of a yardstick with a little butt plate on one end and a clamp to hold the end of the wire. I shove the end of the wire against the butt plate and hold it with the clamp while I stretch it out along the rule and cut it at the right distance. This beats trying to hold the component, a ruler, and a pair of dikes all at the same time.

"*Try to do a professional job of soldering.* Nothing is more important in kit assembly. Common errors include applying the heat of the iron to the solder instead of the joint; using so much heat the foil is lifted off the board; using so little heat that the flux is not evaporated making a cold solder joint; using too much solder; and trying to work with a dirty, untinned iron. If inexperienced in soldering, read and reread the manual instructions in this regard and then make a few practice joints before you start on the kit. Study the joints on a commercially soldered board and try to imitate them. Try hard!

"*Work carefully and methodically.* Check off each operation as it is performed to avoid missing one — which is easy to do. Avoid the need for unsoldering, which is hard on components and the pc board. To do this, watch especially for the correct polarity of diodes and electrolytic capacitors and for the proper arrangement of transistor leads. You may have to put in six transistors in which the center lead was bent *away* from the flat surface of the transistor, but the seventh transistor may require this lead to be bent *toward* that surface. And never plug in IC's or transistors until you're told to do so. They may easily be damaged by other operations performed on the board.

"*Do not work too long at a time.* It hard to quit when things are going well, but errors multiply rapidly when you're tired.

"*Check your work when told to do so and recheck it at the end of each session.* Use good light and an optical magnifier. Look for incorrect placement of parts, solder bridges, cold solder joints, and loose bits of wire. Incidentally, when clipping off leads from the soldered board, I put the board on its side and hold a paper cup in front of the lead as I clip it. This gathers the leads neatly for dumping into a wastebasket instead of allowing them to fly all over the room — possibly into an eye. The duller the diagonal cutters, the farther these clippings sail. When you're satisfied with the unit, store it where it will not be damaged while you do the next one.

"*Check the finished kit carefully before turning it on.* Be sure and make any suggested resistance checks. Even if none are suggested, I always check the resistance from a rectifier output to ground and compare this with the diagram. I'm not much for the technique described as 'tuning up for maximum smoke.'

"*Perform all preliminary adjustments, alignment, and calibration exactly as instructed and in the order prescribed.* Do this, even though you don't understand the reason. It is a very important rule." ◈

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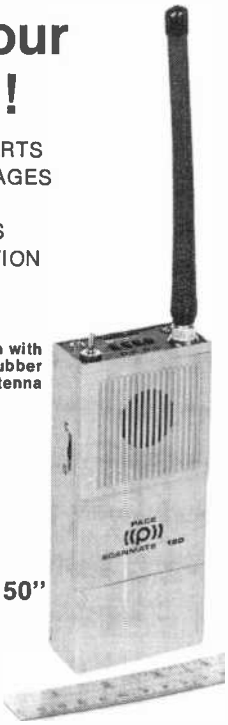

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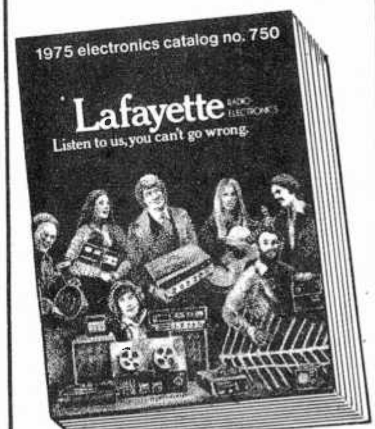

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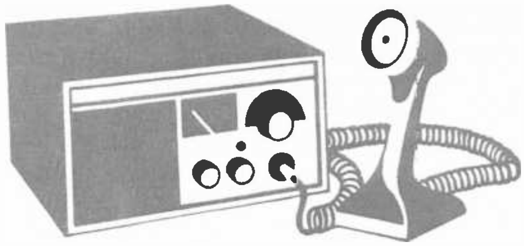

CB Scene

By Len Buckwalter

LIGHTNING AND THE CB BOATER

LIGHTNING strikes somewhere on the earth, says the Weather Bureau, about 100 times every second. It's spawned by some 1800 thunderstorms always raging about the planet. If you live in California or Oregon there's little cause for alarm because almost no lightning hits a thin strip of the West Coast from Washington State to the Mexican border. But if you reside almost anywhere else in the country, electrical storms will strike on 20 to 100 days out of each year. It's especially heavy up and down the Atlantic seaboard, around the Great Lakes and along the Gulf coast. Right now, during the dog days of July and August, the heavenly wrath is at its most intense.

What's it got to do with CB? Plenty, if you're one of the huge fleet of 300,000 CB'ers who use the two-way radio aboard a boat. At home you can hide under a (well-grounded) brass bed when thunder rumbles, but aboard a boat the exposure index is embarrassingly high. That CB marine antenna you mounted topside is not only a high point on the boat, but often the loftiest metal item from stem to stern. And it's a combination of metal and height that a stroke of lightning finds most irresistible. Your antenna is a beckoning finger tempting a bolt from the blue.

If you're struck, the results can be unusual, to say the least. A Virginia man, according to the *Guinness Book of World Records,* lost his eyebrows and big toe nail (only). A while back on Long Island Sound, one amazed boat-owner actually saw a shaft of lightning strike his boat while he was some distance away. Later, when he inspected for damage he discovered everything shipshape, except for one item; the strike had melted his marine toilet!

It can be argued that your CB antenna is a veritable magnet for lightning, but a direct hit on a small boat is uncommon. Sheer luck may assure you a lifetime of safety, as it did for Ben Franklin when he performed his famous kite-flying stunt in a thunderstorm. Not so lucky were a half-dozen or so other experimenters around the world who tried to duplicate the identical feat. They were all killed. But as a result of Franklin's risky sport, we now have a way of converting a CB atennna from an instrument of destruction, to a protective shield.

Antenna As Lightning Rod. The reason is that a CB antenna easily serves as an excellent lightning rod without harming its original function. It's based on the well-known principle that once lightning is drawn to a high

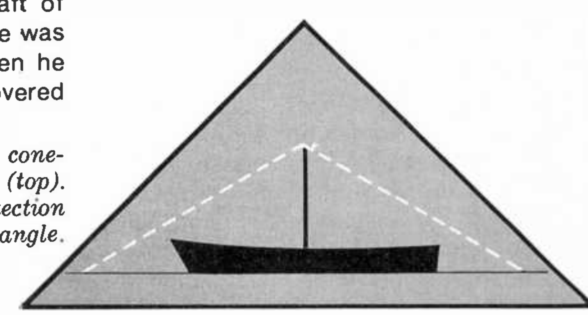

Fig. 1. Antenna protects cone-shaped space above boat (top). Fig. 2. Cone of protection encloses a 60-degree angle.

point it seeks the easiest path to "ground", in this case, the water. If there's a wood hull in between, the bolt can rampage through it, exploding moisture into steam as it expends its awesome energy. Where electrical cabling lies along the path, the wires help duct the discharge, but might melt from the heavy wattage. If you can give the bolt a low-resistance path to ground through conductors of ample size, you'll vastly reduce lightning's potential for death and destruction. Let's start at the top.

First, be sure the tip of your CB antenna is the highest point on your boat. (CB antennas made for marine operation usually rise between 8 to 18 feet.) Height will attract a stroke that would otherwise hit you or some other part of the boat's structure. It also raises the "cone of protection," a tent-like area that encircles and covers the boat. When a storm cloud sends down an exploratory "leader", an electrical "streamer" rises from the ground to create an ionized path for the main stroke to follow. If these preliminary discharges occur in the vicinity of your boat, they are lured by the antenna tip away from objects inside the cone of protection. Though it's invisible, you can easily figure out where the cone lies. Estimate your antenna height above the water line, say 25 feet. Double that dimension (50 feet, in this example) and you have a good idea of how far the cone extends in every direction from the antenna. Note (Fig. 1) that the outline is that of a cone; to find what falls within this electrical tepee, draw an imaginary line from the antenna tip out to that horizontal dimension on the water line. You'll want the antenna high enough to keep all objects inside the cone. Another way to measure the cone is shown in Fig. 2.

The next important consideration is checking for a good path to ground. The shaft of the antenna leads the flow down to the next leg of the grounding circuit, formed by the shield of the coaxial lead. Although the antenna itself is "hot" for 27-MHz signals, it is nearly always "dc-grounded." The manufacturer places a loading coil or matching transformer at the antenna base which acts as a short-circuit to lightning. Lightning currents, therefore, are conducted through the coaxial cable shield down to the CB transceiver. In many instances this is a danger point in a CB marine installation. After a strike, currents travel from the coaxial shield to the radio chassis, then through the negative, or ground, side of the boat's electrical system. There is considerable risk because that ground may be fine for the dc supply powering your rig, but not good enough for lightning careening down the coaxial transmission line toward the water.

Ground Bonding. Thus, the next major step: Interconnect any large metal masses—handrails, prop shaft, rudder, and engine—with heavy copper braid or No. 8 copper wire. Be sure to include the radio chassis, usually done on the rear apron at a grounding screw or terminal. Keep any ground wires as short and curve-free as possible. (The latter prevents coils that could increase impedance and power dissipation at that point.) You don't have to include every small object made of metal, just large masses, to prevent dangerous side flashes that might jump from one metal surface to the next.

Once the ground-bonding is accomplished, decide if you have a good termintion to the water. In many instances, it automatically happens if the boat engine, rudder or other partly submerged metal was strapped into the grounding system. If you don't have metal of at least one square foot in contact with the water, consider installing a ground plate below the water line. We don't mean the classic ground plate for boats—a massive sheet of copper nailed over a huge area underneath the hull—but one of the newer types that are a fraction of the size. They're made of ½-inch porous bronze, measure a mere 6" x 2" and furnish a good electrical contact fo discharging current harmlessly into the water.

Consider, too, a lightning arrestor sold for coaxial cable to introduce an added measure of protection. If you install the arrestor just before the line enters the cabin, you can connect a ground wire at the arrestor then connect the other end of the ground wire to submerged metal. One advantage is that a lightning stroke travelling down the coaxial shield will see somewhat lower resistance (and impedance) because of a shorter, straighter ground run. Another benefit of the arrestor is that it contains tiny air gaps between the shield and inner conductor. These might reduce interference and possible damage to a transceiver's front end by discharging precipitation static that can be created by a nearby storm.

There's an excellent reason for installing a coaxial lightning arrestor if you regularly remove your CB transceiver after each boating day (to prevent theft) or for servicing. In removing the transceiver, you may also destroy any connection to ground between the CB antenna and the water, thus increasing the risk of damage if lightning strikes while the transceiver is not in place. The coaxial arrestor, which remains permanently in the line, keeps your "lighting rod" safely connected to ground at all times. ◈

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Test Equipment Scene

By Leslie Solomon

GRID-DIP METERS

ONE of the least known and used pieces of test equipment is the grid-dip meter. The question running through many readers' minds right now (especially newcomers to electronics) is "Just what the heck is a grid-dip meter? For that matter, what is a grid dip?"

To start with, the name originated in the early days of radio, when tubes (those glass things that get hot) ruled the roost. It was discovered that the current in the control grid (which, in semiconductor terms, performs somewhat the same function as the base of a transistor) in a self-excited oscillator was very sensitive to resonance in nearby tuned circuits. This current would decrease (dip) as the external circuit was tuned to the frequency of the one-tube oscillator.

Modern grid-dip meters use either bipolar or FET oscillators (or tunnel diodes) and have several plug-in coils for various overlapping frequency bands. They also include some form of meter readout and an accurately calibrated tuning control. Most are battery powered so that they can be used in any location. And what it does is to indicate the dip in its own oscillator grid (or base) current when an external resonant circuit is tuned to the oscillator frequency.

How many times do you have a need to check a resonant r-f circuit. Well, maybe not many, but the grid-dip meter is also useful in checking capacitances, inductances, the Q of a circuit, bandwidths, antennas, transmission lines, crystals, and filters. It can also be used as a single-source monitor or a field-strengh meter.

Measuring Resonant Frequency. The classical use of the grid-dip meter is to measure the resonant frequency of tuned circuits—such as those in TV receivers, FM or AM radios, ham or CB rigs, and radio-control systems. In this case it is not necessary to have the equipment supplied with power. All you need is access to the coil in the circuit. The coil of the dip meter is placed close to the coil being checked and the meter is tuned until it gives an indication. The tuning capacitor dial of the meter then indicates the frequency. (Of course, the dip meter's dial can be adjusted for very accurate frequency indications by using a signal generator, receiver, and/or frequency counter.) This is about the only way you can determine whether or not a coil is correctly tuned. It's possible that somebody mistuned it by "tightening up that loose screw."

The resonance of an antenna can be checked by using the grid-dip meter on a straight section of the antenna. If you use a long-wire antenna, simply connect one end of it to ground through a 1- or 2-turn loop. Then couple the dip meter to the loop and measure the frequency.

To check the electrical length of a transmission line, leave the far end open and put a 1-turn loop across the near end. Use the dip meter to determine the lowest frequency. This will be the frequency at which the line is a quarter of a wavelength long. These are only a few of the uses for the grid-dip meter in testing antennas. You will find others.

Checking Circuit Elements. Suppose you want to know the resonant frequency of an unmarked r-f choke. Simply place the choke close to the meter coil and adjust the frequency control. You can measure the self-resonant frequency of any coil by using this technique.

To check the value of an unknown capacitor, connect the capacitor across a known inductance coil. Measure the resonant frequency of the combination and use the expression $C = 25{,}400/(f^2L)$, where C is in picofarads, L is in microhenries, and f is in megahertz. To determine the distributed capacitance of the coil, do the same as above, omitting the capacitor.

The process can also be reversed to find the inductance of an unknown coil. In this case, couple the coil to a capacitor of known value and measure the frequency on the grid-dip meter. Use the same equation as above but solve for L instead of C.

Suppose you wanted to find the easiest way to set the slug on a coil when looking for a particular inductance value. One way is to find the desired dip-meter frequency by solving the expression $f = \sqrt{25{,}400/LC}$. Once you determine the frequency (or if you already know it), set the grid-dip meter to that frequency and adjust the slug in the coil until the meter dips.

Aligning a Radio. How would you align a battery-operated radio without a battery—or an ac radio without the line cord connected? Using a grid-dip meter, you start at the last transformer and couple the dip meter to it. Adjust the slugs (or capacitors) for a dip at the selected i-f frequency. Then work your way back to the antenna, checking each tuned circuit in the same way. When you get to the local oscillator, set the main tuning dial to about 1500 kHz. Set the grid-dip meter to this frequency minus the i-f (usually 455 kHz). This comes out to 1045 kHz. Now couple the dip meter to the oscillator coil and adjust the coil for 1045 as indicated by a dip on the meter.

You can even use the grid-dip meter as an outboard local oscillator coupled to a receiver antenna. The meter is then the beat oscillator for listening to sideband operation. Or, key the grid-dip meter for a code-practice oscillator or use it as a Q multiplier.

In the area of TV servicing, you can use a grid-dip meter to check all the tuning circuits and also as a marker generator when using a sweeper. In this case, couple the dip meter to a 2- to 3-turn coil with one end grounded and the other end coupled through a 0.01-µF capacitor to the signal input to the receiver. With the dip meter, you can check traps in a TV i-f strip.

A grid-dip meter can be used by hams to neutralize an amplifier without the power being turned on. You can also check for parasitics by probing the circuits and looking for odd dips on the meter.

In Closing. So that's the grid-dip meter and what it can do — at the test workbench, in the ham or CB shack, and in the servicing field. ◈

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Solid State

By Lou Garner

USING SURPLUS DIODES

IF YOU'RE a typical electronics hobbyist, whether a circuit experimenter or project builder, chances are you have a fair sized collection of various diodes and rectifiers tucked away in a Mason jar, cigar box, or similar container. These may be surplus devices from earlier projects, leftovers from bargain package assortments, or units salvaged from discarded equipment. Despite your collection, however, you probably buy new devices each time you start a project, except for those relatively rare occasions when a stock unit is *exactly* the type number specified in your schematic.

Your diode collection may include low-power germanium units, silicon devices, selenium rectifiers, and, perhaps, even high-voltage stacks or full-wave bridge assemblies. But regardless of type, size, or electrical specifications, your accumulated diodes share a common characteristic — inactivity. Unfortunately, unlike rare wines and delicate cheeses, diodes do not necessarily improve with age.

Perhaps you've felt that diodes can be used only as detectors in receivers and as rectifiers in power supplies. In actual fact, the diode, though the simplest of solid-state components, is an extremely versatile device.

With a little imagination, you can put your surplus diodes to work in a variety of interesting and useful circuits. Several of many possibilities are illustrated in Figs. 1 and 2. In each circuit, diode specifications are not critical provided peak reverse voltage and maximum current ratings are observed.

Use the arrangement illustrated in Fig. 1(A) to minimize dc electrical contact sparking, thus prolonging contact life and reducing electrical noise that may interfere with nearby electronic equipment. The diode offers high resistance to the normal flow of current, but serves as a spark-suppressing short to the back-voltage that develops when the contacts open. This technique may be used in most low voltage dc applications, including thermostat, relay and switch contact protection. Virtually any standard diode is suitable for this application, although low-forward-resistance types are preferred. If the diode becomes warmish in use, it indicates you need a larger (higher current rating) device, but several identical units may be connected in parallel in place of a single larger diode.

A similar technique can be used to suppress dc motor brush sparking, and with similar advantages — longer brush life and less electrical noise. As shown in Fig. 1(B), the diode is simply connected across the motor's terminals with the polarity indicated. This technique is a good one to remember when working with equipment using small dc motors, such as portable tape recorders and record players.

The simple dc polarity tester circuit given in Fig. 1(C) may be assembled in several different versions. For low-impedance applications, such as checking battery voltages and low-voltage power supplies, simply connect a diode in series with a suitable low-currrent incandescent lamp. You may have to add a current-limiting series resistor if the tested voltage(s) is higher than the lamp's rating. In use, the lamp lights when correct dc polarity is present between the tested points, remains dark with zero voltage or reversed polarity.

A more sensitive version of the polarity tester suitable for a wide range of voltages and high-impedance circuit applications can be assembled by replacing the lamp bulb with a magnetic headphone (1000 ohms or so). Here, a sharp click in the headphone indicates correct polarity or lack of voltage.

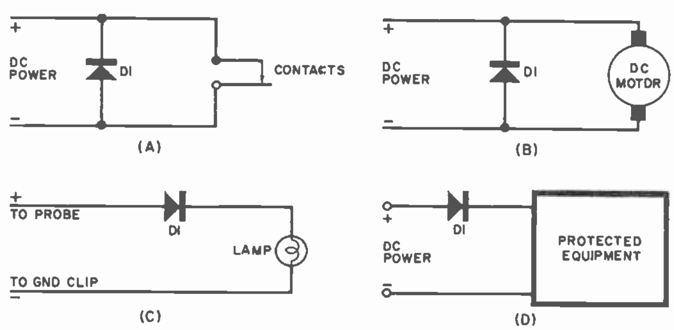

Fig. 1. Some diode applications: (A) contact arc suppressor; (B) motor spark suppressor; (C) polarity tester; and (D) polarity reversal protector.

Although you might expect to find a rectifier in ac line-powered equipment, the use of one with battery powered gear may seem superfluous, so the circuit shown in Fig. 1(D) could cause a "double take." Believe it or not (with suitable apologies), though, this arrangement makes good sense. Many types of solid-state equipment can be seriously damaged if dc power is connected with reverse polarity, whether through circuit fault or improper installation. A series rectifier used as shown serves to void such damage. With correct polarity, the rectifier acts as a virtual short, supplying power to the equipment. If the source polarity is reversed, the rectifier acts as an open circuit, preventing current flow and protecting the equipment. When using this technique, make sure that your rectifier is capable of handling the equipment's current drain.

If you use a soldering iron instead of a soldering gun, the circuit illustrated in Fig. 2(A) will help you to do your bit for the energy shortage. *S1* is a pressure-sensitive normally closed spst switch, *D1* a line voltage rectifier

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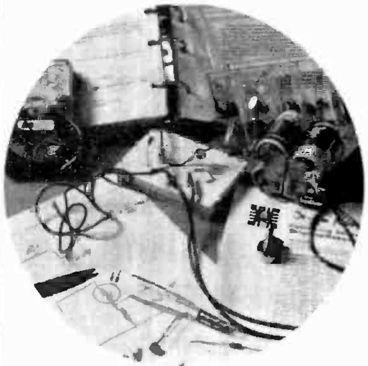

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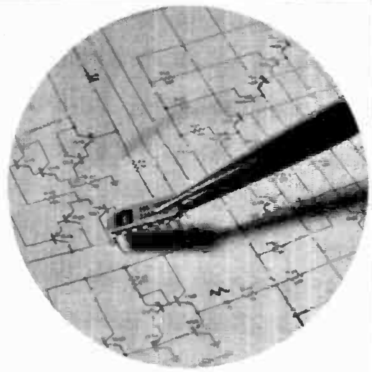

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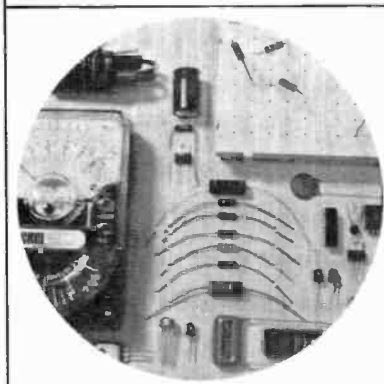

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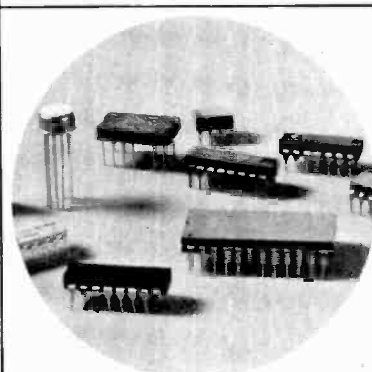

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with a 1 amp or larger rating (depending on the wattage of your soldering iron). The switch is mounted on the soldering iron's stand in such a way that it is held *open* when the iron is in place, closing when the iron is picked up. In operation, the rectifier is in series with the iron's heating element when the iron is in place on its stand, reducing the power supplied, but keeping the iron comfortably warm. When the iron is picked up for use, *S1* closes, shorting *D1* and applying full power, heating the iron to working temperature in a couple of seconds.

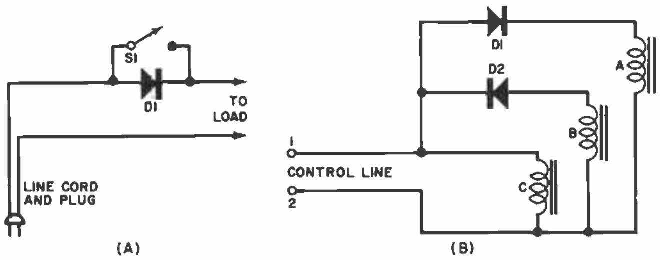

Fig. 2. Circuit (A) shows use of diode in a dual level power control; (B) is simple remote control.

This basic circuit may be used in a variety of other applications where a dual power level is needed. For example, it could be used with heating elements, some types of dc motors, and with incandescent lamps. A photographer, typically, might find it handy for operating his photofloods at reduced intensity while arranging his model and light placement, switching to full output when ready to snap his photo. Here, *S1* could be a standard toggle switch.

An interesting remote control circuit featuring simple diodes is given in Fig. 2(B). If the dc control voltage is applied with terminal "1" positive, "2" negative, devices A and C are actuated. If the control voltage polarity is reversed, devices B and C are actuated. The controlled units may be any non-polarized dc-operated devices, including relays, solenoids, lamps, or alarm generators. Device C is optional, of course, and may be omitted if only two controlled units are needed.

Reader's Circuit. Fascinated by Thomas Fox's *Early Warning Storm Forecaster* (POPULAR ELECTRONICS, September, 1973, pgs. 31-34), reader Richard Andre (58-06 43rd Avenue, Woodside, NY 11377) decided to assemble his own model. Unable to obtain all of the listed components in his area, he substituted general replacement transistors for the devices specified in the original design. Less than ecstatic with the results, Richard applied a little of that ingenuity so typical of POP'tronics' readers, redesigning the original circuit for improved sensitivity. His revised circuit is illustrated in Fig. 3.

Referring to the schematic diagram, Richard replaced the two-stage complementary amplifier in the original version with a Signetics type 555 timer, IC1. Otherwise, the circuit arrangement is similar to that used in Fox's design.

As in the original version, the circuit depends for its operation on the accumulation of a voltage charge on capacitor *C1* by static noise bursts received from an external AM radio receiver and applied through jack *J1* and rectifier diode *D1*. When *C1*'s charge builds up, both *SCR1* and the timer circuit (*IC1*) are triggered to "on" (conducting) states, with the SCR applying power to the *Sonalert* (*SA*) to develop an audible alarm signal and the 555 IC furnishing power to indicator lamp *I1* for a visual

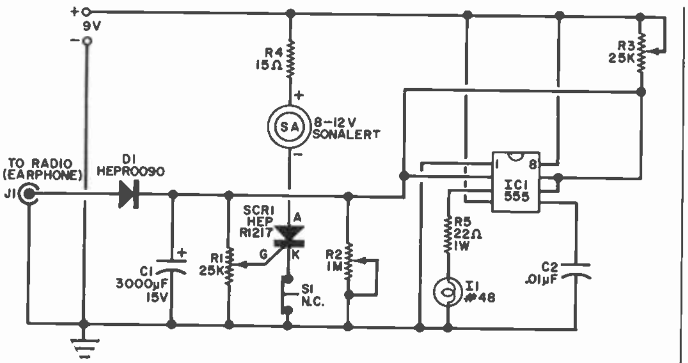

Fig. 3. A reader's version of the low-cost Stormcaster project using a 555 IC timer.

alarm. Since the SCR, once fired, will continue to conduct, *S1* is provided as a *reset* switch, serving to open the SCR's cathode circuit momentarily when depressed, turning off the alarm if *C1*'s charge has dropped to a low enough value.

In practice, potentiometers *R1, R2* and *R3* must be adjusted for optimum performance and the desired level of sensitivity. This is accomplished by connecting the instrument to the earphone jack of a small AM receiver tuned to a station-free point near the low-frequency end of the broadcast band, volume at near maximum. Artificial "static" is then created by switching a soldering gun off and on rapidly in the vicinity of the receiver for preliminary adjustments. Later, final adjustments for nearby or distant storm detection, as preferred, are made when there are known thunderstorms in your vicinity. Normally, *R2* is first set to maximum resistance, with *R1* adjusted to achieve desired sensitivity. Afterwards, *R2* and *R3* are adjusted for best operation.

Manufacturer's Circuit. One of several schematics given in the 12-page data bulletin for the TBA 800 IC, the audio amplifier circuit shown in Fig. 4 may be used in a variety of practical applications. Typically, it might be used as the audio section of a radio receiver or TV set, or in an intercom, signal tracer, record player, booster amplifier, low-power musical instrument amplifier, or power megaphone.

Manufactured by the SGS-ATES Semiconductor Corporation (435 Newtonville Ave., Newtonville, MA 02160), the TBA 800 is a monolithic power amplifier in a 12-lead quad inline plastic package. Integral external cooling tabs permit 2.5 watts output without an external heatsink and 5 watts output using a relatively small heat sink, such as an area of copper on a PC board. With a maximum rating of 30 volts and a peak output current of 2 amperes, the device can be used over a wide range of supply voltages (5-30 volts). It features high efficiency (70% at 4 watts output), very low harmonic distortion and no cross-over distortion.

According to SGS-ATES, the amplifier circuit shown is capable of delivering 5 watts to its 16-ohm loudspeaker load when operated on a 24-volt dc power supply. An 80-millivolt signal is required for maximum output. The circuit's 3-dB frequency response is from 40 Hz to 20 kHz.

For maximum performance, the manufacturer recommends the use of a suitable heat sink but, as indicated previously, this can be a small grounded area of copper on a PC board soldered to the TBA 800's large tabs.

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Device/Product News. If you're with the service and repair bit, you'll be pleased to learn that the International Rectifier Corporation (233 Kansas St., El Segundo, CA 90245) has introduced a new line of original equipment transistors for all major Japanese entertainment products. The line, packaged in a special kit, consists of the 24 transistor types most often specified by the manufacturers of Japanese stereo systems, tape recorders, TV sets and other electronic products. This news is doubly interesting because, according to Don Prescott, IR's Manager of Distributor Sales, Japanese-built models accounted for 28 per cent of all TV sets sold in the U.S. last year.

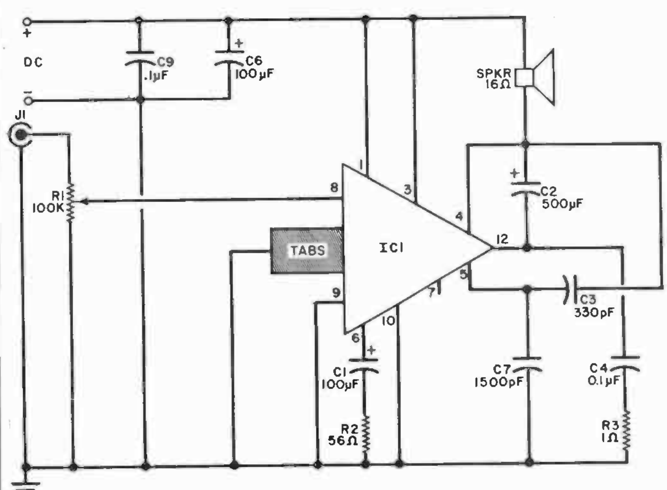
Motorola Semiconductor Products Inc. (Box 20924, Phoenix, AZ 85036) has announced a number of interesting new products, including a new series of high-power plastic transistors, a pair of medium-power Darlingtons, a family of full-wave bridge rectifiers, and an exciting new IC counter.

Assembled in the type 199 plastic package, Motorola's three new power transistors are silicon *npn* devices with dissipation ratings of 80 watts and gain-bandwidth product specifications of 5 MHz. All three devices are rated at 5-A dc continuous collector current, 10-A peak. Designated types 2N6497, 2N6498, and 2N6499, they have V_{ceo} ratings of 250, 300, and 350 volts dc, respectively, and are especially well suited for inverter and ignition system as well as general-purpose applications.

With maximum ratings of 40 volts, 500 mA, and 625 mW free-air dissipation, Motorola's new 2N6426 and 2N6427 Darlington transistors are *npn* devices packaged in the popular TO-92 plastic case. With a typical noise figure of only 3.0 dB, the 2N6426 has a minimum gain of 30,000, the 2N6427 a minimum gain of 20,000, both at 10-mA dc. You'll want to consider these for your high-gain medium-voltage applications, for their prices are competitive with those of earlier lower voltage Darlingtons.

Utilizing the same dice as the popular and time tested 1N4000 rectifier series, Motorola's new MDA100 series of full-wave bridge rectifiers are ideal for most medium-level power supply applications. Encapsulated in miniature plastic cases, they are rated for a full output of 1.5 A at 55° ambient. Their PRV ratings range from 50 volts for the MDA100 to 1 kV for the MDA110.

Fig. 4. General-purpose 5-watt audio amplifier uses single IC. A small area of copper on the pc board acts as a heat sink for the IC.



Anything that can be converted into a clock frequency of up to 5MHz — revolutions per minute, dollars, meters, farads, picas, chains, pounds, volts, mils, furlongs, or whatever — can be counted with Motorola's new McMOS 3-digit decade counter, the MC14553. It can count up to 999 and provides an overflow for cascading devices to obtain higher counts. Outputs are multiplied BCD data to input a display driver, and are TTL compatible. Assembled in a 16-pin ceramic DIP, the basic circuit consists of three negative-edge triggered BCD counters synchronously cascaded. A quad-latch output at each counter holds the data, which is time-division multiplexed, providing one BCD number or digit at a time. Digit-select outputs provide display control. Possible applications for the MC14553 include instrumentation counters, clock displays, digital meters, and whatever a fertile mind can imagine.

Fairchild Semiconductor Components (464 Ellis Street, Mountain View, CA 94042) is in there swinging for the market. In addition to announcing substantial price reductions on one hundred and one TTL ICs, the firm has introduced a number of new devices, including a line of voltage regulators and low-cost numeric displays.

The new voltage regulators, designated the 78L series, are three-terminal monolithic ICs. Available in either TO-92 plastic or TO-39 metal can packages, and with either 5% or 10% tolerance ratings, the 78L series devices are all fixed positive voltage types. Standard voltages for the TO-92 units are 2.6, 5, 6.2, 12 and 15 volts, and for the TO-39 versions, 5, 12, and 15 volts.

Fairchild's new low-cost display is a ½-inch LED device available in either a common anode (FND-500) or common cathode (FND-507) format. Both types are compatible with Fairchild's monolithic driver circuits, the 9368 for the FND-500 and the 9370 for the FND-507, and both also interface directly with MOS logic. The 7-segment display digits require only 5 mA average drive current per segment and a 3-volt power supply, permitting their operation from bipolar logic supplies. For desk top calculator applications, only 2 mA average drive current (per segment) is needed. Designed specifically for use in competitively priced consumer, industrial and commercial applications, the units are legible at distances of up to 20 feet.

Not to be left out, good old RCA (Solid State Division, Box 3200, Somerville, NJ 08876) is celebrating new additions to its own family of semiconductor devices, including a vhf power transistor and 21 new COS/MOS ICs.

Identified as RCA type 41042, the new vhf power transistor can deliver 80 watts peak envelope power (PEP) at 136 MHz. Intended for use in AM amplifiers operating in the 118 to 136 MHz band, the device is an epitaxial silicon *npn* planar transistor with overlay emitter-electrode construction. Supplied in the HF-44 package, the 41042 can provide 20 watts *cw* power with a 13-volt dc supply, and 80 watts PEP with a 26-volt supply, withstanding the infinite load mismatch at the 80-watt PEP level. *Hams — take note!*

Ranging from simple gates to complex functions, and including four second-source types, RCA's twenty-one new COS/MOS IC's feature such devices as a 256-bit static RAM and a variety of gates, counters, oscillators, comparators, inverters and decoders. Detailed information on the devices may be obtained by writing to RCA at the address given above. ◈

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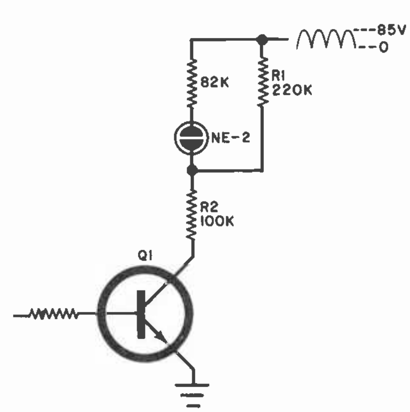
Hobby Scene

Neon Lamp on a Transistor Switch

Q. ***I would like to operate a neon lamp from a transistor switch. I have heard that there is a way to do this using low-voltage (therefore low-cost) silicon switching transistors. Do you know of such a circuit?***

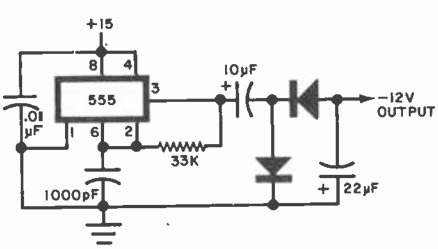
A. You can't just stick a neon lamp in series with a conventional transistor since the high voltage required for the neon would "pop" the transistor. However, you can use the circuit



shown here. Resistors *R1* and *R2* are selected so that the drop across *R2* is safe for the transistor and the drop across *R1* is less than the striking voltage of the neon lamp. When the base of *Q1* is grounded, the lamp is off. A positive base signal turns on *Q1* and the lamp. A 25-volt transistor and an 85-volt half-wave supply are needed.

Needs Negative Supply

Q. ***I have an IC system that uses a +15-volt dc power supply. Now I want to include one IC that requires a −15-volt supply, but I don't want to make a separate power supply. There must be a simple way of getting the negative voltage. Any suggestions?***

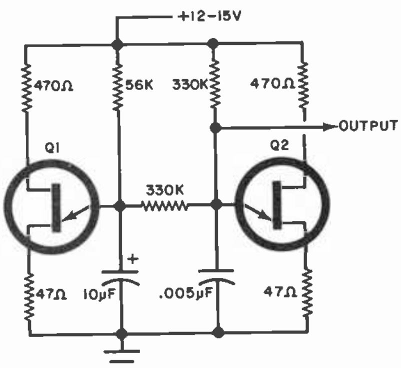


A. The circuit shown here is suggested by NASA. The 555 oscillator works at about 20 kHz and supplies a voltage-doubling rectifier. You can get between 40 and 50 milliamperes from this circuit.

Warbling Tone Generator

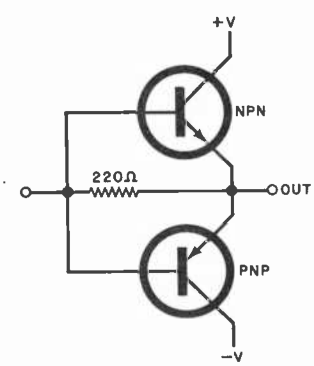
Q. ***I need a circuit for a warbling tone generator to drive an audio amplifier.***

A. The circuit shown here, using two unijunction transistors should do the job. The low-frequency sawtooth generated by *Q1* modulates the high-frequency tone generated by *Q2*. The output should feed into a high-impedance amplifier.



Current Booster for Op Amp

Q. ***I would like to use a particular op amp circuit to drive a relay. Unfortunately, the op amp will deliver only a few milliamperes, and the relay requires close to 100 mA. Is there a simple current booster I could use?***



A. Using only a pair of transistors and one resistor, the circuit shown here can deliver up to 100 mA to an op amp load without harming the op amp. Most any type of standard transistor will do.

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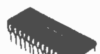

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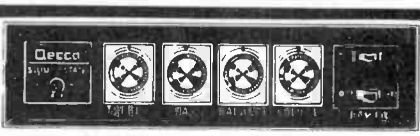

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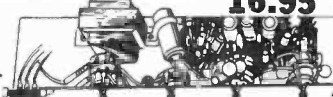
Featuring solid state circuitry throughout, with printed circuit construction. 10 watts "peak" audio power per channel. Handsome walnut veneer grain with chrome trim escutcheon. With provisions for separate escutcheon mounting items as STEREO HEADPHONES, TREBLE, BASS, BALANCE, VOLUME controls, separate PHONO AND AUXILIARY 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 Auxiliary 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**



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- 20-watt Solid State Amplifier!
- All Solid State, Printed Circuitry
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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.

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

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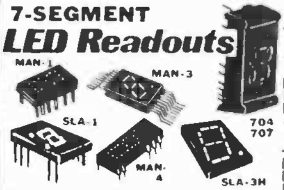

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☐ 704*	.33	2.50	3 for $6.
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☐ SLA-3**	.70	4.95	3 for $13.
☐ SLA-11**	.33†	3.50	3 for $10.
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*By Litronix. **By Opcoa, equal to MAN-1 or MAN-4 specs. Color - RED †Green. †† yellow

LED MITY DIGIT "DCM'S"

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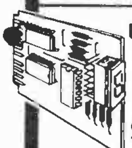

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READOUT	Char.	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

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

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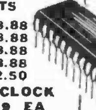

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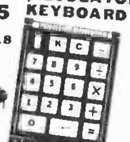

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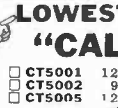

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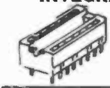

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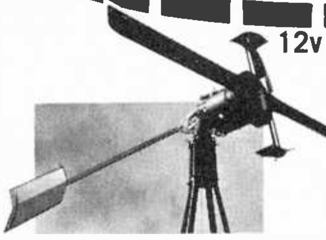

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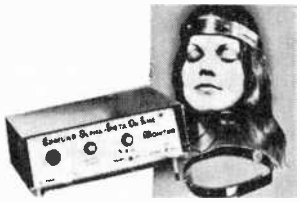

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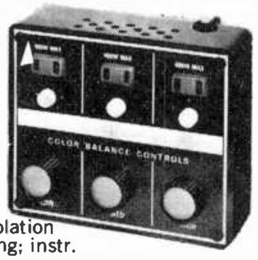

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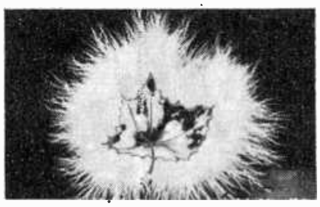

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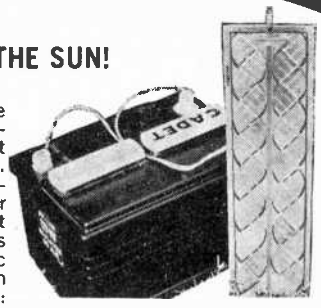

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