

SPECIAL FEATURE—COMMUNICATIONS 1975

75c ■ JAN. 1975

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

3 UNIQUE DIGITAL CLOCKS
You Can Build Them All

CB EQUIPMENT ROUNDUP
What's New—What's Happening

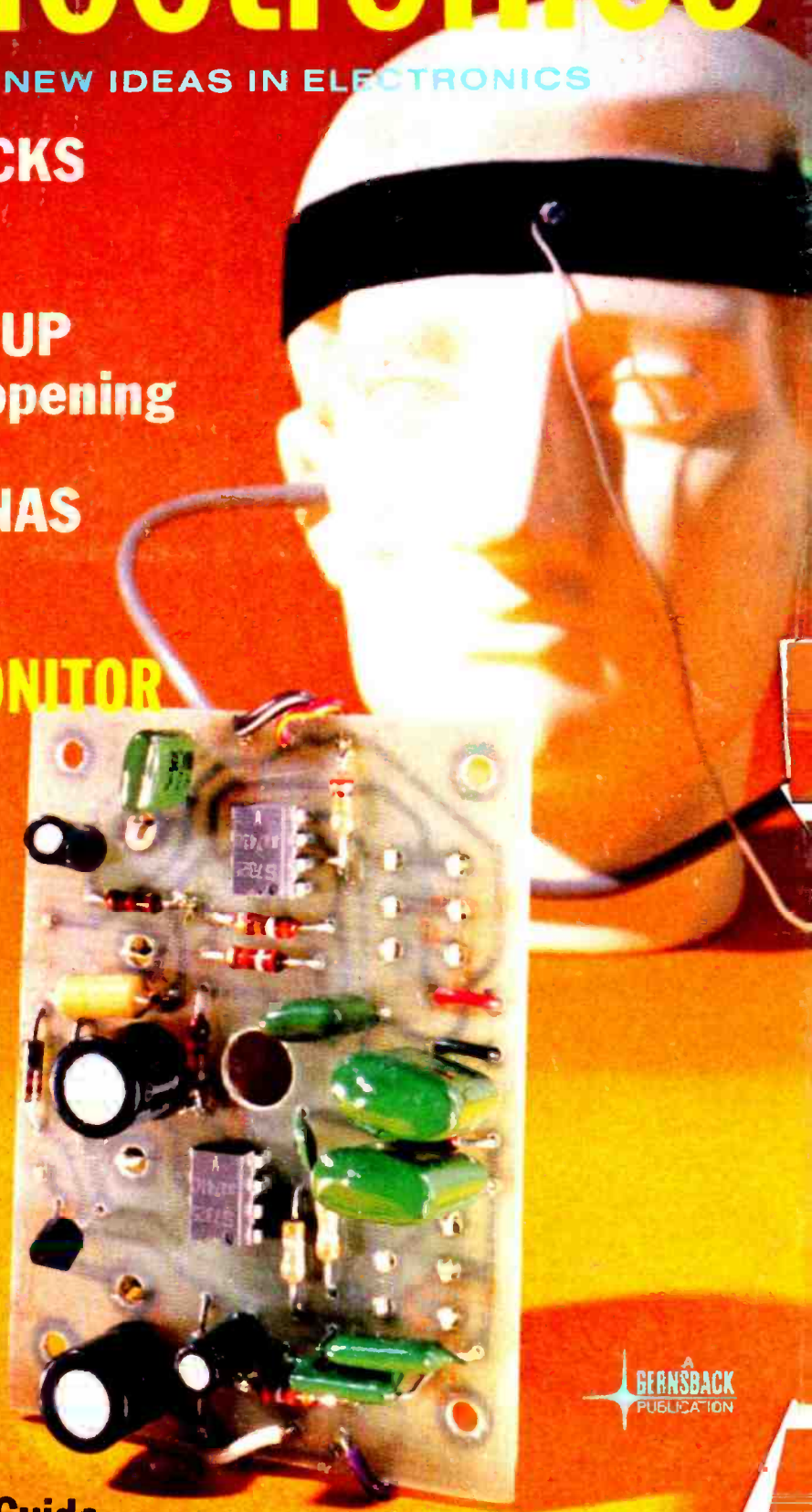
INSTALLING CB ANTENNAS
In RV Vehicles

BUILD A BRAINWAVE MONITOR
And Tune-Up Your Mind

NEW CB RULES
How They Affect You

STATE-OF-SOLID-STATE
New Developments
And Applications

COSMOS PROJECTS
That Really Work



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Circle 1 on reader service card

Jim is one of the busiest antenna installers in Pennsylvania. He does work for 17 major appliance dealers. But the bulk of his antenna sales come from his own advertising, yellow page listings and word-of-mouth recommendations from satisfied customers.

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Jim doesn't try to be the cheapest — only the best. He stresses quality of workmanship plus quality of materials. With this philosophy and a lot of hard work, Action Sales has doubled sales volume each of the four years since Jim started the business.

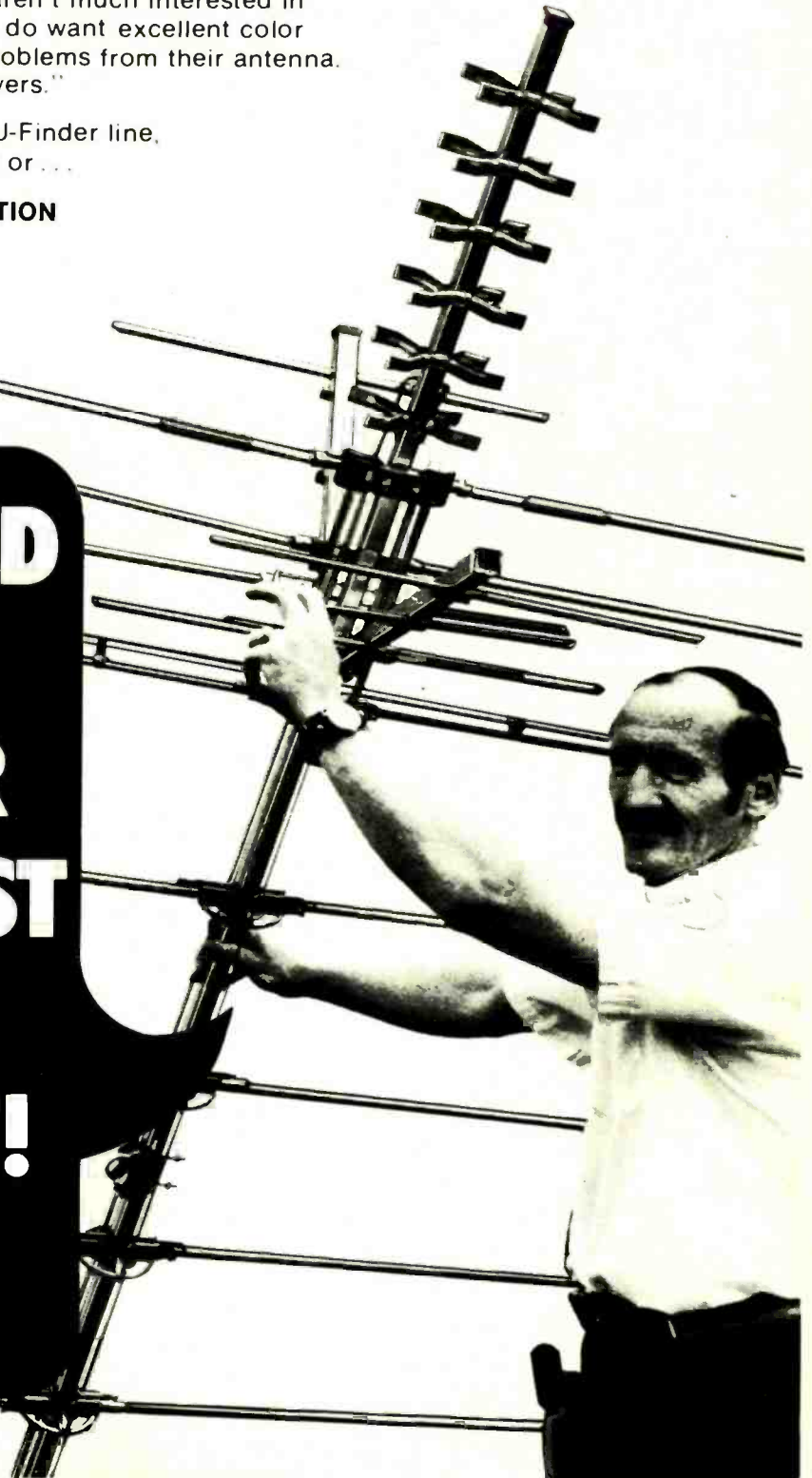
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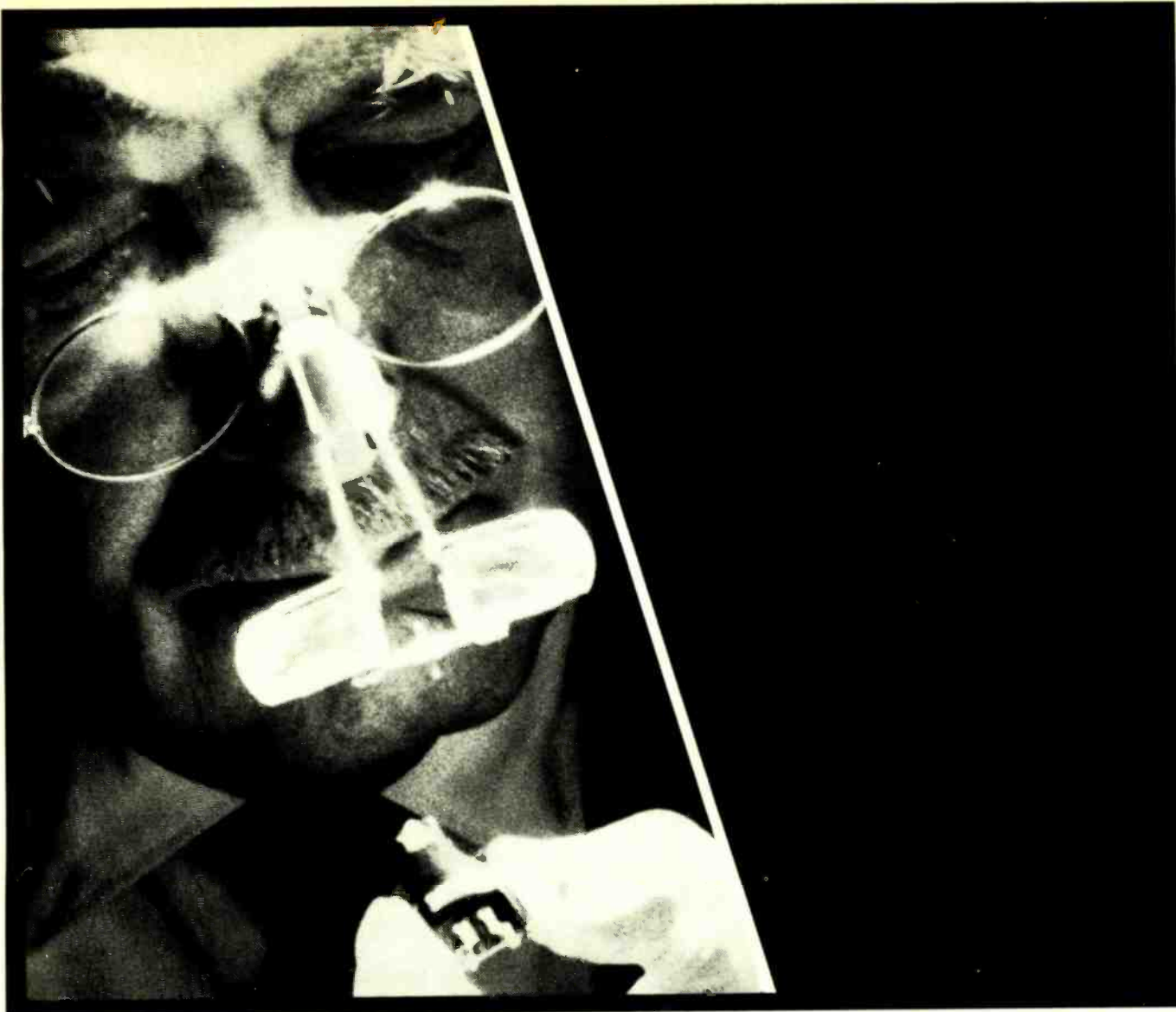
For more information on the Super VU-Finder line, contact your local Jerrold Distributor or . . .

JERROLD ELECTRONICS CORPORATION
Distributor Sales Division
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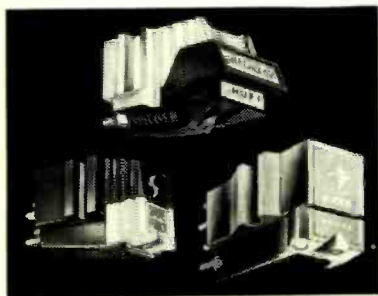
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Circle 3 on reader service card

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

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Cover photograph by Walter Herstatt
Cover design by Louisa G. Rubsamen

Radio-Electronics is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature*.



Radio-Electronics, Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York City 10003. Phone: 212-777-6400. Second-class postage paid at New York, N.Y. and additional mailing offices. One-year subscription rate: U.S.A., U.S. possessions and Canada, \$8.75. Pan-American countries, \$10.25. Other countries, \$10.75. Single copies 75c. © 1974 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

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looking ahead

Videodisc treaty

Prospects for compatibility among videodisc playback systems have improved as the result of an agreement of the two leading proponents of laser-optical readout to bring their systems into compatibility. The Netherlands-based worldwide electronics firm N. V. Philips and the American show-business giant MCA Inc., have signed a pact to assure interchangeability of discs between the VLP and Disco-Vision systems. Both techniques use transparent discs backed by a layer of reflective material. Philips has agreed to discard its rigid disc and adopt the thin, flexible record developed by MCA.

The agreement also should mean a large amount of recorded video programming will be available for the combined optical system from the outset. One of the prizes in MCA-Philips treaty is MCA's huge library of program material—said to number up to 11,000 selections, most of them originally theatrical films owned by MCA's subsidiary Universal Pictures. At press time, Philips and MCA were deeply involved in negotiations with proprietors of a third optical system—the French electronics firm Thomson-CSF—to bring it into the agreement. This may pose a more difficult problem, since Thomson's system uses a transparent disc without the reflective backing (the laser beam "stylus" shines through the record to a photosensitive pickup on the other side, instead of being reflected as in the Philips-MCA system). In the U.S., Zenith has been developing a videodisc system using the Thomson-CSF principles and has also been involved in the standardization talks.

But even a tripartite agreement wouldn't assure compatibility among videodisc systems. RCA is going ahead with its capacitance disc sys-

tem, which it says is simpler and less expensive than the optical approach, and a joint subsidiary of Germany's Telefunken and Britain's Decca says it still plans to market its mechanical disc system in Europe during 1975. Unlike the other systems, the TeD mechanical system doesn't have LP capability—its eight-inch discs have 10 minutes playing time.

The merger of the optical systems will mean another delay in bringing them to market. Philips and MCA had both been promising production in late 1975, marketing in early 1976. With the modification of the systems, these plans could be stretched out another year. RCA hopes that this will give it a one-year lead on the American market, for it still plans to start production toward the end of 1975. However, all plans could change on a moment's notice, as they have for the last five years in the home videoplayer field.

Picture IC

A TV display panel composed of one giant integrated circuit is under development by Westinghouse Research Laboratories. The panel is made of glass covered by a phosphor layer and a layer of thin-film transistor circuits. The phosphor glows when activated by pinpoint subcircuits. Westinghouse has built a prototype six inches square, with 240 rows and columns, giving 20 lines per inch resolution—and containing the equivalent of 36,000 components. Thin-film circuits, according to Westinghouse scientists, constitute a major advance toward flat television screens, since they permit for the first time, an infinitely variable grey or color scale achieved by varying the brightness of each picture element, as well as independent operation of each picture element without activating other elements in the same row or column.

Much work remains to be done before a panel can be developed with the high resolution and color required for television, but thin-film alphanumeric displays may be available as soon as 1976, Westinghouse predicts. The company is now developing a simplified, inexpensive method of depositing thin-film circuits by evaporation.

Philco changes hands

The Philco brand name for television and stereo has been sold by the Ford Motor Company to GTE Sylvania, which will manufacture and sell Philco sets after April 30. Before that, Sylvania will distribute sets made in the current Philco plants. The agreement applies only to the U.S. and Canada and doesn't affect Philco brand products in other countries, or Philco's appliances and car radios in this country. Ford bought Philco about 13 years ago.

Philco became the fifth television brand to change hands or be discontinued during 1974. Packard Bell television was dropped by its parent company Teledyne Corporation and its inventory liquidated, although it is probable the name will be revived by another firm. Motorola's television business was sold to Matsushita Electric Industrial Co. of Japan and the brand name changed to Quasar. Admiral Corporation was sold to Rockwell International. Magnavox Company was purchased by North American Philips Company.

Most of the maneuvering was the direct result of chaotic conditions within the television industry, caught in a cost-price squeeze of inflation and recession. The industry's changeover to solid-state sets and the need to keep up technologically with leaders Zenith and RCA made it impossible for some firms to compete profitably. More mergers and sales may be in store in 1975.

Teletrack

The state of Connecticut has no racetracks, but will soon inaugurate state-operated off-track betting. So it's planning to bring horse racing into the state—via closed-circuit TV. The six biggest betting parlors will be designated as "Teletrack" centers and will be decked out to resemble racetrack clubhouses. Races from five New York state tracks will be piped in, the action shown on large color screens.

TV in circles

The FCC soon will be taking a good hard look at the desirability of circular polarization of television transmission. Experiments by ABC in Chicago have shown some generally favorable results. The most important may be a "significant decrease in observable ghosting." The tests also showed that less receiver input voltage appeared to be necessary for a given quality of picture using circular polarization as opposed to conventional horizontal polarization. Further studies and tests are planned, including various combinations of circular, horizontal and vertical transmitting and receiving antennas.

How long?

The average color television set purchased new lasts 12 years, the average monochrome set 11 years. These "life expectancy" figures, developed by the Agriculture Department on the basis of Census statistics, indicate how long households keep sets, on the average—not how long they could have been made to last. They also show a black-and-white set purchased used lasts five years.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

No other 10 MHz oscilloscope gives you all this for \$545

The TELEQUIPMENT D61 is a low priced 10 MHz dual trace oscilloscope with sweep rates up to 100 ns/div. It is ideally suited for students, technicians, and hobbyists.

Operating Ease. Front panel controls are engineered for instant recognition. Line or

frame displays are selected automatically in the TV trigger position. And, chopped or alternate modes are determined automatically to optimize display clarity.

Bright, stable viewing.

Stable waveforms, displayed on an 8 x 10 cm crt, are easy to view, even under unfavorable ambient light conditions. Two identical input channels simplify generation of X-Y displays. This is particularly useful in analysis of vector patterns.

Application versatility.

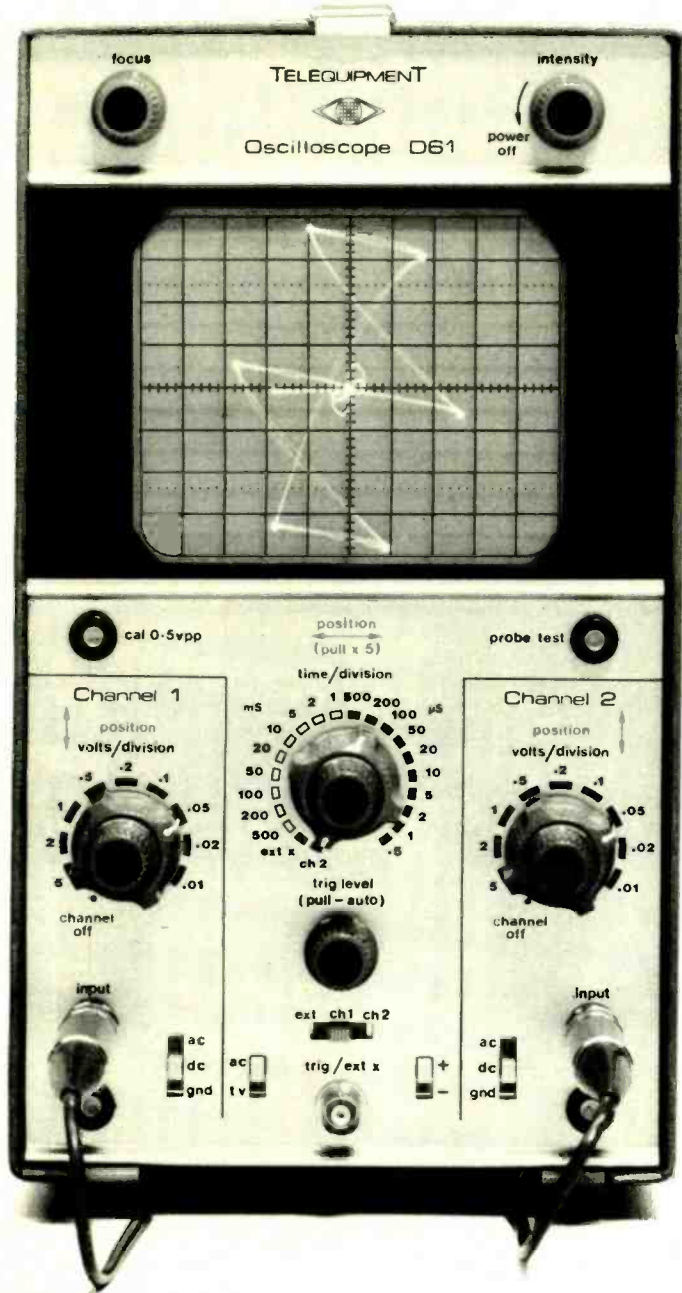
Because of its X-Y capability, the D61 simplifies alignment and troubleshooting of color television sets. Its performance equals or exceeds the requirements for servicing audio equipment, pocket calculators, public safety control, alarm, and communications systems, microwave ovens, digital clocks, and similar consumer electronic products.

Compact, portable.

Fully transistorized, and weighing only 15 pounds, the D61 occupies only 6.3 inches of bench width. It's easy to transport and use in confined working areas.

Tektronix reliability.

TELEQUIPMENT products carry the well-known Tektronix warranty and are marketed and supported by the Tektronix organization.



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New lightweight laser guides aircraft to targets

A versatile hand-held laser that can be used equally well to point out enemy targets or to guide aircraft to the forces using the laser is being developed by Hughes Aircraft for the United States Army. Looking vaguely like a stocky, short-barreled rifle, it is called the AN/PAQ-1 Light Weight Laser Designator.

A detachment cut off from its base, or isolated in enemy terrain, can simply direct their laser "fire" toward any friendly aircraft equipped with the special laser sensors to detect the beam. Since the laser beam is invisible—except to such sensors—there is little chance of laser detection.

If the forces using the laser can illuminate a surface within the enemy target area, the aircraft's sensors can

detect this spot of light and home in on it bringing their weapons to bear where they will be most effective.

The designator is made up of three modules, a battery compartment in the stock, with 22 cells resembling flashlight batteries, a power supply, and the laser transmitter, which resembles the barrel of the "gun." More than 90 per cent of the device's active electronics are mounted in the power supply on a 4 x 5-inch circuit card, which contains the equivalent of 10,000 transistors etched into the circuitry.

Ten thousand TV fires a year, says Federal safety commission

More than 10,000 television fires may erupt annually in the United States, estimates the US Consumer Products Safety Commission. Some of these result in serious injuries and death.

Electric shock is another cause of casualties. (Most of the latter are due to courageous but uninformed TV users.)

The USCPSC quotes three type situations:

James North saw his portable TV start smoking, and pulled the plug. He immediately called the fire department, which was able to put out the fire before it spread to other materials in the room.

Bill Edge kept his TV against the wall in a corner next to the radiator. He piled newspapers on the cabinet. Some of them covered the air vents in the back. One night the set overheated and burst into flames, destroying everything in the room before the fire could be put under control.

Gail White reached into the back of the set to touch what she thought was a malfunctioning tube. Contacting high voltage, she drew her arm back fast enough to cause a painful injury to her elbow.

These are the commonest hazards. A close fourth is spilling liquids into the cabinet. The Commission urges technicians to instruct TV owners in a few important safety rules whenever possible:

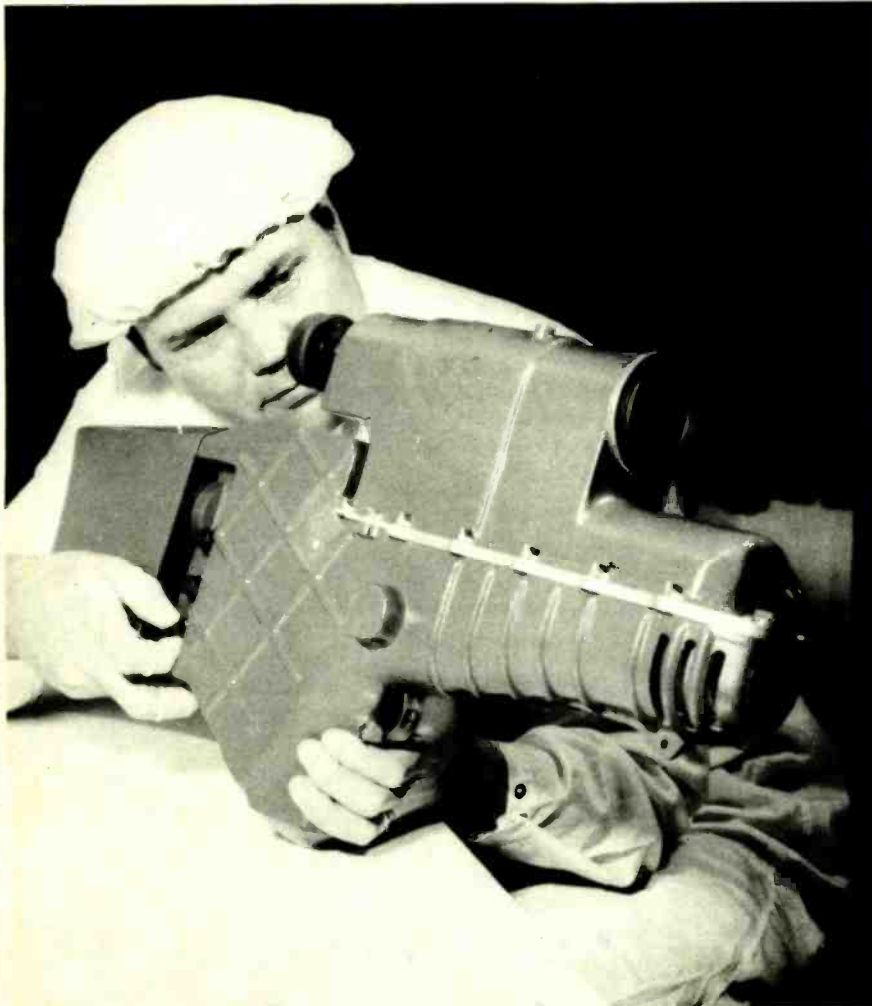
1. **Follow all operating instructions** and safety precautions furnished with the TV.
2. **Warn children** never to drop or push objects into the TV cabinet; they could get dangerous shocks.
3. **Make sure the ventilation openings** are not covered with cloths or papers, and that the TV is placed clear of walls or other ventilation-limiting surfaces.
4. **Be careful to see that drinks** or other containers of liquids are not placed on the TV; they can spill and cause a short-circuit that can create a fire or shock hazard.
5. **Never expose the set** to rain or water. Excessive moisture—even leaving the TV on an outside porch—may cause shorts and resultant fire or shock hazards.

New static computer memory is marvel of dense packing

A static memory has the great advantage that it retains information read into it indefinitely, without the need for refreshing. But it has the disadvantage of a far lower packing density than dynamic memories, which however must be refreshed constantly.

Siemens Research Labs has now produced a static MOS memory of 4 kilobits on an area of 14.7 mm². The memory is an integrated circuit in aluminum gate epitaxial semiconductor film-on-

(continued on page 12)



HUGHES SCIENTIST RICHARD REAMER adjusts the sights on an advanced prototype of the LWLD now being constructed for the US Army.

Avoid serious trouble in color TV sets by using the right replacement capacitor!

polyester film

This capacitor is **GREAT** for 90% of your film capacitor replacements. But . . . it's **NOT** designed for certain critical applications.

SPRAGUE
TYPE PP
polypropylene film

SPRAGUE
TYPE PM
polycarbonate film

These capacitors are a **MUST** for critical commutating and S-shaping applications.

The next time you replace a dipped tubular in one of the newer color TV sets, don't automatically assume you're replacing an ordinary every-day film or paper capacitor. If it happens to be a deflection capacitor used for commutating or S-shaping, you need a polypropylene or polycarbonate film replacement with (1) high a-c current-carrying capability; (2) close capacitance tolerance; (3) good capacitance stability. The standard replacement

capacitors used in the industry, even our superior Type PS dipped tubulars, just won't do the job . . . and they could cause the set to become inoperative again.

Play it safe . . . dipped tubulars may look alike on the surface, but there can be a big difference in the film dielectric. Keep a supply of Sprague Type PP and PM capacitors on hand for those critical situations where ordinary replacements won't work.

SPRAGUE TYPE PP POLYPROPYLENE FILM TYPE PM POLYCARBONATE FILM CAPACITORS

μF @ WVDC	Cap. Tol.	D. x L.	Cat. No.	μF @ WVDC	Cap. Tol.	D. x L.	Cat. No.
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1.5 @ 150	$\pm 5\%$.800 x .937	PM15-M1.5	.01 @ 600	$\pm 5\%$.500 x 1.250	PP6-S10S
.01 @ 400	$\pm 5\%$.400 x .750	PP4-S10	.066 @ 600	$\pm 5\%$.800 x 1.250	PP6-S66S
.015 @ 400	$\pm 5\%$	.450 x .750	PP4-S15	.075 @ 600	$\pm 5\%$	.750 x 1.250	PPS-S75S
.033 @ 400	$\pm 5\%$	.500 x .750	PP4-S33S	.022 @ 800	$\pm 3\%$	.600 x 1.300	PP8-S22S
.06 @ 400	$\pm 5\%$	.800 x 1.250	PP4-S60S	.047 @ 800	$\pm 5\%$	.700 x 1.250	PP8-S47S
.081 @ 400	$\pm 2\%$	.600 x 1.300	PP4-S81S	.051 @ 800	$\pm 5\%$	.800 x 1.250	PP8-S51S
.2 @ 400	$\pm 5\%$	.700 x 1.700	PP4-P20	.0018 @ 1600	$\pm 5\%$	.500 x 1.300	PP16-D18
.0018 @ 600	$\pm 5\%$	.400 x .750	PP6-D18S	.002 @ 1600	$\pm 5\%$	.500 x 1.300	PP16-D20
.0022 @ 600	$\pm 5\%$	.400 x .750	PP6-D22S	.0033 @ 1600	$\pm 5\%$	.550 x 1.300	PP16-D33
				.0039 @ 1600	$\pm 5\%$	.600 x 1.300	PP16-D39

For cross-reference information on close-tolerance polypropylene and polycarbonate film capacitors, showing original part numbers with correct Sprague replacements, ask your Sprague distributor for Cross-Reference Guide C-873, or write to: Sprague Products Company, 509 Marshall Street, North Adams, Mass. 01247.

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

Circle 6 on reader service card



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Including CB design, installation
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The field of communications is bursting out all over. In Citizens Band alone, estimates predict a growth in equipment sales from \$514 million in 1973 to \$1.2 billion dollars in 1982! That means a lot of openings in service and maintenance jobs. NRI can train you at home to fill one of those openings... including your FCC license and solid-state 2-way radio service.

NRI's Complete Communications Course will qualify you for a First Class Commercial License or you get your money back! It covers AM and FM Transmission Systems, Teletype, Radar Principles, Marine Electronics, Mobile Communications, and Aircraft Electronics.

You will learn to service and/or adjust CB equipment... using your own 23-channel Johnson Transceiver and AC power supply for hands-on experience as well as your own personal use.

With NRI's training program, you can learn this important skill easily, at home in

Get 2-way radio training with this solid-state
23-channel transceiver and power supply!



Your CB training will be up-to-the-minute when you experiment with this solid-state transceiver unit. Mount it in your car or use it with your AC power as a base station. You get "hands-on" experience that puts your course theory into practice the practical way.

your spare time. You get 8 training kits, including your own 3½ digit digital multimeter for digital experiments and precise measurements. You'll learn from bite-size lessons, progressing at your own speed to your FCC license and then into the communications field of your choice.



Only NRI offers five choices in TV/Audio Servicing



NRI can train you at home to service and repair commercially-built color and black-white TV, hi-fi equipment, AM-FM radios and sound systems. You can choose from 5 courses, starting with a basic servicing course with 65 lessons... up to a Master Color TV course, complete with 25" diagonal solid state color TV in handsome woodgrain cabinet. All courses are available with low down payments and convenient monthly payments to fit your budget. And all courses provide professional equipment along with NRI-designed kits for hands-on training. With the Master Course, for instance, you receive your own 5" wide band, solid-state triggered sweep oscilloscope, TV pattern generator, 3½ digit digital multimeter, and a high quality NRI 25" diagonal solid state television receiver expressly designed for color TV training.

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Step into the digital age with NRI's Complete Computer Electronics Course



Digital electronics is the career area of the future... and the best way to learn it is with NRI's Complete Computer Electronics Course. You can become a computer or digital technician with NRI's unique

and fascinating home training... while you build and use a real digital computer in your home! This is no beginner's "logic trainer". It's a complete programmable digital computer. And it's just one of ten kits you receive, including a professional digital multimeter for experiments and precise measurement. It's the quickest and best way to learn digital logic, and computer operation.

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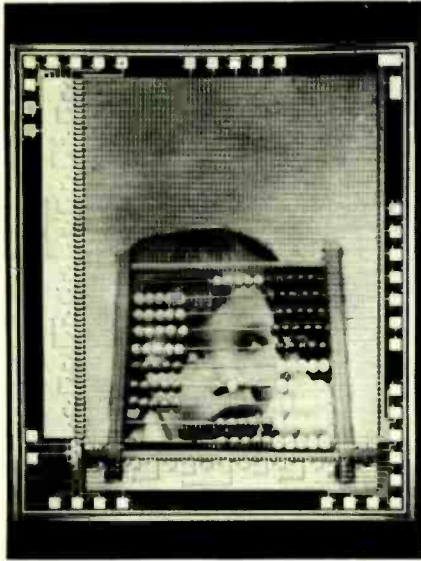
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insulator (ESFI) technology.

The new memory was made possible by replacing two of the transistors in an original 5-transistor memory cell with resistors. A diode was then used to replace one of the three remaining



THE 4-KILOBIT ESFI MOS MEMORY. The size of the integrated circuit (actually about 1 3/8 x 1 3/8 inches) has been exaggerated by placing the young lady (using one of the earliest digital computers) far behind it.

transistors, making an already small 5-transistor unit into a two-transistor, two-resistor, diode cell. Size is 2.4 μm^2 .

These memory cells have been integrated in a configuration of 4096 bits. The chip area is 14.7 mm^2 . The actual memory matrix, word and bit line decoders and the readout circuit are accommodated in a space of 4.2 x 3.5 mm. Access time is about 120 nanoseconds and cycle time 170 ns. Power dissipation is 100 mW.

Delaware Valley technicians elect Tri-State Council

Joseph Papovich of Westville, NJ (member AETA of NJ) was installed as president of the Tri-State Council of TV Service Associations of Delaware, New Jersey and Pennsylvania, at the 17th annual Telerama Convention in Atlantic City.

Other officers installed were Martin Coggan, Bala Cynwyd, PA (member Delaware Valley TSA) vice president; Stuart Little, Willingboro, NJ (member AETA) recording secretary; Frank Piccolella, Trenton, NJ (member RSA, Trenton) corresponding secretary; Peter Rapagnani, Chester, PA (member TSDA of Delaware County, PA) treasurer, and

Arnold Zenker, Broomall, PA (member TSDA of Delaware State) Sergeant-at-Arms.

Tri-State Council represents electronic service technicians over the entire Delaware Valley area, and is a coordinating council for five electronic service associations: TSDA of the State of Delaware; AETA of New Jersey, RSA of Trenton, NJ; TSDA of Delaware Co., PA, and TSA of Delaware Valley.

Fifth 1974 Gernsbach Award Won by Bruce A. Long

Bruce A. Long, of Rio Grande, NJ, is the fifth 1974 winner of the Hugo Gernsbach Scholarship Award—a \$125 grant given each year to an outstanding student in each of eight leading home-study schools of electronics. Mr. Long writes:

"Upon graduating from high school, I attended an electronics trade school. I was fascinated with electricity (my father had been an electrician) and wanted to learn something that would last a lifetime.

After completing the course, I got a job as master console operator at a TV station, but lost it because I couldn't pass the FCC 1st and 2nd Class license tests, which would have allowed me to move into an open job on the transmitter crew.



Bruce A. Long

Then I went to work for a computer manufacturer, teaching others electronics and the repair of computers. I left, feeling frustrated with myself for not having enough education and having the feeling that I was just a small tooth on a giant gear. Two jobs later (repairing electronic machine controls) I still had the same feeling that I was never going to get anywhere unless I got more education.

I looked into three or four correspondence schools; ICS seemed to have the type of course I was looking for. Enrolling, I worked during the day and studied at night. ICS taught me things

I thought I knew, but really didn't!

I took the FCC phone test and passed the first time (after failing six times over the past seven years!) I kept on studying and reading my instructor's notes and comments, and now believing his words of encouragement. Shortly afterward I passed the 1st Class Phone with radar endorsement, and with no trouble.

I am now working as staff engineer at WCMC-AM-FM-TV in Wildwood, NJ (the station where I worked as console operator seven years ago). I am responsible for the operation of the complete network-affiliated television station, an AM and an FM station, while on duty.

If it weren't for ICS I would still be confused and frustrated."

William Alfring is runner-up in scholarship award contest

A second prize in the contest goes to William Alfring, of Anderson, California. It is an RCA WV-529-A VOM, contributed by RCA for the runner-up in each of the 1974 contests.

Bill Alfring was previously a policeman in Los Angeles. Fed up with the environment, he moved to Northern California and got a job as a car salesman. Looking for something better, he enrolled in the ICS TV Servicing Technician program and studied whenever he had any free time. Even before he had completed the course he was troubleshooting TV receivers, had put up his own building, obtained RCA, Zenith, and Sony franchises, and an authorized service dealership from Motorola. He now conducts his business as Shasta TV Sales and Service in Anderson, California.

Benjamin Bauer, CBS Labs gets fourth patent on SQ

Ben Bauer, long known for his contributions to acoustics and audio, and Vice President for Acoustics and Magnetics of CBS Laboratories, has been awarded Patent No. 3,835,255 for his invention of an SQ matrix decoder for Quadraphonic disc records. He has already received patents on the SQ encoder, the SQ logic and the SQ disc. This latest patent covers the matrix portion of the SQ system. (SQ is a trademark of CBS.)

The numerous other contributions that Ben Bauer has made to theoretical and applied acoustics include the invention of the phase-shift type cardioid microphone—now universally used—and several innovations in transducer design, including a 1-gram mov-

(continued on page 14)

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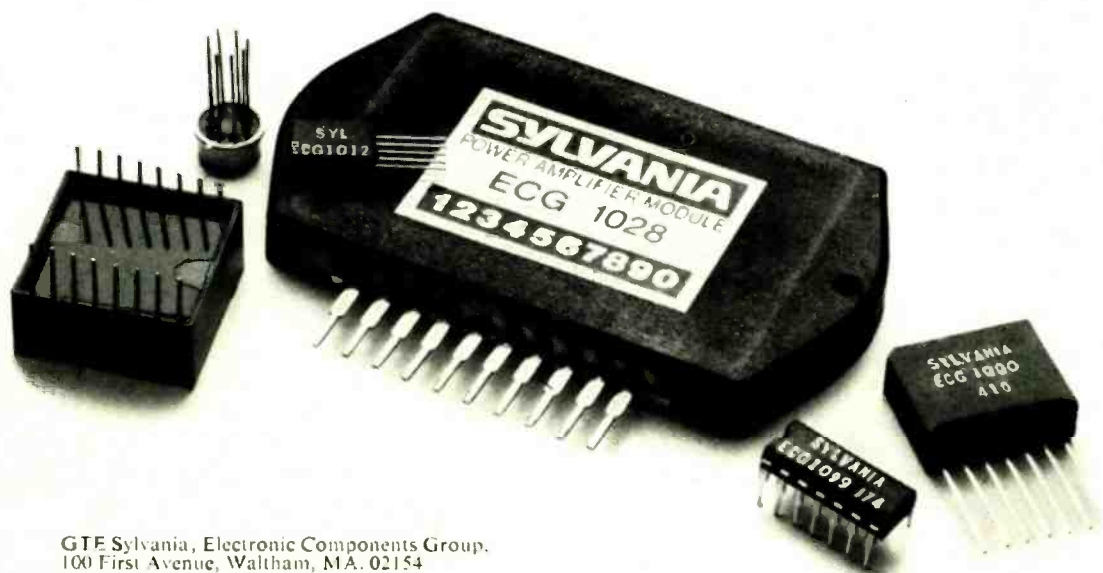
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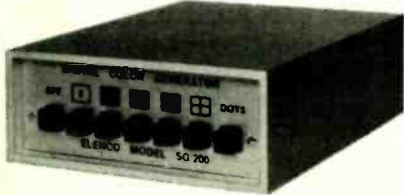


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new & timely (continued from page 12)

ing-magnet, precursor of the modern high fidelity reproducer, as well as methods and apparatus for measuring sound and vibration.

Greatest electronic organ installed in Carnegie Hall

A new electronic organ in Carnegie Hall has an output of 5,000 watts, uses 18 speakers in the main array, has 49 amplifiers and is the first electronic organ ever built with five manuals (swell, bombarde, solo, great and choir). The frequency range (modest as compared to some pipe organs) is 16 to 20,000 cycles per second.

The electronic organ was the result of a decision a few years ago to have a new pipe organ in Carnegie Hall. (An older one, never too satisfactory, had deteriorated and been removed.) But it was found that the architectural modifications required to install the pipes of a satisfactory organ might affect the acoustics of the Hall. It was also noted that a pipe organ might not stand up well in New York's atmosphere, which is harmful to leather, wood and metal.

Among others, the Rodgers Organ Co. of Hillsboro, Oregon, was consulted in the design of a new organ. Becoming much interested in the project, the com-

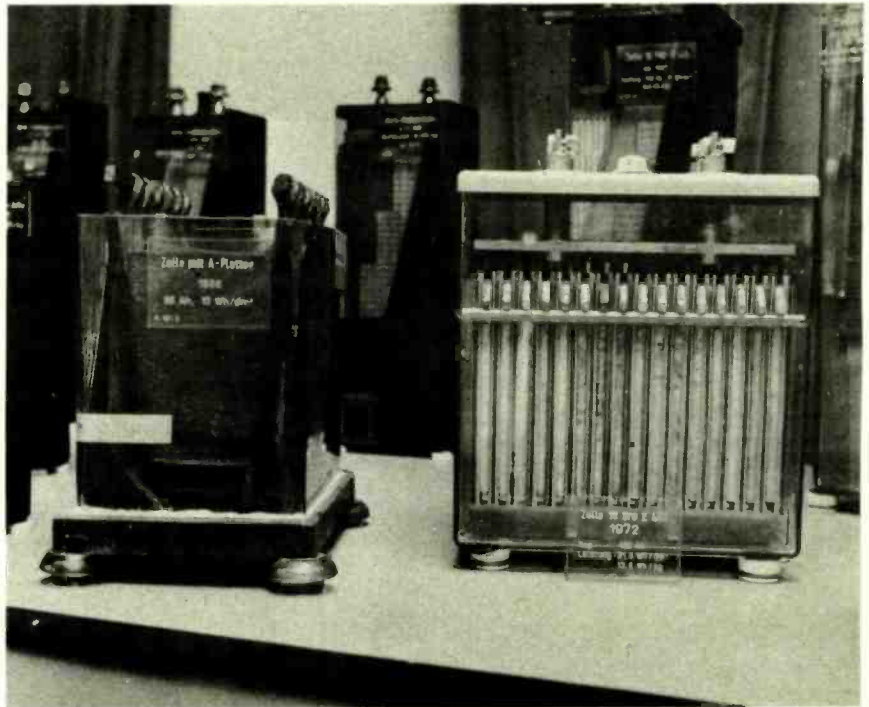
pany agreed to build an instrument and install it in the Hall on a permanent-loan basis.

The 18 speakers are hung in a line over the stage, with the stage itself acting as a reverberation chamber, according to the Hall's acoustician. In this it follows the technique of the older pipe organ—in which all the sound comes from one area—rather than the distributed-sound approach of many electronic sound systems for concert halls. But the organ has features that only an electronic instrument can. It has a computer with memory chords, can be programmed in advance, has electronic echo effects and delayed timing, as well as a number of electronic features still to be worked out completely.

Multiplex FM stereo pioneer dies

Murray G. Crosby, pioneer in FM and phase modulation and in stereo broadcasting, died June 8, 1974, at the age of 70.

An inventor and consultant in recent years, Mr. Crosby held more than 200 patents, the last of which was issued to him the day before his death. It described a subaudible system for the statistical verification of radio and television commercials.



THE ONLY STORAGE BATTERY MUSEUM in the world, according to its sponsors, is this one in Hagen, Westphalia (West Germany). Started on a small scale in 1898, it has now expanded to fill a large building formerly used as a street-car barn. The cell to the left in the foreground dates back to 1888; the one on the right is a modern (1972) product.

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Circle 14 on reader service card

letters

TO MIX 4 TRACKS (INPUTS) DOWN TO TWO (STEREO) OUTPUTS. FOR EACH INPUT THERE MUST BE A VOLUME CONTROL, PLUS THE ABILITY TO SELECT EITHER LEFT OR RIGHT OUTPUT, PLUS THE ABILITY TO BLEND OR DISTRIBUTE THE SIGNAL TO BOTH L AND R OUTPUTS. RESISTORS NECESSARY FOR ISOLATION OF CONTROLS CAUSE TOO MUCH SIGNAL LOSS...

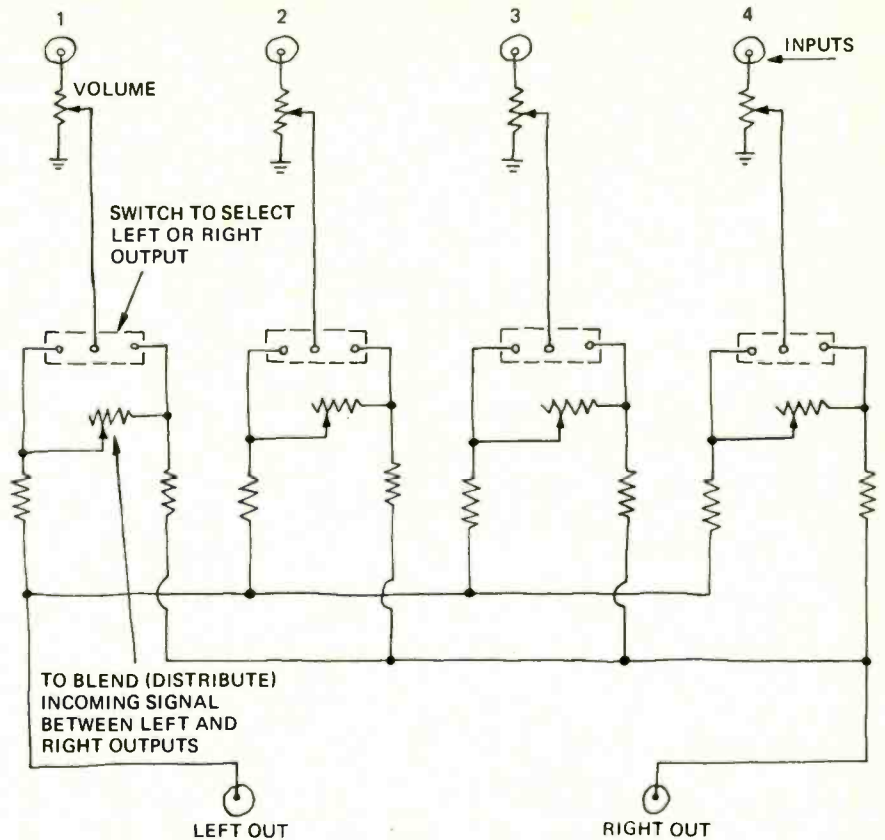
AUDIO MIXER

A number of people are now using 4-track tape decks (such as the Teac 3340 or the Dokorder 7140) to make 4-track recordings which then need to be mixed for re-recording on a stereo deck. These 4-track tape decks allow you to record for instruments or parts, one on each track, and then balance and mix them into two (stereo) tracks. This requires a mixer circuit of some kind. I have made one using resistors for isolation of the controls, but there is too much signal loss. I would very much like to have (and I am sure other readers would) a diagram of a suitable circuit using transistors. It would be nice if someone would like to provide a kit or at least a PC board for this purpose too.

The mixer circuit should do the following things:

- Provide for four inputs and two outputs. Inputs will be from tape deck. Outputs will be to stereo amplifier monitor inputs (100K or 200K in my case).

(continued on page 22)

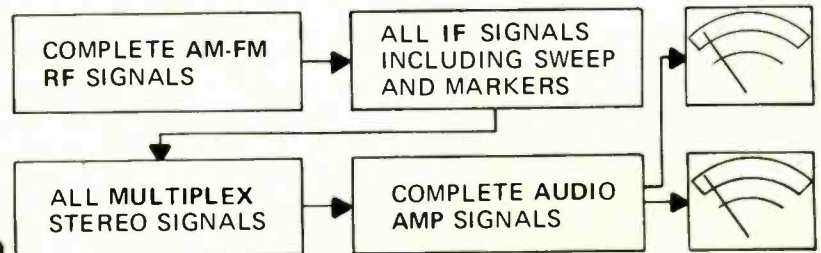


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Read what the experts say about Heathkit Digital-Design Color TV

“The picture on the GR-2000 can only be described as superb. The Black (Negative) Matrix CRT, the tuner and i-f strip, and the video amplifier provide a picture equal to that of many studio color monitors.”

(Popular Electronics, April, 1974)

“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.”

(Family Handyman, June, 1974)

“The plain truth is, with service and repair costs soaring even for the most insignificant in-home repair, the GR-2000 is the way all color TV sets will have to be made in the near future....”

(Elementary Electronics, May-June, 1974)

25" (diagonal) Heathkit GR-2000

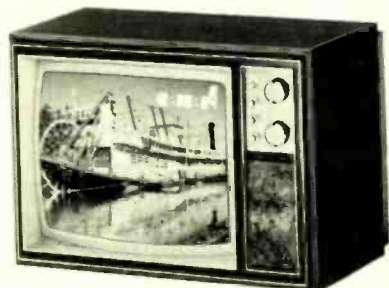
Widely reviewed and acclaimed for its outstanding picture and years-ahead engineering. At the touch of a button, the channel number appears on the screen. The optional clock module displays the time right under the channel readout. The totally solid-state varactor tuner eliminates noisy “clunkers” with contacts that can wear out. Instead, pressing a button silently selects any of the 16 pre-programmed UHF or VHF stations. The unique fixed-filter IF never needs instrument alignment, so pictures retain unmatched clarity and brilliance year after year. And for the ultimate in convenience, add the optional wireless remote control. The GR-2000 can be custom mounted and optional cabinets start at \$119.95*.

Kit GR-2000, less cabinet, 147 lbs., Exp./frt. 669.95*

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Now—a new generation of Heathkit small-screen color TV with digital readout



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GR-300
15" (diagonal)

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A factory-sealed static toroid yoke and magnet assembly completely eliminates convergence and purity adjustments — and the picture is superior to sets requiring manual adjustments.

The list of significant advances goes on and on — dual gate FET mixer, FET RF amplifier, 4 tuned circuits (instead of the 3 most sets have), automatic fine tuning and preset picture control, hi-fi output jack, slide out chassis. The GR-300 and 400 come complete with walnut veneer cabinets, cabinets for the GR-500 start at \$39.95.

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stereo receiver including fixed ceramic filters in the AM and FM circuits and a factory-assembled and aligned FM front-end with 5 μ V sensitivity. With 4 IC's, 41 transistors and 35 diodes, the GR-1075's design is years ahead of ordinary clock radios.

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Kit IO-4510
34 lbs., mailable
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Digital Electronic Clocks with standby power

The GC-1092A is a digital clock with a snooze alarm; the GC-1092D reads the time in 6 digits, the month and date in 4 digits. Both have standby power supplies to keep the clock on time (without the display) even during power interruptions.

GC-1092 A & D, less batteries, 5 lbs., mailable each **82.95***



GC-1092A Time/Alarm



GC-1092D Time/Date

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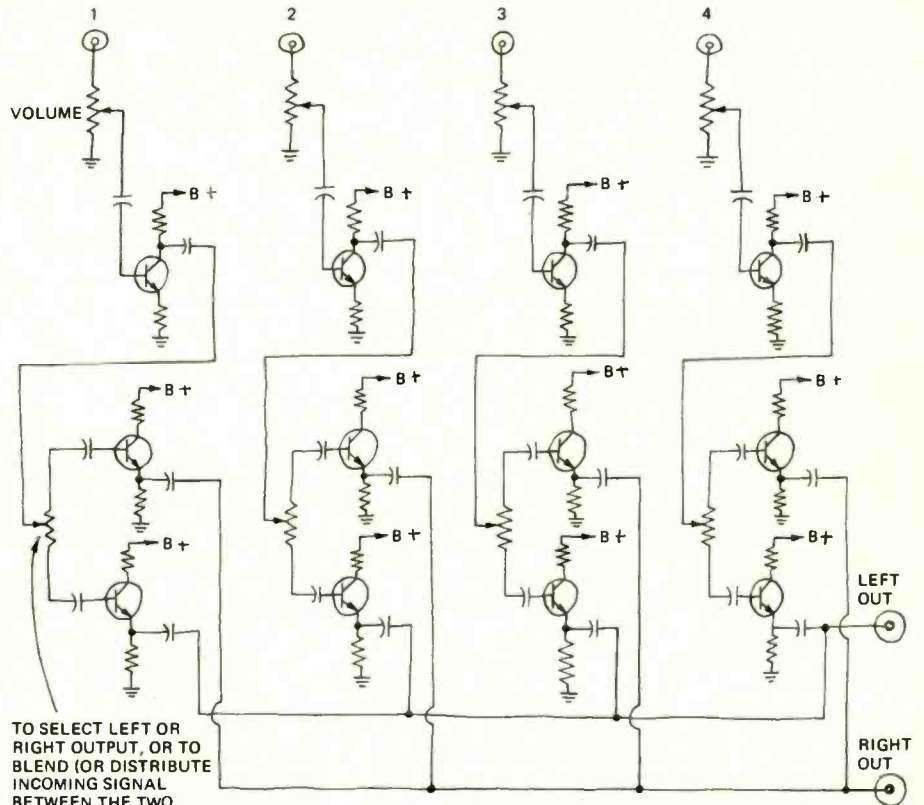


Circle 10 on reader service card

LETTERS

(continued from page 16)

ROUGH PROPOSAL FOR MIXDOWN OF 4 TRACKS (INPUTS) TO TWO OUTPUTS — NEED TO CONTROL LEVEL OF EACH INPUT, AND NEED TO BE ABLE TO DISTRIBUTE EACH INPUT TO LEFT OR RIGHT OUTPUT ONLY, OR TO BOTH.



TO SELECT LEFT OR RIGHT OUTPUT, OR TO BLEND (OR DISTRIBUTE INCOMING SIGNAL BETWEEN THE TWO OUTPUTS)

- Provide some gain. It would be desirable to have an option for considerable gain if needed or just a few dB for normal purposes.
- Allow individual control of volume at each of the four inputs.
- Allow each of the four inputs to be connected to either the left or the right output. (If possible, allow movement of each input signal from one output to the other without having the "pops" that occur with switches.)
- Allow each of the inputs to be blended with or distributed between both outputs. This is not a question of blending the two outputs together, but of being able to distribute each input signal between the two outputs when desired—sometimes more to one output than to the other.
- Provide isolation of controls.

I enclose a copy of a rough resistance circuit I made. There is too much loss with this circuit, especially of higher frequencies and there is no way to fade an input from one output to the other. I also enclose a very tentative drawing with some transistors stuck in to provide isolation. I have no idea what values should be used and I do not imagine that this is the appropriate way to make such a circuit.

I think a number of readers would greatly appreciate information about mixdown systems and a specific indication

of how best to build one doing the above things.

CARL F. HARTMAN
1843 Tradewinds
Newport Beach, CA 92660

If anyone has an answer, write to Carl directly. If you put together an article, send it to us.—Editor

NOTE TO THE FCC

The FCC warning concerning the TV Typewriter in the March 1974 issue of **Radio-Electronics** prompts this correspondence.

Radio-Electronics in the June 1970 issue carried an article on a radar burglar stopper. This device falls under a relatively recent FCC regulation for Field Disturbance Sensors and in all probability is subject to similar regulations as the TV Typewriter, even though many of your readers may have built it prior to the effective date of those regulations.

It appears that any device which has an oscillator which can radiate is now subject to FCC regulation. The necessity of compliance with the regulations and the fees for obtaining type approval will certainly curtail the activity of many hobbyists. On the other hand, if all of the devices which ostensibly fall under the FCC regulations were submitted to the commission for type approval, their work load would be untenable. A more

(continued on page 58)

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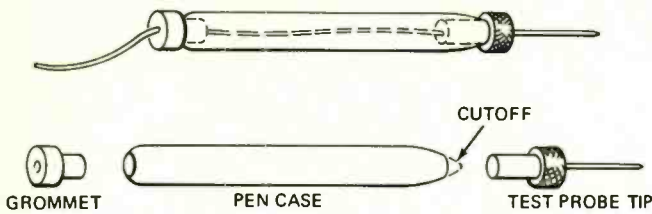
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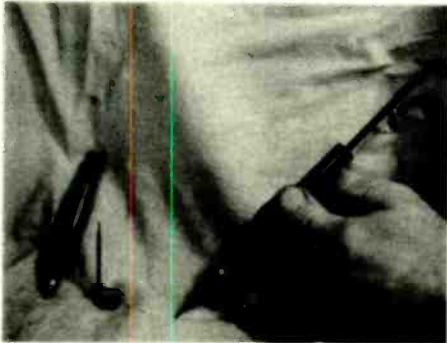
TEST PROBES FROM OLD PENS

I find that test probes made from cheap ball point pens take more abuse than the regular ones because of their

PEN CASE TEST PROBE



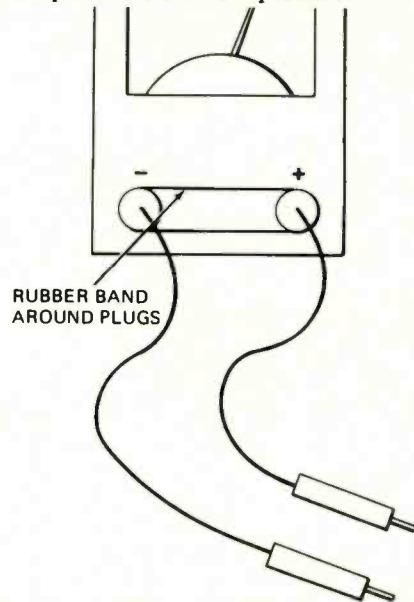
flexibility. Remove the pen's ink cartridge, drill out the front end for a press fit test probe tip and the rear for a small grommet. If the tip becomes loose seal it in place by heating it with your soldering gun.



You can set heavy chassis on these probes but they won't snap to pieces.—Peter Legon

FIX LOOSE TEST LEADS

I experienced considerable frustration when making measurements with my small multimeter because the molded-in pin jacks had loosened up and would not hold the test leads securely. Attempts to purchase leads with slightly larger plugs that would fit were fruitless. Then, I hit upon a simple solution to the problem.



A single rubber band, looped around the test plugs after they are inserted in the jacks (see drawing) holds them in place, maintains good electrical contacts and eliminates the nuisance of having the leads fall out of the meter while measurements are being made.—A. W. Edwards

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Circle 13 on reader service card

equipment report

Leader LCG-391 Color-Bar-Pattern Generator



Circle 98 on reader service card

THE IC-IZATION OF TEST EQUIPMENT has been a nice thing for us, due to the reduction in size, for only one thing. This is very evident in one class of test instruments—the color-bar dot generators. I can remember when they were as big as a tool box. Leader Electronic Corporation's newest entry into this field is the little, but very handy Model LCG-391 Color-Bar-Pattern

Generator. Only six inches wide, eight inches long and two inches high, it takes up practically no room in a tube caddy, tool box, etc.

The LCG-391 is almost 100% IC. Only 6 discrete transistors are used, three in the rf oscillator and modulator, and three more in the offset color oscillator. The heart of this instrument is a pulse synthesizer circuit, made up of nine IC's. It is fed from a 378-kHz clock oscillator, which is counted down to provide the necessary pulses to make up the standard convergence patterns; dots, cross-hatch, horizontal and vertical lines. The dc power supply of the LCG-391 is regulated by a tenth IC, for stability.

A crystal-controlled oscillator, on 3.56795 MHz, generates the offset sub-carrier for the keyed-rainbow pattern output. The vertical and horizontal sync, plus both vertical and horizontal blanking (a new feature) are added

in the video modulator. The rf output is a full 10 mV. This can be switched to either Channel 5 or Channel 6 by a simple pushbutton on the front panel. Two trimmers, accessible through holes in the top of the case, can be used to fine-tune the LCG-391, if needed. The unit I got for test came out right on the money on both channels.

Another added feature is a clean white raster. It can be used for purity testing. It's often difficult to tell whether you have good clean snow or not, without such a pattern. Among other uses, this is handy for checking the dc power supply of the TV set for ripple. This is often the cause of those mysterious "floating bars" up and down the raster, or "bars of colors" doing the same thing. (Found this one in the instruction book, and frankly, I hadn't thought of it before. Thanks, fellers.) (turn page)

INTERNATIONAL Frequency meter FM-2400CH



The FM-2400CH provides an accurate frequency standard for testing and adjustment of mobile transmitters and receivers at predetermined frequencies.

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IF crystals.....	catalog price

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Circle 69 on reader service card

The crosshatch and horizontal-vertical line patterns are also a bit different. The crosshatch actually generates 15 horizontal lines and 21 vertical lines, making the squares smaller than usual. This should make fine convergence adjustments easier. These aren't all visible on a normally-scanned raster, of course. One line each at top and bottom, and one at each side, will be masked off if the set is correctly adjusted for width, height and vertical linearity.

The lines are small and very sharp; one nice feature of IC pulse generators. Their specialty is developing very sharp spike pulses. Also, they're extremely stable, another benefit of this kind of generator. The patterns were all as steady as a rock, on all of the sets we checked. These patterns can also be used for adjusting agc, checking for sync stability, and signal-tracing through the TV set.

Controls are held to a minimum. The front panel has a rocker switch for power, with a LED pilot light, the CHANNEL selector, a little push-button switch for channel selection, and the RF OUTPUT jack. This is a dual jack, feeding a 300-ohm twin-lead cable, with miniature clips. Two little holes in the top of the case allow access to the rf trimmers, if needed. The rf output of the LCG-391 is the standard

300 ohms balanced, but it can be used with TV sets having 75-ohm input, without perceptible mismatch, according to the book. The rf output is high enough to give a clean raster even on sets without too much sensitivity.

A leatherette carrying case comes with it, with plenty of room for the unit, plus the line cord and rf cable. The LCG-391 is housed in a stout metal case, and the construction looks very sturdy. Since this type of instrument will get quite a lot of banging around in use, this is fine. It weighs just a bit over two pounds.

We tried it out as soon as it came in. As usual there were a couple of sets needing to be checked. (Including my own.) One of the things that impressed me on this one was the excellent stability of the patterns. In the very first models, some years ago, this was a real problem. My first one had to be reset every couple of days, or it would hula all over the place.

A very complete instruction book comes with it. This has all of the setup data, plus instructions for making not only convergence tests, but signal-tracing, agc, sync and even high-voltage regulator tests. Vectorscope patterns can also be generated with the LCG-391 plus any good service scope. Complete hookup data is given for this.

Schober TR-3 Power Amplifier



Circle 99 on reader service card

SCHOBER, A NAME LONG ASSOCIATED with organs, has entered the high-fidelity field with two solid-state power amplifier kits: the mono version TR-3M (\$142) and the stereo version TR-3D (\$194.90). The stereo version consists of two independent amplifiers which can be used as a stereo pair, or as individual amplifiers for two separate signal sources and outputs. The mono amplifier can be upgraded at any time to full stereo capacity with a model TCK-3 Conversion Kit (\$59.20).

Both amplifiers are housed in a metal utility cabinet measuring 5½ in. (continued on page 30)

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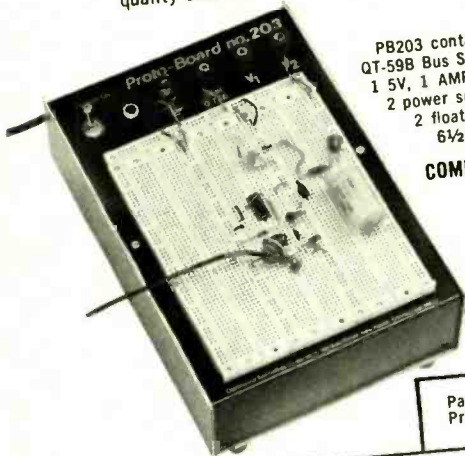
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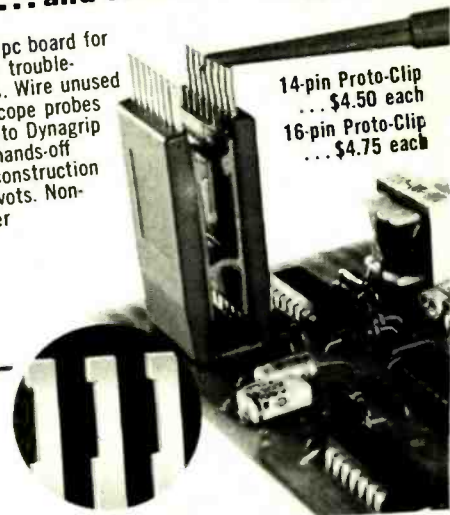
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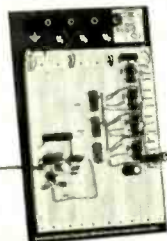
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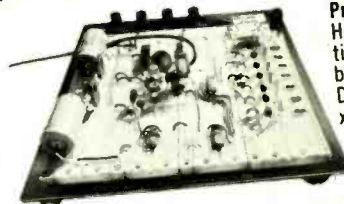


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appliance clinic

AUTOMATIC COFFEE-MAKER

by **JACK DARR**
SERVICE EDITOR

THE FULL NAME OF THIS ELECTRICAL appliance is "Automatic Electric Coffee-Maker With Keep-Warm Provisions", but everybody just says "electric coffee-pot". I'd say that it was a toss-up as to whether there are more of these in use than electric toasters. Anyway, there are an awful lot of them in use.

They differ slightly in actual construction, but basically they're a lot alike. They have a heating element mounted at the bottom of the pot. This is controlled by a thermostat. In the automatic type, the full heat stays on until the coffee is brewed. The thermostat then opens, and connects another heating element in series with the first. This reduces the current and temperature, and the coffee stays warm. The same action also turns on a little neon pilot lamp signalling "Coffee's Ready".

There isn't a lot to go wrong in one of these. Most of the trouble will be found in the line cord. This has a small appliance plug, which fits the contact pins on the base of the pot. If nothing works, this should be checked first. The heating element or thermostat can break down, but this is pretty rare. The elements are of the metal-sealed type, similar to the elements used in the electric ranges, and are very durable. The thermostats are also sealed units, of a special type. Figure 1 shows an exploded view of a typical coffee-maker of this type.

The thermostat uses a ceramic magnet with some unusual qualities. When it's cold, it's a normal magnet. It pulls the thermostat contacts together, closing the circuit. When it has been heated up to a given temperature for a certain period of time, the magnet loses its "pull", and a small spring opens the contacts. When the magnet has cooled off enough, it regains its magnetism and closes the contacts.

An ingenious method is used to control the brewing time, to make coffee stronger or weaker. The body of the thermostat is mounted on the underside of the pot, held in place by a metal bracket. The main heating element is wound around a small "well" in the bottom of the pot. This

concentrates the heat, and starts the "perking" action quicker. A flange on the thermostat bracket goes over and down alongside one turn of the main element. A small lever coming through the side of the base operates a "cam" which is in contact with the flange. Turning the lever toward **STRONG** moves the flange farther away from the element. So, the heat takes longer

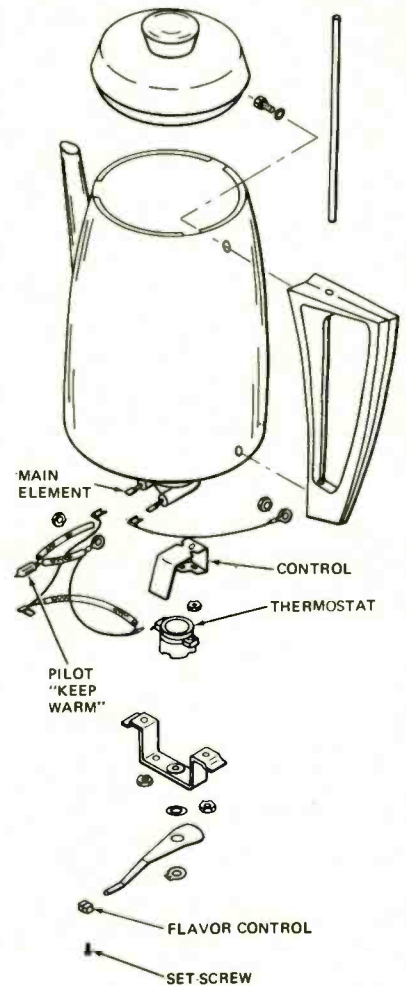


FIG. 1

to get to the thermostat, and the coffee brews longer. Moving the flange closer to the element makes the thermostat heat up faster, and cut off sooner. Fig. 2 shows a rough sketch of how this works.

Fig. 3 shows the schematic of this unit. When the pot is plugged in, the thermostat contacts are closed, shorting out the keep-warm element. When the thermostat operates, the keep-

warm element is connected in series with the main one. So, the current is reduced, and the temperature goes down. The voltage drop across the keep-warm element is enough to make the neon lamp light.

Diagnoses of trouble in these is fairly easy. If the coffee brews normally, but then it gets cold, the main element and thermostat are OK but the keep-warm element is open. In this case, the neon pilot light would light, probably quite brightly. If the pot won't heat at all, check the line cord and appliance plug *first*. Continuity tests across the line pins on the base will tell you whether the element is open or not.

In most types of these units, the pot is mounted on a bakelite or plastic

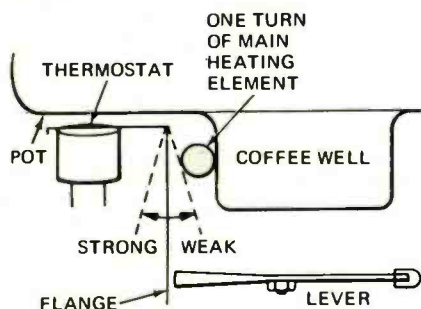


FIG. 2

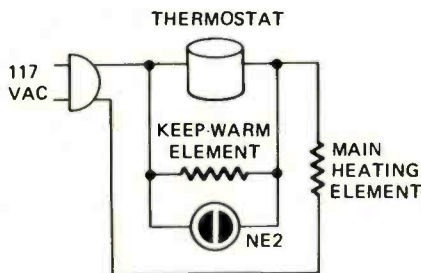


FIG. 3

base. The electrical connections and wiring will be inside this, for protection. To take the base off the one shown in Fig. 1, turn it upside down. You'll see two small screws in the middle of the base. Take these out. There will be a small set-screw on the end of the flavor-control knob. Take this out, and the knob will slide off.

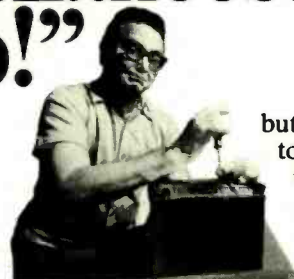
Next, very carefully work the base loose from the pot. Take it easy; the wires are usually pretty short, and you can break them loose unless you're lucky. Most of the connections will be made with push-on connectors. You can reach inside the base with a pair of long-nose pliers and take them off for testing. The thermostat, and other parts, will be bolted in place with metal brackets. Be very careful of the leads to the neon lamp. These are pretty small, and easy to break. If the worst does happen, this is a standard NE-2 lamp. **R-E**

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but the big stuff, too . . . like the washer, oven, even the lawn mower engine.

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EQUIPMENT REPORT

(continued from page 26)

wide x 8 in. high x 11 $\frac{3}{8}$ in. deep. The mono version weighs 16 $\frac{1}{2}$ lbs.; the stereo model is 17 $\frac{1}{2}$ lbs. The rated power output per channel at the clipping level with both channels driven is 100 watts into 4 ohms, 78 watts into 8 ohms and 50 watts into 16 ohms, all with a 117 Vac power source.

Each channel has its own input sensitivity control and full power output is attained over an input signal range of 0.15 to 1 volt. The sensitivity controls are in series with the input signal, and the amplifiers' input impedance is between 33,000 and 100,000 ohms depending on the setting of the sensitivity controls. Volume controls are also provided.

All input and output connections, controls and switches are mounted on the front panel. The outputs are available at 5-way binding posts with standard $\frac{3}{4}$ in. spacing. The inputs are standard phono jacks. The sensitivity controls are recessed screwdriver adjustments, while the volume controls for each channel have standard knobs. In the center of the front panel is a large rocker switch which illuminates when power is applied to the amplifier. Immediately adjacent to the power

switch is a reset circuit breaker. Normally, the power switch can be set to ON, with the line voltage controlled through one of the ac outlets on the associated pre-amplifier.

The amplifier is completely push-pull from input to output. Each amplifier consists of three basic direct-coupled "building blocks", which are, in turn, direct coupled to each other. Because there is no dc output voltage, no output coupling capacitor is used and the amplifier provides almost instant overload recovery.

The assembly manual is greatly detailed, starting with basic construction information and progressing through step by step assembly. This is followed by an *Installation and Operating* section which details mounting and inter-connection procedures. Finally, there is a *Service* section with typical symptoms, probable causes, and a voltage chart.

Measured Performance. In actual lab measurements the TR-3D stereo model with both channels driven at 1000 Hz delivered at the clipping level: 90.3 watts rms into 4 ohms, 72 watts into 8 ohms and 45 watts into 16 ohms. The maximum power output per channel 20 to 20,000 Hz into 8 ohms was 50 watts rms. The power output capacity is actually greater than 50 watts per channel, however, the circuit

breaker opened whenever we attempted to exceed the 50 watts/8 ohms specification with a sustained sine-wave. The power amplifier easily handled its rated power output of 78 watts into 8 ohms with power bursts (less than two seconds).

The frequency response at 50 watts into 8 ohms measured +0.8/-0 dB from 20 to 20,000 Hz. Distortion at this power was 0.2% THD at 20 Hz, falling to 0.1% THD at 1000 Hz, and rising to a maximum of 0.45% THD at 20,000 Hz. Both the signal-to-noise ratio and channel separation measured 71 dB.

The actual input sensitivity range for a 50 watts/8 ohm output was 0.14 to 1.3 volts.

Unusual Use. Because the metal cabinet has a handle, and because of its relatively small size and weight, the Schober TR-3 amplifier, in addition to high-fidelity use, can serve as an excellent power booster for movie and slide shows in typical school and building auditoriums. It can be driven to full power output by all movie and slide projectors, as well as by all cassette, cartridge and reel-to-reel recorders. Even battery portable cassettes can drive the Schober TR-3 power amplifier by simply taking the signal from the "earphone" or "speaker" output of the recorder. **R-E**

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B&K Very good equipment at a very good price.

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

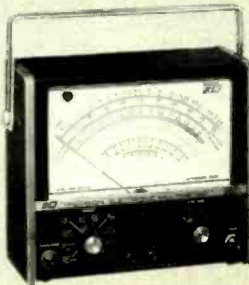
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Introducing the B&K Model 290 solid-state FET Multimeter. Just by glancing at its specs, you can tell that the 290 is capable of more applications than any other multimeter in its class. 75 ranges. Hi-Lo power ohms ranges (low power only 33 mV). 15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

just what you expect from B&K.

Contact your distributor, or write Dynascan Corporation.

Model 290 Hi-Low FET Multimeter including Model PR-21 Probe: **\$151⁰⁰**



B&K Very good equipment at a very good price.

Dynascan Corporation,
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

Circle 20 on reader service card

10MHz 3" Triggered Sweep Scope
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Model
 1431
\$399.00
 only 4 3/4" high

It's a lightweight 13 pounds in your hand with heavy-weight wideband scope performance on your bench or jobsite. Only 35 nanosecond rise time, 10 millivolts division sensitivity and 19 calibrated auto or triggered sweep speeds from 0.5 usec/cm to 0.5 sec/cm with 5X magnification. Pushbutton selected sync modes include internal, external, pos and neg slope, and TV horizontal and TV vertical with exclusive TV sync separator. If you've been waiting to buy a portable scope until you could get all the features you'll ever need at a price you want to pay, you've been waiting for the B&K Precision Model 1431. See your distributor or write Dynascan Corporation.



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**this sweep/marker generator
 replaces four instruments**



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Simplify IF and chroma alignment! Model 415 combines all the functions of a sweep generator, marker generator, marker adder and multiple bias supply. No connection changes are necessary after the initial hookup. Its 10 crystal-controlled IF markers can be shown either vertically or horizontally on your scope, and they light up on the front-panel IF response and chroma bandpass diagrams as you use them. The comprehensive manual helps you make alignments with confidence. In stock now at your local distributor or write Dynascan.



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 curve tracer that
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It hooks up to any scope, old or new. (Like our Model 1460 triggered-sweep scope.)

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Constant current and voltage steps with 3% accuracy make the Model 501A an exceptional value. In fact, it performs like \$2,000 units. Yet you can afford one on each engineer's bench. And another for incoming quality control.

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\$163⁰⁰



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**You'd probably expect a
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You'd be wrong.

Introducing the B&K Model 1403 3" Solid-state oscilloscope. It's so compact, reliable, and inexpensive that it's the perfect scope for most on-the-line monitoring applications. Look at its specs: DC to 2MHz bandwidth at 20mV/cm. Recurrent sweep speeds from 10Hz to 100k Hz. New wide-angle CRT to reduce case depth to a minimum. Direct-deflection terminals for waveforms up to 150 MHz. Weighs only 8 1/2 pounds. And has a smoked acrylic graticule for trace sharpness and easy reading. All the reliability and accuracy you need in a monitor scope — at a surprisingly low price.

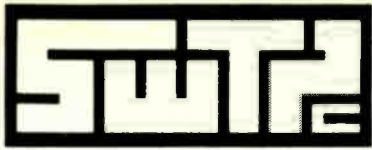
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\$189⁰⁰



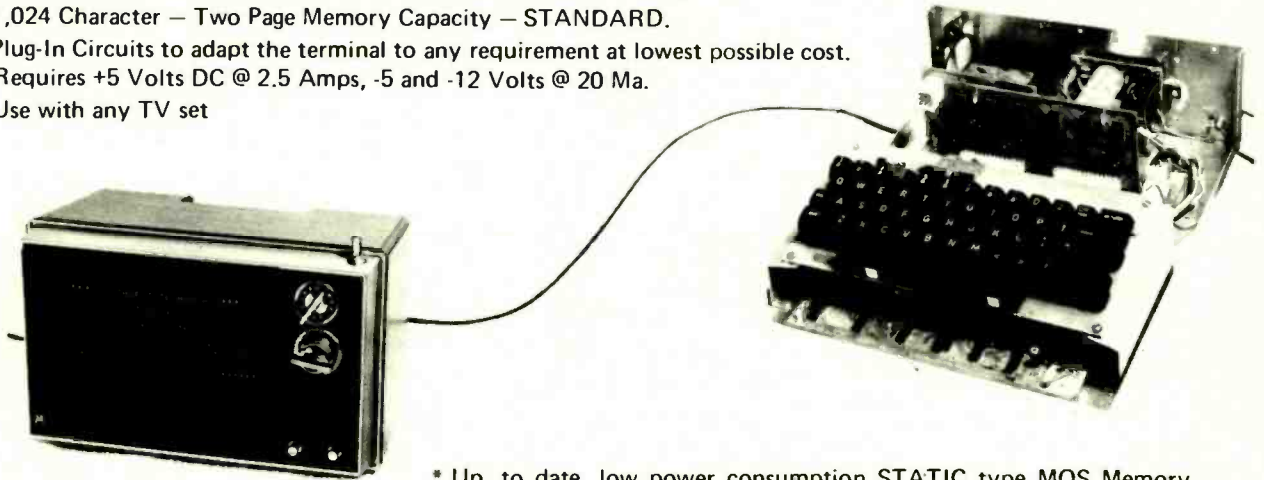
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- * Plug-In Circuits to adapt the terminal to any requirement at lowest possible cost.
- * Requires +5 Volts DC @ 2.5 Amps, -5 and -12 Volts @ 20 Ma.
- * Use with any TV set



- * Up to date, low power consumption STATIC type MOS Memory.
- * No complicated refresh or power-down circuits needed.

At last we can tell you about the most versatile, video-display terminal kit available anywhere; the Southwest Technical CT-1024. Our terminal is designed around a basic mother board and a 6,144 bit memory that will display two pages of data on any standard television set, or monitor. The two pages consist of 16 lines with 32 characters on each line. Input may be any source of parallel ASCII code; keyboard, computer, etc. If the system is to be used for a display, teaching aid, deaf communicator, or other similar purpose; this is all you will need.

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If you are going to use the CT-1024 directly with a computer I/O port that requires a parallel ACSCII input, then you will want our parallel interface card, #CT-P which

allows either the keyboard, or the computer to access the terminals memory and display data on the screen.

For those applications where it is useful, we also have an "off line edit", or "screen read" plug-in circuit #CT-E. This allows you to compose a program, or message on the terminals display screen and transmit it out a line at a time when you are finished and satisfied that everything is correct.

If you would like the convenience of complete cursor control, we have our #CT-CM plug-in board. This gives you Move Right, Move Left, Move Up, Move Down, Home Up, Erase to end of line and Erase to end of frame functions. These are operated by keyswitches, or any other type switches you may wish to use, giving you complete manual control of the cursor.

If the terminal is to be part of a computer system, you might prefer our automatic cursor control circuit #CT-CA. This plug-in not only allows you to control the cursor and to perform the functions listed above, but makes possible computer control of these same functions through the machines software.

# CT-1024 Terminal System Kit with 1024 Memory Card—less cabinet or power supply	\$175.00 PPd
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# CT-M Manual Cursor Control Plug-in Card Kit	\$ 11.50 PPd
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# KBD-2 Keyboard Kit — 53 Keys	\$ 39.95 PPd

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Circle 25 on reader service card

Build this brainwave monitor for Alpha waves. You can use it to learn how to control your Alpha waves and gain from the benefit of the relaxation that comes with it.

by MARK EHREN*

PROBABLY ONE OF THE MOST FASCINATING and intriguing elements within the human body are the constant and cryptic signals that originate within the depths of the brain.

Until a few years ago, these signals were considered to be only messages transmitted from the brain to the various organs and muscles, much like the signals within a telephone exchange. However, recent electronic developments have shown that these miniscule electrical signals are more than just muscle acitvators, but can be "demodulated" to determine the state of the emotions of the person being measured.

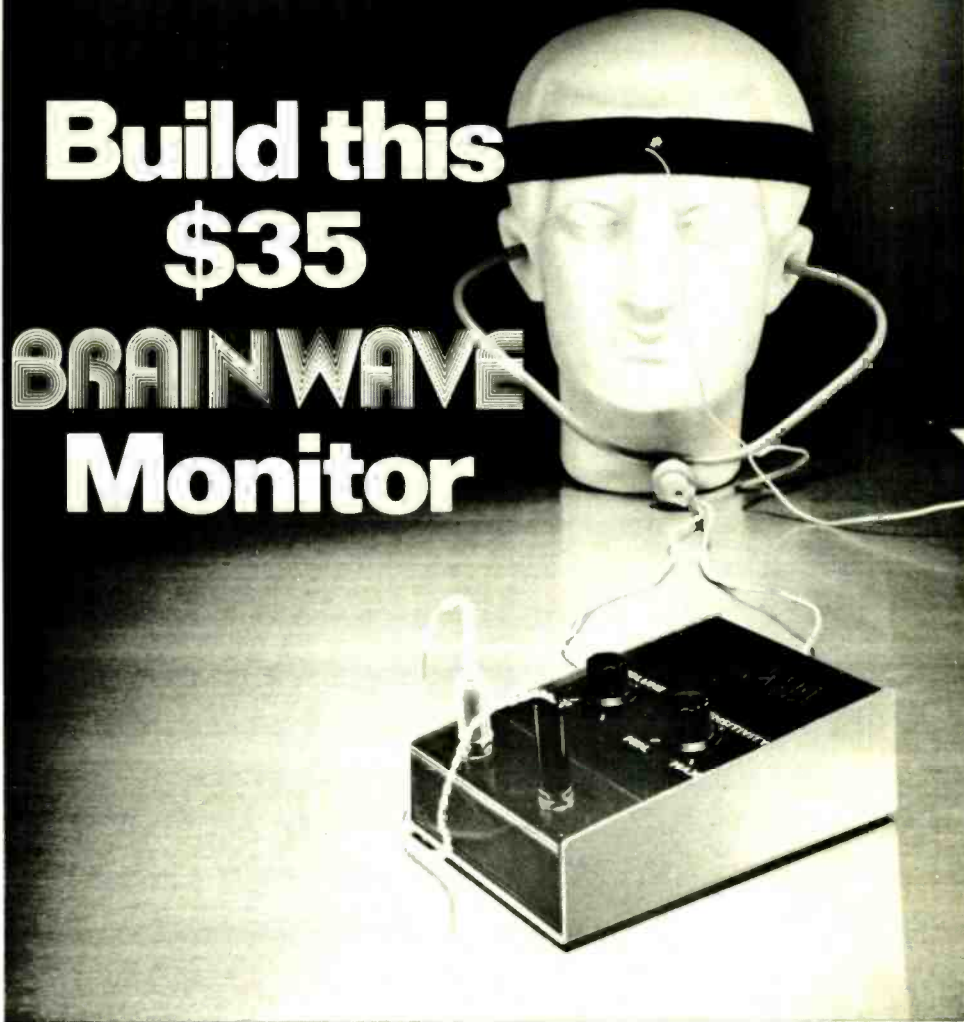
Where do these tiny, but important signals originate? Called bio-potentials, these tiny voltages exist in all living organisms, originate deep within the cellular structure, and can usually be detected in the local skin areas.

A visit to a doctor for a checkup will illustrate the uses of some of these bio-potentials. You will note that the doctor attaches electrodes to certain areas of the chest to record what is called an EKG, or electrocardiogram. The wiggly lines produced on his recorder indicate the state of the heart by amplifying, detecting and further amplifying these tiny voltages to operate the pens in the recorder. With some electrodes attached to certain areas of the skull, the doctor can also perform an EEG—an electro-encephalogram in which certain brain waves are analyzed for the detection of some disorders. In other areas, there is the electromyogram—(EMG), or the measurement of the activity of the muscles that also generate minute voltages as they are flexed. All of these signals are tiny, and range from a few microvolts to as many as 100 microvolts.

Other signals, generated deep within the brain, have not yet been fully explained, but do have a lot to do with

*Marketing Director, EICO, Electronic Instrument Co.

Build this \$35 BRAINWAVE Monitor



the state of the emotions (whether you are calm or irritated, awake or asleep, etc.).

Most of these signals have been identified, and some numbers have been attached to them. The following list illustrates the presently known brain waves, and their associated mental states:

Alpha: frequency is approximately 8 to 12 Hz, and the associated mental state is relaxation, heightened awareness, elation, and in some cases, dreamlike.

Beta: frequency is approximately 13 to 28 Hz, and the associated mental state is irritation, anger, jitters, frustration, worry, tension, etc.

Delta: frequency is approximately .2 to 3.5 Hz, and the associated mental state is usually a deep sleep, or a trance-like state.

Theta: frequency is approximately 3.5 to 7.5 Hz and the associated mental state is fuzzy, unreal, uncertainty, daydreaming, ambiguity.

The various areas and their associated frequencies are not sharply defined and there is some overlap be-

tween alpha and beta, beta and theta, and theta and alpha.

Probably the most discussed brain wave is *alpha*, with its connotations of Eastern meditation, Zen, Yoga, etc. First noted by Hans/Berger (Germany) and E. D. Adrian and B. H. C. Mathews (England) in the early '30's during a study of EEG waves, they noted that the alpha seemed to disappear when the subject's eyes were open, or if the subject engaged in mental activity while he was wired to the EEG device. In the years since, many researchers have attempted to discover whether alpha is associated with mental effort, or from a relief from mental effort. Many brain researchers are still unsure. You can still get many arguments as to whether the eyes should be open or closed during an alpha experiment. Many experimenters close their eye lids but unconsciously turn their eyes upward when they do this. Therefore, in many instances the alpha that does appear at this time is a direct function of what their eye muscles are doing.

Then there are many varieties of

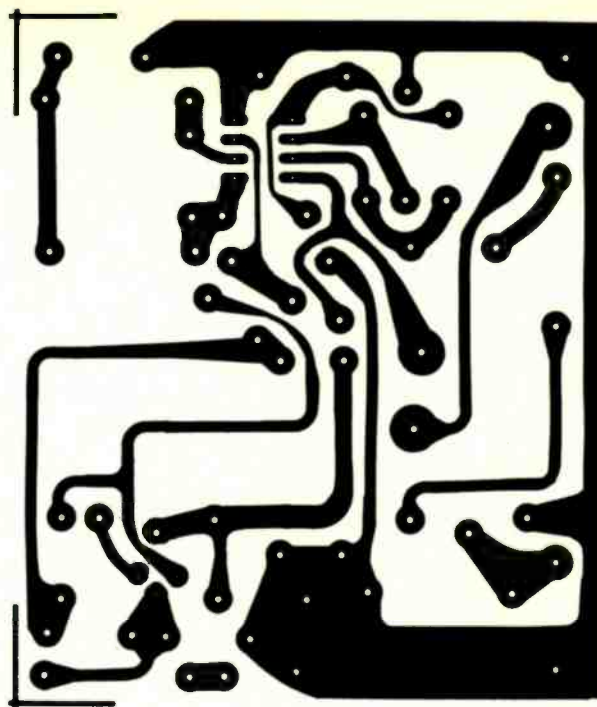
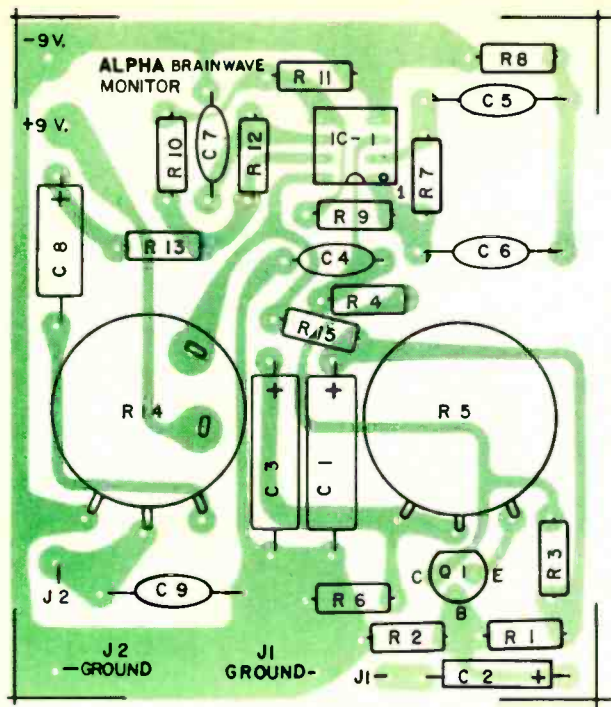


FIG. 1 (right)—SCHEMATIC DIAGRAM of the Alpha Brainwave Monitor. FIG. 2 (above)—FOIL PATTERN of circuit board shown actual size. FIG. 3 (left)—COMPONENT LAYOUT of the circuit board.

alpha. Low-level signals can mean a different set of behavioral and personality characteristics than do a high-level set of signals. Whether the alpha occurs at the lower or higher frequency end of the zone also means different things for different people. Then there is the area of the head that produces the most easily detected alpha. In fact, within the same person, each different aspect of form or location has many different meanings to the trained operator.

To conclude anything about alpha is perilous. The 20-billion cells within the brain runs the mind and body. We cannot learn all the secrets merely by examining some local electrical topography.

The amount of alpha usually increases with practice. Many subjects can double the amount of alpha after a couple of hours of biofeedback practice, and after another session, increase it even further.

Now, how does one detect the existence of alpha and learn to control it to gain benefit from the relaxation

that comes with it? Obviously, several years of Yoga or Zen training will come in handy. But, with advances in the state of electronics, it is possible to use a relatively simple electronic device to short-cut those long years of training. This device *will not* give the same results as those attained in the years of study, but will give you some of them, particularly in the area of relaxation, something that we all have a need for in our busy and complex lives.

Basic alpha detector

Because of the very low levels of signal involved (only a handful of microvolts), a high-gain low-noise pre-amplifier must be used. Some form of bandpass filter must be used to pass only the 8 to 12 Hz of the desired alpha and remove any other signal, and any noise. The filtered alpha frequencies can then be used to control a low-level audio oscillator whose tone signal then indicates the presence of alpha. This is the purpose of the device whose schematic is shown in Fig. 1.

The basic alpha wave is initially detected by a pair of electrodes that make electrical contact with the scalp. Two types of electrodes are used: an earlobe clip that forms the "ground" (or reference) contact, and a nickel-plated electrode that is coupled to the posterior (occipital) region of the scalp via some conductive electrode paste. A headband using a Velcro closure keeps the head electrode in place during the tests.

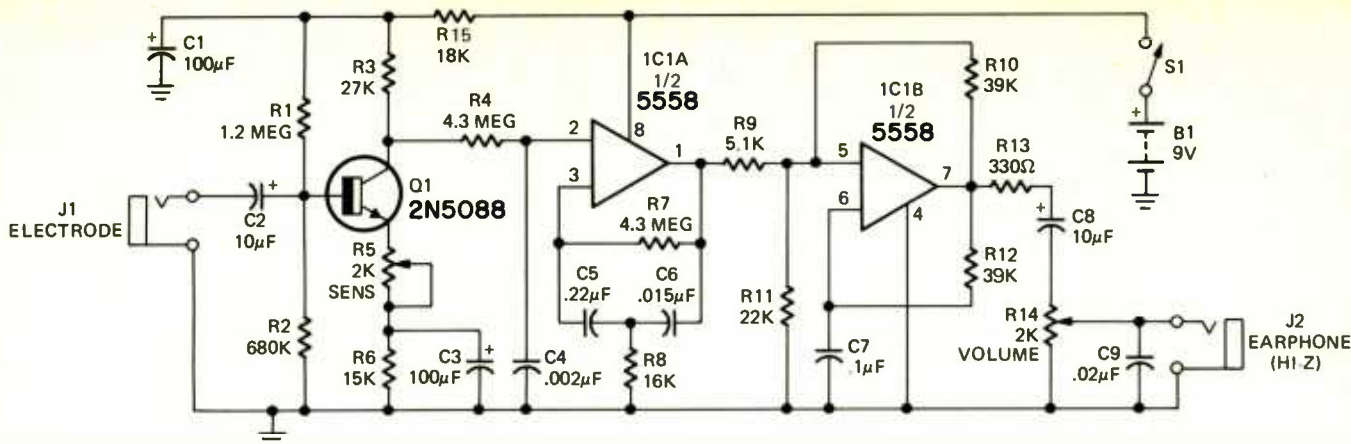
The minute voltages picked up enters the circuit via J1 and fed to a low-noise, high-gain amplifier Q1, whose gain is established by the setting of front panel "Sensitivity" control R5. The amplified output signal at the collector of Q1 consists of a broad spectrum of signals (and noise) including the 8- to 12-Hz alpha we are seeking.

ICI-a (part of a 5558 dual op-amp) is connected as a narrow-band active filter whose components are selected to form a filter having a center frequency of about 10 Hz (center of alpha) ± 2 Hz so as to encompass the entire known alpha frequency span. All frequencies other than the desired alpha are greatly attenuated. Incidentally, other alpha devices that do not incorporate such active filters allow all frequencies to pass, thus unnecessarily complicating the detection of the desired alpha.

The sharply filtered alpha signals are then passed to ICI-b (the second half of the 5558 dual op-amp). This stage forms an almost-square wave generator (actually a rectangular wave having a 20% duty cycle) that is continuously in operation. Other alpha devices that use the alpha signal to start an audio oscillator is considered by some researchers to work against the user as the sudden "turn on" of the tone can startle the use, thus affecting the generation of alpha. Research has also shown that a single, low-level tone that is continuously on, and *frequency modulated* by the users alpha is more conducive to alpha



CIRCUIT BOARD of the Alpha Brainwave Monitor with all the components installed.



Parts List

B1—9-volt battery (NEDA1604, Mercury 146X, or similar)
 C1, C3—100- μ F 15-volt electrolytic
 C2, C8—10- μ F, 15-volt electrolytic
 C4—.002- μ F
 C5—.22- μ F Mylar \pm 10%
 C6—.015- μ F Mylar \pm 10%
 C7—.1- μ F
 C9—.02- μ F
 1C1—5558 dual op-amp
 J1, J2—miniature earphone jack
 Q1—2N5088
 All resistors $\frac{1}{2}$ watt, 10%, unless noted
 R1—1.2 megohm, $\frac{1}{2}$ watt

R2—680,000 ohms
 R3—27,000 ohms
 R4, R7—4.3 megohms
 R5, R13—potentiometer, 2000 ohms
 R6—15,000 ohms
 R7—16,000 ohms
 R8—5100 ohms
 R9, R11—39,000 ohms
 R10—22,000 ohms
 R12—330 ohms
 R14—18,000 ohms
 S1—spst switch

Misc.—PC board, suitable enclosure, knobs (2), battery holder, battery connector, electrodes, interconnecting cable, high-imped-

ance light-weight earphones, electrode paste, headband with Velcro closure, mounting hardware.

The following items are available from Dean Adv. Inc., 283 Malta St., Brooklyn, N.Y. 11207.

Printed circuit board (etched, drilled & screened). \$4.00 postpaid.

Electrode-headband kit including headband with electrodes, electrode cream, high-impedance light-weight earphones. \$6.00 postpaid.

Complete Alpha Brainwave Monitor Kit including all parts with case and knobs. \$34.50 postpaid.

“learning”. The voltage-to-frequency generator used here (ICI-b) emits a low-level (approximately 700 Hz) pleasant tone and when alpha occurs, this tone will shift in frequency. The amount of frequency shift is proportional to the amplitude (intensity) of the alpha and the number of frequency shifts per second is directly related to the brainwave frequency—alpha causes a 10-Hz shift, while theta produces a 5-Hz shift. This sounds something like the “vibrato” on an electric organ.

The output of ICI-b is then coupled to front-panel volume control R14 and fed to lightweight stethoscopic-type high-impedance earphones whose light weight insures maximum comfort even after long hours of use.

How to build it

Although any type of short-lead clean construction may be used, the PC board shown actual size in Fig. 2 is the best approach. The component installation is shown in Fig. 3. In the interest of safety, the device must be powered by an internal battery. Do not connect the alpha device to any external system using an ac power supply as any leakage, however slight, can be lethal across the skull electrodes.

Select an enclosure that can accommodate the PC board, the 9-volt battery and holder, and whose front panel can accommodate volume control R14, and associated on/off switch S1, sensitivity control R5, input jack J1, and output jack J2. Use some form of

press-on lettering to identify the front-panel elements, and the various “level” settings of the two potentiometers as shown in the front-view photograph.

Using the detector

Apply a small amount of electrode paste to the earclip electrode, and then clip this electrode to either the right or left earlobe. Coat the front-surface of the other electrode, and parting the hair at the rear of the skull, press this electrode close to the skin. Use the headband to secure this electrode in place, and the Velcro end to secure it tight. Plug the end of the electrode cable into J1.

Place the earphones comfortably on the ears and position them for maximum comfort. Plug its jack into J2.

Sit in a comfortable chair, located in a quiet place, place the feet flat on the floor. Turn off any radios, hi-fi's, etc., to reduce external influences, turn down the lights, and relax.

Turn on the power, via volume control R14, adjust R14 for a pleasing listening level, turn up the sensitivity. After several seconds with the eyes closed, and as relaxed as possible, the tone will stabilize. You will soon note the slight “warble” or “waa-waa” and this indicates the presence of alpha. Do not try to produce this rhythm—let the mind go and just listen for it. If you fail to attain the tone variation, check the electrode connections and the presence of the electrode paste. In some cases, alpha is more easily detected by placing the large electrode

(suitably paste covered) over one eyebrow. In some cases, alpha production increases in the frontal areas of the brain.

It is difficult to describe how alpha “sounds”. You have to close the eyes, clear the mind of any visual imagery, don’t “try” to produce alpha, and physically relax. Opening and closing the eyes will produce some sort of tone reaction, and what you are searching for is the 10Hz warble of the 700 Hz tone. If you have access to an electronic organ, play F5 note without “vibrato” or “tremolo” and listen for the steady tone. Switch on the “vibrato” or “tremolo” and note the modulation of the tone. This, in essence, is what the alpha sounds like. Alpha monitoring is essentially an indication of the degree of relaxation, therefore almost any relaxation technique you may know (non-alcohol and non-drug) will facilitate alpha production.

Alpha sessions usually last for 10 to 15 minutes per day, and if you stick to it, you will note a general relaxation and a feeling of well being after each alpha session. Do not keep it up for more than 15-minutes a day at first, as fatigue rapidly sets in, nullifying any extra time. The two key words here must be relaxation and patience.

After each session, carefully wipe each electrode clean with alcohol, as skin oils; dirt, and other deposits may accumulate to destroy the good electrical contact, thus degrading performance.

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One of our most successful students wrote this ad!

Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.

By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

"Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

"Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find



Harry Remmert gives his CIE Electronics course much of the credit for starting him on a rewarding career. He tells his own story on these pages.

necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

"Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

"The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams, and the material had always seemed just a little beyond my grasp. Score another point for CIE.

*CIE backs its courses with this famous Money-Back Warranty: when you complete a CIE license preparation course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. Warranty is valid during completion time allowed for your course.

"Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

"When a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. I wanted to be a full-fledged student instead of just a tag-a-long, so CIE's exclusive home-study program naturally attracted me.

"Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

"From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

"Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later.

"These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

"In closing, I'd like to get in a compliment for my Correspondent Counselor who has faithfully seen to it that my supervisor knows I'm studying. I think the monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. My Counselor has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

"And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

"I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many

times over, both in increased wages and in personal satisfaction."

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"... learning by taking things apart and putting them back together... soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. He was recently promoted, with a good increase in income, to the salaried position of Senior Engineering Assistant working in the design of systems to silence submarines. For trained technicians, the future is bright. Thousands of men will be needed in virtually every field of Electronics from two-way mobile radio to computer testing and troubleshooting.

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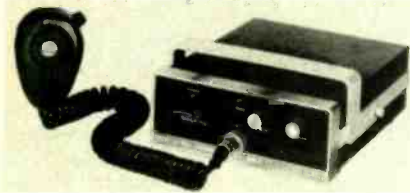
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CB EQUIPMENT ROUNDUP

Here's what the manufacturers are offering at the present time and the direction that they will take in the future.

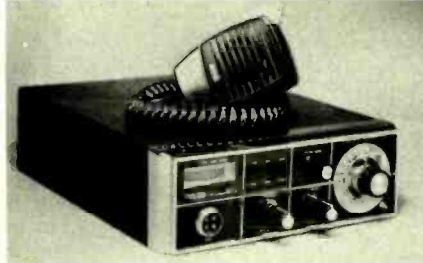
by **HERB FRIEDMAN**

IF THERE HAS BEEN ONE OUTSTANDING feature of Citizens Band equipment it is that each year has seen new and dynamic applications of up-to-the-minute technology. From its humble beginnings with super-regenerative receivers, the modern CB transceiver has grown into single sideband, and all along the way its technological improvements spilled over into other fields. The inexpensive mechanical



REGENCY STL-301 transceiver. and ceramic filters which first became popular in budget priced CB gear is now found in commercial and hobby two-way radio equipments. Similarly, the great CB market which made it

worthwhile for manufacturers to develop new types of mobile antennas made possible the application of these antenna designs for other markets. And frequency synthesis, which



SBE MODEL 26CB transceiver with squelch.

couldn't get off the ground in hobby and consumer equipment, made its entry into the commonplace through CB. Even the integrated circuit made its major entry into the consumer field through CB.

But there is a practical limit to technological advancement, a point beyond which no further improvements can be

made—at the present time—within a given price range. Still, a manufacturer cannot ride along with the same models year after year, and since technology is limited, the logical step is to improve the operating conveniences. And operating convenience is just what you'll find in the latest CB equipments.

Operating convenience is a two-edged sword. To the hobbyist it means all the controls and metering he might possibly use to maximize the total potential of CB. To the straight communications user of CB, maximum operating convenience means push-the-button-and-go, with no extraneous controls or switching to get between the desire to send or receive a message and the actual act of doing so.

So what we have is a basic need for the maximum operating features and a need for equipment virtually stripped to the bare bones, and that's primarily what's being offered in the new CB equipments.



COBRA CAM-89 base station.

NEW RULES FOR CB

New channel allocations could mean a boom to CB. Here are the proposals that are before the FCC and what they could mean to you.

by **JACK HELMI**

SALES OF CB RADIOS ROSE SHARPLY DURING 1974 as a result of nationwide publicity that made more of the public aware that Citizens Band radio existed. Newspapers all over the country ran feature articles about the ever expanding use of CB radio by truckers for keeping in touch with each other and warning both truckers and motorists about road hazards. And, during the Labor Day weekend, newspapers and news broadcasters told the public about truckers using CB radio to identify the car of a Southern California sniper who had killed three people and injured six others.

CB radio received more public attention when it was made known that an application for licensing 2000 CB radios for installation in squad cars had been filed by the Illinois State Police, so that state troopers could communicate directly with motorists in need of police assistance. Still more publicity resulted from the application by the Missouri Highway Patrol for federal funds to cover the cost of CB radios for all of its patrol cars. Earlier, the use of CB

radio by the Ohio State Patrol received considerable national publicity.

And as CB radio got more and more publicity, fewer and fewer newspapers stopped referring to CB'ers as "hams" when their reporters and editors found that they are not the same.

New channel allocations

The booming CB radio business can

be expected to explode when the FCC expands the existing 23-channel Class D citizens band to 70 channels immediately and to 100 channels eventually. As soon as final rules are adopted, according to the FCC proposal, the existing 26.96-27.26 MHz Citizens band will be extended to 27.51 MHz. Channels 1 through 23 and new Channels 24 through 30 will be available for AM and SSB (both upper and lower sideband) transmission. These 30 channels, listed in Table 1, will be available for both inter-station communication (between units of different licensees) and intra-station communication (between units of the same licensee). Channel 9 will remain the emergency channel and Channel 11 will be the calling channel which

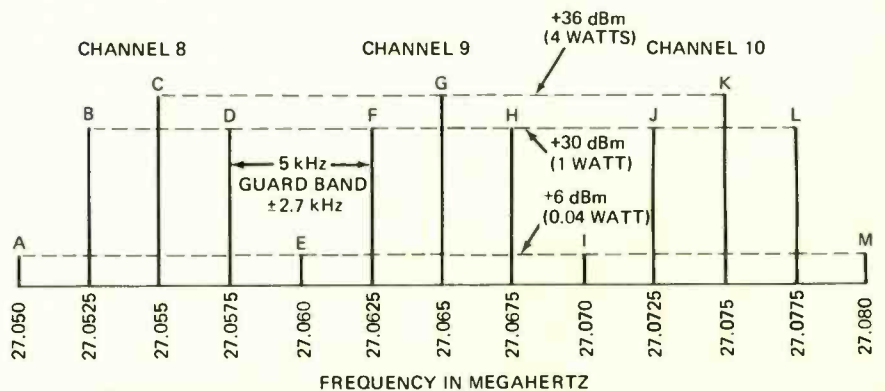
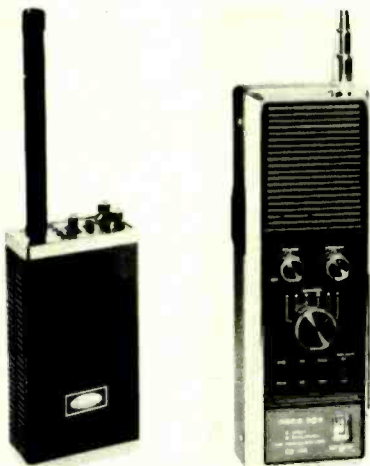


FIG. 1—SPECTRAL ENERGY DISTRIBUTION for the existing 27-MHz band CB Channels with a 2500-Hz modulating signal.

With very few exceptions, CB manufacturers now offer a complete line ranging from a subminiature mobile transceiver accommodating one, two or up to six user-selected channels, through full-coverage 23 channel high-performance AM models, to feature packed high performance AM models, and ending up with high-performance single-sideband (SSB) transceivers. (There are no budget SSB models, yet.)

The basic package still remains the full coverage 23-channel high-performance AM transceiver, most having



(left) COURIER COP-SCAN model VHFL. (right) PACE MODEL CB-105 6-channel portable.



PACE MODEL 120 base station.

"extra" features such as a remote speaker connection, operation as a public address (PA) amplifier (generally with a separate PA speaker connection). Metering is generally provided for relative power output and signal strength, though standard S-meter calibrations are provided. High receiver selectivity is generally attained through ceramic or mechanical filters in the second i.f. amplifier. In short, the transceiver is primarily a repeat of last year's model.

Where differences do exist it is likely to be an upgrading on the basic package, such as a noise blanker, found on Tram's Diamond 40, among others which feature AM and noise blanking. And that's about the only real technical highlight for the new models. Other extras appear to be primarily of special, but low demand user interest; such as more models featuring 12-volt operation with either positive or negative ground; two meters (rf output and signal sensitivity) instead of one doing double-duty; separate switches for the remote speaker

and PA speaker; possibly a headphone output jack (which is nothing more than another remote speaker output); and one of the most useless features of all, a noise limiter (not noise blanker) on-off switch. (Other oddball features of dubious value to most CB'ers are a tape recorder output, and an audio input which permits the transceiver to be used as a low power (about 2.5 watts) audio amplifier. None of these features really contribute either to ease of operation or communications effectiveness, but they do make this year's models different from those of last year.)



GOLD LINE reflected power meter.

One feature formerly found on the "gold-plated specials" which is now being combined into more standard transceivers, and which can be an important operating aid is the built-in

TABLE 1
AM/LSB/USB Channel Frequencies

Chan- nel	MHz	Chan- nel	MHz	Chan- nel	MHz
1	26.965	11	27.085	21	27.215
2	26.975	12	27.105	22	27.225
3	26.985	13	27.115	23	27.255
4	27.005	14	27.125	24*	27.235
5	27.015	15	27.135	25*	27.245
6	27.025	16	27.155	26*	27.265
7	27.035	17	27.165	27*	27.275
8	27.055	18	27.175	28*	27.285
9	27.065	19	27.185	29*	27.295
10	27.075	20	27.205	30*	27.305

* proposed channel allocations

may be used only for establishing communication.

Another 40 new channels (60-99), listed in Table 2, will be available only for intra-station communication and the use of suppressed carrier SSB (upper sideband) only will be mandatory. The proposed new rules also call for inclusion of Channel 9 and Channel 11 capability for all transceivers operable on four or more channels. On these two channels, the use of DSB (double sideband) AM or compatible transmitted carrier single sideband AM will be required so that transmissions can be demodulated by an AM receiver.

The carrier frequencies of the existing 27-MHz band CB channels are separated by 10 kHz as shown in Fig. 1. In this illustration, the Channel 9 carrier frequency (27.065 MHz) is repre-

sented by line G. When modulated by a voice signal containing frequencies up to 2500 Hz, the major upper sideband extends to 27.0675 MHz (line H) and the major lower sideband extends to 27.0625 MHz (line F). In addition, a minor upper sideband (second harmonic of 2500 Hz) extends to 27.070 MHz (line I) and the minor lower sideband to 27.060 MHz (line E). The actual bandwidth is 10 kHz (± 5.0 -kHz). Because of the modulation products, however, which must be at least 25-dB below the carrier level, the apparent occupied bandwidth is 5-kHz when the modulating frequency is 2500 Hz. The illustration shows the relative sideband power levels with respect to 4 watts carrier level when 100 per cent tone modulation is applied.

It can be seen that the Channel 9 signal extends to the edge of the spectrum space allocated to Channels 8 and 10. Fortunately, the level of the minor side-

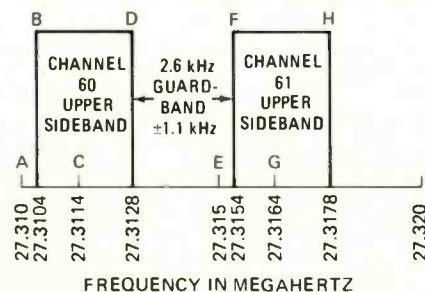


FIG. 2—SPECTRAL ENERGY DISTRIBUTION for the proposed USB channels 60 and 61 with a 400-2800-Hz modulating signal.

TABLE 2
Proposed SSB-Only Channels

Channel	MHz	Channel	MHz
60	27.310	80	27.410
61	27.315	81	27.415
62	27.320	82	27.420
63	27.325	83	27.425
64	27.330	84	27.430
65	27.335	85	27.435
66	27.340	86	27.440
67	27.345	87	27.445
68	27.350	88	27.450
69	27.355	89	27.455
70	27.360	90	27.460
71	27.365	91	27.465
72	27.370	92	27.470
73	27.375	93	27.475
74	27.380	94	27.480
75	27.385	95	27.485
76	27.390	96	27.490
77	27.395	97	27.495
78	27.400	98	27.500
79	27.405	99	27.505

band signals is low enough so that major problems seldom occur. But, it is shown that purity of the transmitted signals and receiver selectivity are important.

The spacing of the Channel 60 and 61 USB signals, when 400-2800-Hz is applied, is shown graphically in Fig. 2. Line B represents the lower edge of the Channel 60 upper sideband which is 400-Hz above the suppressed carrier frequency (27.310 MHz). The upper edge of this sideband is represented by line D and is 2800-Hz above the suppressed

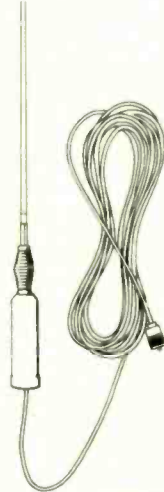
CB EQUIPMENT ROUNDUP

SWR meter such as found on the SBE Console II. The built-in SWR meter, at its worst has absolutely no adverse effect on overall transceiver performance; at its best it gives instant notice of the condition of the antenna system.

The same cannot be said of a microphone gain control—the latest idea to hit the average CB transceiver. Many manufacturers seem to believe that adjustable microphone gain is the up and coming “most desired feature.” When done properly, such as in the Pearce-Simpson Bengal SSB (AM and SSB operation), where a microphone gain control is provided in conjunction with a modulation meter, user adjustable microphone gain can insure optimum modulation. But, and it's a big BUT, several transceivers have a microphone gain control, no means of indicating the percent modulation, and no 100% modulating limiting. The user can easily crank up enough mike gain to severely overmodulate, producing a signal with almost unbelievable distortion. (Most strange. CB transmitters are supposed to be limited to 100% modulation.) Without a modulation meter of some type the adjustable microphone gain is a classic example of a good idea gone wrong.

Moving up to the higher priced, or

“gold-plated” models, we find an interesting feature sure to find its way into many more brands as the year progresses. Hy-Gain has incorporated an antenna tuner into several of its models, among them the Hy-Range III Mobile Transceiver. While all CB transceivers are made to work into the standard 50 ohms impedance of CB antennas, there are times when a mobile/portable unit might have to use a random length of wire for an antenna, or, more typical, a mobile antenna of the straight whip variety won't be 50 ohms. The built-in antenna tuner provides the most optimum match between the transmitter and a



SHAKESPEARE CB whip mobile antenna for cars, trucks and recreational vehicles.



JOHNSON FM 590 portable transceiver. A convenient lightweight, easily carried unit.

non-standard antenna, permitting the transmitter to deliver the highest possible output for a mismatched condition.

Other “new” features found on the deluxe models such as the Royce 1-640 is a tone control and agc (automatic gain control) on-off switch. The tone control can eliminate the sharp, ear-piercing sound common to some transmitters—and receivers having small speakers, by attenuating the highs. But it's debatable whether defeating the agc has any value since any signal stronger than a flea's whisper will overload a receiver without agc.

Modern marketing techniques have also produced new terminology for standard features. All SSB transceivers
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NEW RULES FOR CB

carrier frequency. The lower edge of the Channel 61 upper sideband (line F) is 2600-Hz above the upper edge of the Channel 60 sideband and 400-Hz above the suppressed Channel 61 carrier frequency (27.315 MHz). The guard band between channels is 2.6-kHz wide.

In both Figs. 1 and 2, frequency drift was not taken into consideration. Under the current carrier frequency tolerance of 0.005%, the main sideband of a

Channel 9 signal (Fig. 1) could extend 1.35-kHz closer to the Channel 8 or 10 spectrum, depending upon the direction of the frequency error. The FCC proposes 0.002% frequency tolerance for the USB channels. If the frequency error of a Channel 61 signal (Fig. 2) is -0.002% and that of a Channel 60 signal is $+0.002\%$, the separation of the edges of their main sidebands will be reduced to about 1.1 kHz.

The Notice of Proposed Rules Making tentatively calls for the phase-out of

DSB AM so that AM Channels 1-23 and new AM Channels 24-30, which are spaced 10-kHz apart, can be split into 60 upper SSB channels spaced 5-kHz apart.

To alleviate some of the congestion on the existing 23 CB channels, the FCC, in a separate action, has proposed banning the operation of unlicensed, 100-milliwatt, Part 15 walkie-talkies within the 27-MHz Citizens band seven years after adoption of the proposed rules, banning manufacture after one year and sales after two years. A new five-channel 49.9-50-MHz band would be made available for use by unlicensed low-power communication devices.

To permit greater communication range, the FCC has already increased the CB antenna height limit to 60 feet above the ground. This applies only to omnidirectional antennas. The former antenna height limit—20 feet above an existing structure or natural formation—still applies to directional antennas.

Effect on consumers

Although the Citizens Radio Service was intended to enable citizens to use two-way radio for personal and/or business communications, business users have been all but swamped out by personal users. The allocation of 40 intrastation channels should again make the Citizens Band valuable to business users.

Immediately upon adoption of the new rules, as proposed, none of the existing
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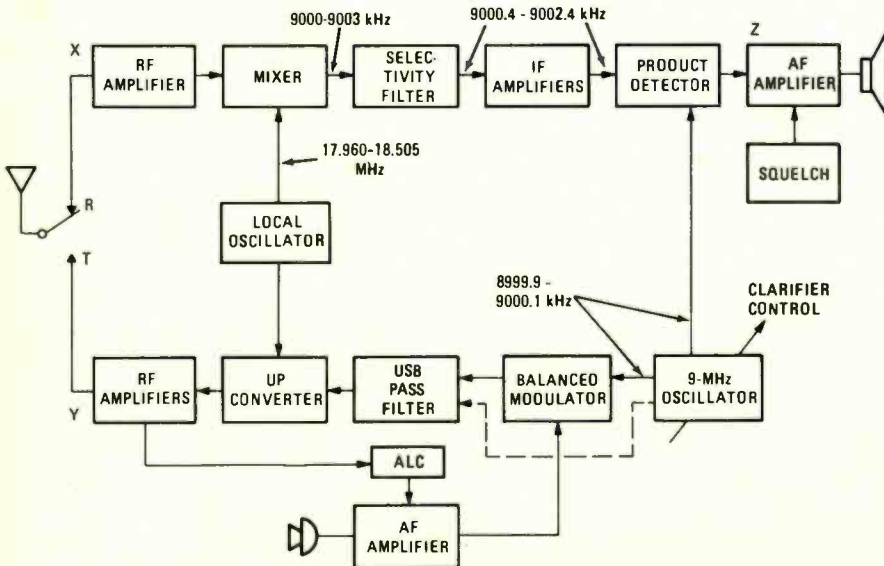


FIG. 3—HYPOTHETICAL USB-ONLY TRANSCEIVER configuration.



Build 3 Unique Clocks

Each clock uses a different readout display. You can choose between two 6-digit desk clocks and a quartz controlled wall clock with 3½-inch LED readouts.

by CHARLES CARINGELLA and
MICHAEL ROBBINS

IF YOU'VE HAD THE URGE LATELY TO JUMP on the bandwagon and build yourself an all solid-state digital clock, then look no further! We suspect there is a digital-clock cult emerging in this country, and if you're already a collector of digital clocks, you'll want to add these three unique clocks to your collection. You can choose from two 6-digit desk clocks using different readout displays, or you can elect to build the quartz-controlled 6-digit wall clock with jumbo 3½-inch LED readouts. By using the latest solid-state devices, you'll see how easy it is to build a precision timepiece to enhance your home or office.

The clock chip

At the heart of all three clocks is the popular National MM5314N P-MOS integrated circuit. This large-scale IC uses p-channel, low threshold, enhancement-mode devices. The equivalent of

over 450 transistors are squeezed into this one IC.

The organization of the IC provides many options which are exploited in these clocks. For proper timekeeping, the time-base for the IC can be either 50 or 60-Hz, but it may go as high as 60,000-Hz and still operate properly. This feature is used in the unique time-setting circuit of the wall clock.

The 50 or 60-Hz input is applied to a shaping circuit in the IC and then to a prescaler, which divides the 50-Hz input by 50, or the 60-Hz input by 60, to produce a 1-Hz signal. This is applied to a counter, which counts from zero to 59 of these one-per-second pulses, then resets itself back to zero. The actual count (0-59) output of the seconds counter is in Binary Coded Decimal (BCD) form.

The reset pulses from the seconds counter occur once per minute. These are counted in the minutes counter, which also counts from zero to 59, and resets. Its output is also BCD.

The reset pulses from the minutes counter are counted by a programmable hours counter. By either grounding or leaving pin 10 of the IC floating, the hours counter is programmed to count zero to 12, or zero to 23, and then reset on the next pulse. Thus, the counters can be programmed to count up to 12 hours, 59 minutes, 59 seconds or up to 23 hours, 59 minutes, 59 seconds.

The seconds and minutes counters each have seven outputs, while the hours counter has six outputs, for a total of 20. In order to reduce this number for simplification of the output circuitry, the outputs of the counters are selected sequentially, one at a time. This selector, or multiplexer, is like a four-pole, six-

position switch, continuously rotating at a speed controlled by a resistor and capacitor connected externally to pin 23 of the IC.

This "switch" selects the seconds (S_1), tens of seconds (S_{10}), minutes (M_1), tens of minutes (M_{10}), hours (H_1), and tens of hours (H_{10}), over and over in that order. In addition, a "fifth pole" of the multiplex "switch" energizes a different digit-enable output terminal for each digit, to let the outside world know which position it is at, at any instant. More about this later.

Within the IC, the four BCD signals are next fed into a read only memory. The ROM converts the BCD code into a 7-segment code, required by the display devices. This code is brought out on seven pins on the IC (pins 3 to 9), which, along with the six digit-enable outputs (pins 17 to 22) contain all of the required output information to operate a 6-digit, 7-segment display.

Switching gates, located before the prescaler, before the seconds counter, and after the seconds counter, are used to stop or speed up the counter. Using this method, it is possible to accurately set the correct time, by means of external pushbutton switches.

The displays

Each of the three clocks uses a different display. The 6-digit desk clock shown in Fig. 1 uses the popular RCA Numitron. This is an incandescent-type display tube. Each segment is a low-temperature tungsten filament. Seven filaments make up the 7-segment display and are housed in a glass vacuum-tube envelope that plugs into a standard tube socket. The Numitron filaments are operated at a low temperature, resulting in



FIG. 1—THE 6-DIGIT DESK CLOCK with Numitron display blends into almost any home or office decor. Smoke-gray or clear "see through" acrylic may be used for the cover. Oiled walnut is used for the side pieces.

a rated life of about 10 years. Unlike LED's, the Numitron emits light in a wide spectrum, permitting a wide variety of color filters to be used over the display. This type of display is also suited for viewing in bright daylight and will not wash out. Two different size readouts

are used in the Numitron desk clock to avoid confusion caused by the rapidly changing seconds and to eliminate distracting colors. The hours and minutes digits are 0.6-inch high displays, while the seconds digits are 0.4-inch high displays. The overall display is very pleasing

to the eye, and can be read easily from across an average size room and from almost any angle.

The 6-digit LED desk clock uses the latest jumbo-size LED (light-emitting diode) readouts, made by Litronix. These new 7-segment readout displays feature

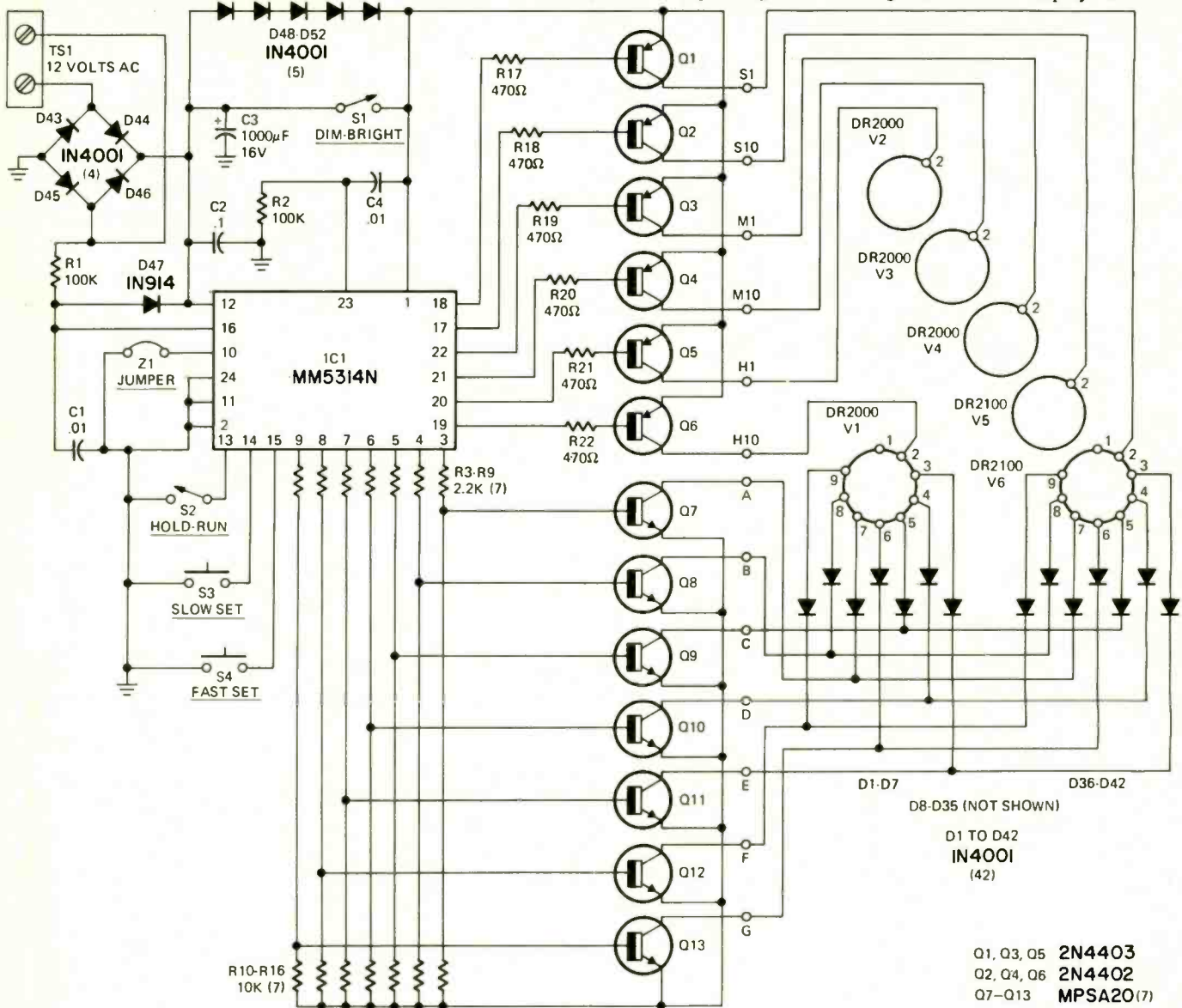


FIG. 2—SCHEMATIC OF THE NUMITRON DESK CLOCK. Both the control section and the display section are combined here. S1 serves as the display BRIGHT-DIM switch. S2 serves as the HOLD-RUN switch. S3 is the SLOW SET pushbutton and cycles the minutes and seconds. S4 is the FAST SET pushbutton and cycles the hours and minutes.

DESK CLOCKS PARTS LIST

CONTROL SECTION

- C1—0.01- μ F disc ceramic
- C2—0.1- μ F disc ceramic
- C3—1000 or 2200- μ F, 16-volt, electrolytic
- C4—0.01- μ F Mylar film
- D1 to D46, D49 to D52—1N4001
- D47—1N914
- D48—not used (see text)
- IC1—MM5314N (National) MOS Digital Clock

- Q1, Q3, Q5—2N4403 npn
- Q2, Q4, Q6—2N4402 or 2N4403 npn
- Q7-Q13—MPSA20 npn
- R1, R2—100,000 ohms, 10%, 1/2 watt
- R3 to R9—2200 ohms, 10%, 1/2 watt
- R10 to R16—10,000 ohms, 10%, 1/2 watt
- R17 to R22—470 ohms, 10%, 1/4 watt
- S1, S2—spst slide

- S3, S4—spdt pushbutton

- TS1—2-lug terminal strip

- Z1—Jumper (see text)

- MISC—Printed circuit board, suitable cabinet, solder, wire, etc.

NUMITRON DISPLAY

- D1 to D42—1N4001
- V1 to V4—DR2000 RCA Numitron
- V5, V6—DR2100 RCA Numitron
- MISC—Four 9-pin PC-type tube sockets, printed circuit board, solder, etc.

LED DISPLAY

- LED1 to LED4—DL747 Litronix
- LED5, LED6—DL707 Litronix
- R1 to R7—120 ohms, 10%, 1 watt
- MISC—Printed circuit board, solder, wire, etc.

NOTE—The following are available from

Caringella Electronics, Inc., P.O. Box 327, Upland CA 91786: PC board, etched and drilled, No. DDC-1, at \$6.95 postpaid; PC board, etched and drilled, No. MDC-1A, at \$6.95 postpaid; PC board, etched and drilled, No. SSC-1, at \$6.95 postpaid; complete kit of parts for the Numitron Desk Clock, including cabinet, hardware, U.L. approved plug-in stepdown transformer No. LVT-1, wire, solder, step-by-step instructions, etc., No. DDC-1 KIT at \$59.95 plus \$2.00 handling and shipping; complete kit of parts for the L.E.D. Desk Clock, including cabinet, hardware, U.L. approved plug-in stepdown transformer No. LVT-1, wire, solder, step-by-step instructions, etc., No. SSC-1 KIT at \$59.95 plus \$2.00 handling and shipping. California residents add 6% sales tax on all items.

a unique light-pipe construction with the segments appearing as bright red bars. Each segment contains two tiny LED chips mounted on a substrate. The light-pipe construction spreads and diffuses the emitted light into a bright evenly-lit bar in each segment. Again, two different size displays are used. The hours and minutes digits are 0.6-inch high displays, and the seconds digits are smaller 0.3-inch displays. This clock display is also very pleasing to the eye, and can be read easily from across an average size room, and from almost any angle.

The display in the 6-digit wall clock is perhaps the most impressive in terms of physical size. A total of 148 discrete LED's are mounted on a single, large printed circuit board to make up the entire display! The hours and minutes digits are 3½-inch high readouts, and the seconds digits are 2½-inches high.

The giant wall clock display can be read up to about 100 feet away, and is ideal for studios, schools, laboratories, factories, stores, etc. The large readout formed this way can have other applications including scoreboards and signs. Of course it will also make an unbelievable conversation piece.

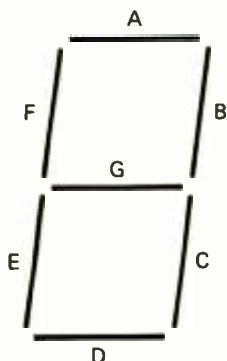


FIG. 3—SEVEN-SEGMENT READOUTS are used in the displays of all three clocks. The designation of each segment is shown here.

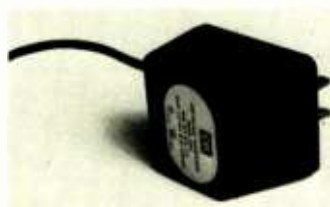


FIG. 4—PHOTO OF THE PLUG-IN TRANSFORMER Model LVT-1. This UL listed device steps the line voltage down to a safe 12-volts ac and is used to power all three clocks described in this article.



FIG. 5—THE ATTRACTIVE, COMPACT 6-DIGIT LED DESK CLOCK features large easy-to-read 0.6- and 0.3-inch high light-emitting diode readouts, and is housed in a smartly styled simulated-walnut cabinet.

How the clocks work

The schematic of the Numitron desk clock is shown in Fig. 2. IC1 is the MM5314N clock chip. The digit-enable outputs are amplified by six high-beta transistors, Q1 to Q6, which supply current to pin 2 of each Numitron, V1 to V6.

The segment outputs of the IC are amplified by transistors Q7 to Q13. These transistors act as current sinks for the display segments. The designation of each segment is shown in Fig. 3. Each Numitron segment has a series diode added as part of a huge diode OR gate. The cathodes of all A-segment diodes are connected together to the A current sink transistor, Q7. Likewise, the other corresponding segment diodes are connected to Q8 through Q13.

For viewing at night, the display can be dimmed with BRIGHT-DIM switch, S1, and the diode voltage-divider string, D48 to D52. Each diode has a forward voltage drop of about 0.6-volts, or a total drop of 2.4-volts for the entire string of diodes (D48 is not actually used). S1 is open in the DIM position.

Switch S2 is the HOLD-RUN switch. This feature allows the clock to be accurately set, and if desired, easily synchronized to sources of accurate or standard time.

The FAST SET pushbutton, S4, speeds up the clock by a factor of 3600, and is used to set the hours and minutes. S3 is the SLOW SET pushbutton. Depressing it speeds up the clock by a factor of 60, and is used to set minutes and seconds. (The clock is speeded up by a factor of 3000 and 50, respectively, when operating from a 50-Hz input).

The 50- or 60-Hz time base is derived from the ac line through R1, then clamped and filtered by D47 and C1.

The clock operates on 12 volts ac provided by an external UL-approved plug-in stepdown transformer, shown in Fig. 4. In this way, the bulky transformer is kept out of the clock cabinet, and only safe low-voltage ac is fed to the power terminals on the back of the

cabinet. The dc required to operate the clock circuit is provided by diode bridge D43 to D46 and filter capacitor C3.

Z1 is a jumper on the clock circuit board. With the jumper installed, the clock displays the standard 12-hour time format. Removing the jumper allows the clock to display military style 24-hour time. Actually, 24-hour time is becoming widespread among police departments, fire departments, public utilities, government agencies, etc. Many businesses that operate around the clock and on an international scale, are converting to and standardizing on 24-hour time. Digital clocks are the only type of timepiece that will do this conveniently!

The LED desk clock shown in Fig. 5 has the same control circuitry as the Numitron clock. However, instead of the six Numitrons and 42 diodes, we use six 7-segment jumbo LED readouts, LED1 to LED6, and seven current-limiting resistors, R1 to R7. The schematic of this LED display section is shown in Fig. 6, and the display circuit is directly compatible with the schematic shown in Fig. 2. S1 is not used in the LED version of the desk clock.

The giant wall clock is shown in Fig. 7, and its circuit is shown in Fig. 8. Each 3½-inch high digit (used for the hours and minutes) is made up of 27 discrete LED lamps and seven resistors. Each 2½-inch high digit (used for the seconds) consists of 20 discrete LED lamps and seven resistors.

A different number of LED's are used in each segment of a typical digit to obtain the proper digit and overall display geometry. This results in different voltage drops across each segment. To equalize the brightness between all segments, different resistor values are used in each segment.

The integrated circuit clock chip, shown as IC3 in this schematic, and transistors Q1-Q13, perform the same functions in the wall clock as they do in

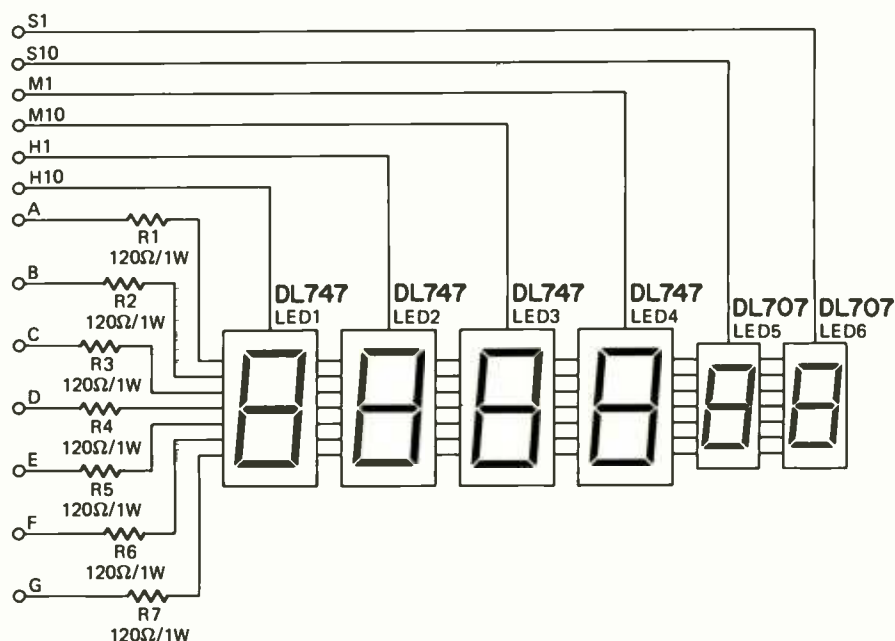


FIG. 6—SCHEMATIC OF THE LED DESK CLOCK DISPLAY SECTION. The LED display is compatible with the electronic control section shown in Fig. 2. S1, the display BRIGHT-DIM switch, is not used in the LED version of the desk clock.

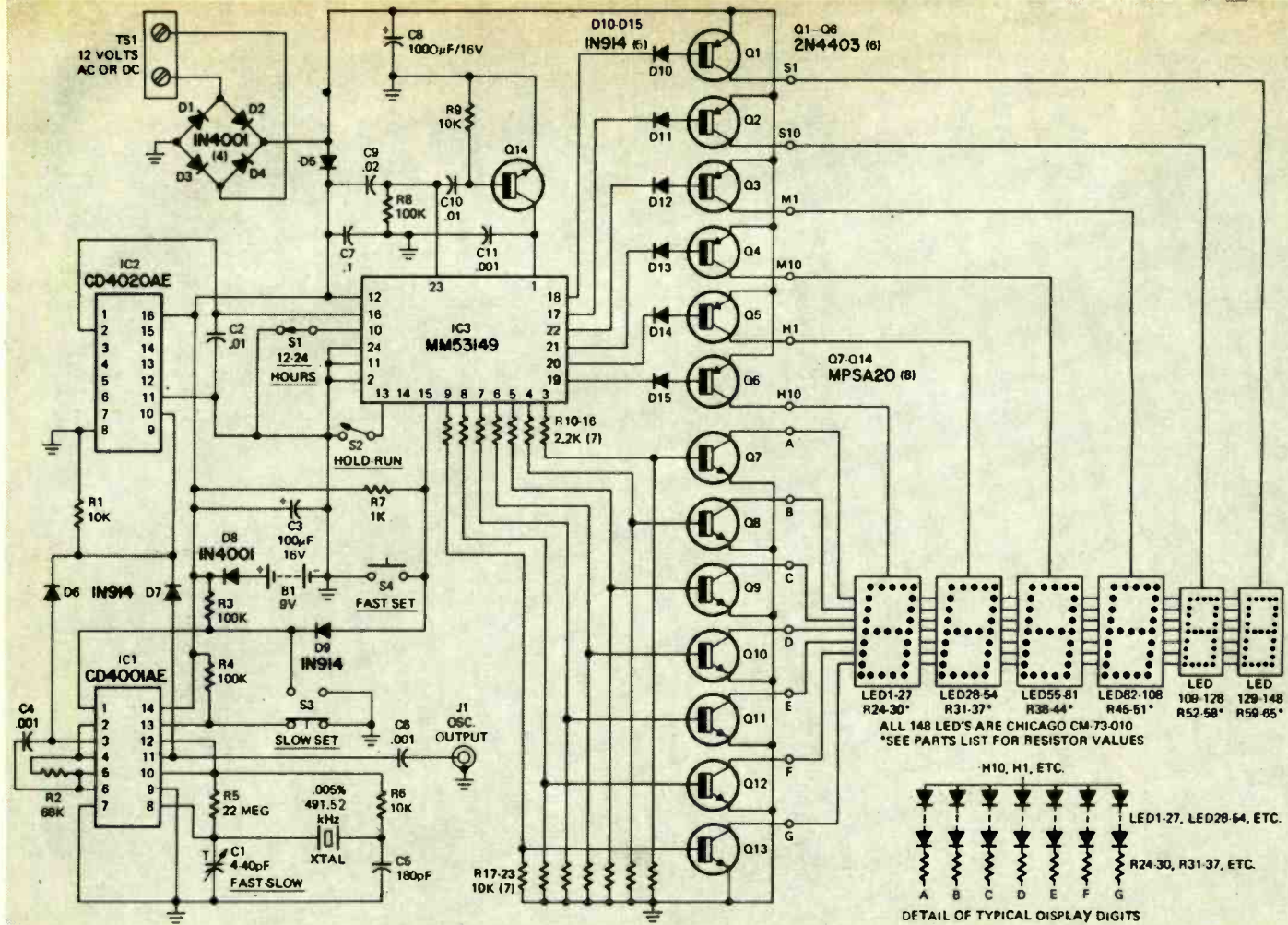


FIG. 8—SCHEMATIC OF THE WALL CLOCK. S1 selects 12 or 24-hour time. S2 is the HOLD-RUN switch. S3 is the SLOW SET pushbutton and cycles the minutes only. S4 is the FAST SET pushbutton and cycles the hours and minutes. The seconds readouts have a 4X7 format.

- B1—9-volt (Eveready 216 or equal)
- C1—4 to 40-pF trimmer (Arco 403 or equal)
- C2, C10—0.01- μ F disc ceramic
- C3—100- μ F, 16-volt, PC-type electrolytic
- C4, C6, C11—0.001- μ F disc ceramic
- C5—180-pF, N2200 negative temperature coefficient, disc ceramic (Sprague 10TCY-T18 or equal)
- C7—0.1- μ F disc ceramic
- C8—1000 or 2200- μ F, 16-volt electrolytic
- C9—0.02- μ F disc ceramic
- D1 to D5, D8—1N4001
- D6, D7, D9 to D15—1N914
- D16 to D20—not used (see text)
- IC1—CD4001AE (RCA) CMOS Quad NOR gate
- IC2—CD4020AE (RCA) CMOS 14-Stage Binary Counter/Divider
- IC3—MM53149 (National) MOS Digital Clock
- J1—Phono jack
- LED1 to LED148—Light-emitting diode

- (Chicago Miniature Lamp CM-73-010 or equal) selected for 3:1 light-intensity range and chip centering, (see text)
- Q1 to Q6—2N4403 pnp
- Q7 to Q14—MPSA20 npn
- R1, R6, R9, R17 to R23—10,000 ohms, 10%, 1/2 watt
- R2—68,000 ohms, 10%, 1/2 watt
- R3, R4, R8—100,000 ohms, 10%, 1/2 watt
- R5—22 megohms, 10%, 1/2 watt
- R7—1000 ohms, 10%, 1/2 watt
- R10 to R16—2200 ohms, 10%, 1/2 watt
- R24, R27, R28, R31, R34, R35, R38, R41, R42, R45, R48, R49, R52, R55, R56, R59, R62, R63—150 ohms, 10%, 1/2 watt
- R25, R30, R32, R37, R39, R44, R46, R51, R53, R58, R60, R65—56 ohms, 10%, 1/2 watt
- R26, R29, R33, R36, R40, R43, R47, R50, R54, R57, R61, R64—100 ohms, 10%, 1/2 watt

- S1, S2—spst slide switch
 - S3, S4—spdt pushbutton switch
 - TS1—2-lug terminal strip
 - XTAL—491.520-kHz crystal, HC/6 holder, 0.005% tolerance at room temperature
 - MISC—Printed circuit boards, suitable cabinet, solder, wire, etc.
- NOTE—**The following are available from Caringella Electronics, Inc., P.O. Box 327, Upland CA 91786: PC board, etched and drilled, No. MDC-1-1, at \$7.95 postpaid; PC board, etched and drilled, No. DWC-1A, at \$14.95 postpaid; Set of 148 selected LED's for display panel at \$60.00 postpaid; Complete kit of all parts including cabinet, hardware, UL approved plug-in stepdown transformer No. LVT-1, wire, solder, step-by-step instructions, etc., No. DWC-1 KIT at \$159.95 plus \$3.50 handling and shipping. California residents add 6% sales tax on all items.



FIG. 7—JUMBO-SIZED DIGITS, measuring 3 1/2-inches high, make the 6-digit wall clock particularly impressive, and well suited for office, school, factory, and many other applications. This large wall clock is housed in a simulated-walnut cabinet and has a red sheet-acrylic clock "window".

the two desk clocks. However, most of the remaining circuitry is unique to the wall clock.

The 60-Hz time base is generated internally, making the timekeeping accuracy independent of the power-line frequency or power-line failures! This also allows for operation from an ex-

ternal 12-volt dc power source.

One gate of a CMOS quad 2-input NOR gate, IC1, is used as a crystal-controlled oscillator. A 491.520-kHz crystal is used. A second gate amplifies and buffers this signal, to provide an output through J1, located on the back panel, to a frequency counter. Trimmer capacitor C1 sets the quartz-crystal frequency precisely. This frequency can be varied over a limited range, to compensate for seasonal temperature changes that can affect the operating frequency of the crystal. Access to C1 is shown as

(continued on page 85)

40 PROJECTS

Using COSMOS Digital IC's

This is the final part in a series of articles describing COSMOS IC applications, the latest in solid-state technology. The series concludes with oscillator, alarm generator and alarm circuits.

by R. M. MARSTON

LAST MONTH WE EXPLORED WAYS OF USING the CD4001 in lamp flasher, time-delay, oscillator and alarm generators. This final article in the series will conclude with alarm generators and electronic alarm projects.

Figure 41 shows how the CD4001 can be wired up as a one-shot alarm generator, which starts to generate a monotone alarm signal as soon as pushbutton switch S1 is momentarily closed, but stops generating automatically after a pre-set period. The period can be varied from a fraction of a second to more than 15 minutes by selecting the value for C1.

The operation of this circuit is quite simple. Gates 1 and 2 are wired as a gated monostable or one-shot multivibrator which is triggered by momentarily closing S1, and gates 3 and 4 are wired as a gated astable multivibrator that operates at 800 Hz. The output of the monostable turns the astable circuit on and off, and the output of the astable is fed to the speaker via Q1. Thus, the alarm is normally off, but turns on as soon as S1 is closed, and then turns off again automatically after a pre-set period. The period is roughly equal to 1 second per μF of C1 value. C1 must be a low-leakage capacitor in this application.

Finally, Fig. 42 shows how the CD4001 can be wired as a self-latching alarm generator. Here, gates 1 and 2 are wired as a manually-triggered bistable multivibrator, and gates 3 and 4 are wired as a gated astable multivibrator. The output of the bistable is used to turn the astable on and off, and the output of the astable is fed to the speaker via Q1. The action of the circuit is such that the alarm turns on and self-latches as soon as S1 is briefly operated. The alarm then remains on until S2 is pushed at which point the alarm resets and self-latches off.

Note that the circuits of Figs. 40 to 42 are designed to give only a low output power level, as in the case of Fig. 37.

These circuits can be modified to give medium or high output power levels by altering their output stages to conform to Figs. 38 or 39. (Figures 37 through 40 can be found in the December 1974 issue.)

Electronic alarm circuits

The versatility and near-zero standby current of the CD4001 makes it suitable for use in a variety of electronic alarm applications. Figure 43 shows how the IC can be used in a break-to-operate self-latching low-power alarm circuit.

Here, gates 1 and 2 are wired as an electronically-triggered bistable multivibrator, and gates 3 and 4 are wired as a 800-Hz gated astable multivibrator. The output of the bistable provides the gating signal to the astable circuit, and the output of the astable is fed to the speaker through Q1. The action of the circuit is such that the alarm turns on and self-latches as soon as S1 is momentarily opened or broken. The alarm then remains on until S2 is momentarily closed, at which point the circuit resets and self-latches into the OFF state, and the quies-

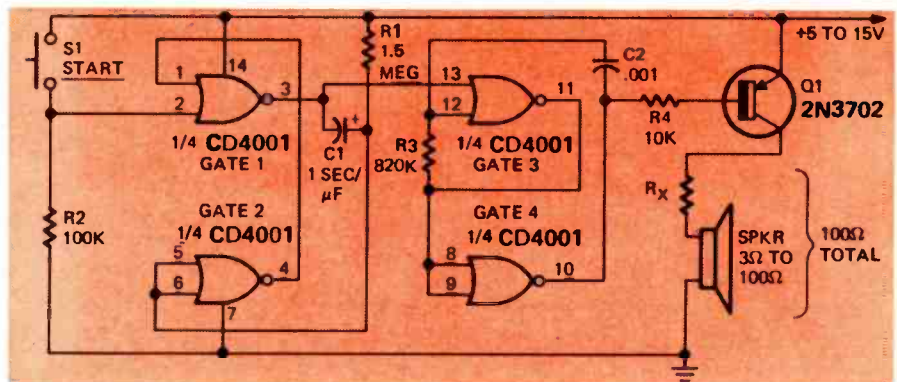


FIG. 41—ONE-SHOT ALARM GENERATOR.

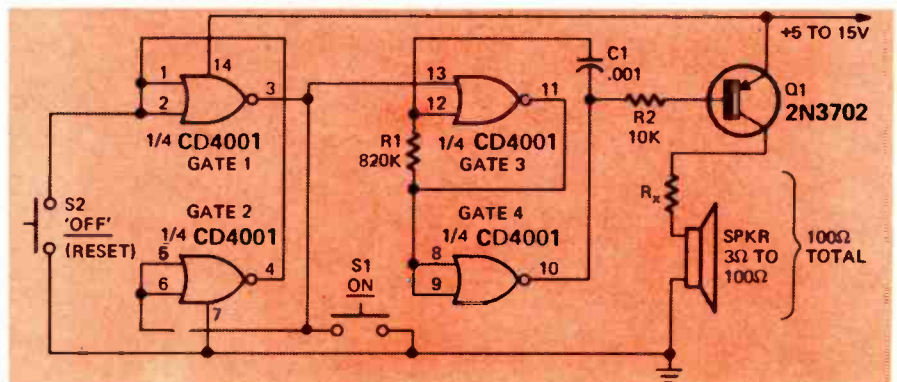


FIG. 42—SELF-LATCHING ALARM GENERATOR.

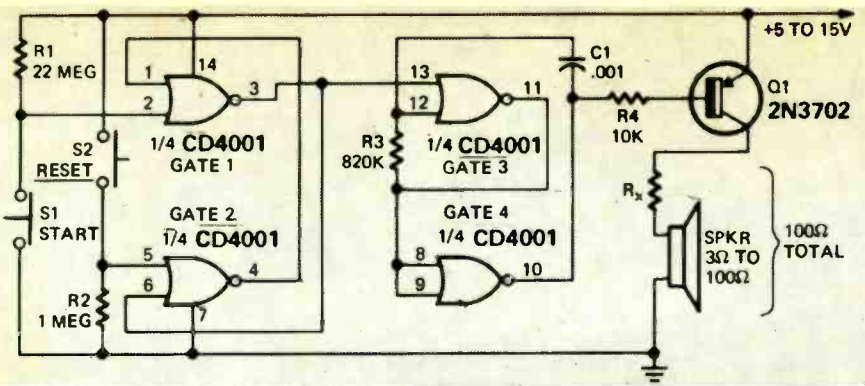


FIG. 43—BREAK-TO-OPERATE self-latching low-power alarm.

cent current falls to near-zero.

Figure 44 shows how the circuit in Fig. 43 can be modified for use as a multi-input burglar alarm. The circuit is basically similar to Fig. 43, except that the input circuitry is modified, the output of the bistable multivibrator is coupled to the input of the astable via 1-megohm resistor R4, and the output of the astable is fed to the speaker via Q1 and Q2. The circuit is designed for operation from a 12 to 15-volt supply, and gives an output of about 10 watts into a 15-ohm speaker.

The action of the circuit is such that the alarm turns on and self-latches as soon as any of series-connected switches S1 to S3 are momentarily operated or

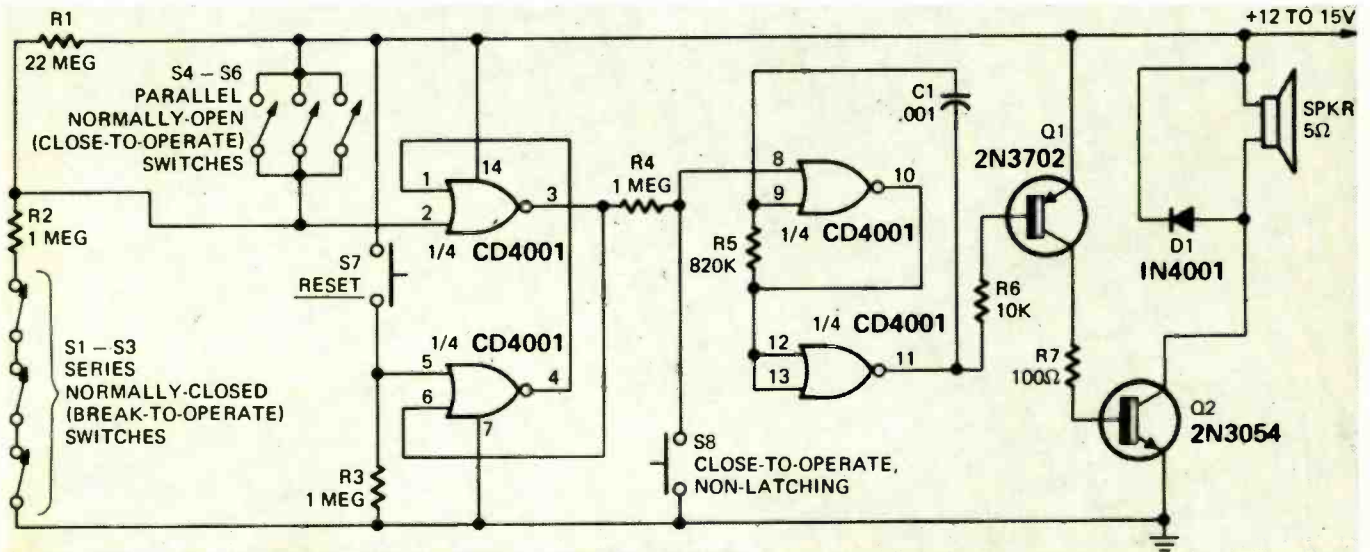


FIG. 44—MULTI-INPUT BURGLAR ALARM (gives approximately 10 watts output).

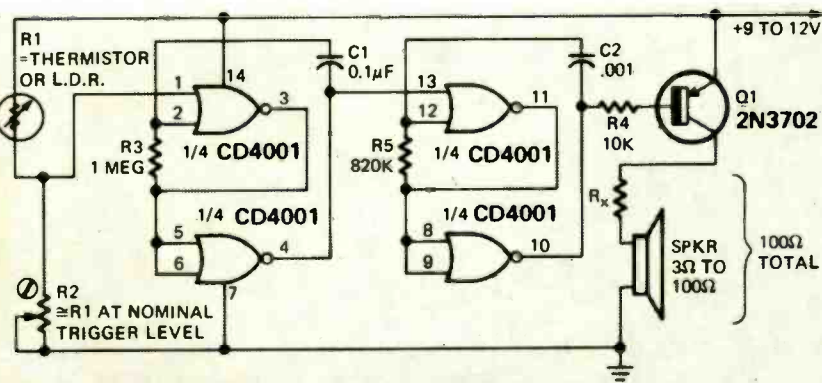


FIG. 45—PULSED-OUTPUT WATER-ACTIVATED ALARM.

broken, or as soon as any of parallel-connected switches S4 to S6 are momentarily closed. The alarm then remains on until S7 is momentarily closed, at which point the circuit resets and self-latches into the OFF state, and the quiescent current falls to a value of about 10 μ A.

Note that any number of additional normally-closed switches can be wired in series with S1—S3, and any number of normally-open switches can be wired in parallel with S4—S6, so there is no limit to the number of input trigger switches that can be used with the circuit. Also note that normally-open switch S8 can be used to operate the alarm in the non-latching mode, and that any number of additional normally-open switches can be wired in parallel with this switch. S8 can be used simply to test the functioning of the alarm, as a "panic button" or to activate it via sensing circuitry that does not require the alarm to be operated in the self-latching mode. Finally, note that a standing current of about 0.65 μ A flows in resistors R1 and R2 when the circuit is in the standby mode, and that this current is insignificant relative to the normal leakage current of about 10 μ A of output transistor Q2.

Figure 46 shows how the CD4001 can be used as a pulsed-output water-activated alarm. Here, gates 1 and 2 are connected as a gated 6-Hz astable multivibrator, and gates 3 and 4 are connected as a gated 800-Hz astable. The 800-Hz

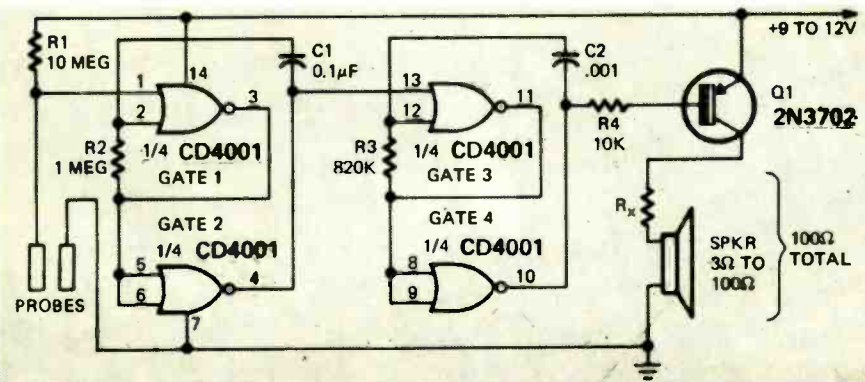


FIG. 46—PULSED-OUTPUT UNDER-TEMPERATURE or light-activated alarm.

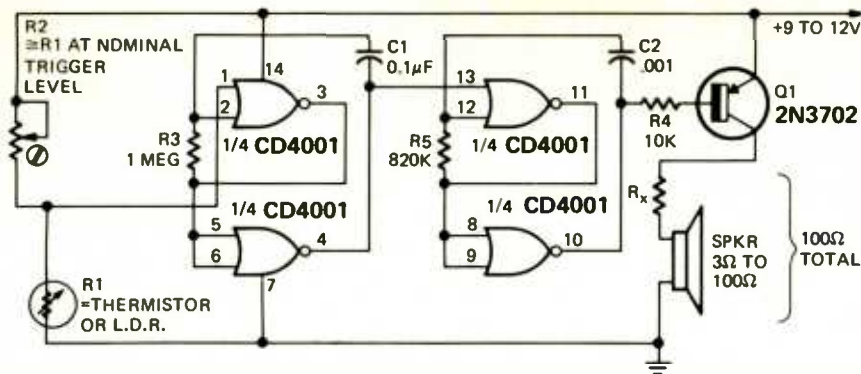


FIG. 47—PULSED-OUTPUT OVER-TEMPERATURE or dark-activated alarm.

multivibrator controls the 6-Hz astable, and its output feeds to the speaker via Q1. The 6-Hz astable is gated via the resistance appearing between a pair of metal probes.

Normally, the two probes are open circuit, and under this condition both multivibrators are disabled and the circuit passes near-zero quiescent current. When a resistance is placed across the probes, a voltage divider action takes place between that resistance and R1, and some fraction of the supply voltage is applied to the input terminal of gate 1. When this voltage falls below the transfer voltage of the gate, the two astable multivibrators become enabled, and a pulsed alarm signal is generated. COSMOS I.C.'s have nominal transition voltage values of 50% of the supply voltage: Consequently, the circuit in Fig. 45 is activated when

the probe resistance is reduced below a nominal value of 10 megohms. Water (in common with many other liquids) has a fairly low resistivity, so the alarm circuit can be turned on by simply placing both probes simultaneously into water. The circuit thus acts as a water activated alarm, and gives a low-level pulsed output. The circuit can be used to indicate flooding in cellars or basements, the overflowing of cisterns or water tanks, or simply to give an announcement when the bath water has reached a given level.

Finally, Figs. 46 and 47 show how the circuit in Fig. 45 can be modified for use as a pulsed-output temperature or light-activated alarm. In the explanation of circuit operation given above, it was pointed out that the alarm turns on as soon as the input voltage falls below the transfer voltage value of the IC. This transfer

voltage is reasonably stable, and the turn-on action of the alarm is quite sharp. Consequently, the alarm can readily and reliably be activated via a light or temperature-sensitive potential divider wired across the supply lines.

Figure 46 shows the connections for making an under-temperature or light-activated alarm, which turns on when the temperature of a thermistor falls below a pre-set level, or when the illumination of a light-dependent resistor rises above a pre-set level. The light or temperature-sensing element (R1) forms the upper arm of the potential divider, and sensitivity control R2 forms the lower arm.

The action of this circuit can be reversed, so that it acts as an over-temperature or dark-activated alarm that turns on when the temperature rises above a pre-set level or when the illumination falls below a pre-set level, by simply transposing the positions of R1 and R2, as shown in Fig. 47. In either case, any negative-temperature-coefficient thermistor can be used as the temperature-sensing element, or any cadmium sulphide photocell can be used as the light-sensing element: Ideally, however, these elements should have large resistance values at their nominal operating values, so that the quiescent current consumption of the circuits are kept to reasonably low levels. R2 is a pre-set resistor, and should be adjusted to give a value roughly equal to that of the sensing element at the nominal light or temperature triggering level. This resistor acts as a sensitivity control. R-E

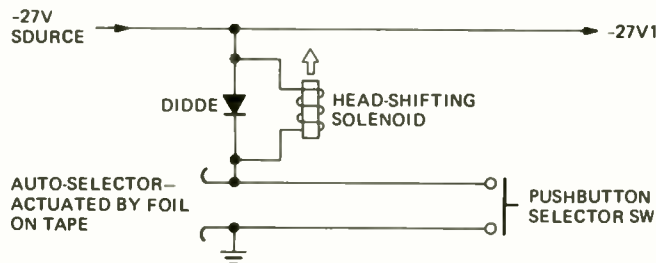
service questions

NO TRACK CHANGE

The channel selector doesn't work in this Mayfair 888 stereo tape player. Everything else is fine. Can't find a schematic listed on this anywhere. The selector and cam are OK, but nothing happens when I push the button.—C.K. Cheektowaga, NY.

Look in Sams Home Tape Player Manual, Vol. HTP-9, pp. 61-70. You'll find it listed there.

Channel or track selector: if the cam and selector unit



are free, check the solenoid coil. Also make sure that the dc voltage is getting to the solenoid. Last check; if an ammeter shows a sudden pulse of current when the track-selector button is pushed, but nothing happens, check that transient-suppressor diode. It is connected across the solenoid. If it's shorted, nothing will work.

PULL-IN AT SIDES

The brightness goes way down, (high-voltage drops) and the raster pulls in at the sides, in this

RCA CTC-22AD. This is intermittent, of course. I think it's somewhere in the brightness limiter stage. Dc voltages up to the 11HM7 video output seem to be OK. Any ideas?—J.R., Tucson, AR.

Check that 11HM7 tube. If all dc voltages are within tolerance up to that point, there could be some kind of problem here; an intermittent short in the tube, etc. The brightness limiter, like the regular brightness control, works through the 11HM7 video output to react on the picture tube cathode circuits.

UNBELIEVABLE

The syncs (both horizontal and vertical) went completely out, on this RCA CTC-19. Scope on the first video grid showed a mess, with a big hum-component. Pull the horizontal output tube, and the video signal looked OK. Now comes the weird part.

I turned on a small black-and-white portable very near by. Worked fine. Then, for one more check, I turned on the CTC-19. Out went the syncs ON THE PORTABLE. Turn the -19 off, normal sync. Sound not affected.

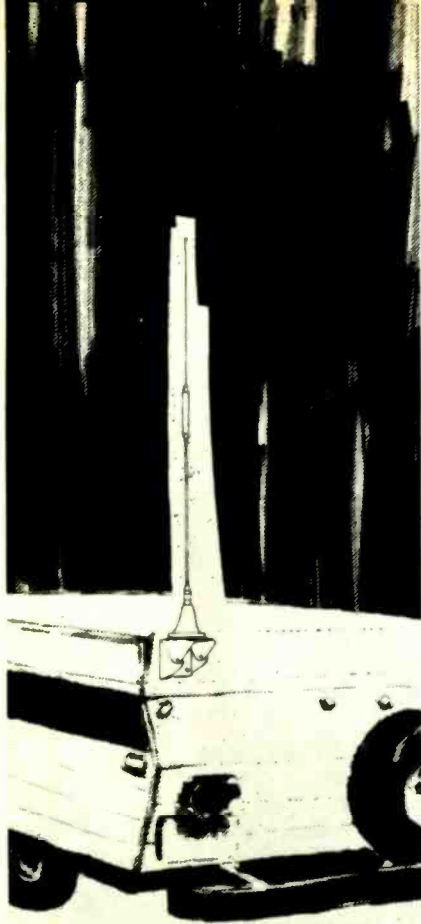
There was a weird sound that seemed to be coming from the high-voltage cage of the -19. As nearly as I could tell, it came from the vicinity of the 6BK4 high-voltage Regulator. I pulled this tube, and lo! Normal picture. Both sets. New 6BK4 cleared up the whole thing. Evidently the 6BK4 was radiating some kind of hash that was killing the sync. Would you believe that?—W.A., Los Angeles, CA.

Yes.

R-E

Installing CB

Installing CB antennas correctly can be the subtleties that are involved. height, and proper grounding are all prime



INSTALLATION OF AN EFFICIENT CB antenna on any form of recreational vehicle, familiarly known as an "RV" by the camping fraternity, presents special problems not normally encountered in the average antenna installation. Special problems will also be found with antenna installations on the family car if it is used to tow an RV. And among RV's themselves, certain types are more difficult to adapt to a CB antenna than others. One thing is clear however; since the FCC permits only 4 watts output power on AM, or 12 watts on SSB, the antenna must be as free from losses and as efficient as possible.

The ordinary, full-length, CB mobile antenna designed for Class D operation will tend to be at least 96 inches long. Adding these 8 feet to the RV height averaging between 7 and 10 feet, will effectively deny use of any highway with underpasses that are the national, legal height of 13½ feet above the pavement. Many are lower than that.

Additionally, many RV roofs are of plastic and cannot be considered good electrical "grounds" which is vital for radio communications. When CB antennas are mounted on the rear deck or bumper of a tow car, the RV will effectively blanket the transmission and even the reception of radio signals.

CB/RV antenna installations

Commercial CB whip antennas come complete with a mount which must be electrically connected to a large, horizontal, metallic surface. This metallic surface will serve as a "ground" against which the antenna works. An exception is the magnet-based CB antenna which

has, as its name suggests, a magnet in its base mount to adhere to any surface of iron or steel composition. However, where the roof is aluminum or plastic, it won't hold and other means must be employed for such RV roofs.

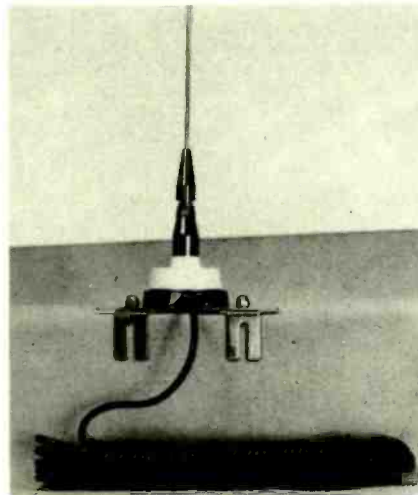
While the average CB whip is 8 feet or more long, there are others that are shorter, down to 18 inches, which can be effective. These shorter antennas include an electronic compensating device within the base or built integrally into the whip configuration so that they are effectively ¼ wavelength long. Over the short distances most used in RV operations, these smaller antennas work very well and they are quite satisfactory.

Because of the necessity of providing a good ground, this should be the first

verted as will be described later in order to be used for CB work. The sole limitation to use of the RV roof may be the resulting height of the RV with the added antenna. However, even that has been commercially surmounted.

The lowest underpass on national or Federal highways is supposed to be 13½ feet above the pavement. Unfortunately, this is not always true, and they can be much lower, some being under 11 feet high. Many recreational vehicle campgrounds are accessible only by local, back roads where it is not unusual to encounter underpasses as low as 10 feet. And when these back roads pass through heavily wooded sections, the overhanging branches are rarely respecters of RV heights, being much lower than even 9 feet! However, since most RVs are originally not much over 9 feet high, they will pass under the back road bridges and even under the tree branches without trouble as long as the RVs are not sporting CB antennas making them higher.

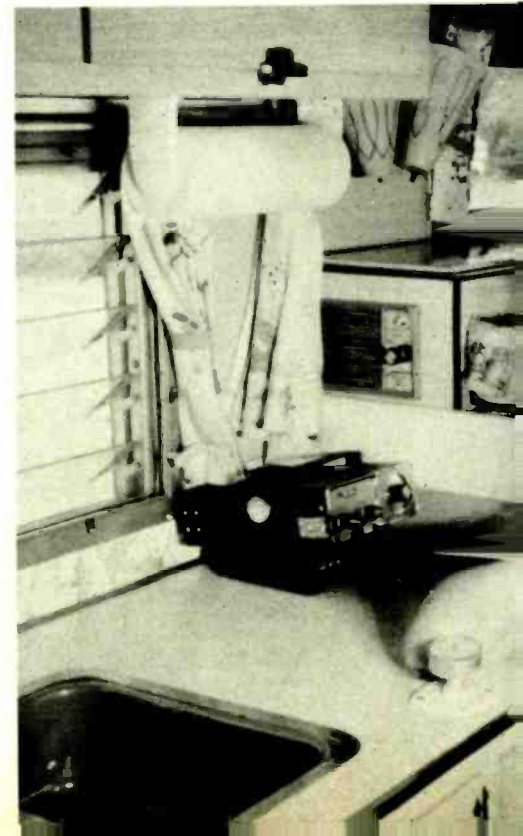
One solution to the problem is to use an 8-foot whip on the roof with the installation such that it permits the antenna to be changed to a horizontal position on option. Unfortunately, a CB antenna will not normally function well in the mobile service when positioned horizon-



ANTENNA MOUNT which allows mounting antenna on the side of an RV with bolts. The coax is integral with the mount.

consideration of the CB/RV installation, and not the antenna itself. Of all possible locations, the best is, naturally, the roof of the RV or tow car since it will place the antenna as high as possible. This will extend the range of the equipment to its maximum. While the ground is of great importance, the average antenna location runs a very close second. In fact, the average CB/RV installation is a compromise of both requirements—the best ground available coupled with the highest possible antenna location.

The RV roof is a good location only as long as it also provides a good electrical ground. A metallic roof of iron, steel or aluminum sheeting makes a good ground, as is. Plastic roofs, however, are normally poor grounds and must be con-



Antennas

be a difficult task if you are not familiar with. Such factors as antenna location, antenna considerations for a proper installation.

by DR KARL A. KOPETZKY,
KFZ-8971

tally. Another solution is to use the magnet-based antenna, with the antenna secured from being swept off the roof by a length of nylon cord. When this has been knocked down, it will have to be re-positioned vertically by someone climbing the RV roof. This itself presents hangups if the roof is not constructed to withstand a person's weight.

Another consideration when seeking a good CB antenna location is interference. The receiver will pick up all kinds of electrical interference. Some of it will be man-made, the rest created by nature. Most of the man-made interference is generated by the engine as well as the various gauges, tire and wheel static and even static from dust particles hitting the moving antenna structure. Natural interference is generated mostly by atmospheric conditions, and is relatively unavoidable.

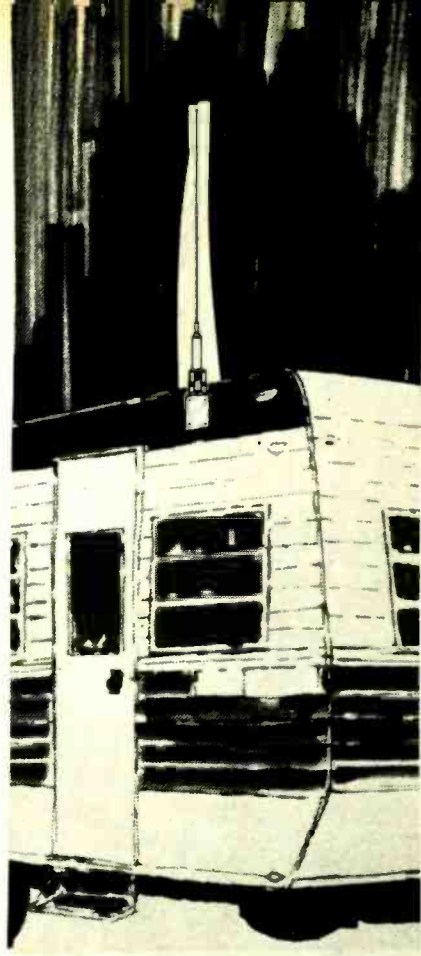
Interference from the engine and vehicle parts can be reduced to a great extent through proper choice of antenna location and installation together with other protective measures. In some instances a compromise must be made; accept the best location as a trade-off against slightly more than usual interference to assure maximum possible range from the installation.

RV/CB antenna locations

The noisiest location with regard to the engine is right on the engine hood or alongside it on a front fender. The least noisy place would be the rear bumper of a towed RV. The poorest location would be on the front bumper because it is so close to the pavement. The best location is the roof of the RV, dead center. Somewhere between these extremes will be a relatively good site, somewhat free of interference to provide acceptable reception and transmission of CB signals.

The furthest location away from interference would be the back bumper, if there is one on the RV. Unfortunately, while not particularly noisy, antennas operate poorly there because of signal absorption by the RV and tow-car. The rear deck of the tow car is a fair location. Yet it also has the disadvantage of being shielded by both vehicle bodies. Still, many CB antennas are located there, regardless.

There are several better locations. On a tow car, for example, a good choice would be the car's roof. For those who do not wish to cut a hole in the car, the magnet-based antenna mount will hold tightly to the metallic roof, and remain very nearly immovable at speeds

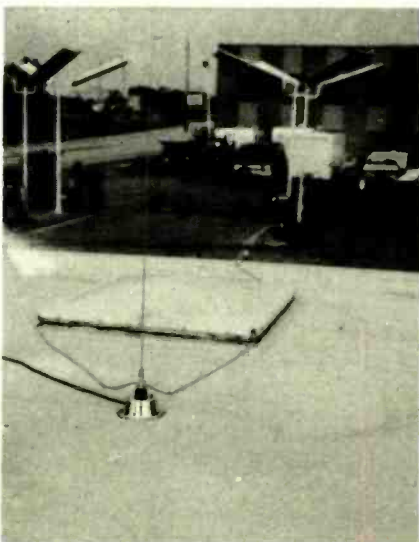


up to 75 mph or higher. The antenna lead-in cable can be sneaked through an open window, or through any convenient opening.

Another type which does not require defacing the car is the "gutter mount" antenna. This can be attached to the gutter of the car window and work well, all things considered. It can easily be removed, an advantage offsetting the pilferage somewhat common with unattended RVs or cars. The gutter mounted antenna will also work well with any RV which is built to include window gutters. Some don't have these, so check before purchasing this type of gear.

Regarding the RV roof location, two types of antenna mounts are available. One requires drilling holes in the RV roof. The other is the magnet-based antenna requiring an iron or steel roof to which to adhere. If the roof is aluminum or plastic, the magnet-based antenna won't work. To overcome this handicap, a 6-inch square piece of 1/8 or 3/32-inch iron or steel plate can be fastened to the roof with self-tapping screws. The magnet-based antenna will stick to this plate. Additionally, it would be wise to install a 1- or 2-inch screw eye in the roof to secure a length of Nylon cord to the antenna so that it will not be lost if hit by an obstruction.

Another excellent antenna location is on the side of the RV near to its roof. Two ways are available. One is a mount that swivels through 90° permitting the antenna to be mounted vertically with its base in a horizontal position against the RV side. A disadvantage is the need to drill into the RV side not only for the mounting screws, but also the an-



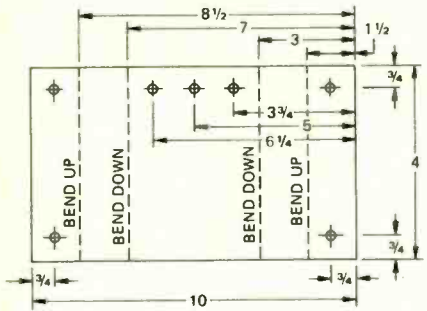
MAGNET-BASED antenna mounted on sheet-metal RV roof. Note the Nylon cord to prevent loss if it is accidentally hit.

CB RIG is operated from the interior of a camper. The CB set was built from a Heath Co. kit; base contains 117 Vac adapter.

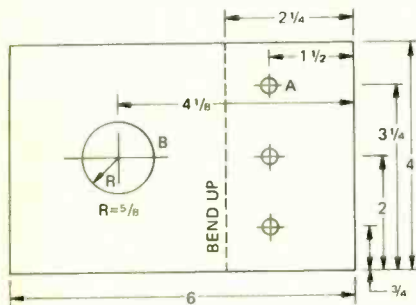
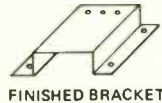
tenna connection. If there is special panneling within the RV interior, this could be a serious hangup.

Some commercially available antenna mounts contain angle plates which can be set to any desired angle. Their disadvantage lies in that they depend on a single nut and bolt assembly to hold the antenna together. This assembly could come apart in transit with resulting antenna loss.

A good, inexpensive, two-piece, metal, antenna mount for the side of an RV can be easily constructed with just ordinary tools. It is illustrated in Fig. 1.



NOTES:
TOLERANCE $\pm 1/64$
7 HOLES AT $5/16$ " DIA.
ALL DIMENSIONS IN INCHES
MATERIAL: $1/8$ " STEEL OR
ALUMINUM PLATE
ROUND ALL CORNERS



NOTES:
3 HOLES AT A EACH $5/16$ " DIA.
1 HOLE AT B $5/16$ " RADIUS
ALL DIMENSIONS IN INCHES
TOLERANCE: $\pm 1/64$ "
MATERIAL: $1/8$ " STEEL OR
ALUMINUM PLATE
ROUND ALL CORNERS

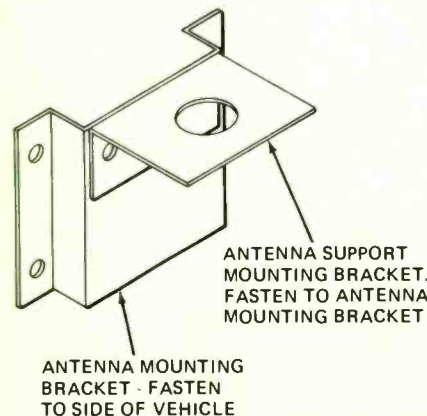
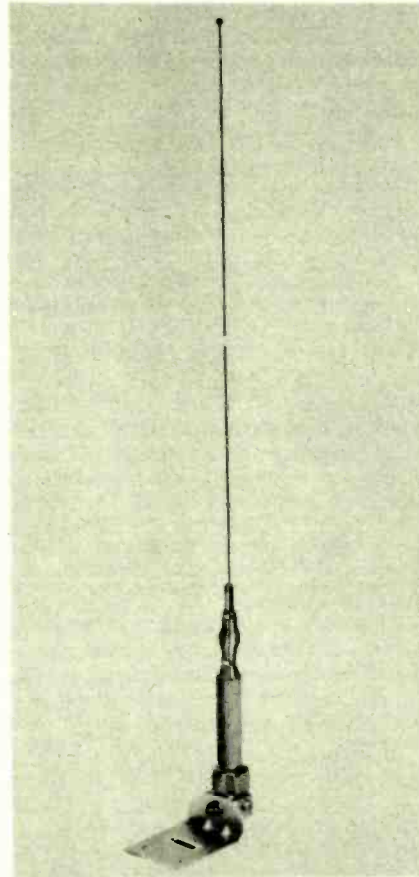


FIG. 1—Construction details for a home-brew, CB antenna mount for use with an RV. Its use is explained in the text.

It has an added advantage that by choosing a proper location, an 18-inch antenna can be used during transit and can be replaced with an 8-foot or longer antenna when in the campgrounds.

There is a commercial variation of this home-built mount with which it is possible to change position of the antenna from vertical to horizontal or near-horizontal for travelling. The change is made before starting out. With the antenna rod positioned horizontally, it is less likely to be struck while in motion. However, in this position the transmitted signals are horizontally polarized and the



ANTENNA MOUNT from Antenna Specialists Co. permits change from vertical to horizontal.

reception favors a similar polarization. Reception of horizontally polarized signals with a vertically positioned antenna has never been too successful, making the normal, Class D, mobile, CB communications virtually impossible. Furthermore, whenever an antenna is in close proximity to any solid object such as an RV roof or side as an antenna would be when in the travelling position, some detuning may take place in the transmitter which might possibly damage the CB set beyond repair. This might occur even if the roof is plastic!

Dual CB installations

For the RV'er who wishes to use CB with his car alone, and then wants CB to be available while towing his RV, the ordinary rear deck car antenna installation is a poor choice. While towing, the RV blankets the CB antenna. In this case the best choice is the car roof and a

magnet-based mount in order not to cut holes in the car. Now, if the RV'er wishes to use CB in his car while towing and then in the RV while in the campgrounds, a different type antenna installation can be worked out. Normally, there is no reason for two antennas and two separate CB sets unless communications between the car and the RV are intended while in camp, with the car being away from the RV.

Where the RV'er wants to use the same antenna for the car when it is hitched to the RV as well as when the car is unhitched, and wishes to use the same CB gear in the car while towing and in the RV while in camp, a special hookup for both CB set and antenna is indicated. The most obvious solution is a single CB set with two mounts, two similar antenna mounts which will accommodate the same antenna rod and a single antenna rod. One each of the CB set brackets and antenna mounts will be installed in the car and RV. The CB set itself will be switched back and forth between the car and RV as needed. To make this easy, instead of the usually provided nuts to hold the set in its mounting bracket, substitute wing nuts which are easily removed without any tools.

The car antenna installation should provide connecting coaxial cable and power cables suitably terminated with the proper matching connectors. The RV installation likewise is terminated in similar antenna and power connectors. Now it is only a matter of carrying the CB set from car to RV and vice-versa.

CB antenna lengths

Because the maximum output power of Class D CB (the most popular classification) is limited to 4 watts AM and 12 watts SSB, it is essential that the antennas be as efficient as possible. One way to assure this, besides the good ground mentioned previously, is to cut the antenna to the correct length. This is required because there is a definite relationship between antenna length and its ability to radiate or receive radio signals of a specific frequency or wavelength. All the Class D CB channels are within the 26.995-27.255 MHz region. The most easily matched antenna in that range for CB gear, and also the most practical both mechanically and electrically, is a $1/4$ wavelength long.

Of prime importance to the RV enthusiast is CB channel 9, reserved by the FCC for emergency use only, including all roadside and travelling situations requiring assistance. Most of the RV campgrounds monitor Channel 12, so that also is important. Without going into the physics, a full quarter-wavelength antenna cut specifically to Channel 9 would be 109.07 inches. This length will also operate on Channel 12 without too much loss. For this reason, whenever an antenna is to be cut to the full quarter-wavelength, the 109-in. length will be best suited for RV/CB operations. However, the measurement must include both the antenna rod and the mount unless the antenna is quite a bit shorter and the difference is being made

up by electronic compensating devices within the base. It should always be remembered that if a 9- or 8-foot antenna rod is mounted on the average RV roof, it will not be possible to travel the average highways without taking it down, since the RV and the antenna are too high to go under the bridges, etc.

Antennas that are far shorter than a quarter wavelength are available with integral loading devices in their bases or mounts. Such devices consist mainly of coils, or coils plus capacitors, so connected as to make the complete assembly equal electronically to a quarter wavelength CB antenna. When tested in relatively open space and with a good ground, there seems to be little change in efficiency between these various length antennas, irrespective of their physical dimensions.

CB antennas are sold in two ways; either as an assembly including antenna rod (generally of stainless steel) and an integrally connected base mount complete with loading coil and coaxial cable; or in two pieces—the antenna rod and the mount. In the latter case there is a choice of the antenna rod length to be employed. It should be recalled that where the mount is purely mechanical and has no electronic components within it, the final antenna plus mount length can become quite critical. Where the antenna mount includes some electronic component, follow the directions as to the length in the instructions which accompany the product.

In the final analysis, it is necessary that the antenna, whatever its length or how that length is arrived at, match the output impedance of the CB set with which the antenna is to be used. The usual and normal impedance of commercial CB sets is 50 to 53 ohms. This is what must be matched.

For successful operation, the antenna must be connected to the set with coaxial cable. Coax comes in many sizes, insulations and impedances, but the kind used for CB work must be either the 50 or 52-ohm, small diameter, single-insulation type. The breakdown voltage of this insulation of this type is 1500 volts.

Coax is identified by specific terms originated during World War II. The wire catalogs list the coax by these terms. The RV'er can use any of the following for his CB installation: RG-58/U, RG-58A/U, RG-58C/U or RG-174/U.

Coax must be terminated in some sort of connector which will match the receptacle on the CB set chassis. Visual investigation of the chassis to determine which type must be made. Match the chassis antenna connector with the similar matching plug. Thus if the chassis employs the coax cable SO-239 receptacle, the matching plug is the PL-259. A Motorola Pin Jack must be matched with the corresponding Motorola Pin Plug. If in doubt, ask the dealer or any electronic jobber. Incidentally, do not make the mistake, if PL-259 plugs are indicated, of soldering the plugs on both ends of the coax cable before snaking it through whatever openings are re-

quired. Too often the plugs are too large to permit passage through the holes, and the whole procedure must be done over. Solder a PL-259 on one end first. Snake the cable through the openings. Then solder the other end plug.

Antenna grounds

A good ground is necessary for CB gear to work properly. Where the vehicle roof on which the antenna is mounted, is of metal, the problem is minimized. However, lately, more and more RV's are being manufactured with plastic roofs. Plastic is not a good electrical ground, so some means must be found to make the RV roof into a good ground, or else forego this as a CB antenna location. Since of all locations, the RV roof is the best, it can be modified such that it can become a ground.

One solution is a metal-faced, pressure-sensitive tape with excellent elec-

tronic and electrical characteristics. Available in 50-foot rolls, 3 inches wide, such tape can be laid on a plastic or fibre-glass RV roof in a grid configuration (Fig. 2), creating an excellent ground system for any CB antenna. The tape grid will work for all sizes of roofs, the larger RV units requiring more tape than the smaller ones. The grid squares should be approximately 18 inches on a side. To make it larger may deteriorate the ground system; to make them smaller will not improve the ground by any appreciable amount.

When using the tape grid, the antenna should be mounted as nearly in the center as possible. Mounting it at the corners will change the radiation pattern to favor certain directions. (Fig. 3). It is absolutely necessary that a good electrical connection be made between the antenna mount and the tape. The best way you can do this is to bolt the

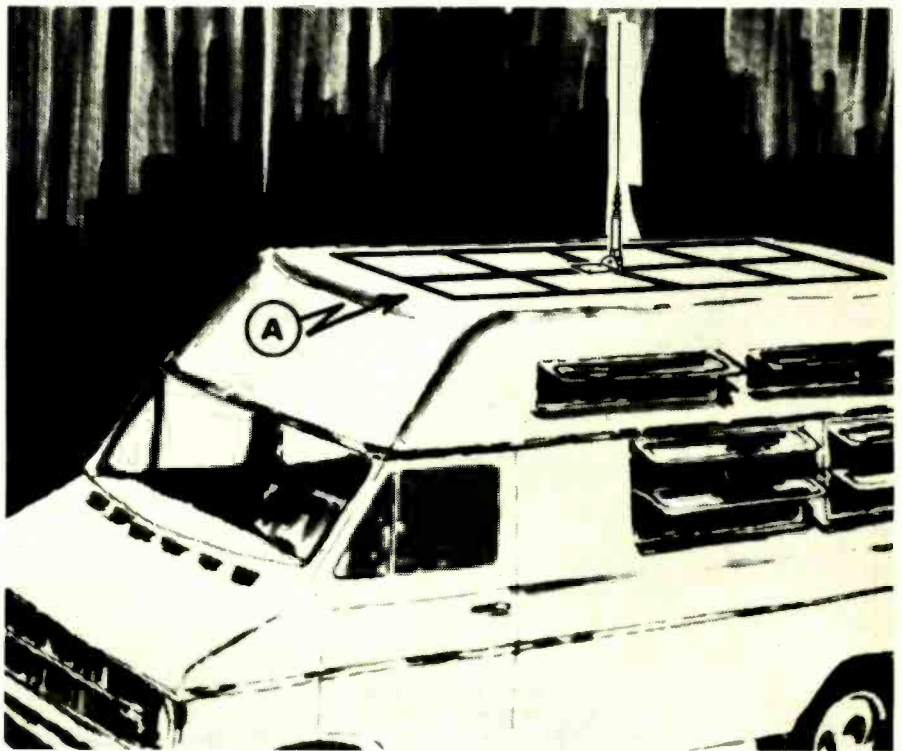


FIG. 2—Using a grid made up of metallic faced, pressure sensitive tape laid on the RV roof at "A" to create a ground on an RV with a plastic roof. Antenna is mounted at the grid center.

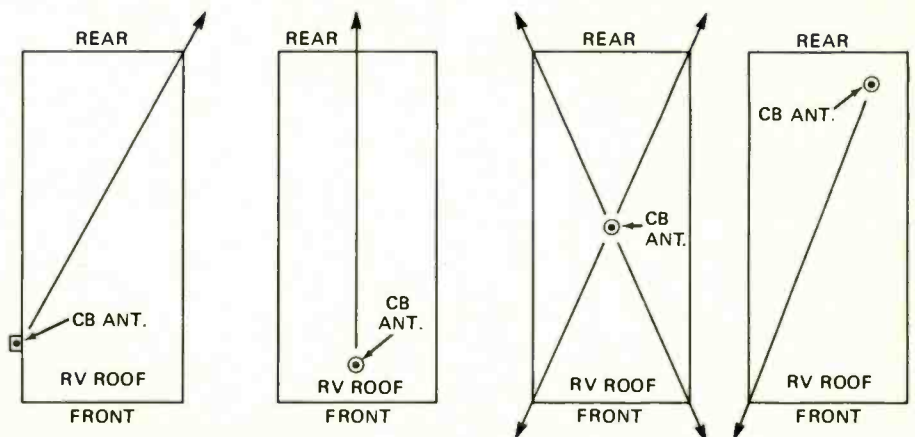
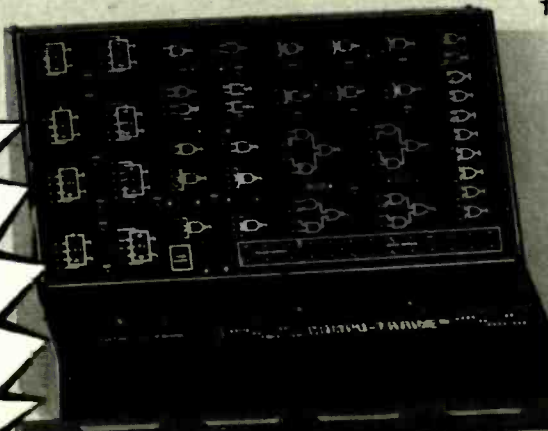


FIG. 3—Arrows indicate the most probable directions CB signals will take depending on the location of the antenna on an RV roof. Arrows point to the transmitting direction, and to the area from which best reception will occur.

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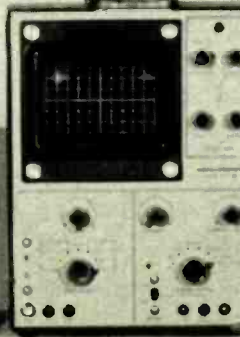
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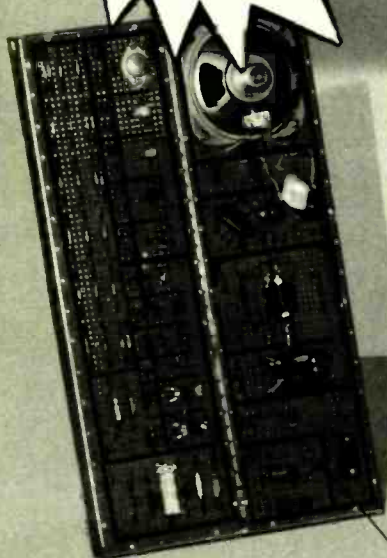
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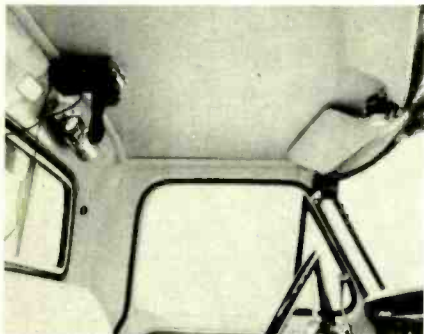
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mount directly through the tape and into the roof. Yet sheet metal or self-tapping screws rarely possess sufficient strength to hold the antenna upright even in the slightest summer breeze, let alone the strong wind created by 55 mph travel on the highway. So the mount must be bolted through the roof. If this is undesirable for whatever the reason, the antenna mount can be bolted to a heavy piece of steel which in turn can be mounted on the roof by a large number of shorter screws.

If the magnet-based antenna mount on a plastic RV roof is contemplated, a 6-inch square piece of steel or iron should be positioned and fastened so that it makes excellent, electrical connection with the tape grid at the center cross-over points of the grid. Soldering to the tape cannot be done and should not be attempted; it'll destroy the tape. Any coax cable connection to the tape for a ground should be made at the antenna mount to the terminal provided, and not to the tape itself.

Antenna mounting tips

Do not depend on the aluminum, RV siding to support an antenna and its mounting bracket. Always drive screws



CB TRANSCEIVER mounted on the roof of the cab of a pickup truck-camper combination. Transceiver has 3-channels and is ideal.

into a wooden stringer or stud. In RV construction these are usually a 2 x 4. In roof installations, seek out the roof beams into which to drive the screws. Only when you install the 6-inch square metal piece for use with the magnet-based antenna, can the roof beams or stringer be dispensed with, and the metal piece fastened to the roof with a number (at least 4 to a side) of short self-tapping screws. Do not over-drive these when working with plastic. Place a small amount of RV roof putty, even ordinary window-pane putty will do, under each screw head, to seal the roof against leaks.

For those who prefer a short antenna mounted on the roof while travelling, but want a full-sized 8 or 9-foot antenna in campgrounds—a "quick-disconnect" device is commercially available. A short turn of the wrist will mount or demount any antenna made to use with the device. Such devices are useful in storing RV's where storage space will not permit full extension of the CB antenna.

When disconnecting any antenna from a permanent type of mount, the two resulting holes—the one for the rod and the other for the coax cable terminal plug (if any)—should be covered with short pieces of ordinary household adhesive tape to keep out dirt, etc. If the antenna cracks, it must be replaced. Normally it cannot be repaired. A cracked antenna mount can cause the antenna to become detached from the RV and lost while in motion. Mounts to match nearly every type of antenna on the market are available from CB, electronic jobbers and dealers.

That "tricky" CB set ground

The CB set should be thoroughly and separately grounded for optimum operation and range. Do not depend on grounding the CB set with the screws or bolts which hold the set in its mounting brackets, or the screws which hold the

bracket to the car dash or the RV frame, etc. Some car dashboards are plastic, a non-conductor and no ground at all! Run a separate, No. 10 or 12, insulated copper wire between the negative pole of the car's or RV's storage battery if that pole is indeed already at ground potential, and the CB chassis, or ground terminal if there is one on the chassis. Or run the wire to the car or RV frame, being sure to scrape off the paint before fastening the wire under a convenient bolt head. Some types of CB gear can be operated from the 117-volt ac campground mains. In this case it is necessary to be sure that either the RV or the CB chassis itself is actually grounded into the earth. The very best, and most simple manner through which this can be accomplished is as follows. Acquire (from any radio jobber or dealer) an ordinary, 3 to 6-foot, copper-flashed steel ground rod. It comes complete with connecting screw bracket. Provide a length of No. 10 or 12 insulated copper wire long enough to reach from the antenna mount to about 2 feet above the pavement. Attach the large, battery-type clips to each end of this, which will be called the "ground wire."

Drive the ground rod into the earth until at least 2 feet of it is in the ground. Clip the ground wire to the top of the ground rod and the other end to the ground portion of the antenna mount. If a coax plug, type PL-259 is being used, the shell of that plug makes an excellent place to which to clip the ground wire. The plug shell should have been soldered or electrically connected to the coax shield which in turn is electrically connected to the CB chassis which is ground.

If the campground is not of the grassy type, but with paved patios, the ground wire can be clipped to the outside of the 117-volt access box, or to the electrical conduit. Each is supposed to be at ground potential and suitable for this use. **R-E**

LETTERS

(continued from page 22)

realistic criteria, in the case of "flea-power" devices, would be whether or not they are causing interference and if so, be subject to FCC direction that their use be discontinued.

Incidentally, I would like to see more information on microwave techniques in your magazine.

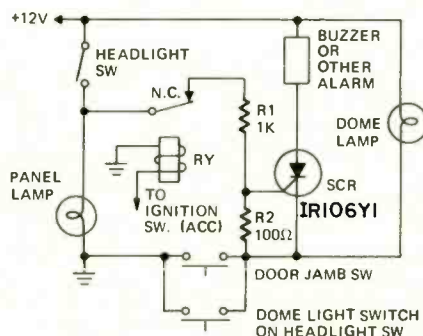
AUSTIN W. NELSON
Seattle, Wash.

Thank you Austin! We'd like to get other readers' viewpoints on this radiation question. Why don't you drop us a note and tell us what you think.—Editor

HEADLIGHT REMINDER IMPROVEMENT

In the July 1974 issue, a simple headlight reminder was described by Mr. Bixby (page 42). I encountered the following problem with the circuit. If the dome light is switched on by using the headlight switch while the headlights are on, the buzzer will sound even if the

door is closed. This makes it impossible to switch on the dome light to read a map, for example, while the headlights are on. The reason for this is that the headlight switch completes the ground



circuit just as the door jamb switch does (see figure). As shown in the article, a switch could be wired in series with the buzzer, but there is always the problem of forgetting to re-activate the alarm.

On late model GM products, the door jamb switch is an spdt type switch. The

other side of the switch is used for the key-reminder buzzer. By tying the cathode of the SCR and R2 to the high side of this side of the switch eliminates the problem. If it is necessary to operate the headlights with the door open, a relay with normally closed contacts could be wired in series with R1 with the coil of the relay wired to the accessories (Acc) position on the ignition switch (see figure). With this modification, the headlights can be operated with the door open by turning the ignition switch ON or to ACC.

KEN KAMPSHOFF
Canova, SD

R-E



Would you like to put the screws back in this yourself—and save about ten dollars additional service time?

State of SOLID STATE

This new column will explore new developments in discrete and integrated circuits and their applications. New releases are featured at the end of the column.

by **KARL SAVON**
SEMICONDUCTOR EDITOR

I spend a fair amount of time going through the incessant flow of technical papers and new product information that pass over my desk each week. It leaves a realization that the semiconductor arena has become fantastically complex during the last few years. The transistor is being exercised to its fullest potential, and the integrated circuit is now way past its infancy. The emergence of the microcomputer, a large, powerful arrangement of logical circuit blocks laid out on a single monolithic IC, hints at the magnitude of system concepts that are now being designed into commercial products.

This new column will be a stab at seeing through the trees by picking out significant semiconductor applications and exploring their principles. It will help reveal what is going on by featuring developments in discrete and integrated circuits and related technologies. I will answer questions of interest to Radio-Electronics readers and the technical community. Towards the end of the column you will find some short release type items of interest to the semiconductor hobbyist and technician.

Well, enough for the ground rules and on to an examination of a display system that reshapes the neon bulb and combines it with a state of the art scanning concept to give a different and unusual product.—Karl Savon

Burroughs Self-Scan display

This is an innovative display system that mixes a handful of IC's and transistors with a new readout to give real competition to the long implanted electromechanical panel meter.

When a solid-state system is designed to measure something such as voltage, frequency, or time, it must display the result to the equipment user in a way that is easy to interpret and does not in itself introduce a significant part of the total measure-

ment error. These applications might be best met by a digital LED or liquid-crystal readout.

There are some applications where comparing two or more readings is more important than the actual numerical value of a measured quantity. A multi-engine boat or plane normally shares the power requirements evenly among its power plants. A factory operator wants to know immediately if there is a discrepancy in the operating speeds of machinery that may warn of a serious production problem. Burroughs Self-Scan displays are ideal for such comparison measurements when they are mounted side by side. The first series of these displays consist of two bar-graphs in the same gas-filled chamber.

As an attractive alternative to the meter movement, Burroughs has put together the Self-Scan bar-graph plasma display, patterned after their Panaplex II display panels. The display, which can be likened roughly to a string of 200 neon bulbs arranged with precision in a single envelope, does not have the accuracy problems of a mechanical meter since it does not suffer from the inertial and frictional limitations of moving parts. Though direct comparison is the forte of this display, it makes a very acceptable meter replacement in most any system by marking increments along the height of the gas-discharge tube. It presents an illuminated bar, with a resolution of one out of its 200 segments. This resolution is mathematically expressed as one divided by 200 or 0.5%.

To use the bar-graph, the gas ionization must be started at the lower zero reference end, and then propagated up its elements in domino fashion. Only one element is lit at any moment, and it is a repetitive scan action that gives the appearance of a

constantly illuminated bar. When the desired indication length is reached the display must be turned off so it does not illuminate the remaining elements. The process is repeated at a rate fast enough to prevent flicker, yet slow enough to permit the glow to propagate reliably. Typically, the elements are stepped at a 50- μ s per segment rate giving a maximum scan time equal to $200 \times 50 \times 10^{-6} = 10$ ms. If a new scan is started immediately after each 10-ms interval, the scan rate is 100 scans per second. To keep the display brightness consistent, the scan is initiated at regular intervals rather than immediately following termination.

Figure 1 shows how the device is assembled and used in an analog voltage measurement scheme with the necessary circuit logic to drive it. Three groups of alternating printed cathodes on a ceramic substrate are the key to its operation. Adjacent segments are driven sequentially by a modulo 3 counter and decoder to move a single lit element one segment at a time at the clock-generator rate. The ϕ driver boils down to a three-stage counter with a reset capability. The reset state is a fourth state that is entered only once during each scan.

A common transparent wrap around anode printed on the glass cover plate is biased through a limiting resistor from a 250-volt power supply. A separate keep-alive anode and corresponding grounded cathode constantly illuminates the cathode area acting like a pilot light. Nothing further can happen until the glow is transferred past the blocking reset cathode. Keeping the reset cathode at a high voltage prevents the glow from propagating up the 200-segment display.

A voltage high enough to prevent conduction and low enough to reduce

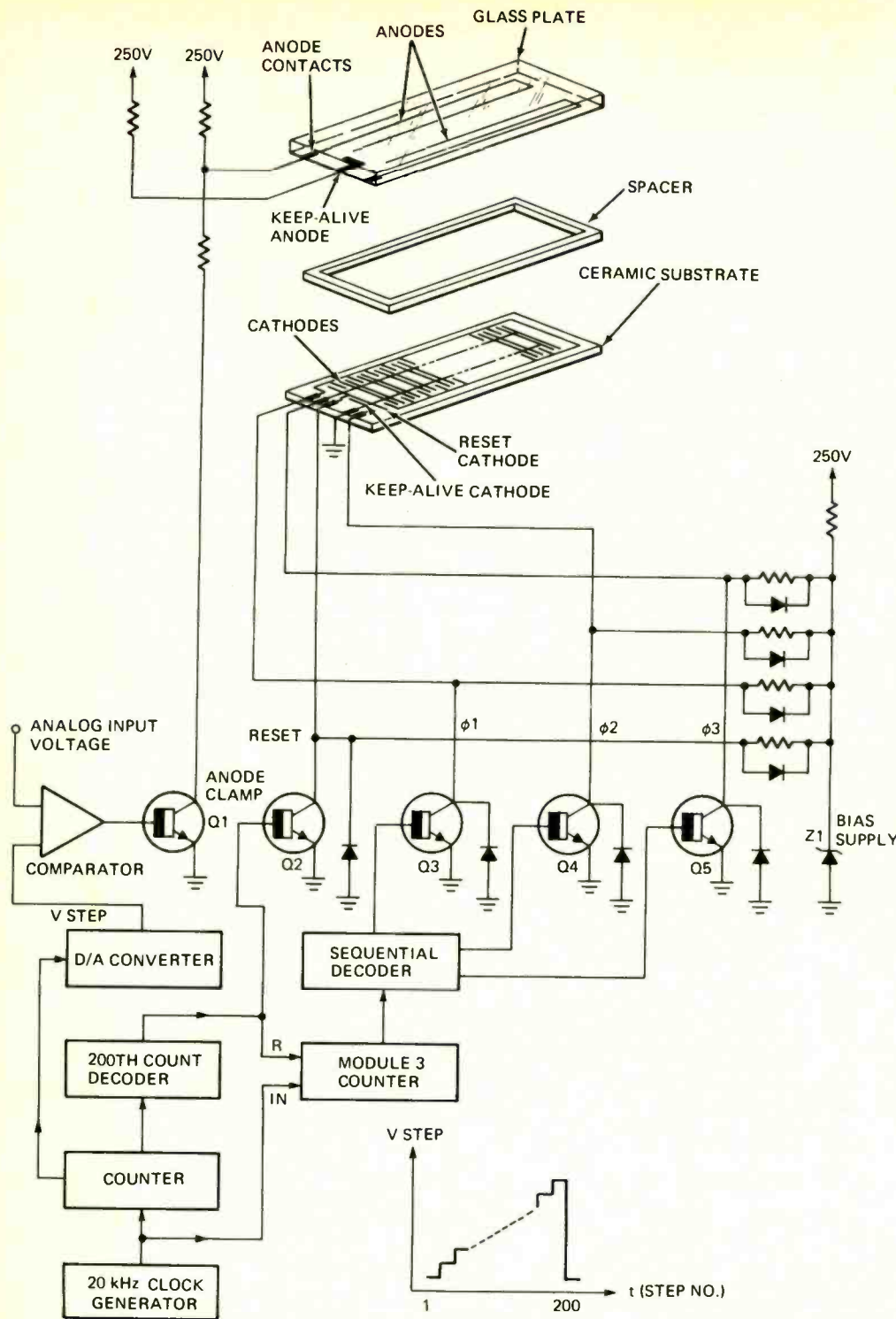


FIG. 1—BURROUGHS SELF-SCAN DISPLAY is shown with the necessary circuitry to drive it in an analog voltage measurement scheme.

the transistor peak collector voltage is developed by Zener diode Z1 bias supply. The reset cathode is primed or preconditioned by its proximity to the keep-alive cathode and its ionized glow. Every 200th clock pulse, Q2 is turned on, grounding the reset cathode and beginning the actual display process. Throughout the display time, the glow must be transferred from a previously activated cathode priming the adjacent, next to be grounded element, by the ionized particles in its vicinity. Once the reset cathode glows, the

gas-discharge is no longer isolated from the $\phi 1$, $\phi 2$, $\phi 3$ cathodes. As the cathodes are sequentially grounded, the display propagates up the length of the bar by the three-phase drive. In this system, every third cathode is simultaneously grounded, but only the primed one can accept the transferred glow. The anode resistor value is selected to permit only enough current to flow to ionize one segment at a time. At the desired clock count, Q1 is turned on, lowering the anode-to-cathode voltage below its sustaining

level and ending the scan. The keep-alive cathode is still glowing and now waits for the next reset pulse to repeat the linear scan.

In the illustration (Fig. 1), an analog input voltage is compared with a counter generated step waveform from the digital-to-analog converter. At each clock pulse this waveform jumps an equal step in voltage. At the instant the input equals or exceeds the step voltage, the comparator activates Q1 to terminate the scan. Proportioning the two compared waveforms determines the full scale display voltage calibration.

Two or more displays can be economically driven by paralleling the corresponding cathodes so they are driven by common circuitry. Individual display control is retained by the separate control of the particular anode.

Reader circuit

Frank E. Stanley of Glenside, PA asks some questions about the often seen circuit configuration of Fig. 2.

How do you change gain? The circuit is a common emitter amplifier with dc and ac feedback. Circuit gain is determined by both the open-circuit loop gain and by the amount of feedback. Loop gain is the amplification measured between a broken circuit path. For example, if the base lead of the transistor is opened and drive from a signal source with a dc

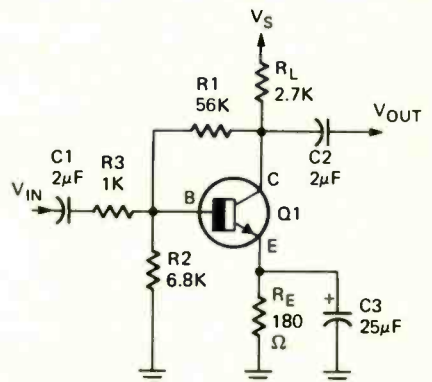


FIG. 2—COMMON EMITTER AMPLIFIER circuit with ac and dc feedback. Gain is determined by the open-loop gain and the feedback.

bias adjusted for the proper transistor currents, and if the R1, R2, R3 junction is loaded by the equivalent input resistance of the transistor base, then the open-loop gain is the ratio of the signal voltage at the junction of the three resistors to the injected input level at the transistor base. Open-loop gain depends on the transistor collector current, along with the values of R_E and R_L . The feedback factor is approximately the impedance at the base of the transistor including the loading of R2 and R3 divided by this

impedance plus R_1 . R_1 was neglected since it is small compared to R_1 . If the open-loop gain is much larger than the inverse feedback factor, the closed-loop gain is relatively insensitive to the exact value of the open-loop gain and is largely dependent on the amount of feedback. Varying R_1 over a reasonable range, provides good control over the closed-loop circuit gain. Increasing R_1 reduces the voltage collector to base feedback which increases gain.

How do you change input and output impedance? A virtual ground is simulated at the base of the transistor because of the significant amount of negative voltage feedback. In other words, the ac impedance looking at the transistor base node is close to zero. I calculate it to be about 12 ohms. R_3 added to the 12 ohms then becomes the input impedance. As R_3 is 1000 ohms, it can be considered the entire input impedance and so can be changed directly by changing the resistor.

Some caution must be used though, since radical decreases in R_3 lowers the feedback factor and eventually will alter the relative gain approximation and destroy the virtual ground. The output impedance is R_L divided by the loop gain which calculates to about half of R_L or 1300 ohms. Changing R_L will change the output impedance in the same direction of the change. The impedance change will not be proportional due to the complication of changes in loop gain. Loading the output decreases the ac signal fed back to the transistor base giving a net increase in signal at the base. The output signal voltage tends to increase which is a direction to compensate for the loading.

Can I substitute a pnp transistor and still keep the negative power supply grounded? Yes, the circuit can be inverted with the pnp emitter resistor returned to the positive voltage supply. The new hook-up will have a loss in power supply noise rejection though, since there will be increased signal coupling between the supply and the transistor base.

When is C_3 needed? C_3 bypasses the emitter of the transistor for signal frequencies and raises the open-loop ac gain. In some amplifiers a second unbypassed resistor is inserted in series with the emitter giving flexible independent control of both the ac and dc gains.

When is R_E needed? R_E affects the dc biasing of the amplifier stage and in turn influences all of its characteristics. It is a dc feedback resistor because it is common to both the output and input signal paths and is bypassed for ac.

What is the purpose of R_1 and R_2 , and should R_1 be returned to the power supply? R_1 and R_2 form a voltage divider that helps determine the base voltage on the transistor and its emitter current. Returning R_1 to the supply interrupts the collector to base feedback and the circuit becomes more dependent on parameters to which it would otherwise be nearly immune. For example, the dc bias conditions can be analyzed with respect to the influence of transistor beta.

Figure 3 is the equivalent dc circuit

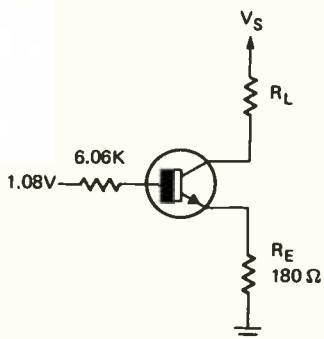


FIG. 3—EQUIVALENT DC CIRCUIT of the common-emitter amplifier.

where R_1 has been connected to the power supply. The R_1 , R_2 voltage divider has an open-circuit voltage of 1.08 volts with a 6.06 kilohm impedance which is their paralleled resistance. In the diagram, the divider is replaced with its Thevenin equivalent. If the transistor has a nominal beta of 50 and the total beta spread of the device is 25 to 100, the collector current changes with beta because it is accompanied by a corresponding change in base current, in turn modifying the emitter voltage and current. Some figuring gives the following results:

Beta	I_E	I_C	V_C	V_C Change
25	1.16 mA	1.12 mA	6.99 V.	+22%
50	1.61	1.58	5.74	0 (ref. value)
100	2.00	1.98	4.65	-19

These results were based on a power supply voltage of 10 volts. Halving and doubling the nominal beta changes the collector voltage by about plus and minus 20%.

Reconnecting R_1 to the collector re-instating the feedback gives a modified table:

Beta	V_C	V_C Change
25	7.04 volts	+ .14%
50	7.03	0
100	7.02	-.14

The % V_C change is now only $\pm .14\%$, an improvement of about 130 times! I_E and I_C were not calculated as intermediate steps and so are not tabulated. Similarly the ac parameters such as gain and impedance levels are stabilized by the feedback against

transistor parameter variations.

Interdesign monochip

Designing a custom integrated circuit from scratch is a very expensive and time consuming proposition. It is a practice normally reserved for the major corporations expecting to sell thousands to millions of pieces a year.

Interdesign presents a more economical alternative using inventoried, pre-diffused IC wafers. Three bipolar chips are available ranging in size from 50 x 50 mils to 80 x 80 mils and with 110 to 300 components. It may be hard to imagine how this number of components could be wired into a user's product. The intent is to have a sufficient variety of devices to assemble all or most of the customer's circuit on a single IC. IC techniques do use more active devices than their discrete counterparts, since it is paramount to eliminate external components such as capacitors and the terminals needed to get off and back on the chip.

CT5031 calculator chip

Cal-Tex has introduced a MOS calculator chip that uses less than 10 mW of power. When combined with LED displays, series segment resistors, and display drivers, a 9-volt battery will keep it going for up to 20 hours.

Basically a four-function 6 or 8-digit floating point machine, powers can be calculated by repeated operations of the multiplication key. Reciprocal powers are computed by multiple operations of the division key. Negative numbers are entered with double keying of the decimal point key.

A unique test system built into the 5031 checks the competency of 95% of its circuitry. Eight 8's are entered and a special test key is hit. If everything is right the LED's will indicate —1.5.9.1.2.3.8..

A display hold terminal can be optionally connected through a 10- μ F capacitor to the single power supply voltage. A series resistor and switch paralleled with the capacitor enables the display for 30 to 45 seconds, an energy conservation measure.

Another optional feature is an answer light that differentiates between a keyboard entry and the result of a previous calculation. Single unit samples are priced at \$15 each.

Proto-Clip

For those of you into integrated circuit construction projects, Continental Specialties is selling their Proto-Clip for easy circuit troubleshooting without the danger of shorting IC leads.

No springs or pivots are used in
(continued on page 98)

TECHNICAL TOPICS

Here is a new antenna for the 20-meter ham band plus five other circuits for you to scrutinize. There is a road ice alarm, touch-operated volume control, two precedent detector circuits and a speech alarm.

by **ROBERT F. SCOTT**
TECHNICAL EDITOR

AMATEUR RADIO AS A COMMUNICATIONS medium has a potential unsurpassed by other media when it comes to things of interest to the ham. Yet, circuits and devices developed and widely used on one continent are often almost unheard of on another. This is particularly true of antennas. The quad was popular in South America for several years before it was described in several American ham publications and gained popularity in the U.S. The Swiss Quad—a sturdier version of the quad—is almost completely ignored by American hams whose quads are prone to damage by the first heavy wind or freezing rain.

With this in mind, we open this month with details on a new type of vhf beam antenna that may well be adopted by CB'ers and others desiring a compact antenna with moderate gain and a good front-to-back ratio.

A new antenna is born

Many hams all over the world are forced, by neighbors' prejudices, to use an unobtrusive antenna such as a long-wire or vertical when they prefer a much more effective Yagi or quad beam antenna.

This problem, faced by Zygmunt T. Chowaniec, G3PTN, led to the development of a 2-element beam antenna configuration which, for 20 meters, is hardly larger than a high-gain TV antenna. Its turning radius is only 7 feet! The new beam—called a *Zygi*—was described in *Radio Communication*. To reduce the spread of the antenna—a 20-meter beam is approximately 34 feet across—G3PTN folded the dipole into a horizontal rectangle with its sides having a 2:1 ratio or about 11½ x 5 feet. The rectangular radiator has a radiation resistance of 48 ohms.

The antenna was converted into a beam by adding a second loop fed through a transposed phasing line (see Fig. 1-a). It is assembled from ½- and ¼-inch aluminum tubing. The larger elements are mounted at right angles to the boom by "U" bolts through plates 12 inches long and 2½ inches wide. The plates at the input ends of the loops are No. 18 gauge mild steel with ¼ inch of each lengthwise edge turned up 90° for rigidity. The plates at the high-voltage (open) ends of the loops are ½ inch thick acrylic plastic such as Lucite or Plexiglas. Lengths of PVC tubing insulate the antenna elements from the "U" bolts.

Two 9-inch and two 11-inch pieces of ½-inch O.D. wooden dowel have 3 inches on each end turned or filed down for a snug fit inside the ½-inch tubes. They are then

given several coats of shellac or marine varnish as weatherproofing. The 9-inch dowels join tubes at the driven ends and the 11-inch pieces connect the tubes at the high-voltage ends. Cadmium- or nickel-plated No. 10 bolts go through the tubing and dowel (Fig. 1-b). Two washers and an extra nut form terminals at the feed ends of the loops.

The outer ends of the ½-inch pieces are slotted and then crimped with pliers or swaged for a sliding fit on the ¼-inch pieces. The ¼-inch tubes are each 72 inches long with 6 inches at each end bent 90°. (You can make a smooth bend without crimping with a spring-type tubing bender used by plumbers and in garages and filling sta-

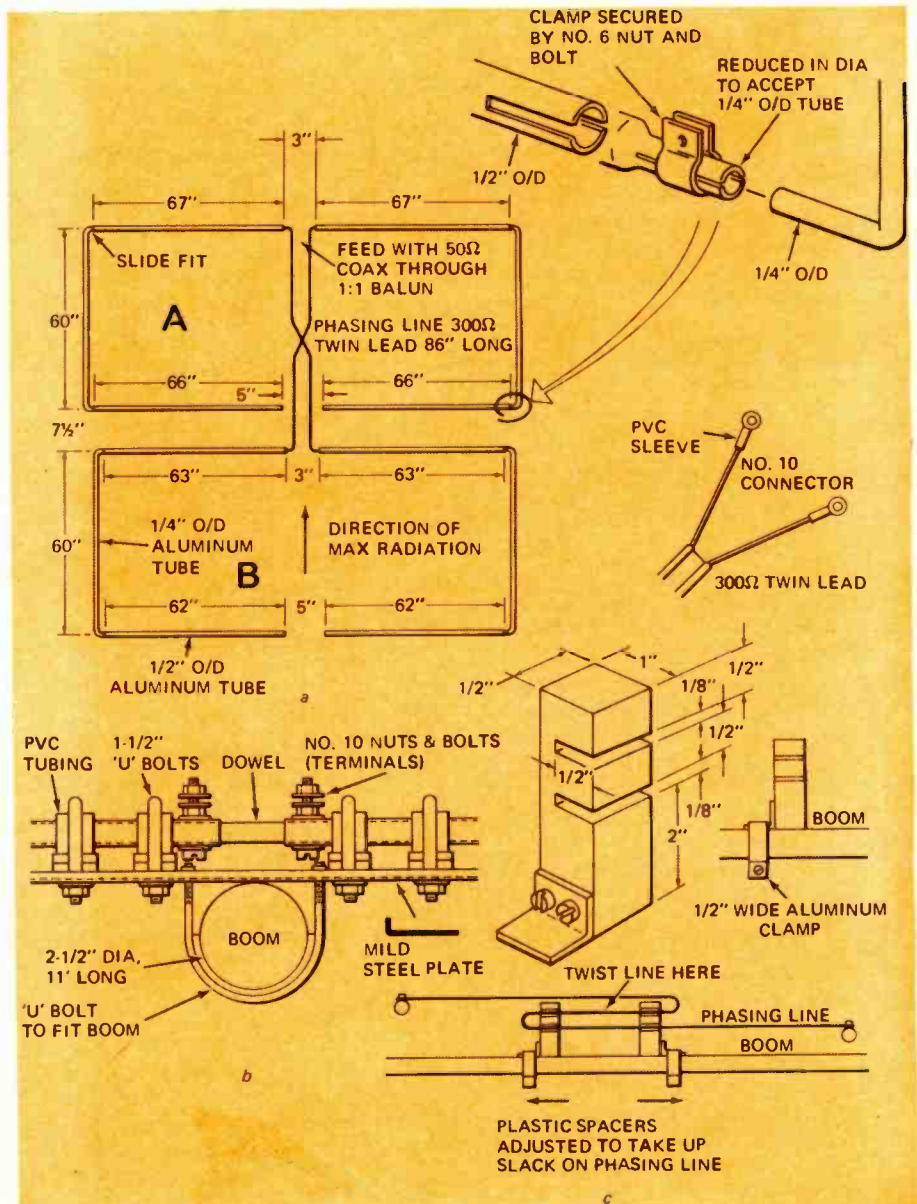


FIG. 1—THE ZYGI ANTENNA is a 2-element beam designed for 20-meters. Its turning radius is only 7 feet.

tions to bend gas lines). The loops are tuned by telescoping the smaller tubes into the larger—adjusting both sides equally to maintain symmetry.

The phasing line between the loop feed-points is an 86-inch piece of 300-ohm twin-lead with No. 10 ring soldering terminals on each end. The ribbon is held in place by two acrylic plastic blocks formed and adjusted as in Fig. 1-c.

Tuning up

Loops A and B are grid-dipped—with the phasing line disconnected—to frequencies outside the band (G3PTN used 13.75 and 15.50 MHz, respectively) by sliding the sides in or out about 1 inch for each desired 100-kHz shift. Extending the sides lowers the frequency; pushing them in raises it.

With the phasing line in place, connect the 50-ohm coax line to the antenna through a 1:1 balun and raise the antenna to the planned working height. Connect an impedance bridge or SWR bridge between the coax and transmitter and check the SWR across the band. It should be around 1.1:1 at the operating frequency. Adjust the length of loop A to get the minimum SWR where you want it and then adjust loop B for the best front-to-back ratio. With the antenna tuned to 14.2 MHz for a SWR of 1.1:1, the SWR does

not rise above 2:1 at the band edges. Forward gain is around 4 dB and the front-to-back ratio is 8-10 dB.

The G3PTN Zygi antenna is covered by British patents, but amateurs may construct and operate one for their own personal use.

Speech timer

At public meetings, conferences, debates and in speech classes and the like, each speaker is limited to a predetermined amount of time. This timer (Fig. 2), described in *Break-In*, a New Zealand amateur radio magazine, can be set for time periods of either 3 or 5 minutes. A green indicator lamp comes on at the beginning of the timed period, an amber light warns the speaker that he has only one-half minute left and a red light indicates the end of the period. A HOLD position on switch S2 interrupts the timing cycle to allow for such interruptions as when points of order are decided. Switching S2 to OPERATE allows the timing cycle to continue so the speaker does not lose time due to the interruption.

The device uses two timers; one for either 2½ or 4½ minutes and the other for ½ minute. The 30-second timer turns on when the first timer has completed its pre-selected interval to give a total countdown of either 3 or 5 minutes.

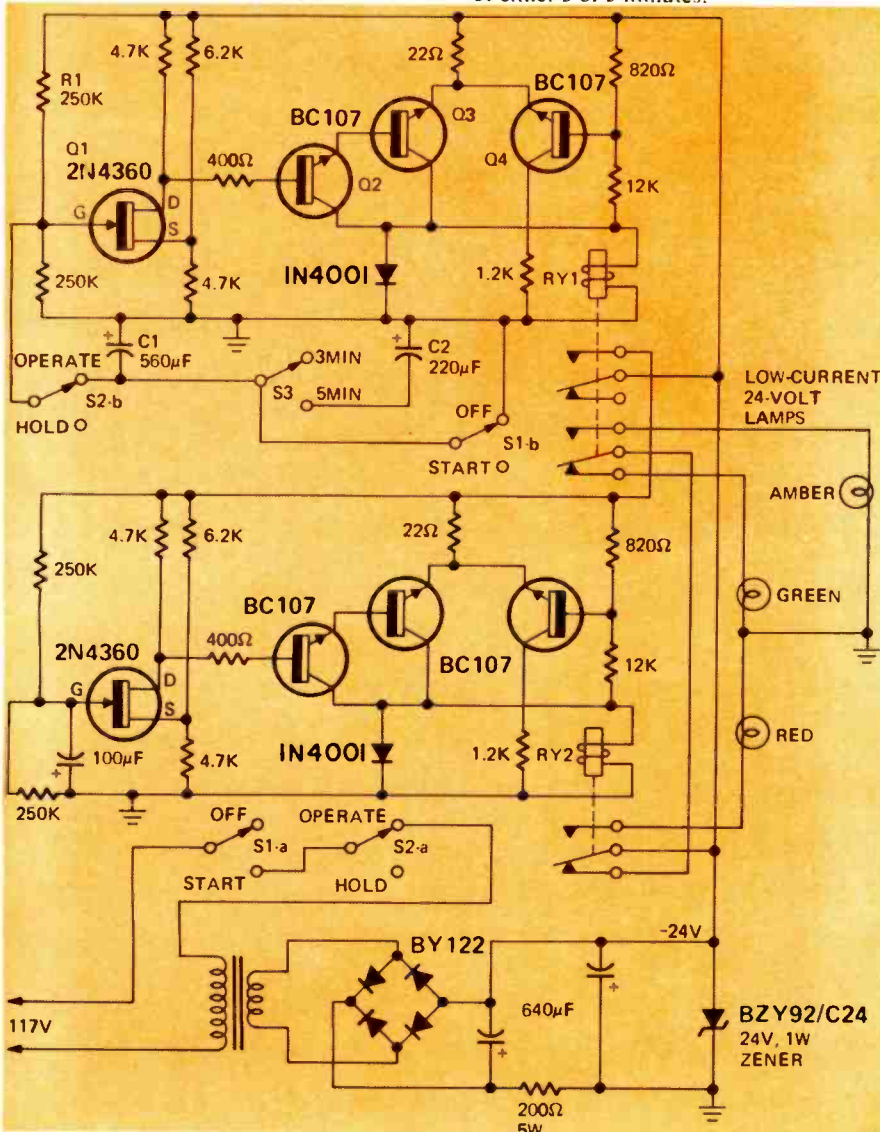


FIG. 2—SPEECH TIMER uses two separate timing circuits to control relays which switch the indicator lights.

Throwing S1 to START applies power to the first timer (Q1-Q4) and turns on the GREEN indicator through the normally closed contacts on relays RY1 and RY2. Q1, a p-channel FET, is initially cut off with its gate at 0 volts and -24 and -10 volts on its drain and source, respectively. With power applied, the FET's gate gradually rises to half the supply voltage level (-12 volts) in a period determined by the time constant of $R1 \times C1$ (or $R1 \times C1 + C2$). When the timing capacitance's charge reaches -12 volts, Q1 saturates and its drain goes to about -9 volts. Q3 and Q4 form a Schmitt trigger with Q3 cut off and Q4 conducting. Q2 amplifies the trigger pulse from Q1. When Q1's drain drops from -24 to -9 volts, the regenerative action of the Schmitt trigger quickly drives Q3 to saturation.

Relay RY1 is energized, switching the indicator from green to amber and applying power to the 30-second timer. In 30 seconds, the 100-μF timing capacitor charges to -12 volts so RY2 operates, removing power from the amber lamp and turning on the red one.

When the timer is turned off, S1-b shorts the timing capacitor(s) in the first timer to insure that the next timed interval starts with Q1's gate at 0 volts. When S2 is thrown to HOLD, S2-b disconnects the timing capacitance in the first timer so it will hold its remaining charge so the timed interval can continue when S2 is again thrown to OPERATE.

The power supply delivers -24 volts regulated. You can use a 28-32-volt filament transformer and four general-purpose silicon rectifier diodes rated at 1 ampere or so. The transistors are general-purpose npn silicon types similar to the Workman WEP 735 and Zenith ZEN 103.

Two precedence detectors

A device that indicates which of two or more close-spaced events occurs first has many potential uses in industry, science, entertainment games, sporting events and in electronic troubleshooting. A circuit that will detect and store the indication of the first of two events is shown in Fig. 3. It was described in *Radio & Electronic Constructor*. It is based on an R-S flip-flop using two of the four NAND gates in a 7400 IC. (A NAND gate develops a low or logic "0" output when all logic input signals are either high or "1." When either or both inputs are "0," the output is "1.")

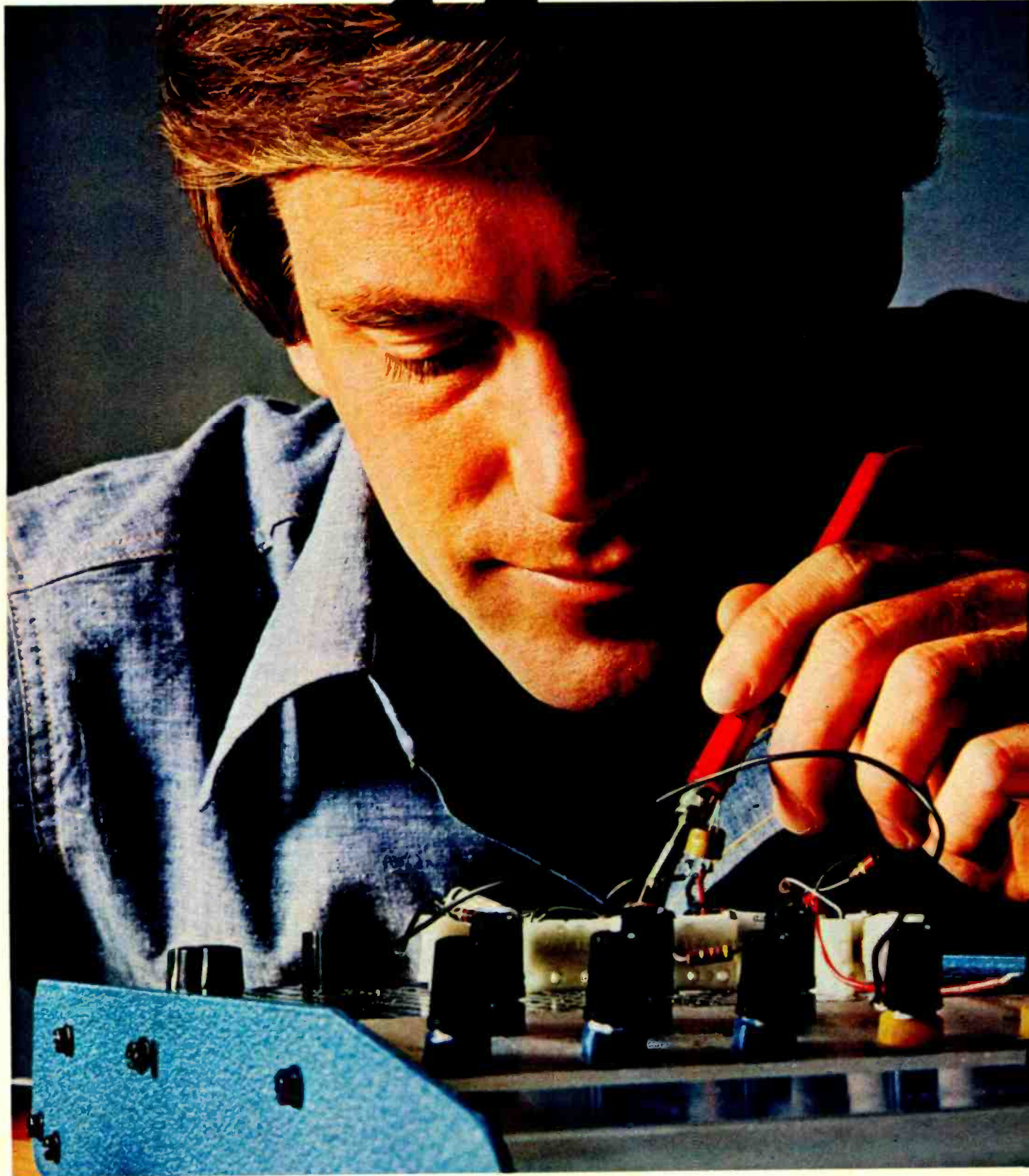
In operation, S1 and S2 are closed and the circuit shows which is opened first. With the switches closed, the R (reset) and S (set) inputs are connected to -4.7 volts ("0"), and, because of the cross-coupling, both outputs are at "1." Transistors Q1 and Q2 are biased near cutoff so the indicator lights are off.

Now, suppose that S1 is opened, causing the input connected to it to go high. Both inputs to gate 1 are "1" and the gate 1 output goes to "0." With its base going negative, Q1 conducts and turns on the indicator lamp for S1.

No matter how closely behind S1 switch S2 is opened, S2's indicator cannot turn on because both inputs of a NAND gate must be "1" for the "0" required to turn on Q2. In any event, with both switches open, one lamp will be on and the other off. The circuit resets to its original state when both

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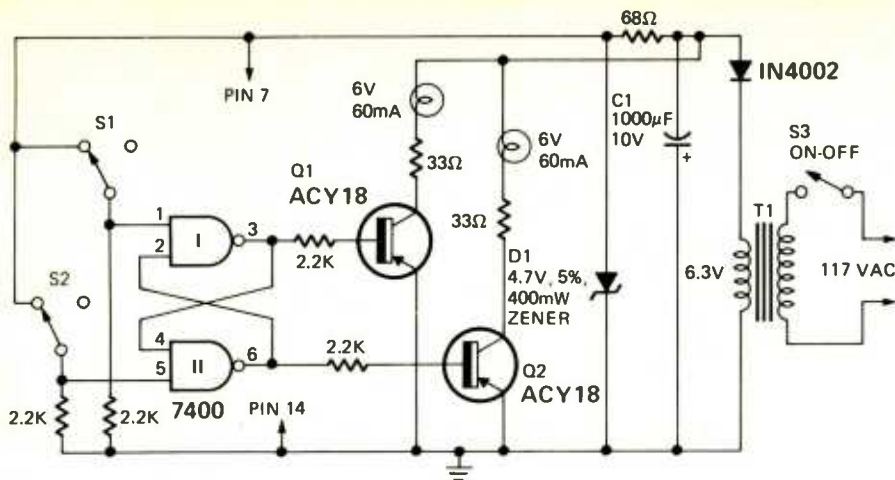


FIG. 3—PRECEDENT DETECTOR uses a flip-flop to determine which switch is opened first.

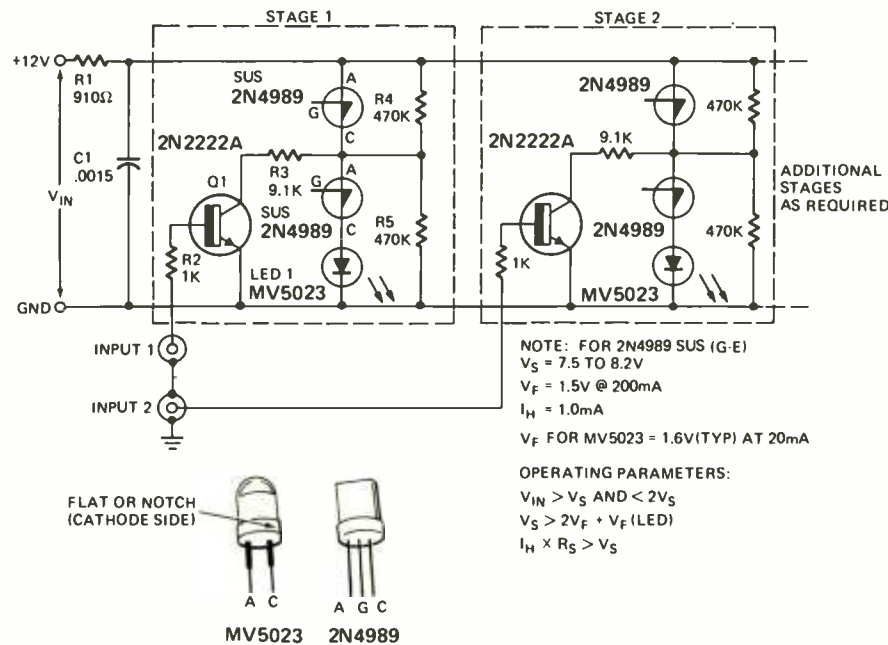


FIG. 4—PRECEDENT DETECTOR uses two SUS devices in each stage to control the LED indicator.

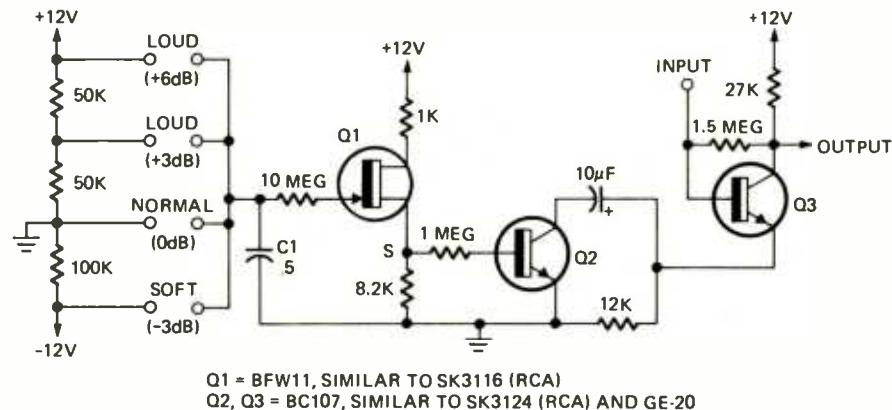


FIG. 6—TOUCH-OPERATED VOLUME CONTROL. Volume is determined by charge on C1.

switches are closed. The ACY18 used for Q1 and Q2 is a European germanium switching transistor similar to the 2N650-2N652 series and the 2N1186.

The circuit in Fig. 4 is a concept by Neal E. Pritchard of ACDC Electronics appearing in *Electronic Design News*. It is designed around the SUS (silicon unilateral

switch) with as many stages as needed. Noted that each stage has a voltage divider of two 470K resistors fed from the supply (V_{IN}) through R1. R4 of each divider is shunted by a 2N4989 SUS and R5 is shunted by a 2N2222A transistor connected between the R4-R5 junction and ground. Circuit

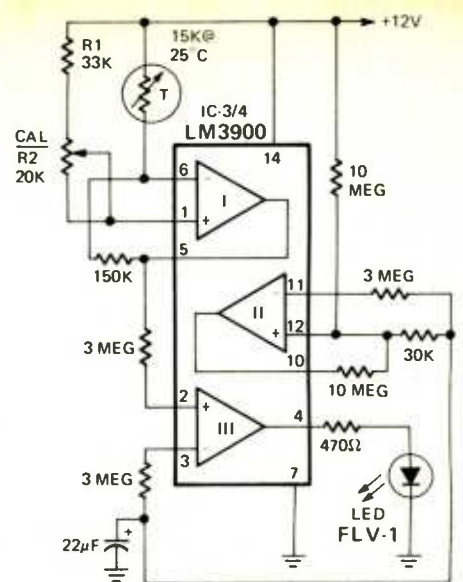


FIG. 5—ROAD ICE ALARM monitors the exterior temperature.

operating parameters are on the diagram. The inputs are initially at 0 volts and any circuit can be triggered ON by a momentary positive pulse of at least 1 μsec duration.

In the untriggered state, the detector inputs are at 0 volt and the voltage across each SUS is $V_{IN}/2$. This is lower than striking voltage V_S , so no current can flow through the LED's. Now, suppose that the initial event occurs in the circuit of the device (continued on page 96)

R-E's Substitution guide for replacement transistors

PART XXII

by ROBERT & ELIZABETH SCOTT

- ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107
- DM—D. M. Semiconductor Co., P.O. Box 131, Melrose, Mass. 02176
- G-E—General Electric Co., Tube Product Div., Owensboro, Ky. 42301
- ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735
- IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245
- MAL—Mallory Distributor Products Co., 4760 Kentucky Ave., Indianapolis, Ind. 46241
- MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036
- RCA—RCA Electronic Components, Harrison, N.J. 07029
- SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247
- SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154
- WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578
- ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

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ARCH DM G-E ICC IR MAL MOT RCA SPR SYL WOR ZEN

2N4967	NA	T-730	GE-62	ICC-730	IRTR-53	PTC 133	HEP-730	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 116
2N4968	NA	T-737	GE-60	ICC-737	IRTR-53	PTC 139	HEP-737	SK 3122	RT-102	ECG 123A	WEP-735	NA
2N4969	NA	TS-0004	GE-20	ICC-S0004	IRTR-65	PTC 123	HEP-S0004	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 127
2N4970	NA	T-735	GE-20	ICC-735	NA	PTC 123	HEP-735	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 119
2N4971	NA	T-716	GE-21	ICC-716	IRTR-54	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	WEP-717	ZEN 107
2N4972	NA	T-708	GE-67	NA	NA	PTC 127	NA	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4976	NA	NA	GE-28	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N4980	NA	NA	GE-67	NA	NA	PTC 103	NA	NA	NA	NA	NA	NA
2N4981	NA	NA	GE-21	NA	NA	PTC 103	NA	NA	NA	NA	NA	NA
2N4982	NA	NA	NA	NA	NA	PTC 103	NA	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4983	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	ECG 6404	NA	NA
2N4984	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4985	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4986	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4987	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	ECG 6404	NA	NA
2N4988	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4989	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4990	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4991	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 6403	NA	NA
2N4993	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 6403	WEP-735	NA
2N4994	NA	TS-0007	GE-63	ICC-S0007	NA	PTC 121	HEP-S0007	SK 3122	RT-102	ECG 123A	WEP-735	NA
2N4995	RS276-2013	T-728	GE-63	ICC-728	TR-21	PTC 121	HEP-728	SK 3122	RT-102	ECG 123A	WEP-728	ZEN-114
2N4996	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 133	HEP-56	SK 3018	RT-113	ECG 108	WEP-56	ZEN 104
2N4997	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 133	HEP-56	SK 3018	RT-113	ECG 108	WEP-56	ZEN 104
2N5022	NA	NA	GE-67	NA	IRTR-88	PTC 141	NA	SK 3025	RT-115	ECG 129	WEP-242	NA
2N5023	RS276-2021	T-76	GE-67	ICC-76	IRTR-88	PTC 141	HEP-76	SK 3025	RT-115	ECG 129	WEP-242	NA
2N5024	RS276-2011	T-709	NA	ICC-709	NA	PTC 133	HEP-709	SK 3039	RT-108	NA	WEP-709	ZEN 105
2N5027	RS276-2009	T-53	GE-20	ICC-53	TR-21	PTC 136	HEP-53	NA	RT-100	NA	WEP-53	ZEN 102
2N5028	RS276-2009	T-53	GE-20	ICC-53	TR-21	PTC 136	HEP-53	NA	RT-100	NA	WEP-53	ZEN 102
2N5030	NA	NA	GE-20	ICC-50	TR-21	PTC 136	HEP-50	NA	RT-115	NA	EWSP-53	ZEN 100
2N5031	RS276-2011	T-709	GE-11	ICC-709	IRTR-70	PTC 133	HEP-709	SK 3039	RT-108	ECG 107	WEP-709	ZEN 105
2N5032	RS276-2011	T-709	GE-11	ICC-709	IRTR-82	PTC 133	HEP-709	SK 3039	RT-108	ECG 107	WEP-709	ZEN 105
2N5033	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5034	NA	T-247	NA	ICC-247	NA	PTC 116	HEP-247	SK 3036	RT-164	ECG 223	WEP-247	NA
2N5035	NA	T-247	NA	ICC-247	NA	PTC 116	HEP-247	NA	RT-164	ECG 223	WEP-247	NA
2N5036	NA	T-247	GE-14	ICC-247	TR-59	PTC 116	HEP-247	SK 3027	RT-164	ECG 223	WEP-247	NA
2N5037	NA	T-247	NA	ICC-247	TR-59	PTC 116	HEP-247	NA	RT-164	ECG 223	WEP-247	NA
2N5039	NA	TS-7000	NA	ICC-S7000	NA	NA	HEP-S7000	SK 3511	RT-149	NA	WEP-S7000	NA
2N5040	RS276-2021	T-51	GE-67	ICC-51	TR-30	PTC 103	HEP-51	NA	RT-101	NA	WEP-51	ZEN 101
2N5041	RS276-2021	T-716	GE-67	ICC-716	IRTR-52	PTC 103	HEP-716	NA	RT-115	NA	WEP-716	ZEN 107
2N5042	NA	NA	GE-67	NA	NA	PTC 127	NA	NA	RT-115	NA	NA	NA
2N5045	NA	NA	NA	NA	NA	PTC 752	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5046	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5047	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5050	NA	T-241	NA	ICC-241	NA	NA	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
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2N5052	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N5053	RS276-2011	T-709	GE-20	ICC-709	TR-95	PTC 133	HEP-709	SK 3018	RT-113	ECG 108	WEP-56	ZEN 105
2N5054	NA	NA	GE-20	NA	TR-95	PTC 133	NA	SK 3018	RT-113	ECG 108	WEP-56	NA
2N5056	RS276-2023	T-52	NA	ICC-52	NA	PTC 103	HEP-52	NA	RT-103	NA	WEP-52	NA
2N5057	RS276-2023	T-52	NA	ICC-52	NA	PTC 103	HEP-52	NA	RT-103	NA	WEP-52	NA
2N5058	RS276-2008	T-706	GE-27	ICC-706	TR-78	NA	HEP-706	SK 3045	RT-110	ECG 154	WEP-244	NA
2N5059	RS-2008	T-706	GE-32	ICC-706	IRTR-78	NA	HEP-706	SK 3045	RT-110	ECG 154	WEP-244	NA
2N5060	NA	SR-1001	GEMR-5	ICC-R1001	NA	NA	HEP-R1001	NA	NA	ECG 5400	NA	NA
2N5061	NA	SR-1002	GEMR-5	ICC-R1002	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N5062	NA	SR-1003	GEMR-5	ICC-R1003	NA	NA	HEP-R1003	NA	NA	ECG 5402	NA	NA
2N5063	NA	SR-1004	GEMR-5	ICC-R1004	NA	NA	HEP-R1004	NA	NA	ECG 5403	NA	NA
2N5064	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	ECG 5404	NA	NA
2N5065	RS276-2009	T-53	NA	ICC-53	NA	PTC 123	HEP-53	NA	RT-100	NA	NA	ZEN 102
2N5066	RS276-2009	T-733	GE-64	ICC-733	TR-24	PTC 153	HEP-733	NA	RT-105	NA	NA	NA
2N5067	NA	T-247	GE-19	ICC-247	TR-36	PTC 118	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N5068	NA	T-247	GE-14	ICC-247	TR-36	PTC 118	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N5069	NA	T-704	GE-14	ICC-704	TR-36	PTC 118	HEP-704	NA	RT-131	NA	WEP-704	NA
2N5073	NA	TS-3021	NA	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP-S3021	ZEN 208
2N5078	NA	NA	GE-FET-2	NA	NA	PTC 152	NA	SK 3116	NA	NA	NA	NA
2N5079	NA	TS-3001	GE-28	ICC-S3001	NA	NA	HEP-S3001	NA	RT-154	NA	NA	NA
2N5080	NA	NA	GE-28	NA	NA	NA	NA	NA	RT-154	NA	NA	NA
2N5081	RS276-2009	T-736	NA	ICC-736	TR-21	PTC 136	HEP-736	SK 3122	RT-102	ECG 123A	WEP-736	ZEN 120
2N5082	RS276-2009	T-736	NA	ICC-736	NA	PTC 136	HEP-736	SK 3122	RT-102	ECG 123A	WEP-736	ZEN 120
2N5086	RS276-2021	T-715	GE-67	ICC-715	IRTR-52	PTC 127	HEP-715	SK 3114	RT-115	ECG 159	WEP-715	ZEN 106
2N5087	RS276-2024	T-57	GE-22	ICC-57	TR-19	PTC 127	HEP-57	SK 3114	RT-115	ECG 159	WEP-57	NA
2N5088	RS276-2013	T-730	GE-62	ICC-730	NA	PTC 139	HEP-730	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 116
2N5089	RS276-2013	T-730	GE-62	ICC-730	NA	PTC 139	HEP-730	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 116
2N5090	NA	NA	NA	NA	IRTR-66	PTC 128	NA	NA	NA	NA	NA	NA
2N5103	NA	NA	GE-17	NA	NA	NA	NA	SK 3116	RT-176	NA	NA	NA
2N5104	NA	NA	NA	NA	NA	NA	NA	SK 3116	RT-176	NA	NA	NA
2N5105	NA	NA	NA	NA	NA	NA	NA	SK 3116	RT-176	NA	NA	NA
2N5106	NA	TS-3001	NA	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N5107	RS276-2009	T-736	GE-20	ICC-736	TR-21	PTC 136	HEP-736	NA	RT-114	NA	NA	ZEN 120
2N5108	NA	TS-3001	NA	ICC-S3001	TR-21	PTC 144	HEP-S3001	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5109	NA	T-75	NA	ICC-75	TR-21	PTC 144	HEP-75	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5110	RS276-2025	T-242	NA	ICC-242	TR-21	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP-242	NA
2N5111	NA	TS-3031	NA	ICC-S3031	TR-21	PTC 141	HEP-S3031	SK 3025	RT-115	ECG 129	WEP-242	NA
2N5112	NA	NA	GE-69	NA	NA	NA	NA	NA	RT-155	NA	NA	NA
2N5116	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	RT-177	NA	NA	NA
2N5120	NA	NA	GE-18	NA	NA	NA	NA	NA	RT-114	NA	NA	NA
2N5126	RS276-2009	T-727	GE-60	ICC-727	IRTR-51	PTC 121	HEP-727	SK 3124	RT-113	ECG 161	WEP-719	NA

NA=NOT APPLICABLE

(turn page)

ARCH DM G-E ICC IR MAL MOT RCA SPR SYL WOR ZEN

2N5127	RS276-2009	T-727	GE-62	ICC-727	TR-24	PTC 139	HEP-727	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N5128	RS276-2009	T-53	GE-20	ICC-53	IRTR-51	PTC 123	HEP-53	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 102
2N5129	RS276-2009	T-53	GE-20	ICC-53	IRTR-87	PTC 123	HEP-53	SK 3024	RT-114	ECG 128	WEP-243	ZEN 102
2N5130	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 121	HEP-56	SK 3018	RT-113	ECG 161	WEP-719	ZEN 104
2N5131	RS276-2009	T-50	GE-10	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-113	ECG 108	WEP-56	ZEN 100
2N5132	RS276-2009	T-732	GE-60	ICC-732	TR-21	PTC 121	HEP-732	SK 3124	RT-108	ECG 107	WEP-720	NA
2N5133	RS276-2009	T-50	GE-62	ICC-50	IRTR-51	PTC 139	HEP-50	SK 3018	RT-113	ECG 161	WEP-719	ZEN 100
2N5134	RS276-2009	T-724	GE-20	ICC-724	TR-21	PTC 121	HEP-724	SK 3124	RT-114	ECG 123A	WEP-735	ZEN 112
2N5135	RS276-2009	T-53	GE-20	ICC-53	IRTR-21	PTC 153	HEP-53	SK 3124	RT-114	ECG 128	WEP-243	ZEN 102
2N5136	RS276-2009	T-53	GE-20	ICC-53	IRTR-21	PTC 123	HEP-53	SK 3124	RT-114	ECG 128	WEP-243	ZEN 102
2N5317	RS276-2003	T-53	GE-20	ICC-53	IRTR-51	PTC 123	HEP-53	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 102
2N5138	RS276-2023	T-52	GE-21	ICC-52	IRTR-52	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N5139	RS276-2023	T-52	GE-20	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N5140	NA	NA	NA	NA	TR-20	PTC 131	NA	SK 3118	RT-126	ECG 106	WEP-52	NA
2N5141	NA	NA	GE-22	NA	TR-20	PTC 131	NA	SK 3118	RT-126	ECG 106	WEP-52	NA
2N5142	RS276-2021	T-51	GE-22	ICC-51	TR-20	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N5143	RS276-2021	T-51	GE-22	ICC-51	TR-10	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N5144	RS276-2009	T-736	GE-20	ICC-736	TR-21	PTC 136	HEP-736	NA	RT-103	NA	NA	ZEN 120
2N5145	NA	TS-3001	NA	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N5155	NA	NA	GE-25	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N5156	NA	T-625	GE-25	ICC-625	TR-27	PTC 122	HEP-625	NA	NA	NA	NA	NA
2N5157	NA	T-740	NA	ICC-740	IRTR-88	PTC 129	HEP-740	SK 3025	RT-115	162	WEP-242	ZEN 206
2N5160	RS276-2021	T-76	GE-29	ICC-76	IRTR-88	PTC 127	HEP-76	SK 3025	RT-115	129	WEP-242	NA
2N5161	NA	NA	GE-69	NA	NA	NA	NA	NA	RT-155	NA	NA	NA
2N5163	NA	T-802	GE-FET-1	ICC-802	FE-100	PTC 151	HEP-802	SK 3116	RT-175	ECG 132	WEP-802	ZEN 123
2N5168	NA	SR-1220	GEMR-3	ICC-R1220	NA	NA	HEP-R1220	SK 3504	NA	ECG 5521	NA	NA
2N5169	NA	SR-1221	GEMR-3	ICC-R1221	NA	NA	HEP-R1221	SK 3504	NA	ECG 5524	NA	NA
2N5170	NA	SR-1222	GEMR-3	ICC-R1222	NA	NA	HEP-R1222	SK 3504	NA	ECG 5507	NA	NA
2N5171	NA	SR-1223	NA	ICC-R1223	NA	NA	HEP-R1223	SK 3504	NA	ECG 5529	NA	NA
2N5172	RS276-2011	T-56	GE-62	ICC-56	NA	PTC 139	HEP-56	SK 3124	RT-108	ECG 107	WEP-720	ZEN 104
2N5174	NA	T-713	NA	ICC-713	IRTR-51	PTC 123	HEP-713	SK 3045	RT-110	ECG 154	WEP-712	NA
2N5175	NA	T-712	GE-27	ICC-712	TR-78	PTC 125	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N5176	NA	T-712	NA	ICC-712	TR-78	PTC 125	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N5179	RS276-2011	T-709	NA	ICC-709	NA	PTC 133	HEP-709	SK 3039	RT-108	ECG 107	WEP-720	ZEN 105
2N5180	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 132	HEP-56	SK 3018	RT-113	108	WEP-56	ZEN 104
2N5181	RS276-2013	T-729	NA	ICC-729	NA	PTC 132	HEP-729	NA	RT-113	ECG 161	WEP-719	ZEN 115
2N5182	RS276-2011	T-56	NA	ICC-56	NA	PTC 132	HEP-56	NA	RT-113	ECG 161	WEP-719	ZEN 104
2N5183	NA	TS-3001	GE-63	ICC-S3011	NA	NA	HEP-S3001	SK 3124	RT-100	ECG-123	WEP-53	NA
2N5184	NA	T-712	GE-27	ICC-712	TR-79	PTC 117	HEP-712	SK 3040	RT-110	ECG 154	WEP-712	ZEN 205
2N5185	NA	T-712	GE-27	ICC-712	TR-79	PTC 117	HEP-712	SK 3040	RT-110	NA	NA	ZEN 205
2N5186	RS276-2009	T-50	GE-20	ICC-50	TR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N5187	RS276-2009	T-53	GE-20	ICC-53	TR-21	PTC 136	HEP-53	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 102
2N5188	NA	TS-3001	NA	ICC-S3001	IRTR-64	PTC 144	HEP-S3001	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5189	NA	TS-3010	GE-28	ICC-S3010	IRTR-64	NA	HEP-S3010	SK 3529	RT-154	NA	NA	ZEN 207
2N5190	RS276-2019	TS-5003	GE-57	ICC-S5003	NA	PTC 137	HEP-S5003	SK 3054	RT-152	ECG 184	WEP-WS5003	ZEN 210
2N5191	RS276-2019	TS-5003	GE-57	ICC-S5003	TR-92	PTC 137	HEP-S5003	SK 3054	RT-152	ECG 184	WEP-WS5003	ZEN 210
2N5192	NA	TS-5000	GE-55	ICC-S3000	NA	PTC 137	HEP-S5000	SK 3054	RT-152	ECG 184	WEP-WS5003	NA
2N5193	RS276-2027	TS-5007	GE-58	ICC-S5007	NA	NA	HEP-S5007	SK 3083	RT-153	ECG 185	WEP-WS5007	ZEN 211
2N5194	RS276-2027	TS-5007	GE-58	ICC-S507	NA	NA	HEP-S5007	SK 3083	RT-153	ECG 185	WEP-WS5007	ZEN 211
2N5195	NA	TS-5006	GE-56	ICC-S506	NA	NA	HEP-S5006	SK 3083	RT-153	NA	NA	NA
2N5200	RS276-2015	T-720	NA	ICC-720	NA	PTC 133	HEP-720	SK 3124	RT-113	ECG 108	WEP-56	ZEN 109
2N5201	RS276-2015	T-720	NA	ICC-720	NA	PTC 123	HEP-720	SK 3020	RT-118	ECG 100	WEP-720	ZEN 109
2N5202	NA	NA	NA	NA	NA	NA	NA	SK 3021	RT-128	NA	NA	NA
2N5204	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5547	NA	NA
2N5205	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5531	NA	NA
2N5208	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3118	RT-126	ECG 106	WEP-52	NA
2N5209	RS276-2013	T-720	GE-61	ICC-729	TR-24	PTC 153	HEP-729	SK 3122	RT-102	ECG 123A	WEP-729	ZEN 115
2N5210	RS276-2013	T-728	GE-62	ICC-728	IRTR-51	PTC 153	HEP-728	SK 3122	RT-102	ECG 123A	WEP-728	ZEN 114
2N5211	NA	NA	NA	NA	IRTR-87	PTC 144	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5219	RS276-2009	T-722	GE-62	ICC-722	IRTR-51	PTC 139	HEP-722	SK 3122	RT-102	ECG 123A	WEP-723	ZEN 110
2N5220	RS276-2011	T-721	GE-20	ICC-721	NA	PTC 123	HEP-721	SK 3122	RT-102	ECG 123A	WEP-728	NA
2N5221	RS276-2021	T-51	GE-67	ICC-51	NA	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	WEP-51	ZEN 101
2N5222	RS276-2015	T-720	NA	ICC-720	NA	PTC 133	HEP-720	SK 3039	RT-108	ECG 107	WEP-720	ZEN 109
2N5223	RS276-2009	T-727	GE-62	ICC-727	IRTR-51	PTC 139	HEP-727	SK 3122	RT-102	ECG 123A	WEP-723	NA
2N5224	RS276-2009	T-727	GE-10	ICC-727	IRTR-51	PTC 121	HEP-727	SK 3122	RT-102	ECG 123A	WEP-723	NA
2N5225	RS276-2011	T-721	GE-20	ICC-721	TR-21	PTC 123	HEP-721	SK 3122	RT-102	ECG 123A	WEP-728	NA
2N5226	RS276-2021	T-716	GE-67	ICC-716	TR-20	PTC-127	HEP-716	SK 3114	RT-115	ECG 159	WEP-716	ZEN 107
2N5227	NA	NA	GE-62	ICC-S0006	IRTR-51	PTC 139	HEP-S0006	SK 3114	RT-115	ECG 159	WEP-717	NA
2N5228	NA	NA	GE-22	NA	IRTR-52	PTC 103	NA	NA	RT-126	ECG 106	WEP-52	NA
2N5229	NA	NA	GE-22	NA	TR-19	PTC 103	NA	NA	RT-103	NA	NA	NA
2N5230	NA	NA	GE-21	NA	TR-19	PTC 103	NA	NA	RT-115	NA	NA	NA
2N5231	NA	NA	GE-21	NA	TR-20	PTC 103	NA	NA	RT-115	NA	NA	NA
2N5232	RS276-2009	T-736	GE-62	736	TR-24	PTC 139	HEP-736	SK 3124	RT-102	ECG 123A	WEP-736	ZEN 120
2N5233	NA	NA	NA	NA	IRTR-87	PTC 121	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5234	NA	TS-0001	NA	ICC-S0001	IRTR-87	PTC 144	HEP-S0001	SK 3024	RT-114	ECG 128	WEP-712	ZEN 125
2N5235	NA	NA	NA	NA	IRTR-87	PTC 121	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2N5236	RS276-2009	T-75	NA	ICC-75	NA	PTC 143	HEP-75	NA	RT-114	NA	WEP-243	NA
2N5237	NA	NA	NA	NA	TR-25	NA	NA	NA	RT-115	NA	NA	NA
2N5238	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N5239	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	NA	707	ZEN 204
2N5240	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	SK 3021	RT-128	ECG-124	707	ZEN 204
2N5241	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	NA	707	ZEN 204
2N5242	NA	T-51	GE-67	ICC-51	IRTR-88	PTC 141	HEP-51	NA	RT-115	ECG 129	WEP-51	ZEN 101
2N5243	RS276-2021	T-716	GE-67	ICC-716	IRTR-88	PTC 141	HEP-716	NA	RT-115	ECG 129	WEP-716	ZEN 107
2N5244	RS276-2023	T-52	NA	ICC-52	NA	PTC 103	HEP-52	NA	RT-103	NA	WEP-52	NA

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

NA=NOT AVAILABLE

(continued next month)

Step-by-step TV Troubleshooters Guide

Servicing a receiver that has good luminance but no color can be a real headache. With the correct approach, however, servicing time and cost can be greatly reduced. Here's how to do it.

by STAN PRENTISS

WHAT'S YOUR REACTION WHEN A RECEIVER appears for repair with fair-to-good black and white and no color? Do you pull all tubes, or modules, or transistors and replace them as fast as you can? Or do you take a look at the schematic (or block diagram) and do a little analysis? What, for instance, are the three basic color problems?

1. Color isn't passing the bandpass amplifiers.
2. There are faults with subcarrier regeneration and demodulation.
3. Or the color output amplifiers have singly or collectively quit.

If you're fortunate in having a single chroma plug-in board that can easily be inserted, then by all means replace it. But older receivers without such conveniences are those that usually need service now, rather than the yearlings. Therefore, let's develop tactics:

Connect a color bar generator to the rf terminals and, if you have a good oscilloscope-vectorscope, look at the output of the color amplifiers where they drive either the grids or cathodes of the picture tube. Should the Fig. 1 pattern appear, there is

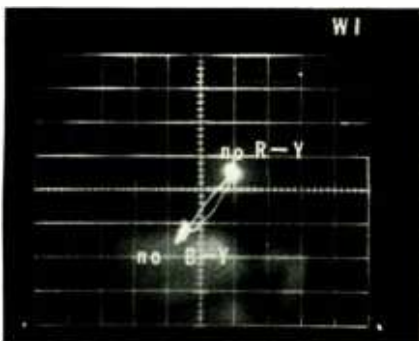


FIG. 1—VECTORSCOPE PATTERN taken at the output of the color amplifiers shows absence of chroma signal.

obviously no color output. You can then safely make the assumption that the picture tube is probably good, which means that it's a circuit problem and you have a job cut out for you. If a vectorscope isn't handy, then

the usual sharks-tooth display can't appear at the chroma outputs, and you'll see only a fairly smooth 52.4- μ s horizontal scan line and a 11.1- μ s blanking pulse. The problem, then, is to find the culprit.

Divide and conquer

In troubleshooting any color breakdown—where monochrome information is good—there is one sound approach: divide and conquer. The block diagram of Fig. 2 shows only two inputs into any color subsystem,

tal sync pulse. As the burst keys the amplifier into conduction, its load transformer can impedance-couple these 8 or 9 cycles of 3.579545 MHz information either into what's known as a phase-lock-loop type of dc feedback circuit, that also usually contains agc, or rings a simple crystal arrangement to drive an amplifier or subcarrier oscillator. Sinewaves, phase shifted between 74° and 90°, are then coupled into the demodulators as R-Y and B-Y references. Along the way, a tint control in either the chroma or

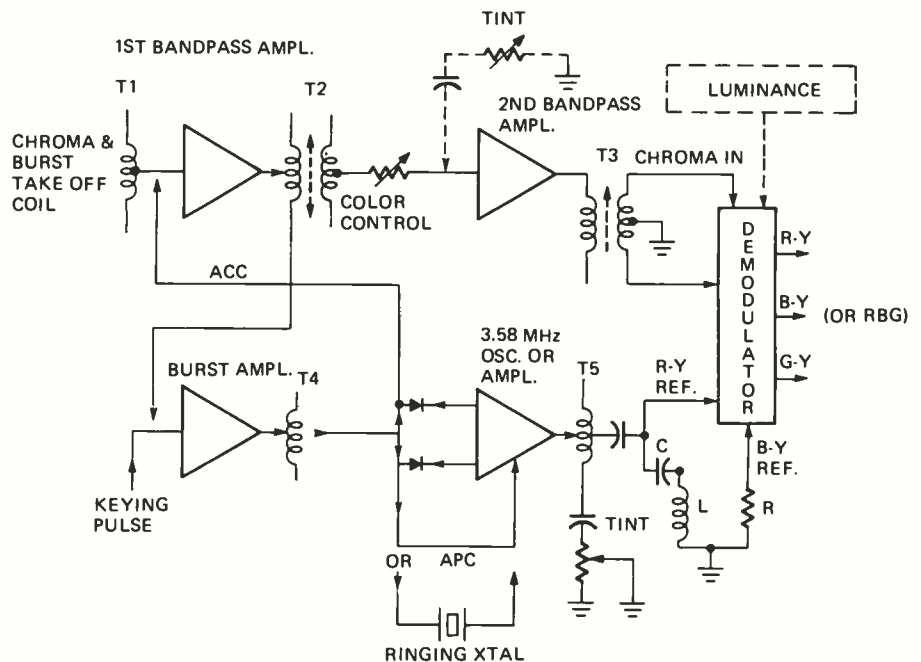


FIG. 2—UNIVERSAL BLOCK DIAGRAM for popular chroma circuits.

and they are burst and chroma into the first bandpass amplifier and a fly-back or horizontal sync pulse (Japanese sets) into the burst amplifier. So burst and chroma are amplified by the initial (or one and only) bandpass amplifier, and chroma then proceeds to the demodulator in either single or dual (illustrated) phase. The burst signal goes to the burst amplifier for amplification during horizontal retrace, which is always the 5- to 8- μ s period of the flyback or horizon-

subcarrier circuits is inserted to phase shift the chroma signal, with its reactance manually adjusted from the front panel. Finally, luminance and chroma are either mixed before entering the picture tube in R-G-B receivers, or after entering the picture tube in color-difference receivers. Demodulators, consisting of IC doubly-balanced synchronous switches or discrete transistors or diodes, then pass selected portions of chroma synchronized with broadcast transmissions and

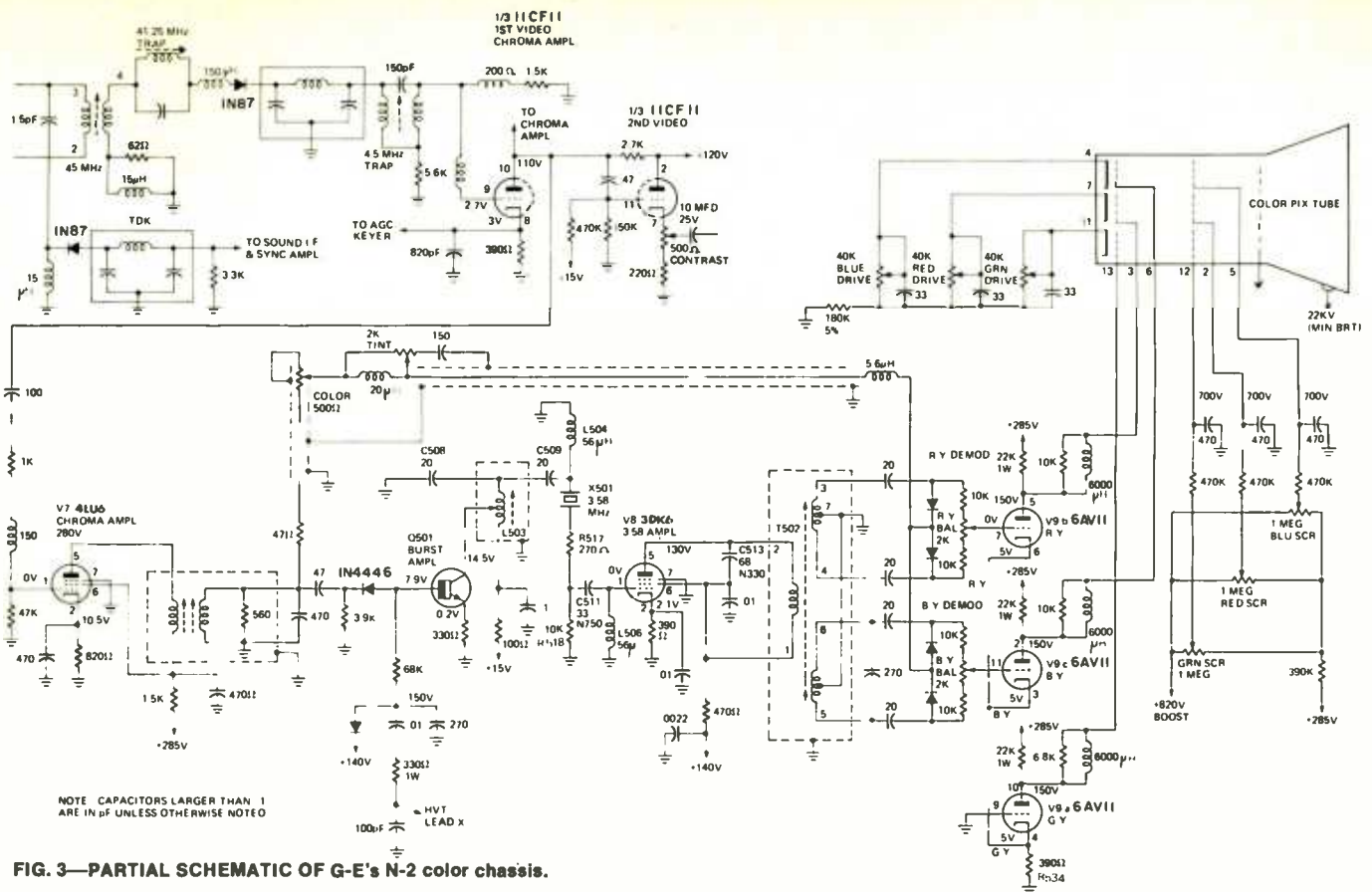


FIG. 3—PARTIAL SCHEMATIC OF G-E's N-2 color chassis.

paint a color picture on the picture-tube screen. Buffer amplifiers often drive the picture tube directly.

Now, like the three basic breakdowns, there are also three basic approaches to finding color problems:

1. Investigate the bandpass amplifiers.
2. Check arrival and amplification of burst.
3. Be certain there are burst keying pulses.

The rest, believe it or not, is a simple matter of follow through. That means using a good color bar generator, setting the correct waveform amplitudes at selected points (as far as you can) following the video detector, and proceeding the rest of the way with an oscilloscope. Analog or digital meters, of course, cannot follow an ac signal.

A case in point

The set was a General Electric N-2 chassis, Mod. WM257NWD-2 produced in 1971, with 13 tubes, 9 transistors, and agc-afc. The subcarrier regenerator (Fig. 3) consists of a burst amplifier (Q501), series 3.58-MHz crystal (X501), and 3.58-MHz amplifier (V8). This is supplied by a single chroma amplifier (V7), the usual double-tuned first bandpass transformer, and a series color control that supplies color information directly to the two sets of R-Y and B-Y demodulators. G-Y, you'll ob-

serve, is developed across the common cathode resistor of the R-G-B-Y amplifiers (R534). Luminance and chroma are subsequently matrixed in the pix-tube. This is a good example of a color-difference receiver which has separate luminance and chroma subsystems.

The problem, of course, was *no color*, as the initial vector pattern (Fig. 1) amply illustrates. But there were also remarkable phase shifts of reds and blues (intensity markers on either end) from their standard 90- and 180-degree vector positions, indicating general chroma misalignment. An ac check of the color bar signal at the plate of the first video amplifier (Fig. 4, upper trace) and a dc check at the grid of the chroma amplifier (Fig. 4, lower trace) through the luminance-rejecting RLC tuned circuit showed this portion of the subsystem was not only responding, but could easily accept the necessary color bar amplitude setup. The base of burst amplifier Q501, (Fig. 5, upper trace) showed a good pulse of 20V/div. at a negative dc level of some 10V—entirely adequate, since initial voltages were taken with a 20K-ohms voltmeter, and this would have both shunted and loaded the base input of this transistor amplifier.

But look at the plate of the V8 3.58-MHz amplifier (Fig. 5, lower trace). G.E. specifies this waveform to have a p-p amplitude of 100V, and

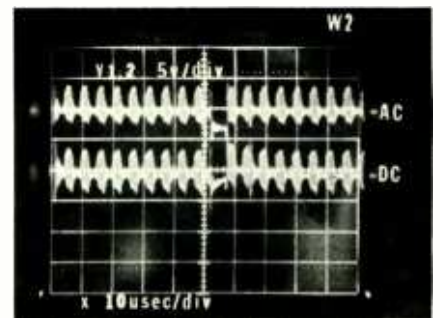


FIG. 4—UPPER WAVEFORM shows the signal at the plate of the first video amplifier. Lower trace shows the grid signal of the chroma amplifier.

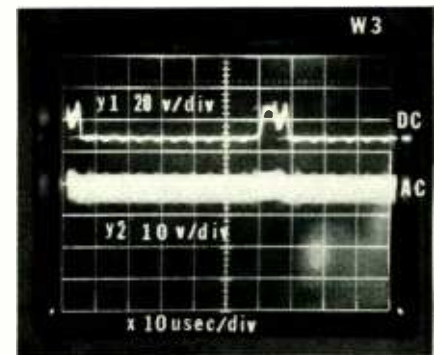


FIG. 5—NORMAL WAVEFORM at the base of the burst amplifier is shown in upper trace. Lower trace shows abnormal signal at plate of 3.58-MHz amplifier.

here it is only 10V tall. So our problem evidently lies between the base of Q501 and the plate of V8. One additional measurement between the collector of the burst amplifier and the

TROUBLESHOOTING CHART (chroma circuits)

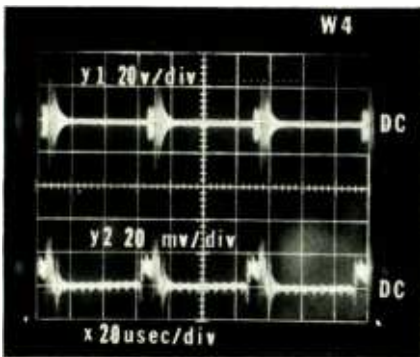
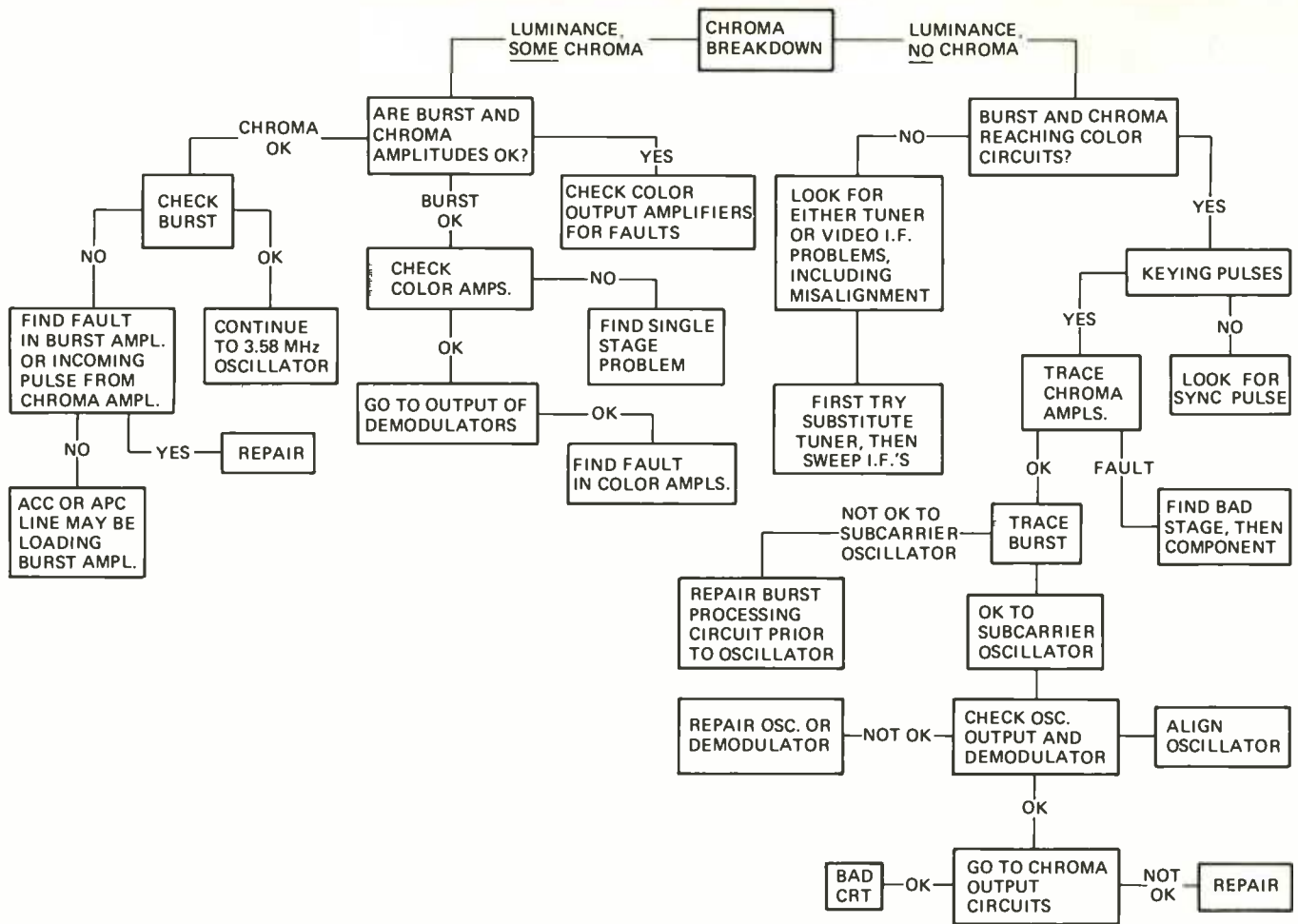


FIG. 6—NORMAL SIGNAL taken from the collector of the burst amplifier is shown in upper trace. Lower trace shows abnormal signal at the grid of the 3.58-MHz amplifier.

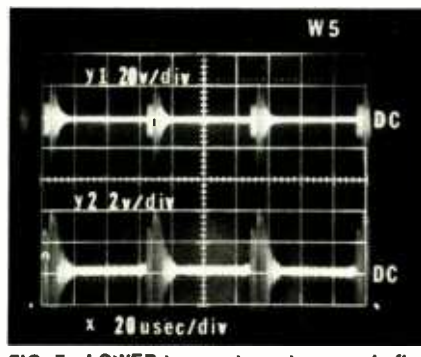


FIG. 7—LOWER trace returns to normal after repairs are made.

control grid of the 3.58 MHz amplifier shows 60V of hard burst (Fig. 6, upper trace) directed at crystal X501, and only 40-mV of signal arriving at the grid of V8. Now our question becomes: is V8 loaded by its T502 output transformer or are there problems exclusively in its grid?

Circuit analysis

Here, without pulling out components like a wild man, let's simply do a little circuit analysis to avoid both costly mistakes and subsequent headaches. In any ringing circuit, remember that it is pulsed within 10-

Hz of phase sync during horizontal retrace prior to the beginning of each new scan line so that receiver demodulation may occur in precise timing with modulation in the transmitter. So in this problem area, the center tapped burst transformer (L503), along with dividers C508, C509, and ringing coil L504, help shape the burst signal that must ring the 3.58-MHz Xtal (X501) for 8 cycles every 58 μs. Resistors R517 and R518 are damping and divider loads and, with C511 and L506 constitute a phase shift, peaking, and smoothing input for subcarrier amplifier V8. From the waveforms, it's obvious that X501 is ringing, but there's a strange

interruption in the signal at the grid of V8 (Fig. 6, lower trace) as burst rises almost +20 mV before entering the grid of the amplifier.

So do we have a grid or a load problem? If C513 isn't shorted, it's a grid fault, since the dc voltages measure properly at the screen and plate of V8, and the 2V dc on its cathode show that the tube has dc conduction. Disconnecting one end of C513 proves negative, so we immediately return to the grid and its RLC network. An ohms measurement across the R517 and R518 resistors established adequate tolerance. And, a voltmeter shunted across C511 shows no short when the hot lead is put to the junction of the two resistors and its negative lead to the top of the coil (L506). So this brings us to L506.

Inductor L506 carries more weight in the grid circuit than meets the casual eye. In addition to being part of a phase-shift network, it is also the dc grid return for V8 and has a reactance of 1260 ohms at 3.58 MHz. Now, where a capacitor's reactance to ac is low, and high to dc; an inductor is exactly the opposite, and has high impedance to ac, but low imped-

(continued on page 85)

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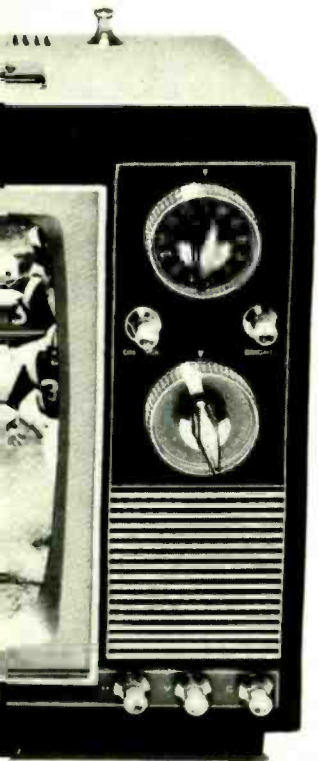
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RE's Service Clinic

The orphan amplifier

Part II: Pick a replacement

by JACK DARR
SERVICE EDITOR

YOU HAVE AN AMPLIFIER WITH THE OUTPUT transistors blown and no schematic. Last month I described how to find out the information necessary to select a replacement transistor. Now let's do it.

Choosing a replacement transistor

Now that we have a few facts about the original transistor, we need to locate a replacement. Let's assume we have a stack circuit for simplicity. The original transistors were npn, and the dc voltage maximum is +25 volts. In addition, they were in TO-1 cases, in heat-sinks clamped to the metal case.

So we go to our Replacement Guide. Look for a transistor rated for at least 50-volts collector breakdown, npn, and in a TO-1 case. This should be silicon. RCA's SK-3124 ought to do; rated 200-mA collector current.

We mount two of these in the chassis. (Never replace one of a pair. Can't tell what's going to happen.) As a precaution, we connect a dc milliammeter in series with the collector of the top transistor. Now, we plug the line cord of the amplifier into a variable-voltage transformer. Set the transformer to zero volts and turn the amplifier switch on. Now bring the input voltage up gradually and watch the current meter.

When you get up to about 50 or 60-volts line, check the amplifier. It should be working fairly well, and showing a surprising amount of amplification. Check the collector current; if this goes over 150 mA at about half-line voltage, STOP! You've got a bias problem, or something. You're already drawing almost the full maximum current rating and your line voltage is still way too low. Check the driver transistor, base-emitter voltage of the new transistors, etc. Also check for a short across the speaker. These amplifiers will handle an open-circuit across the output, but they dislike shorts very much. The electrolytic coupling capacitor to the speaker, or the speaker leads themselves, may be shorted.

One very good check for proper operation of this circuit is the dc voltage at the midpoint, where the speaker connects. This should be almost exactly one half of the applied dc. In this case, with 30 volts open-circuit dc output, it should drop to about 25

volts under load. So, you should read about 12 volts at the emitters, if the circuit is operating normally.

If the amplifier works, crank the line voltage up to normal and check the current. Let it run for a minute or two, and check the temperature of the cases of the output transistors. This is with *no signal* applied. If they get hot, or the current starts to creep up, look out! Something is wrong, and it's probably the bias. Check the driver transistor. You may have to replace it as well.

If they pass this part of the test, put the output transistors back in the heat-sinks, and feed a fairly loud signal through it. Your collector current will (normally) go up quite a bit, since these transistors are in Class B operation. Watch this to be sure that it doesn't go over about 50% of the replacement transistor's maximum collector current rating. Play it for about 1 or 2 minutes and check for overheating of the output transistors, and for creeping collector current. By the way, a pure sinewave audio signal at about 1 kHz is a good test, since this is hard on the amplifier. You dissipate more power with this input than with a constantly changing music signal. If they'll keep their cool with this, the chances are they will be all right. R-E

reader questions

ODD COLORS, DIM PICTURE

A whole lot of things happened on this RCA CTC-22B chassis. The colors were very odd; a color-bar pattern showed 6 green bars followed by 3 red bars. The video was also very dim. Scoping the video output showed a very severe white compression.

The color problem was fixed by discovering that L703, the 620 μ H choke in the output of the B-Y demodulator, was open (Scoping the blue grid and finding no waveform led me here). Replacing this fixed the color.

Video, however, was still very dim. You lost the whole picture if you turned the color control off. Scoping the video output again showed only about 1/4 of the normal p-p signal,

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

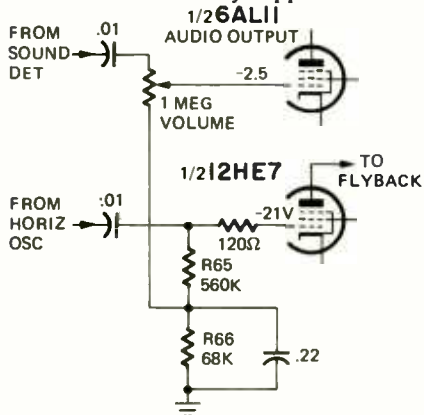
If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included, we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, N.Y. 10003.

compressed. Checking the video plate voltage showed it very low, about +50 volts instead of the normal +180. Peaking choke L710 was open, and the ¼-watt 5600-ohm shunt resistor was up to 30K. Replaced these, and the job was done! J.D., Mena, Ark.

BIAS RESISTORS REVERSED

I've got sound problems in this Muntz AS-5002 TV. With volume control wide open I can barely hear the sound and it's gargling. When I checked the schematic, I found that R65 and R66 had been reversed. I put them back, and got less sound than I had before! I'm lost.—G.R., Greensboro, NC.

You've been boobytrapped! These

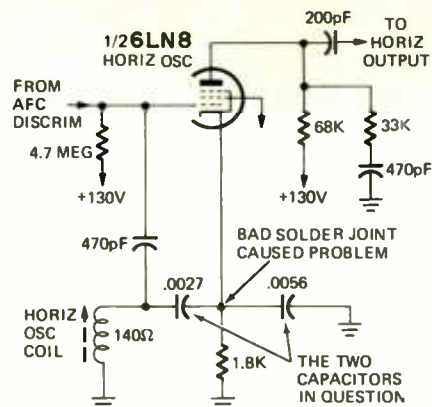


two resistors were accidentally reversed on the schematic. The horizontal output tube's negative grid voltage (-21 volts) is used across a voltage-divider, to provide bias for the audio output tube as shown. The audio tube grid should be only -2.5 volts. With the 560K resistor in the "ground leg" of the divider, you'll wind up with about a -12 volts or more on the audio tube, and it will clip. Put the two resistors back as shown and it'll work a lot better. If it still distorts, check the coupling capacitor for leakage.

INTERMITTANT HORIZONTAL OSCILLATOR?

A Broadmoor model 6912 has an odd intermittent. If I touch the plate cap of the horizontal output tube with a pencil, the set comes on. I note that when it does not come on, I have no boost voltage. Once in a great while, it falls out of horizontal sync. Here again, by touching a meter anywhere in the horizontal circuit, the set comes on. I'd appreciate any help.—G.B., New Britain, CT.

This has all of the symptoms of an intermittent horizontal oscillator. The "touch anything and it starts" reaction is typical. Check the two capacitors



across the horizontal oscillator coil. Best cure is usually a replacement of both at once, with exact duplicates.

(Letter from reader says, "That was it, bad solder joint.")

REPLACEMENT TRANSISTOR

An output transistor is shorted in this Capitol SA-707T record player. No data; transistor has "274, CV61" on it. What will replace it?—D.F., Pomfret, CT.

Service data on this is in Sams 973-4. However, this transistor has only S-1570, no substitute given. From the voltages, etc., I'd try an RCA SK-3020. It's an npn, in a TO-5 case, with collector connected to case. (Don't forget the heat-sink insulator!) R-E

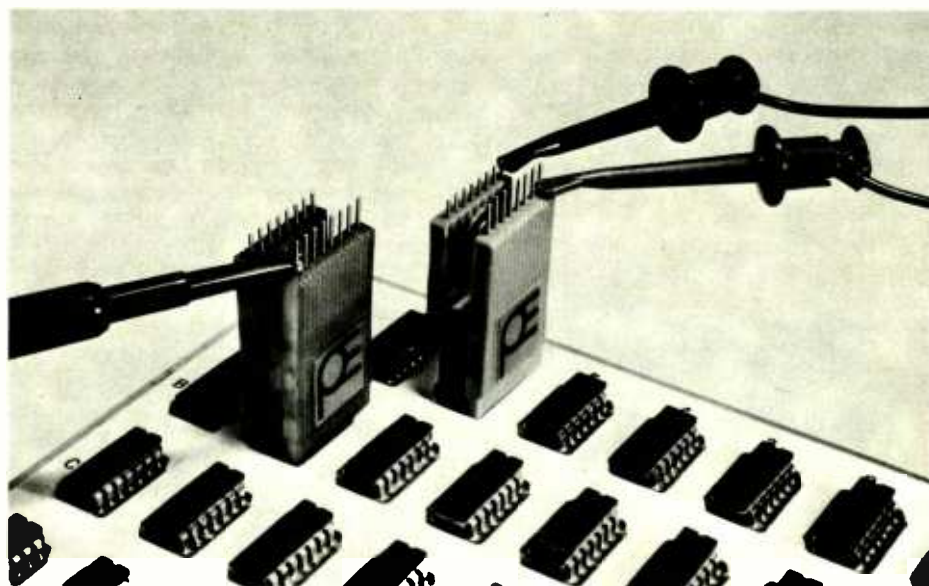


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Circle 27 on reader service card

CB RULES

(continued from page 42)

23 channels will be reserved for intra-station use and 47 new channels will be available. Owners and buyers of 5- to 12-channel AM transceivers employing plug-in crystals (two per channel) will be able to equip their sets with crystals for operation on the new AM channels (24-30).

Those who own or plan to buy synthesized 23-channel transceivers will be able to operate on Channels 1-23. And by means of an external adaptor, they will be able to also operate on Channels 24-30. Such adaptors are already being designed. Their use, however, will

require FCC type acceptance of adaptors for use with specific types of transceivers.

When the proposed rules are adopted and the 40 intra-station, SSB-only channels (60-99) are allocated for CB use, many new transceivers will be introduced. But, they will undoubtedly be higher priced than existing models because more sophisticated designs will be required and tighter technical standards will have to be met.

New generation equipment

What will the new generation CB transceivers be like? It all depends on the ingenuity of the designers and what the buyers want. Of course, someone will bring out a 70-channel rig, expandable to 100 channels. It could be operable in

the suppressed carrier USB mode on all of the 70 channels and in the AM-compatible USB mode on the 30 AM/SSB channels. But, who needs 70- or 100-channel capability? Some will want it but few actually need it. Most of the intra-station channel users would probably settle for 2 to 6 channel units. Many hobbyists will want the "works".

Look forward to use of state-of-the-art technology, especially the PLL (phase-locked loop) which enables multi-channel frequency generation using a minimum of crystals and other components. Linear Systems (SBE) is already using it.

One only has to note the great technical progress that has been made since the Heath Company introduced its popular "lunch box" CB transceiver kit some 17 years ago. The sophistication of currently available CB transceivers—considering the modest price tags—is amazing. But, you ain't seen nothing yet.

The existing 23-channel AM/SSB transceivers are necessarily complex since 69 modes are required—23 AM, 23 LSB, and 23 USB. The means used for obtaining this flexibility are clever indeed. But USB-only transceivers need not be as complex.

A simplified block diagram of a hypothetical USB-only transceiver is shown in Fig. 3. The objective is to accept a USB signal at point X, to provide a 12-watt PEP (max) USB signal at point Y, and to recover the intercepted audio at point Z.

Assuming that a Channel 99 USB signal extending from 27.5054-MHz to 27.5075-MHz is present at point X, the local oscillator will have to feed an 18.505-MHz signal to the mixer to translate the intercepted USB signal so it will occupy the 2.1-MHz wide i.f. band extending from 9000.4 to 9002.5 kHz. To be able to demodulate the suppressed carrier USB signal, a 9-MHz signal is fed to the product detector. When the carrier frequency which was suppressed at the distant transmitter is exactly 27.505 MHz, the af signals at point Z will extend from 400 to 2500-kHz. Since some frequency error at the distant transmitter and at the receiver local oscillator can be expected, the frequency of the 9-MHz master oscillator is varied by adjusting the clarifier control to make the recovered audio sound natural.

When transmitting on Channel 99, the 9-MHz master oscillator signal and the audio modulating signal are fed to the balanced modulator. If the modulating signal extends from 400 to 2500 Hz, the output signal of the balanced modulator will consist of a lower sideband extending from 8997.5 to 8999.6 kHz and an upper sideband extending from 9000.4 to 9002.5 kHz, but the 9-MHz carrier will be suppressed by the balanced modulator. The two sidebands are fed through a filter which passes only the upper sideband, which is fed to the up-converter.

When an 18.505-MHz signal from the local oscillator is also fed to the up-converter, a USB signal extending from 27.5054 to 27.5075 MHz is fed through rf amplifiers to the antenna.

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The local oscillator, which determines both the transmitting and receiving frequencies, may be crystal controlled for operation at one or any number of channels, or it may consist of a phase-locked-loop (PLL) which will enable operation on any or all of the proposed 70 (immediate) or 100 (eventual) channels. To enable transmission and reception on all 100 channels, the PLL circuit would have to be able to generate frequencies within the 17.960-18.505 range.

Since the proposed frequency tolerance would be ± 0.002 per cent, the range of the clarifier control would have to be no more than ± 540 -kHz minus the frequency errors of the local and master oscillators. It is not known at this time if the FCC will type accept transceivers when the clarifier control adjusts both the transmit and receive frequencies.

Obviously, it is not expected that all future transceivers will employ a 9-MHz master oscillator/beat frequency oscillator (BFO). The block diagram is shown only as an example of how it could be done. Anticipate surprises—CB engineers are clever.

The dotted line between the master oscillator and the transmitter filter, shown in Fig. 3, symbolizes bypassing of the balanced modulator for transmission of compatible SSB AM on Channels 9 and 11, as required by the proposed new rules.

Effect on service technicians

CB service technicians will have to expand their knowledge and master new servicing techniques in order to service SSB-only CB transceivers. Since the carrier is suppressed, measurement of transmit frequencies requires unbalancing or bypassing the balanced modulator to allow some carrier to get through. This could be the hard way. An easier way is to modulate the transmitter with a 1000-Hz tone and measure the resulting sideband frequency and then subtract 1-kHz to determine the frequency of the suppressed carrier.

When the time comes that only upper SSB transmission will be permitted, it would be less confusing if the FCC would designate CB channel frequencies on the basis of center of sideband frequencies. For example, 26.965-MHz could be designated 26.9664-MHz, 1.4-kHz above 26.965-MHz. When modulated by voice containing frequencies within the 400-2800-Hz range, the center of the sideband would be 1.4-kHz above the suppressed carrier frequency, as shown in Fig. 2 by lines C and G. By modulating the transmitter with a 1400-Hz tone, the transmit center-frequency can be measured directly with a frequency meter or frequency counter.

To adjust the alc (automatic level control) so that output PEP will not exceed 12-watts and so that serious distortion will not occur, a wideband scope (up to 30-MHz response) and a two-tone (400-Hz and 1800-Hz) audio generator (or two audio generators) will be required. Output PEP can be calculated if the scope is accurately calibrated. Better is to also use a peak reading rf watt-

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meter (such as Bird 4311) which indicates PEP on a meter. Or, a conventional rf wattmeter can be used by multiplying its meter indication by 2.5. In either case, the scope is required for observing output waveform when two-tone modulation is applied.

Receiver trouble shooting and alignment will require the use of a high-precision rf signal source which can be set accurately to 1.4-kHz above the suppressed carrier frequency so that a signal will be present at the center of the receiver passband. And, for i.f. alignment, the test signal must also be offset from the i.f. by 1.4 kHz.

Servicing SSB equipment takes longer and requires more skill than servicing

AM equipment. Service charges will undoubtedly be higher because more time and costly equipment will be required. Wet finger voltmeter testing techniques won't work. And, because of the larger numbers of transceivers that will be in use, more qualified technicians will be required to service them.

Spectrum juggling

To expand the 27-MHz Citizens band, the channel space will have to be taken away from somebody. Proposed channels 24, 25, 26 and 27 (27.235, 27.245, 27.265 and 27.275 MHz) are catch-all channels currently allocated to the public safety/industrial/and transportation radio services on a shared basis. Channels 28, 29,

30 and 60 through 66 will also occupy space now allocated to other services. Present occupants of these frequencies would have to vacate them after a date yet to be determined. All of the spectrum from 26.96 MHz to 27.51 MHz, with the exception of the five Class C (remote control) channels interspersed between Class D CB channels, would be allocated to the Class D Citizens Radio Service.

The FCC is considering lowering the CB license eligibility age limit from 18 to 16 and has proposed reducing the station license application fee from \$20.00 to \$6.00. (The lowered fee may or may not be in effect by the time this appears in print.) Earlier, the FCC had proposed hiking the license fee to \$25 for the first five units, but the U.S. Supreme Court put a stop to it. Under current rules, a CB station license may cover any number of units and is good for five years unless revoked earlier.

Since 1964, it has been unlawful to use CB radio as a hobby. But, this rule could not be effectively enforced. Most CB'ers are hobbyists. Proposed new CB rules would relax the hobby-use ban by permitting communications related to a licensee's "activity" unless such activity is otherwise unlawful. The new rules, however, would preclude the activity being CB radio itself. In other words, a CB'er would be able to talk about almost anything except about the technical aspects of CB radio.

Many CB'ers use "handles" and do not use their call signs as required by current rules which call for transmission of the call signs of both the called and calling stations at the beginning and conclusion of every exchange of communications. The proposed new rules would require call sign identification only by the calling station. Also, the proposed new rules would reduce the waiting time between an exchange of inter-station communication from five minutes to one minute.

Among other rule changes, the FCC is reported to be considering is point-of-sale licensing. At present, the new buyer of CB radio equipment is expected to apply and wait for issuance of a CB station license before going on the air. Many do not wait for the license to be issued and some do not even apply for one. As a result, millions of CB transceivers have and are being operated illegally without a license. Such illegal use would be curbed by requiring equipment buyers to show or buy a license at the time the purchase is made. Also being considered is an open-book exam on the rules. Implementation may be difficult and costly, but no more so than examining and issuing licenses to auto drivers.

Since 1958 when the Class D citizens band was established, the Citizens Radio Service has become the largest of all radio services regulated by the FCC in terms of numbers of licensees and authorized transmitters. And when the Class D band is expanded to 70 channels, countless millions can be expected to join existing CB'ers in utilizing tool-free two-way radio communication. **R-E**

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CB ROUNDUP

(continued from page 42)

have some form of fine tuning to permit proper reception of SSB signals; for with SSB the received signal can easily turn into Donald Duck chatter if the receiver isn't precisely tuned to the received signal. The old way to upgrade fine tuning was to call it a "clarifier". But in some new models it's now termed a "voice lock", "Receiv-o-slide", "voice tune", or some similar euphemism for ordinary fine tuning. Whatever it's called, it's not a new state-of-the-art development, it's the same fine tuning that's been in use for years. (Hams, SWL's and Old Timers called it bandspread.)

If there is one outstanding development in this year's CB designs it is probably in miniaturization. There has been little selection in miniature transceivers that could actually be tucked away in the glove compartment, or so small that mounted under the dash it wouldn't interfere with a middleseat passenger. Today, there's a wide selection of miniature equipment such as Radio Shack's TRC-11, which measures a miniscule 1.5"H x 4.1"W x 6.8"D. Pace, Lafayette and Midland are three more, among others, who feature subminiature mobile transceivers. The sub-mini's are available in full-23 coverage, or from one to (usually) 6 user-selected channels. As a general rule the performance is quite good, often equal to a "basic" transceiver. If there are any complaints they would probably be about a sharp, high pitched speaker output, caused by the necessity for a relatively small speaker for the sub-mini sized cabinet.

One really unusual design which is certain to be a hot attraction for others to copy is the new Johnson Messenger 130 and Lafayette's COMPHONE 23 CB transceiver styled similar to a mobile telephone right down to the handset. The operator can send and receive through the handset, or he can switch to speaker monitoring. When the handset is in the cradle the speaker is automatically connected so the operator can hear calls.

While these models don't deliver any better performance than "basic black" transceivers using similar circuit designs, they sure look a lot sexier.

Sky hooks

Unfortunately, the best transmitting equipment won't work well without a decent antenna, and when it comes to antennas, the designers have been on overtime. To all the standard goodies from Hy-Gain, Shakespeare, Avanti, Antenna Specialists, New-

Tronics, Mosley, Cushcraft and the other ski-hook producers, we now have some hardware that inexpensively turns the pipsqueaks from a 5-watt transceiver into a rock-crushing signal. For example, Avanti and Shakespeare have co-phased electrical half-wave-length mobile whip beams that will fit the rear bumper of the standard car. Mosley and Cushcraft have 5-element base station beams that make the 5 watt transmitter almost the equal of a 50 watter. And to keep the antenna system as free from trouble as is possible, Antenna Specialists has a non-corrode mobile out as the Super Can

III. And for those who like their whips on the car roof for best omnidirectional coverage, there is the Hustler system with four different mounting and shock-spring arrangements.

Even the truckers and campers come in for some special antenna hardware. Several antennas are available with mounting hardware to fit directly on a "West Coast" side view mirror. And if you've got a mirror on both sides there's a special co-phasing harness so two antennas can be fed as a beam.

Of course, the new FCC rules in-



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
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find enough help for an antenna-
raising party there's no good reason
you can't get your antenna up to the
new limit.

Walkie-talkies

Little is new in the walkie-talkie
field; there is simply more of what
already existed. Seemingly endless
brands of 100 mW models, and many
3, 4 and 5-watt models featuring either
full 23 channel coverage or up to 6-
or 8-user selected channels. Almost
without exception, the high power
models are the equal of high perform-
ance mobile transceivers, with high
selectivity, excellent sensitivity and
many conveniences such as S/rf/bat-
tery meters, remote speaker jacks, PA
operation and even, perhaps, Delta
tuning such as on Fanon's T-1000. If
anything can be considered new it's
that there are more military styled
high-power models with separate
transmitter (microphone) and re-
ceiver (speaker); you hold these two
elements to the ear just as you would
a telephone.

Oddball entries

One really good idea just didn't
seem to take off; that of the channel
9 (only) transceiver for people who
have no primary need for CB but
might like the security offered by an
emergency radio link. Small and in-
expensive, on first view they seemed
the answer to security while on the
road, but even American Motors,
which now provides dealer-installed
CB installations, has opted for a multi-
channel Johnson transceiver. Perhaps
the channel-9 transceiver will catch
on only when it is a *factory installed*
option available for all cars.

One really terrific idea, requested
by many active CB'ers, has finally seen
the light of day. The Midland 13-883
has an auxiliary volume control
mounted on the microphone, so a
mobile operator doesn't have to reach
out to adjust the received signal vol-
ume. He can adjust the sound level
from either the microphone or the
transceiver.

It seems like 1975 is shaping up as
the "Year of the operating conveni-
ence features." Most likely there will
be no new or startling technological
advancements until the manufacturers
start using LSI integration techniques
that will produce a high-performance
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CLOCKS

(continued from page 46)

the FAST-SLOW adjustment on the back panel.

IC2 is a 14-stage CMOS binary divider integrated circuit. Thirteen of the stages are used in this circuit to divide the oscillator frequency by 2^{13} (or 8,192). The output of IC2 is 60-Hz.

The additional two gates in IC1 are used as an astable multivibrator operating at about 8-kHz. When the SLOW SET pushbutton is activated, the 8-kHz oscillator replaces the 491.520-kHz oscillator as the input to the divider. The SLOW SET pushbutton, S3, also sets the MM5314N to its fast-set mode. By using the fast-set mode with the lower frequency input, the slow-set mode is simulated. Why go to so much trouble when the MM5314N already has a slow-set function built into the chip? Good question! Answer: 1) most of the parts are already available, and 2) this allows us to set the hours and minutes without effecting the seconds. In actual operation, this feature makes it easier to set the time accurately or to easily synchronize the time against a standard source. S4 is the FAST SET pushbutton.

S1 is mounted on the back panel of the wall clock, and is used as a convenient way of switching the display time-format from the 12-hour to the 24-hour mode. S2 serves as the HOLD-RUN switch.

Transistor Q14 is used for interdigit blanking. Without it, some segments would glow slightly when they are supposed to be off, because of the inductance of the conductors in the large display panel, as well as the length of the interconnecting cables.

The wall clock operates on 12-volts ac or dc. Since the time base is generated internally by the quartz-crystal oscillator, the ac-line frequency is not needed, and the clock will run on 12-volts dc. For ac-line operation, the UL-approved plug-in stepdown transformer shown in Fig. 19 is also used with the wall clock. When operating from 12-volts dc, polarity is not important. Either lead may be connected to either lug on the terminal strip, TS1. This is possible because of the bridge rectifier, D1 to D4, used in the circuit.

A standard 9-volt transistor radio battery, B1, protects the wall clock against power-line failure. B1 powers the three IC's in the clock circuit during a power failure, and time information is never lost. Under normal operating conditions, B1 is on "standby" and is not delivering power to the circuit. The instant the power fails, diode D8 switches B1 into the circuit until ac power is restored. Since the display consumes most of the power, it is off while the power is off but will display the correct time when power is restored to the circuit. Battery B1 should be replaced after a total of about 100-hours of power failures, or once each year, whichever comes first.

The article will conclude next month when construction details, foil patterns and inside views of the clocks will be presented. (continued next month)



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new products

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

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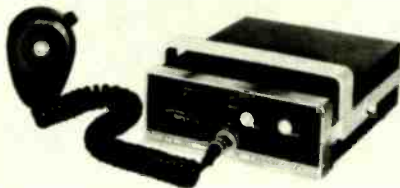


need for an SWR bridge. GLC 1087 is a 500-watt, 13-78-MHz unit and costs \$28.95; GLC 1088 has a rating of 1000 watts and 144-

220 MHz and costs \$33.95.—**Gold Line Connector, Inc.**, 25 Van Zant Street, East Norwalk, CT 06855.

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TRANSCEIVER, model BTL-301. .35-micro-volt receiver has selectivity of 6 dB @ ± 7.5 -kHz, 70 dB @ ± 15 -kHz and delivers an audio output of 5 watts. Power output is rated at 30 watts from a 13.8-volt dc power source. i.f. system is double conversion 10.7 MHz-455 kHz. Noise-operated squelch system is adjustable by a front panel control. Transmitter section is protected by VSWR bridge limiting circuitry. High-impedance



plug-in ceramic mike is included with each unit as is a dash-mounting bracket.

Solid-state American-made unit is type accepted by the FCC under parts 21, 89, 91 and 93 of operation over the low-band frequency range. 2 5/8 x 6 1/2 x 9 1/2 in.; 6 1/2 lbs.; \$329.00.—**Regency Electronics**, 7900 Pendleton Pike, Indianapolis, IN 46226.

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MULTITESTER, FET-300. Portable test instrument is a differential amplifier that uses field effect transistors and is designed for use at the workbench and to meet the field needs of the serviceman or engineer. Provides uniswitch design, front-panel calibration facility and a zero center scale for FM tuner alignment. Mirror arc design helps eliminate parallax error from readings.



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2-WAY RADIO, model FM 545. Hand-held uhf 2-way radio features plug-in modular construction. Dual phase-lock loop circuitry keeps the receiver on frequency even if the



transmitter being received should drift off frequency. Unit is available with these options and accessories that include: 2- or 4-watt transmitter output, Call Guard tone squelch, one to six channel operation, external microphone, speaker and antenna provision, leather carrying case and leather holster and several battery chargers. 6.8 x 2.6 x 1.5 in., less antenna; 21 oz.—**E. F. Johnson Co.**, Dept. 72-19, 299 Tenth Avenue, SW, Waseca, MN 56093.

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ADD-A-METER, model HVM3900. Add-on provides continuous monitoring of the picture-tube anode voltage of the chassis under test without additional connections. Meter enables you to adjust the high voltage to manufacturer's specifications, avoid-

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accuracy of 2%. Multiplier assembly is a calibrated high-voltage resistor. Self-contained; completely assembled with hardware for mounting at any location up to 36 inches from the test rig.—TeleMatic, 2862 Fulton Street, Brooklyn, NY 11207.

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PRINTED CIRCUIT KIT, Cat. No. 22-297 contains drafting aids, tray set, etch resist sensitizier, etch resist lacquer, developing solution, etching solution, stripping solution, layout film (two sheets that are 8½ x 11 inches), contact frames and two



copper clad boards (3 x 5 x ¼ inches; 4 x 6 x ¼ inches). Kit is for students with back-to-school projects as well as for the serious hobbyist or technician.—GC Electronics, 400 South Wyman Street, Rockford, IL 61101.

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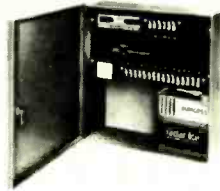
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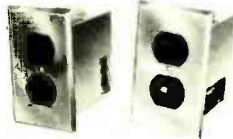
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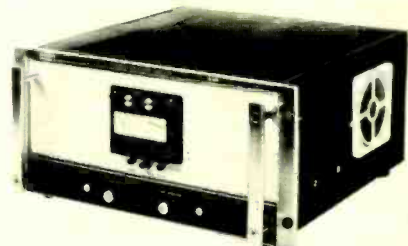
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new lit

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CB COMMUNICATIONS CATALOG. 16-page catalog features the company's complete line of base station and mobile antennas; highlights its new P.D.L. II Polar Diversity Loop model that handles over 2000 watts and three new mobile HIPPO (HI Power Potential) models. Also included are trunk-lid and deck mounts, co-phasing harness kit and other mobile accessories.—Avanti Research & Development, Inc., 33 West Fullerton Avenue, Addison, IL 60101. R-E

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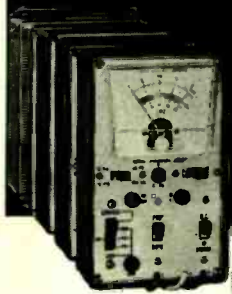
MOBILE RADIO CATALOG. Mobile radios, together with a base station, are illustrated in this 8-page catalog. In addition to photos and specifications on Golden Eagle AM and AM/SSB models, this catalog also contains photos and spec information on the Brownie model—a new mini-mobile.—Browning Laboratories, Inc., 1269 Union Avenue, Laconia, NH 03246.

Circle 40 on reader service card

COMMUNICATIONS EQUIPMENT CATALOG. 16-page catalog features transceiver evaluation system called Range Rated Radios. Also contains CB base models, CB handheld models, CB mobile models, CB power supplies and accessories, scanners, land mobile models, a marine model and an amateur model. Many illustrations and complete specifications for each model.—Linear Systems, Inc., 220 Airport Blvd., Watsonville, CA 95076. R-E

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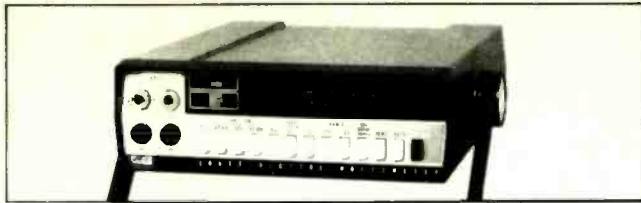
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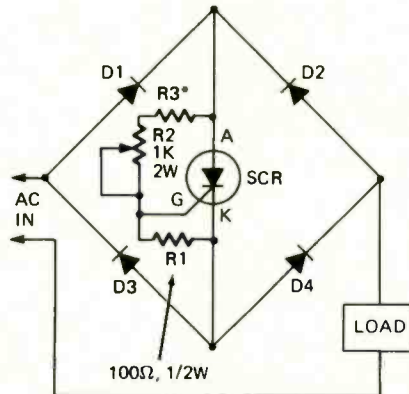
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circuits

UNIVERSAL FULL-WAVE SCR CONTROL CIRCUIT

The circuit in Fig 1. shows how an SCR (Thyristor) can be used to obtain fullwave control of current into a resistive load. As resistor R2 is varied, varying portions



*SEE TEXT

FIG. 1

of the ac power cycle will be supplied to the load. Figure 2 shows the current flow for each half-cycle of the applied voltage. The diodes are arranged to insure that the SCR conducts in the same direction, regardless of the phase of the applied voltage.

The value of series resistor R3 depends on the sensitivity of the SCR being used. Set R2 to its maximum resistance of 1000 ohms and select a value for R3 so the load current just cuts off. (In some cases, the sensitivity of the

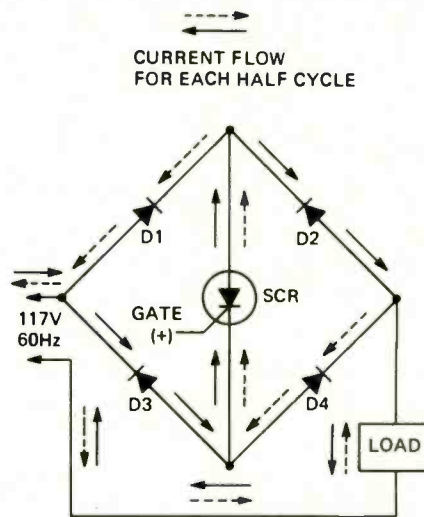


FIG. 2

SCR will make it necessary to adjust the value of R1.) Diodes D1-D4 may be any 3-amp devices rated at 200 PIV. Similarly, the SCR is a 3-amp, 200 PIV device. Although the devices are rated at 3 amps, increasing the rating of the SCR makes it necessary to increase the diode ratings as well.—William R. Shippee

R-E

next month

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TECHNICAL TOPICS (continued from page 68)

connected to input I. Q1 saturates. Collector current through R4 turns on the pot SUS and R4 is effectively shorted out. The voltage drop across R3 and Q1 turns on the lower SUS and lights the LED. The circuit stays locked on until reset by momentarily removing V_{IN} or shorting C1.

The other stages are locked out and cannot be triggered on because the current drawn by the conducting stage drops the supply voltage available to them to the sum of the forward voltages of the two SUS's and the LED—about 4.6 volts for the devices shown. This is less than striking voltage V_x .

Road ice alarm

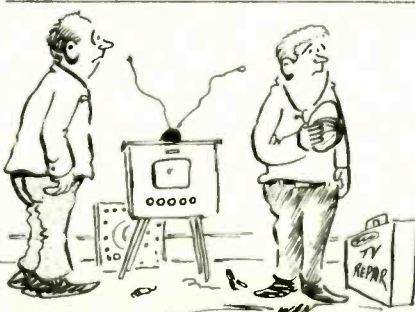
In 1968, we ran a construction article on a road-ice alarm that was basically an AND circuit that turned on warning lights when the temperature was near freezing and humidity close to 100%—conditions under which ice is likely to form unnoticed on road surfaces. The humidity sensor specified was discontinued by the manufacturer and many readers were unable to build the detector. The circuit in Fig. 5 is a simpler ice-warning alarm described in the "Designer's Casebook" column in *Electronics* magazine.

The circuit uses a thermistor and three sections of a LM3900 quad op-amp IC. When the temperature drops to 36° F, the LED indicator flashes at about once each second. The flashing rate increases as temperature drops until 32° when the LED remains on.

Amplifier I compares the thermistor's resistance to the resistance of the standard network connected to its non-inverting input. Its output—fed to the non-inverting input of op-amp III—varies with temperature. Op-amp II is a free-running multivibrator feeding a pulse signal of about 1 Hz to the inverting input of op-amp III. This amplifier compares the outputs of op-amps I and II and turns on the LED when the multivibrator's output level drops below that op-amp I.

The monitor is calibrated by placing the thermistor in a mixture of crushed ice and water and adjusting the 20K pot so the LED stays on.

No information was supplied on mounting the sensor (thermistor) but in the earlier device, the sensor was mounted in a 2 3/4 x 2 1/8 x 1 1/8 inch aluminum utility box. A 3/4 x 1 inch hole was cut in the top surface of the box to admit a flow of air that leaves the box through about twenty 1/16-inch holes drilled in the bottom. The sensor box was mounted behind the radiator grille where air flowed through the box when the car was moving. R-E



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- Date of filing: October 7, 1974
- Frequency of Issue: Monthly
- Location of known office of publication: 200 Park Avenue South, New York, NY 10003.
- Location of the headquarters or general business offices of the publishers: 200 Park Ave. South, New York, NY 10003.
- Names and addresses of publisher, editor and managing editor: Publisher and Editor-In-Chief, **M. Harvey Gernsback**, 200 Park Ave. South, New York, NY 10003; Editor, **Larry Steckler**, 200 Park Avenue South, New York, NY 10003.
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Systematically, the book explains antennas and transmission lines, electronic servicing equipment, the use and application of common circuit components, basic TV theory and troubleshooting. Included is a realistic sample test that will serve as a dry run for an actual CET exam.

BASIC ELECTRICITY AND AN INTRODUCTION TO ELECTRONICS, Third Edition, by the Howard W. Sams Editorial Staff. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 208 pp. 10¾ x 8¼ in. Softcover \$5.95 (in Canada \$7.25).

Written for the student and beginner, this book covers the basic electrical laws, direct current, cells and batteries, magnetism, alternating current, measurement and control, distribution, heating and lighting and radiation, current flow and gases, electrochemistry and an introduction to the science of electronics.

The logical format used in the presentation of the subject lends itself to student study and also serves as a quick reference.

ABC'S OF CITIZENS BAND RADIO, Third Edition, by Len Buckwalter. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 128 pp. 8¼ x 5¼ in. Softcover \$3.95 (in Canada \$4.95).

This book is a guide to the establishment of a CB system—from the initial idea to the completed functioning installation. For the novice CB user who is mechanically inclined and has a few simple tools, he can install a CB set in his car, home or boat, erect an antenna and start operations.

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MODERN RECORDING TECHNIQUES, by Robert E. Runstein. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 367 pp. 8¼ x 5¼ in. Softcover \$9.95 (in Canada \$11.95).

This book introduces the reader to the equipment and controls he will encounter in the modern multi-track recording studio in terms of both the operating techniques currently in use and the roles they play in creating the finished product.

This descriptive book fills the information gap between recording engineers, record producers and recording artists. It covers the techniques of pop music recording as well as all aspects of the recording engineer's job. Both presently employed and aspiring recording engineers will appreciate the practical job information that is given. Producers and recording artists will benefit from familiarity with the techniques and equipment they will be using in the studio.

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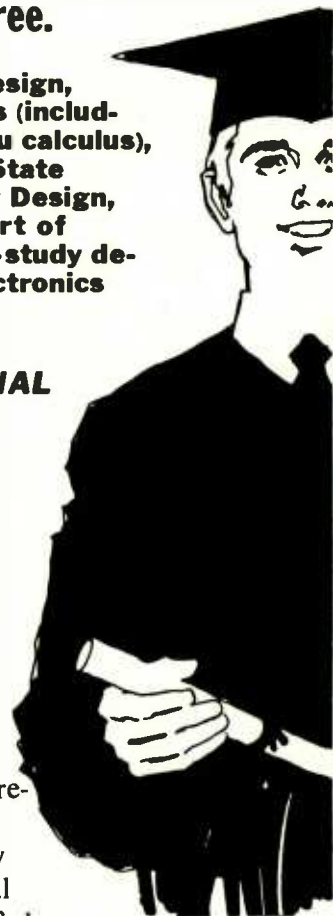
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STEP BY STEP

(continued from page 73)

ance to dc. Disconnecting one end of this component will do you no good at all, whether it is open or shorted, since V8 won't operate normally anyway unless its biased just right. Therefore, substitution is the only answer—and sometimes 56- μ H isn't easy to come by. A new coil, of course, did the trick and all waveforms returned to normal as Fig. 7 amply illustrates. At 2V/div., the signal at the control grid of V8 now measures some 8 volts, (Fig. 7, lower trace), while burst continues ringing the crystal at better than 50V, with a time duration of approximately 10 μ s.

A vectorscope alignment from scratch was then undertaken that consumed about 20 minutes, instead of the usual 5-minute touchup, and the receiver was returned to normal operation. True, this problem is a bit unusual, but a shorted coil (and this one would not ring) cannot be measured with an ohmmeter and must be evaluated by ac voltages and an oscilloscope . . . Unfortunately, there is no other way. R-E

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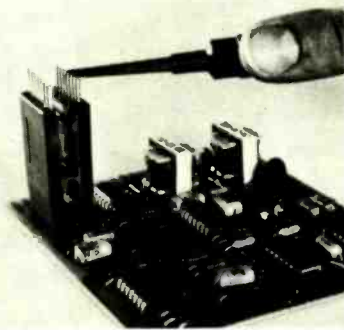
(continued from page 61)

their plastic design and it uses low resistance nickel-silver contacts.

It sells for \$4.75 in a 16-pin model and a quarter less in its 14-pin version.

IC releases

RCA has again expanded their COSMOS IC line with a slew of new numbers. Among them, the CD4066A Quad Bilateral Switch is an improved version of the CD4016A with lowered on resistance. There is a 200-stage shift register and a 256-bit Static RAM



with access times less than 250 nanoseconds.

In their linear line, two FM multiplex stereo decoders, the CA758E and CA1310E use RC oscillators. RCA already markets the CA3090AQ stereo

decoder using a novel LC voltage controlled oscillator.

Stewart-Warner has also entered the CMOS market by bringing out their versions of the 4011, 4012 and 4023 NAND gates.

Silicon General is manufacturing the CG556 dual 555 type timer. The two timers are contained in a single 14-pin package. Both timers, are contained on a single chip and are matched within 0.05% on timing and both will track within ± 10 ppm $^{\circ}$ C. Supply voltage drift is matched to 0.1% per volt. The 100 piece plastic package price is \$1.50. R-E

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3.3 uF/50V	14c	12c	11c	47 uF/16V	17c	14c	13c	470 uF/16V	37c	30c	27c
4.7 uF/50V	14c	12c	11c	47 uF/25V	19c	15c	14c	470 uF/25V	49c	39c	35c
10 uF/16V	14c	12c	11c	100 uF/16V	19c	15c	14c	1000 uF/16V	49c	39c	35c
10 uF/25V	14c	12c	11c	100 uF/25V	24c	18c	17c	1000 uF/25V	75c	60c	55c
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7413 .79	7492 .79	74199 2.19
7416 .39	7493 .79	74200 6.95
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7421 .35	74100 1.50	CD4002 .55
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7427 .35	74123 .99	CD4011 .55
7429 .40	74125 .60	CD4012 .55
7430 .22	74126 .79	CD4013 1.10
7432 .29	74141 1.15	CD4016 1.25
7437 .45	74145 1.10	CD4017 2.50
7438 .39	74150 1.05	CD4019 1.25
7439 .50	74151 .89	CD4020 1.50
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7447 1.10	74163 1.59	74C20 .65
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7450 .24	74165 1.89	
7451 .27	74166 1.65	
7453 .27	74170 3.00	
7454 .39	74173 1.65	
7459 .25	74174 1.85	
7460 .49	74175 1.85	
7470 .15	74176 .89	
7472 .36	74177 .89	
7473 .43	74180 1.05	
7474 .42	74181 3.50	

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7437-39¢	7483-79¢	74161-1.15	
7438-39¢	7490-75¢	74164-1.29	

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 CD4002-39¢ CD4013-89¢
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- C gates, interface elements, clock drivers, etc.
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- 2 memory board #1 (employs 1101 rams)
- 3 memory board #2 (employs 1101 rams and 5203 erasible PROMS)

Basic Data Package

available separately
refundable with purchase of basic kit \$5.00

TRANSISTORS

DEVICE	FUNCTION	CROSS REF. **		SPECIFICATIONS									
		SK	HEP	HFE	VCEO	VCBO	VEBO	IC(A) AMP	IB(IA) AMP	TOT DIS (WATTS)	FREQ MHZ	CASE	PRICE
PWR AMP AUDIO													
40411		3036		35 100	80	90	5.0	30	15	150	1.5	TO-3	\$3.75
40636		3027	704	20 70	95*	95*	7.0	15	7.0	115		TO-3	1.95
2N3714		3036	704	25 90	80	100	7.0	10	4.0	150	4.0	TO-3	2.59
2N3715		3036	704	50 150	60	80	7.0	10	4.0	150	4.0	TO-3	2.75
RF PWR AMP													
2N5320		3512	53002	30 130	75	100	7.0	2	1.0	10	50	TO-5	1.65
2N5322 (P)				30 130	75	100	7.0	2	1.0	10	50	TO-5	1.75
2N5321		3512	53010	40 250	50	75	5.0	2	1.0	10	50	TO-5	1.65
2N5323 (P)		3513		40 250	50	75	5.0	2	1.0	10	50	TO-5	1.65
PWR DRIVER													
2N5679 (P)	Audio/RF		53031	40 150	100	100	4.0	1.0	0.5	10	30	TO-5	1.70
2N5681				40 150	100	100	4.0	1.0	0.5	10	30	TO-5	1.70
AUDIO DRIVER													
40594		3024	53002	70 350	95*		4.0	2.0	1	10	1.0	TO-5	1.45
40595 (P)		3025	53031	70 350	95*		4.0	2.0	1	10	1.0	TO-5	1.65
2N5781 (P)				20 100	65	80	5.0	3.5	1	10	1.0	TO-5	1.75
2N5784			53002	20 100	65	80	5.0	3.5	1	10	1.0	TO-5	1.75
2N5864 (P)	RF & Audio			25 500	70	90	5.0	1.5		8.75	50	TO-39	1.35
40348		3044	243	30 125	40	60	7.0	1.5	0.5	8.75	1.6	TO-5	1.72
40544		3045		35 200	50*	50*	5.0	0.7		7.0	100	TO-5	.79
GEN PURP AMP													
2N2895	RF & Audio	3024		40 120	65	120	7.0	1.0		1.8	120	TO-18	1.25
2N930A	Lo Noise	3039	50	100 300	60	60	6.0	.03		45	45	TO-18	.95
2N2219A	Audio UHF Amp/SW	3024	53001	75 375	40	75	6.0	8		1.8	300	TO-5	1.05
2N2846	High Speed Sw	3024		30 120	30	60	5.0	8		3.0	250	TO-5	1.55
HF GEN PURP													
2N3933	VHF/UHF Amp	3039	56	60 200	30	40		.002		2	750	TO-72	1.55
40894	VHF/UHF RF Amp	3039		50 250	12	20	2.5	.05		.3	1200	TO-72	1.10
40895	VHF/UHF Mix. Osc	3039		40 250	12	20	2.5	.05		.3	1200	TO-72	.95
40897	VHF/UHF IF Amp	3039		70 250	12	20	2.5	.05		.3	800	TO-72	.90
2N5179	LoNoise, Amp, Osc, Mix, Conv	3039	709	25 250	12	20	2.5	.05		.3	2000	TO-72	1.10
2N918	VHF/UHF Amp	3039	709	20 Min	15	30	3.0	.05		.3	600	TO-72	.95
2N2905A(P)	Mix, Conv DC, VHF, Amp Hi Sp Sw	3025	708	100 300	60	60	5.0	6		3.0	200	TO-5	1.15

** Manufacturers: (SK - RCA, HEP - MOTOROLA) Suggested Cross Reference. *External Res (R_{BE}) = 100 OHMS

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15	ohm	5%	1w Corning	Film	.08
15	ohm	5%	25w Ohmite	WW	.75
28.7	ohm	1%	1w Dale	Film	.25
75	ohm	5%	8w Ohmite	WW	.39
102	ohm	1%	1/2w Corning	Film	.15
200	ohm	5%	5w Intl. Tect.	WW	.30
220	ohm	10%	1/2w Stackpole	C Comp	.07
330	ohm	5%	1/2w Stackpole	C Comp	.10
390	ohm	5%	2w Allen Bradley	C Comp	.25
450	ohm	5%	5w Dale	WW	.30
500	ohm	5%	1w Allen Bradley	C Comp	.19
620	ohm	5%	1/2w Stackpole	C Comp	.10
681	ohm	1%	1/2w Dale	Film	.20
750	ohm	1%	1/2w Dale	Film	.20
1	Kohm	1%	1/2w Corning	Film	.15
1	Kohm	5%	10w Dale	WW	.35
1.2	Kohm	1%	1w Intl. Rect.	C Comp	.25
1.6	Kohm	5%	1/2w Stackpole	C Comp	.10
2	Kohm	1%	1/2w Dale	Film	.20
2	Kohm	5%	5w Intl. Rect.	WW	.30
2.15	Kohm	1%	1/2w Corning	Film	.15
2.4	Kohm	1%	5w Intl. Rect.	WW	.50
2.5	Kohm	5%	25w Ohmite	WW	.75
2.7	Kohm	5%	5w Dale	WW	.30
3.01	Kohm	1%	1/2w Electra	Film	.15
4	Kohm	5%	10w Dale	WW	.35
4.7	Kohm	1%	1/2w Corning	Film	.15
5.6	Kohm	5%	2w A.B.	C Comp	.25
7.5	Kohm	5%	1/2w Burroughs	C Comp	.10
8.25	Kohm	1%	1/2w Electra	Film	.15
9.09	Kohm	1%	1/2w Corning	Film	.15
9.1	Kohm	5%	2w A.B.	C Comp	.25
10	Kohm	1%	1/2w Corning	Film	.15
15	Kohm	10%	1/2w Stackpole	C Comp	.07
17.4	Kohm	1%	1/2w Corning	Film	.15
20	Kohm	5%	1w A.B.	C Comp	.19
23.7	Kohm	2%	1/2w Corning	Film	.15
39	Kohm	1%	1/2w Corning	Film	.15
51	Kohm	5%	1/2w Burroughs	C Comp	.10
75	Kohm	1%	1/2w Corning	Film	.15
100	Kohm	1%	1/2w Corning	Film	.15
120	Kohm	5%	1/2w Burroughs	C Comp	.10
130	Kohm	5%	1/2w Stackpole	C Comp	.10

CAPACITORS

.0033	mfd	100V	5% Skottie mylar axial	\$.10
.0047	mfd	100V	10% G.E. mylar axial	.09
.0047	mfd	100V	10% Gen. Inst. mylar axial	.09
.01	mfd	200V	20% Aerovox paper axial	.05
.02	mfd	100V	1% Sprague mylar axial	.15
.1	mfd	600V	3% Aerovox paper axial	.20
.1	mfd	400V	Aerovox paper axial	.20
.1	mfd	200V	CDE paper axial	.15
.1	mfd	200V	Aerovox paper axial	.15
.5	mfd	400V	10% Gen. Inst. mylar axial	.35
1.0	mfd	200V	Aerovox axial	.20
2.0	mfd	200V	20% Aerovox axial	.20
4.0	mfd	350V	Sprague Elec axial	.45
5.0	mfd	25V	Gen. Inst. Elec axial	.15
10	mfd	150V	Sprague Elec axial	.30
30	mfd	300V	Mallory Elec axial	.35
60	mfd	350V	Mallory Elec axial	.75
1,000	mfd	100V	Sangamo Comp grd can	2.65
1,000	mfd	50V	CDE Elec axial	1.25
2,000	mfd	15V	Mallory Elec can	.85
6,000	mfd	25V	Sangamo Comp grd can	3.75
50	mfd	285V	I.C.C. oil imp bathtub	.60

SWITCHES

SPST	1A Momentary Return P.B. A.H.&H.	.25
SPST	15A Micro switch Flat leaf	.50
DPST	5A Micro switch Pin plunger	.75
DPST	10A Micro switch-mini Pin plunger	.65
DPST	10A Pin plunger	.65
4P3T	6A Slide Stackpole	.25

MISC. COMPONENTS

1 ohm 25w 5A	Memcor wire wound pot.	1.95
100 ohm 1/2w	Bourns EZ trim WW 30 turn pot.	1.50
10 Kohm 1/2w	Bourns EZ trim WW 10 turn pot.	1.50
MDA 962	Motorola fullwave bridge 10A 100V	4.95
AEX 43-1	TEC selenium Rectifier	.05
IN 2990A	Motorola 33V 1w zener diode	1.95
LA 2751	Fenwell Thermister 550 100	.75
6113	Elwood Thermal	.75
Panel Light PTT	red DPST SW W/ Mount Tec	.95
Panel Light	red Neon W/NE 2 Bulb Snap Mount	.45
4 Terminal	Chassis Count Terminal Strip	10/25
Chassis Mount	Cable Clamp 1/2" Nylon	15/25

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Part No.	Ea.	Part No.	Ea.	Part No.	Ea.
7400	\$.19	7447	\$1.15	74141	\$1.23
7401	.19	7448	.15	74145	1.15
7402	.19	7450	.24	74150	1.09
7403	.19	7451	.27	74151	.89
7404	.22	7453	.27	74153	1.29
7405	.22	7454	.39	74154	1.59
7406	.39	7460	.19	74155	1.19
7407	.39	7464	.39	74156	1.29
7408	.25	7465	.39	74157	1.29
7409	.25	7472	.36	74161	1.39
7410	.19	7473	.43	74163	1.59
7411	.29	7474	.43	74164	1.89
7413	.79	7475	.75	74165	1.89
7415	.39	7476	.47	74166	1.65
7416	.39	7483	1.11	74173	1.65
7417	.39	7485	1.39	74176	1.65
7420	.19	7486	.44	74177	.99
7422	.29	7489	2.75	74180	1.09
7423	.35	7490	.76	74181	3.65
7425	.39	7491	1.29	74182	.89
7426	.29	7492	.79	74184	2.69
7427	.35	7493	.79	74185	2.19
7430	.22	7494	.89	74190	1.59
7432	.29	7495	.89	74191	1.59
7437	.45	7496	.89	74192	1.49
7438	.39	74100	1.65	74193	1.39
7440	.19	74105	.49	74194	1.39
7441	1.09	74107	.49	74195	.99
7442	.99	74121	.57	74196	1.85
7443	.99	74122	.53	74197	.99
7444	1.10	74123	.99	74198	2.19
7445	1.10	74125	.69	74199	2.19
7446	1.15	74126	.79	74200	7.95

LOW POWER TTL

74L00	.33	74L51	.33	74L90	1.69
74L02	.33	74L55	.33	74L91	1.45
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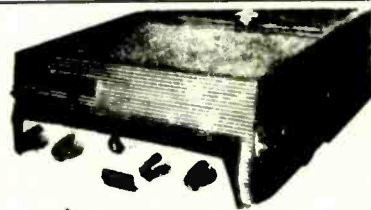
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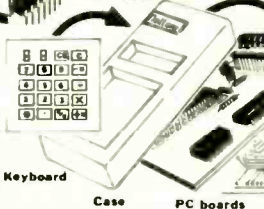
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		SN7471	.55	SN7507	1.85
				SN7508	1.85
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Radio-Electronics is published by Gernsback Publications, Inc. 200 Park Ave. S. New York, NY 10003 (212) 777-6400

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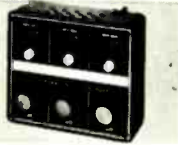
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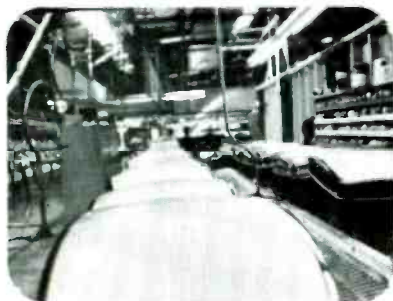
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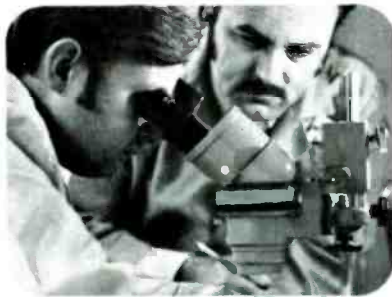
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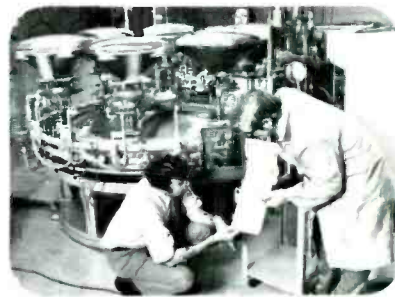
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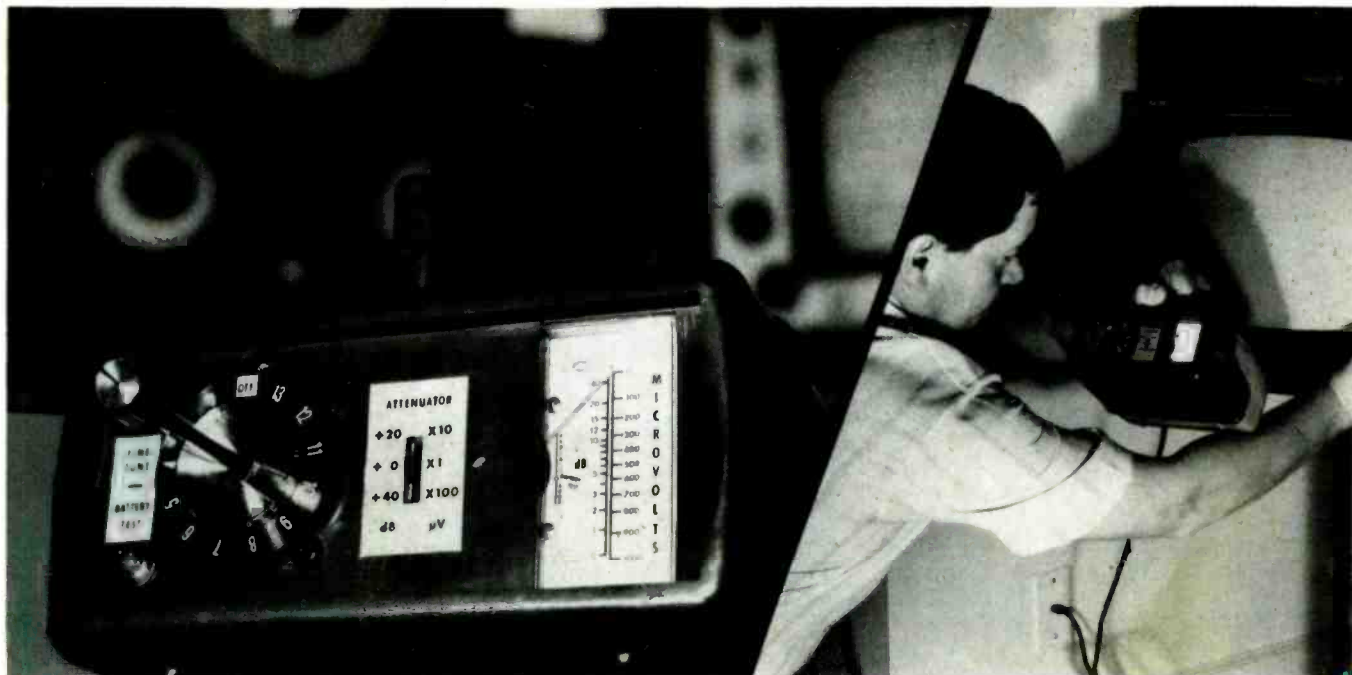
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Tuning: All 12 VHF channels
Inputs: 75 ohms - "F" connector; 300 ohms - screw terminals
Accuracy: \pm 3dB typ.



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