Build Last-Word IC Stereo Preamp

How IC Logic Circuits Work

Build a 50-Watt Guitar Amplifier

All About Ovonics

60c ■ MAY 1969

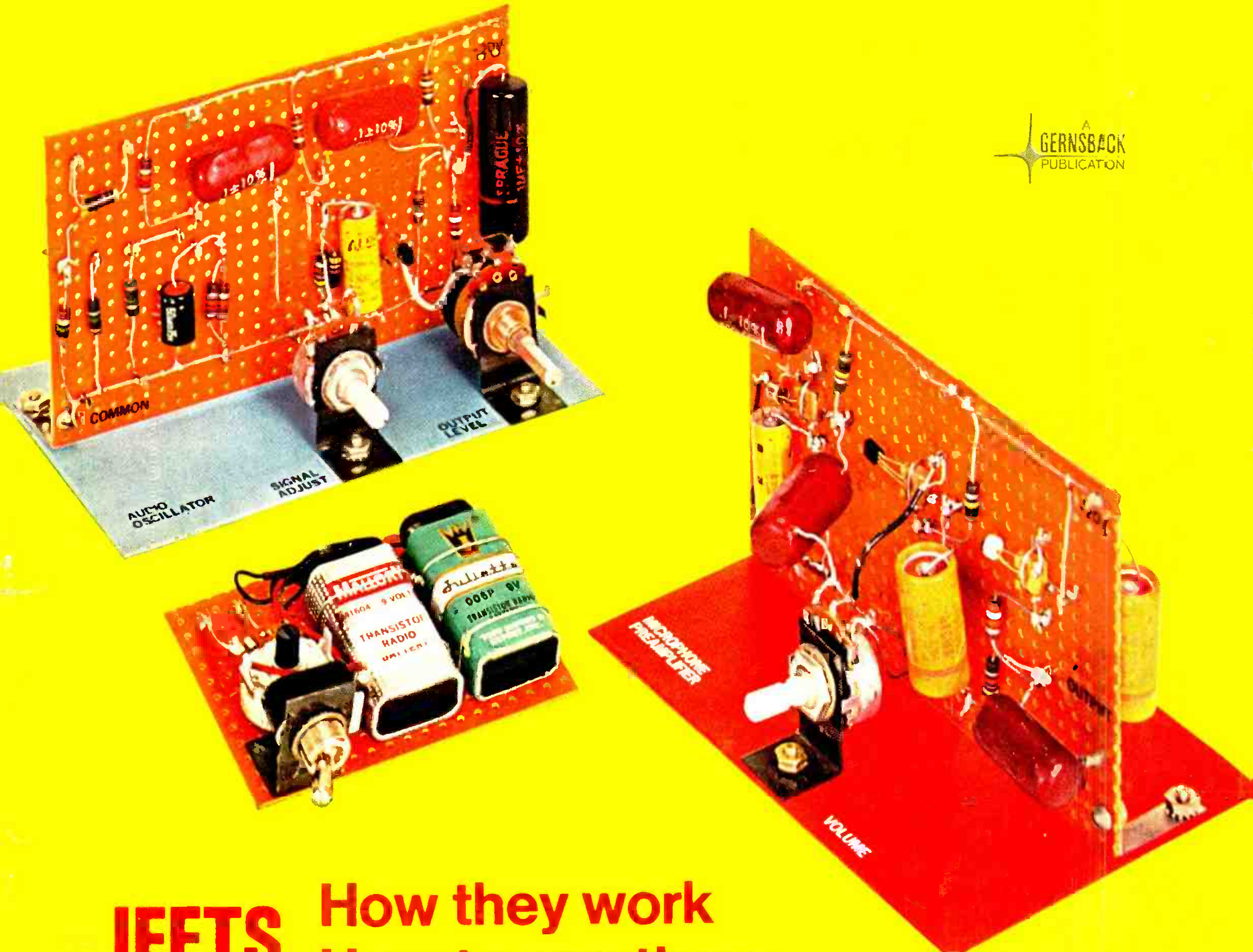
Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

What's New in 5-Watt CB Gear

Electronics For Weekend Sailors

A GERNSBACK PUBLICATION



JFETS How they work How to use them

EICO Makes It Possible

Uncompromising engineering—for value does it!
You save up to 50% with Eico Kits and Wired Equipment.

NEW

NEW

Cortina Stereo

THE VERDICT IS IN. High fidelity authorities agree: Cortina's engineering excellence, 100% capability, and compact dramatic esthetics all add up to Total Stereo Performance at lowest cost.

A Silicon Solid-State 70-Watt Stereo Amplifier for $99.95 kit, $139.95 wired, including cabinet. Cortina 3070

A Solid-State FM Stereo Tuner for $99.95 kit, $139.95 wired, including cabinet. Cortina 3200.

A 70-Watt Solid-State FM Stereo Receiver for $169.95 kit, $259.95 wired, including cabinet. Cortina 3570.

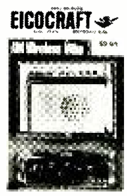
NEW Silicon Solid State 150-Watt Stereo Amplifier designed for audio perfectionists. Less than 0.1% harmonic distortion, IM distortion. Less than 0.6% at full output. Controls and inputs for every music source. $149.95 kit, $225.00 wired including cabinet. Cortina 3150

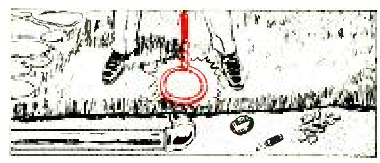
NEW 70-Watt Solid State AM/FM Stereo Receiver for $189.95 kit, $279.95 wired including cabinet. Cortina 3770.

Eicocraft

The newest excitement in kits. 100% solid-state and *professional.*
Fun to build and use. Expandable, interconnectable. Great as "jiffy" projects and as introductions to electronics. No technical experience needed. Finest parts, pre-drilled etched printed circuit boards, step-by-step instructions.

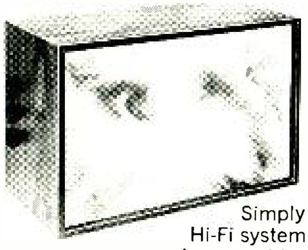
EC-100 Electronic Siren $4.95, EC-101 Electronic Burglar Alarm $6.95, EC-102 Electronic Fire Alarm $6.95, EC-200 Electronic Intercom $5.95 EC-300 Audio Power Amplifier $5.95, EC-400 Electronic Metronome $3.95, EC-500 Tremolo $9.95, EC-600 Electronic Light Flasher $3.95, EC-700 Electronic "Mystifier" $4.95, EC-800 Photo Cell Nite Lite $4.95, EC-900 Power Supply $8.95, EC-1000 Code Oscillator $2.50, EC-1100 FM Wireless Mike $9.95, EC-1200 AM Wireless Mike $9.95, EC-1300 Electronic VOX $8.95, EC-1400 Solid State FM Radio $9.95, EC-1500 Solid State AM Radio $8.95, EC-1600 Electronic Bongos $7.95





6 EXCITING NEW PROJECTS
EC-1700 Ham/CB Vox $8.95,
EC-1800 Electronic "TOX" $8.95,
EC-1900 "Treasure Finder" $9.95,
EC-2000 Electronic Organ $9.95,
EC-2100 Electronic "Eye" $9.95,
EC-2200 "Magic Switch" $9.95

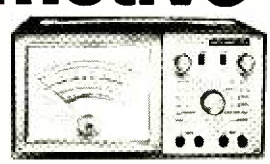
Color n' Sound



Add a new dimension to your music system. Introducing the first inexpensive solid-state electronic system which provides true synchronization of color with sound. Watch the music you love spring to life as a vibrant, ever shifting interplay of colors. Simply connect to speaker leads of your Hi-Fi system (or radio). Kit can be assembled in several hours — no technical knowledge or experience necessary. Kit $49.95, Wired $79.95.

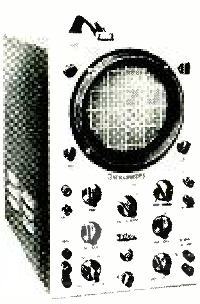
Automotive

EICO 888—Car/Boat Engine Analyzer.
For all 6V/12V systems; 4, 6, 8-cyl. engines.



Now you can keep your car or boat engine in tip-top shape with this solid-state, portable, self-powered universal engine analyzer. Completely tests your *total* ignition/electrical system.

Complete with a Tune-up & Trouble-shooting Manual. Model 888; $49.95 kit, $69.95 wired.



Test Equipment EICO®

100 best buys to choose from.

"The Professionals"
—laboratory precision at lowest cost.

Model 460 Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. $99.95 kit, $149.95 wired.

Model 232 Peak-to-Peak VTVM. A must for color or B&W TV and industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® $34.95 kit, $49.95 wired.

FREE 1969 CATALOG
EICO Electronic Instrument Co., Inc.
283 Malta Street, Brooklyn, N.Y. 11207
☐ Send me **FREE** catalog describing the full EICO line of 200 best buys, and name of nearest dealer.

Name ______
Address ______
City ______
State ______ Zip ______

Circle 8 on reader service card

Grantham School of Engineering RE-5-69
1505 N. Western Ave., Hollywood, Calif. 90027

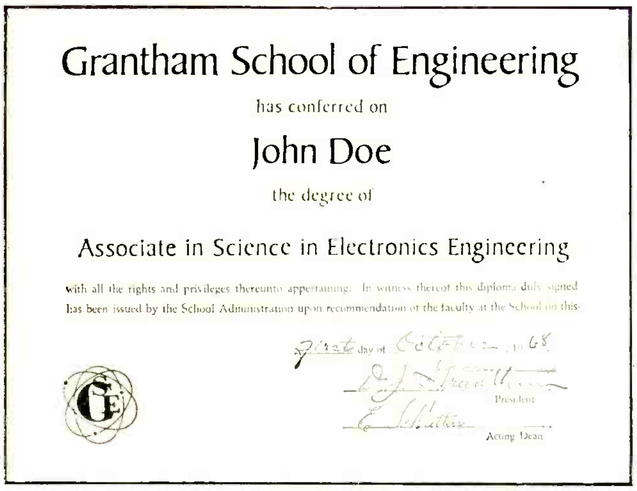
Please mail me your free Bulletin, which explains how the Grantham educational program can prepare me for my Associate in Science Degree, and my Bachelor of Science Degree in Electronics Engineering.

Name ______________________ Age ______

Address ______________________

City ____________ State ________ Zip ________

2



Grantham School of Engineering

has conferred on

John Doe

the degree of

Associate in Science in Electronics Engineering

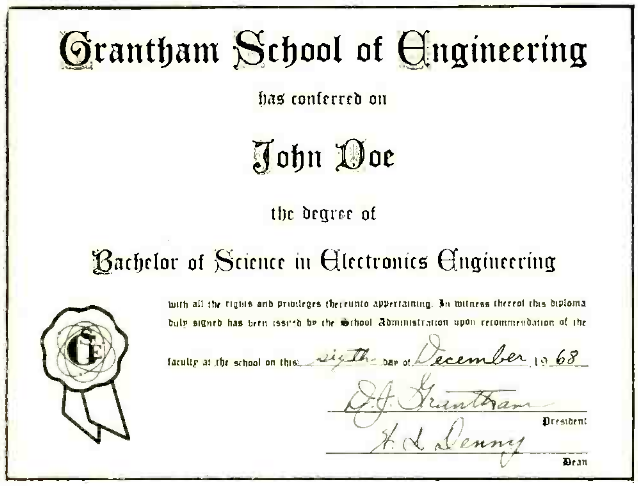
with all the rights and privileges thereunto appertaining. In witness thereof this diploma duly signed has been issued by the School Administration upon recommendation of the faculty at the School on this

first day of October 1968

President

Acting Dean

3



Grantham School of Engineering

has conferred on

John Doe

the degree of

Bachelor of Science in Electronics Engineering

with all the rights and privileges thereunto appertaining. In witness thereof this diploma duly signed has been issued by the School Administration upon recommendation of the faculty at the school on this sixth day of December 1968

President

Dean

Grantham School of Engineering

1505 N. Western Ave.
Hollywood, Calif. 90027
Telephone:
(213) 469-7878

1

Three Big Steps to Success... in ELECTRONICS ENGINEERING

There they are — three big steps that lead electronics technicians to *greater success* — three deliberate steps to *greater recognition* and *more income*. Your future is shaped by the moves you make — by the steps you take. Begin now with Step #1.

STEP #1 is a simple request for full information on the Grantham Electronics Degree Program. You take this first step by filling out and mailing the coupon. Then, we *mail* our catalog to you; we do not send a salesman.

STEP #2 is earning your Associate in Science Degree in Electronics Engineering (the ASEE). If you have completed at least one year of fulltime experience as a bona fide electronics technician, you may earn your ASEE Degree almost entirely by correspondence — including a minimum resident attendance of only two weeks.

STEP #3 is earning your Bachelor's Degree in Electronics Engineering. Success in engineering requires heavy emphasis on fundamental concepts of logic and mathematics, rather than on superficial manipulative skills. Since these fundamental ideas are relatively unfamiliar to electronics technicians, they are developed in a systematic manner in the Grantham Electronics Degree Program.

Accreditation and G.I. Bill Approved

Grantham School of Engineering is *accredited* by the Accrediting Commission of the National Home Study Counuil, is *approved* under the G.I. Bill, and is *authorized* under the laws of the State of California to grant academic degrees.

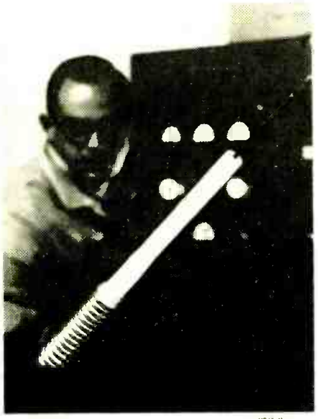
Grantham School of Engineering is a *specialized*, college-level, educational institution — established in 1951. Grantham specializes in teaching engineering by the so-called "new approach" — the method (often referred to by names such as "independent study") that has recently created great interest among college educators. Actually, this "new approach" is not new at all. Grantham and many other good schools have been using it for years, under such names as "home study" and "correspondence instruction".

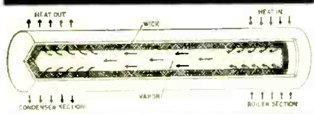
Now that the method has become "respectable" and is being used by reputable colleges to lead to bachelor's degrees, Grantham can offer you the opportunity to study for your ASEE and BSEE mostly by correspondence. Since you are already a technician and know the "hardware" side of electronics, you can upgrade from technician to engineer while you continue your present employment in electronics. Get complete details. Mail the coupon for our free Bulletin.

NEW & TIMELY

Volume 40 Number 5 RADIO-ELECTRONICS 1969

FLUID HEAT PIPE FOR SPACE POWER





Operating at 1350°F, this glowing pipe demonstrates the efficiency of a key component in a new space satellite thermoelectric generator. Heat from the induction coil is transferred uniformly along the pipe 500 times better than along any solid rod. In the generator being built by Westinghouse, a radioisotope is the heat source.

The heat pipe is a closed tube with a wire mesh "wick" on its internal surface. A low-vapor-pressure fluid such as liquid sodium saturates the wick and, when heated at one end of the tube, vaporizes and moves rapidly to the other end. There the vapor condenses, giving off heat. Capillary forces return the fluid to the evaporation end.

A generator consists of a heat source, heat pipe, thermoelectric module and planar radiator—a package similar in size to a large console TV set. Heat is transferred by the pipe to the inside of a tubular generator, the hot side of the thermoelectric couple. The radiator is the cold side. Output of a unit is about 120 watts (3.5 volts at 34 amps).

BETTER IR LASERS

PRINCETON N. J.—A new breed of "close-confinement" lasers developed at RCA Labs may find use in completely portable range finders, communication systems, intrusion alarms and heavier, more sophisticated searchlights and aircraft altimeters. Using gallium arsenide, the new devices can convert 10 watts of electric power directly to 1-watt infrared light pulses at room temperature. Efficiency of the devices is 10% compared to 2% of other solid-state lasers at room temperature. Larger units have generated 70-watt pulses of light.

In addition to having small power supply requirements, the lasers are about five times as reliable as other semiconductor infrared lasers since they operate at lower current levels.

IN THIS ISSUE

Two special roundup stories provide you with up-to-date details on the latest 5-watt CB gear, and electronic equipment for boating. Find out how new devices and circuits are making CB and marine electronics more sophisticated, but bringing costs down.

LOOKING AHEAD

By DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Bright idea

Goodbye Yttrium—Hello Gadolinium!

This might be the hit song from the upcoming color TV saga, "The Battle of the Rare Earths," as the color tube brightness war stands on the brink of a new escalation for manufacturers.

At least one manufacturer is planning a new super-bright tube, keyed to the use of the rare earth gadolinium and a new shadow-mask. The combination could result in another brightness step-up of about 32%. Most color tubes now use a red phosphor formulated from either europium-activated yttrium vanadate or europium-activated yttrium oxide. The new phosphor, now being produced by two chemical firms, is based on europium-activated gadolinium oxide, and is claimed to add a brightness factor of about 20% to the red color.

The rest of the brightness increase will be gained by using a new shadow-mask with hexagonal holes which are slightly larger than the round holes in current masks. (R-E, August 1968).

1971 color TV preview

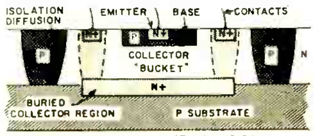
Looking ahead for another year or so—to the 1971 color TV models—it's probable that we'll see three new large-screen color tubes. Two will have squared-off corners—a "supertube" 25 inches in diagonal measurement, with 315 square inches of viewing area, and a 21-inch tube with about 226 square inches. They're designed as eventual replacements for the current 23-inch tube (295 square inches) and the 20-inch (226 square inches, same

(continued on page 4)

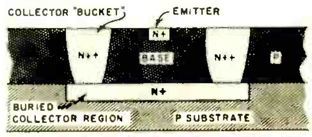
NEW FABRICATION METHODS TO CUT IC COST AND SIZE

Although fabrication of monolithic integrated circuits has been somewhat standardized for mass production, the process is still complex and costly. But now independent research by scientists at Bell Labs and Japan's Kyodo Electronic Labs has simplified fabrication, eliminating up to three masking steps, reducing transistor areas on the chip 75% and making switching times less than 1 nsec possible.

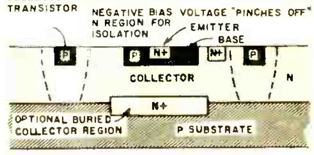
A disadvantage to conventional IC fabrication methods is the separate masking process required to electrically isolate chip components. In this diffusion isolation method



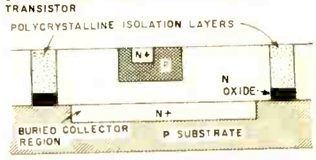
STANDARD BURIED COLLECTOR STRUCTURE OF A TRANSISTOR



COLLECTOR DIFFUSION ISOLATION STRUCTURE OF A TRANSISTOR



BASE-DIFFUSION ISOLATION STRUCTURE OF A TRANSISTOR



POLYCRYSTALLINE ISOLATION STRUCTURE OF A TRANSISTOR

(top drawing), p-type material is spread through the n-type layer to form a p-n junction with the p substrate. The diode property of this junction acts as an insulator.

One of the new techniques, proposed a year ago by Bell and now tested, uses a p-type layer grown on the p-substrate. Called collector-diffusion isolation, the process

(continued on page 4)

Radio-Electronics

May 1969 • Over 60 Years of Electronics Publishing

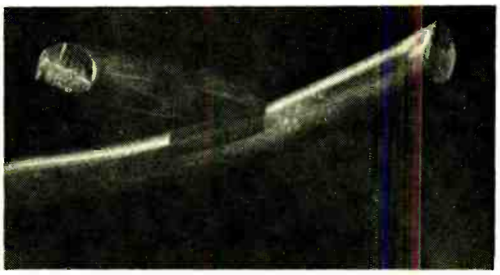
SPECIAL FEATURES

TELEVISION

BUILD ONE OF THESE

ELECTRONICS TODAY

AUDIO HI-FI

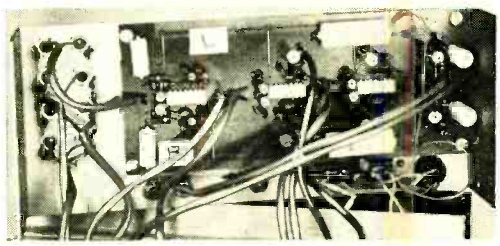


A glassy coating on these two wires may lead to a new solid-state electronics era. Inside, the complete story on ovonic semiconductors.

see page 41

Lost at sea? Not if you're equipped with the latest marine electronics equipment.

see page 37



Behind the front panel of our "last-word" hi-fi preamp. Three IC op amps do the job.

see page 45

DEPARTMENTS

RADIO-ELECTRONICS, MAY 1969, Vol. 40, No. 5
Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302
Editorial, Advertising, and Executive offices: 200 Park Ave. S., New York, N.Y. 10003. **Subscription Service: Boulder, Colo. 80302.**
Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U.S. and possessions, Canada, $6. Pan-American countries, $7. Other countries, $7.50. Single copies, 60¢.

POSTMASTER: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

Member, Institute of High Fidelity
Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

achieves several things in one strongly doped n-type diffusion step: collector-contact areas are established that also serve as isolating regions, and transistors bases and resistances are formed. Two masking operations can be eliminated and transistor area needs are quartered. IC's made with this method are suitable for moderate speed and power applications.

A second method, called base-diffusion isolation, uses a narrow p-type ring diffused around the transistor when its base is built up. Negative bias on the ring isolates the n-type region. Very low power is necessary, but transistor area is ¾ less than with conventional IC's and an optional buried collector offers below 1 nsec switching.

The Kyodo isolation technique involves depositing a polycrystalline layer such as silicon oxide where needed on the substrate. When the n-type layer is grown on the substrate slice, it forms an insulating polycrystalline layer above the oxide deposits, but a normal-conducting single crystal where circuit elements are fabricated.

When incorporated into IC production lines, the new methods should reduce costs. Two to three as many circuits fit on a silicon slice than with standard IC circuits.

NEXT MONTH

Here's just a few of the features you'll be seeing in your June issue of RADIO-ELECTRONICS:

- **How to Make Etched Circuits—Complete details on how to turn a PC pattern into a circuit board that works.**
- **SCR Projects—A two-part feature explains how silicon controlled rectifiers work, and presents dozens of useful SCR circuits you can build.**
- **Servicing VTR's—Video tape recorders are becoming more popular as costs go down, but how do you fix them? If you've shied away from this lucrative repair field because you think VTR's are too complex, don't miss this one.**

ELECTRONIC TYPESETTER HELPS IN THE CLASSROOM

Computerized information retrieval and an ultrafast electronic typesetting system have made it possible for teachers to tailor textbooks to individual class needs.

The page of text shown—complete with headlines, subheads, footnotes and rules—was set in 25 seconds by an RCA Videocomp typesetter. Speeds of up to 6000 characters a second are possible with the electronic composition system. The page is one of more than 12,000 forming the Encyclopaedia Britannica's new *Annals of America*, a set of reference books stressing original historical documents.

When a school system decides which articles and paragraphs are needed, the request is keypunched by the publisher and fed to a computer. The information is put on a magnetic tape, which is used with the Videocomp to write each page on film prior to platemaking and printing.

LOOKING AHEAD

(continued from page 2)

as its successor). The third type will be the first slim-line color tube with a 110-degree deflection angle—a new version of today's 18-inch tube (which has 90-degree deflection), designed for more compact large-screen portables.

Rapid warm-up CRT

Although the spotlight's on color, new developments are coming in black-and-white tubes, too. One, by Sylvania, is an ingenious directly-heated cathode designed for quick-on performance in solid-state sets. The video signals are applied to the tube via the combination heater-cathode. The tube's low power requirement—0.5 volts at 0.8 amperes—permits the heater to be driven by a simple (single-loop transformer) link to the horizontal yoke circuit. Tested in a 12-inch tube, the new design provided a raster in as little as 1½ to 2 seconds after turn-on.

Consumer IC breakthrough?

The spread of integrated circuits in consumer products has been slower than expected, with monolithic chips generally showing up only in higher-priced products because of their high costs—an average of a dollar each in large quantities.

This could begin to change rapidly. Now in production is the forerunner of a line of consumer ICs designed to sell in manufacturer quantities at—would you believe 20 cents?

The IC in question is a plastic quarter-watt audio

(continued on page 6)

NEA SUGGESTS GUIDELINES TO SIMPLIFY SERVICING

Recommended servicing guidelines for home entertainment products were recently drawn up by a National Electronic Associations committee. The suggestions for manufacturers on equipment serviceability are designed to reduce repair problems for technicians and cut unsafe manufacturing practices.

General—Tuners and other subassemblies should be easily removable for cleaning and inspection, and "parking space" for them provided on the main chassis. Transistors should plug in, and shields should not hinder tube removal. Interconnecting wires, test and other important points should be clearly identified.

Field servicing—Cabinet retaining devices should release without tools, and provisions made for supporting

(continued on page 6)

There's nothing wrong with the set.

You fixed the picture a week ago, now you're back repairing your repair job. And paying for it.

Replacement parts are supposed to last longer than that.

Like electrolytic capacitors. If they're wound in computer-grade, 99.99% pure aluminum foil, they'll hold up for a long time at continuous temperatures of 85 C.

Like Arcolytic capacitors do.

Even though they cost the same as any other home entertainment capacitor. And come in more than 2000 exact replacement values to maintain the set's stability.

Any Arcolytic distributor can fill you in on the whole line of Arcolytic types—twist mounts, printed circuit twist mounts, tubular electrolytics (including very high capacitance values) and miniature tubulars in the smallest physical sizes. He can also sell you Elmenco capacitors.

Then you won't have to do repair jobs twice. If the lady in the set seems to be missing something, a week after you've done a repair job, it's her problem. Not yours.

Loral Distributor Products
A DIVISION OF LORAL CORPORATION
Pond Hill Industrial Park, Great Neck, New York 11022

Circle 10 on reader service card

(continued from page 4)

the back when fasteners are released. Unusual methods of securing panels, knobs, etc. should be explained in prominent cabinet instructions. In-field adjustments should be clearly identified on the chassis and layout chart.

Bench service—Chassis should be stable when positioned for access to top and bottom with the tuner and assemblies on. A color yoke should be standardized in each deflection category by a manufacturer and adaptation kits made available. Circuit components should be easily accessible and removable. All adjustable components should be covered in service literature.

Schematics & literature—Service notes should explain new circuitry and avoid common-knowledge items. Location of adjustments should be next to adjustments. Schematics should be clear and easy to read; voltages should be included for signal/no-signal and color/no-color conditions. Parts list should be complete for the main chassis, sub-chassis, tuner and control mounting assembly, etc.

For details on the suggestions or comments write to NEA's secretary, Leon F. Howland. 4622 E. 10 St., Indianapolis, Ind. 46201.

MONOLITHIC IC DEVELOPS 18 WATTS

A monolithic IC chip capable of delivering a whalloping 18 watts continuous rms will soon be turning up in Sony Corp's stereo sets, TV's and other home entertainment products.

The Sony-developed chip contains two power transistors, four additional transistors, a diode and six resistors, and comes in a flat package with a special strap heat sink. For applications where lower power is adequate, the chip is also available in a standard TO-5 can. The dimensions of the monolithic chip are 1.5 x 1.75 mm. Although it's expected to find use primarily in audio circuits, the new IC can be used in TV vertical deflection circuits.

To operate at full output, the IC requires 40 volts with a 4-amp p-p maximum current. The fabrication technique used for the chip enables both poly-crystalline and single-crystal silicon to be grown so that buried-collector connections have low resistance and a high breakdown voltage.

Although hybrid IC's made in this country develop similar power levels, the Sony monolithic device has a power capability three times that of similar IC's now available.

THIS MONTH

Turn to Robert Ehle's article on electronic music and learn how to turn street noise, bongos, etc. into wayout sound.

Are transistors on the way out? Read Fred Shunaman's article to find out how a new glassy semiconductor works.

LOOKING AHEAD

(continued from page 4)

amplifier designed for radio and TV, being built by Motorola, which says it could turn out more than a million weekly by year's end. Coming later will be versions for i.f. strips in AM and FM sets. So certain is Motorola that it can break the IC price barrier that it plans to ship the units in huge quantities to manufacturers in Japan, Hong Kong and Taiwan, and eventually produce them in its own plant in South Korea.

Other semiconductor manufacturers are working on low-cost plastic ICs for everyday consumer electronics use, too, and the true microcircuit age for low-cost products could begin early next year.

Another new tuner

A unique uhf tuner with the "feel" and ease of a vhf tuner is scheduled to show up in some television sets to be introduced late this year. It provides a combination of continuous and detent (click) tuning, at the descretion of the user.

The device has two concentric knobs—the inner knob a continuous tuner, the outer detented to six positions. To pre-set uhf channels, the user merely tunes the center knob to the desired channel, then pushes it in, like setting a car-radio pushbutton. Then the outer knob is clicked to the next position for pre-setting the next channel, and the process repeated for as many as six channels.

After presetting, any uhf channel may be quickly located by using the outer knob. At any detent position, the inner knob may be used for fine tuning, or as a

(continued on page 14)

Radio-Electronics

HUGO GERNSBACK (1884-1967) *founder*

M. HARVEY GERNSBACK, *editor and publisher*

LARRY STECKLER, *managing editor*

Robert F. Scott, *W2PWG senior technical editor*

John R. Free, *associate editor*

Jack Darr, *service editor*

I. Queen, *editorial associate*

Matthew Mandl, *contributing editor*

David Lachenbruch, *contributing editor*

Carrie Ng, *editorial assistant*

Vincent P. Cicenia, *production manager*

Elizabeth Shincel, *production assistant*

G. Aliquo, *circulation manager*

Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
200 Park Ave. South
New York, N.Y. 10003
(212) 777-6400

President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo

ADVERTISING REPRESENTATIVES

EAST
John J. Lamson, Eastern Sales Mgr.

MIDWEST/N.&S. Car., Ga., Tenn.
Robert Pattis, the Bill Pattis Co.,
4761 West Touhy Ave.,
Lincolnwood, Ill. 60646
(312) 679-1100

W. COAST/Texas/Arkansas/Oklahoma
J. E. Publishers Representative Co.,
8380 Melrose Ave., Los Angeles,
Calif. 90069, (213) 653-5841;
420 Market St. San Francisco, Calif.
94111, (415) 981-4527

UNITED KINGDOM
Publishing & Distributing Co., Ltd.,
Mitre House, 177 Regent St.,
London W.1, England
RE 6534,5

SUBSCRIPTION SERVICE: Send all subscription orders and correspondence to RADIO-ELECTRONICS, Subscription Department, Boulder, Colo. 80302.

MOVING? For change of address, allow six weeks, furnishing both the old and new addresses and if possible attaching label from a recent issue below. Otherwise please print clearly your name and address exactly as it appears on your label.

ATTACH LABEL HERE

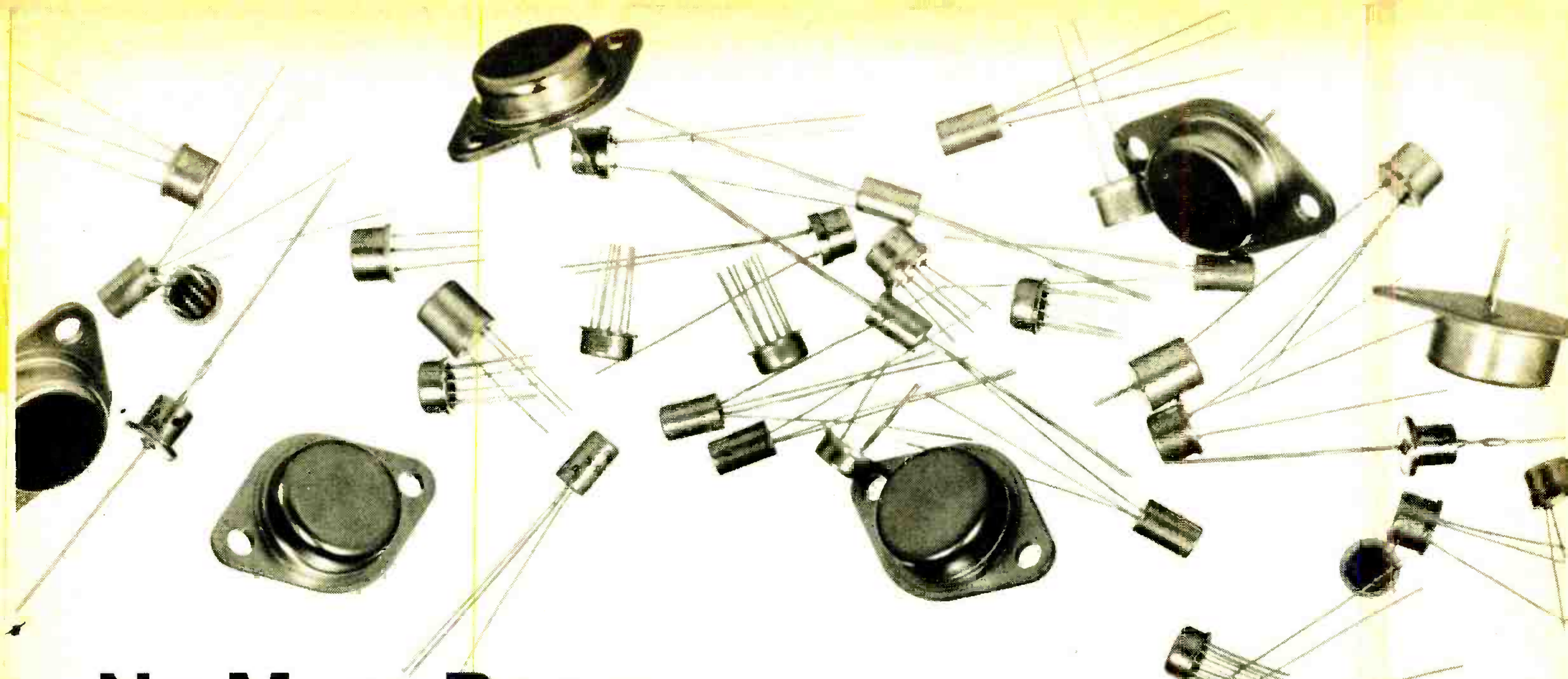
name (please print)

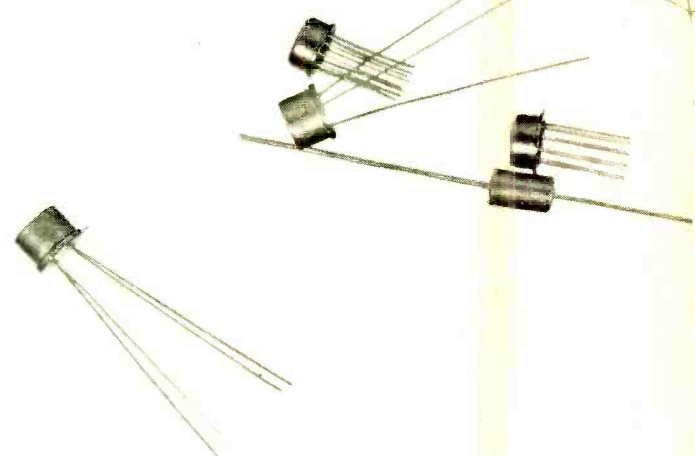
address

city state zip code

Mail to: RADIO-ELECTRONICS
SUBSCRIPTION DEPT., BOULDER, COLO. 80302

Circle 11 on reader service card →





No More Room at the Top?

There's always room . . . for improvement! And, because RCA understands this, the SK Series solid-state replacement line is constantly up-dated to meet your growing needs.

Backed by production excellence and premium specifications, RCA's "Top-of-the-Line" series—transistors, rectifiers, integrated circuits—is precisely engineered, manufactured, and tested for use specifically as replacements.

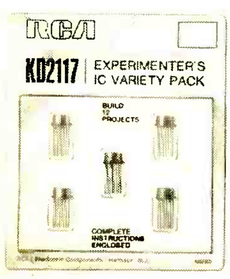
If you're building a name for yourself in solid-state servicing, your solid-state replacements should be RCA SK "Top-of-the-Line" devices. They are top-quality units—no cast-offs, no factory seconds, no unbranded culls.

The line is comprehensive—39 devices that can do the work of almost 13,000 others. Each unit has electrical characteristics comparable to or better than originally designed-in devices. RCA's SK series can be your answer for any needs from small signal to the newest in silicon audio output applications.

RCA SK Series and the types they replace are cross-referenced in the RCA Solid-State Replacement Guide—SPG-202G. Get your copy at your RCA Distributor. Today.

RCA

And, if you want an inexpensive way to extend your integrated circuit skill, try RCA's KD2117 Linear IC Variety Pack . . . includes 5 integrated circuits:



two KD2114 transistor arrays
one KD2115 audio amplifier
two KD2116 transistor arrays
plus
instructions for 12 useful circuits, schematics, parts lists, etc.

RCA | Electronic Components | Harrison, N. J. 07029

GET A FASTER START IN THE COURSE YOU CHOOSE WITH NRI'S REMARKABLE ACHIEVEMENT KIT

When you enroll with NRI we deliver to your door everything you need to make a significant start in the Electronics field of your choice. This remarkable, new starter kit is worth many times the small down payment required to start your training. And it is only the start . . . only the first example of NRI's unique ability to apply 50 years of home-study experience to the challenges of this Electronics Age. Start your training this exciting, rewarding way. No other school has anything like it. What do you get? The NRI Achievement Kit includes: your first set of easy-to-understand "bite-size" texts; a rich, vinyl desk folder to hold your training material in orderly fashion; the valuable NRI Radio-TV Electronics Dictionary; important reference texts; classroom tools like pencils, a ball-point pen, an engineer's ruler; special printed sheets for your lesson answers—even a supply of pre-addressed envelopes and your first postage stamp.

Learning electronics at home is faster, easier, more interesting with new achievement kit

Only NRI offers you this pioneering method of "3 Dimensional" home-study training in Electronics, TV-Radio . . . a remarkable teaching idea unlike anything you have ever encountered. Founded more than half a century ago — in the days of wireless — NRI pioneered the "learn-by-doing" method of home-study. Today, NRI is the oldest, largest home-study Electronics school. The NRI staff of more than 150 dedicated people has made course material entertaining and easy to grasp. NRI has simplified, organized and dramatized subject matter so that any ambitious man — regardless of his education — can effectively learn the Electronics course of his choice.

DISCOVER THE EXCITEMENT OF NRI TRAINING

Whatever your reason for wanting knowledge of Electronics, you'll find the NRI "3 Dimensional" method makes learning exciting, fast. You build, test, experiment, explore. Investigate NRI training plans, find out about the NRI Achievement Kit. Fill in and mail the postage-free card. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D. C. 20016

ELECTRONICS COMES ALIVE AS YOU LEARN BY DOING WITH CUSTOM TRAINING EQUIPMENT

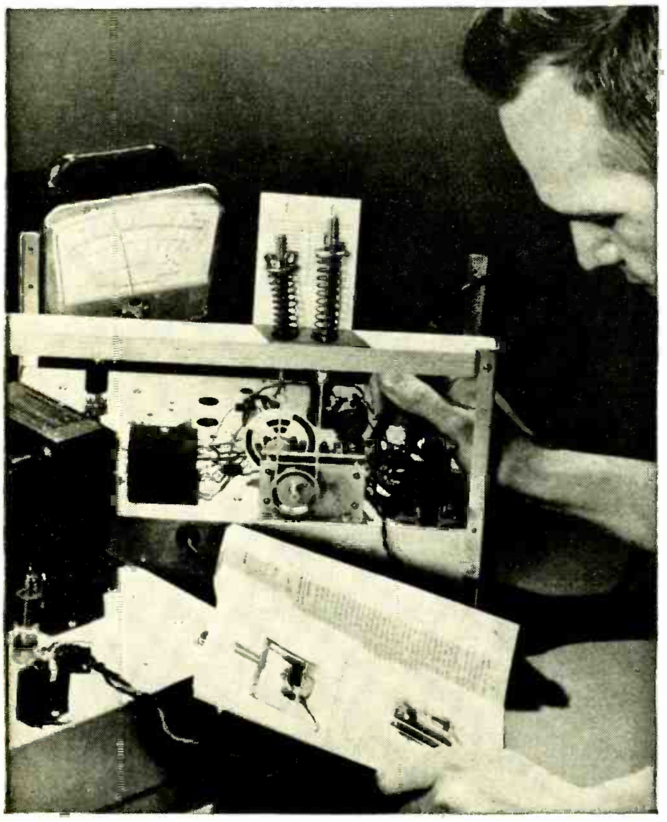
Nothing is as effective as learning by doing. That's why NRI puts so much emphasis on equipment, and why NRI invites comparison with equipment offered by any other school, at any price. NRI pioneered and perfected the use of special training kits to aid learning at home. You get your hands on actual parts like resistors, capacitors, tubes, condensers, wire, transistors and diodes. You build, experiment, explore, discover. You start right out building your own professional vacuum tube voltmeter with which you learn to measure voltage and current. You learn how to mount and solder parts, how to read schematic diagrams. Then, you progress to other experimental equipment until you ultimately build a TV set, an actual transmitter or a functioning computer unit (depending on the course you select). It's the practical, easy way to learn at home—the priceless "third dimension" in NRI's exclusive Electronic TV-Radio training method.

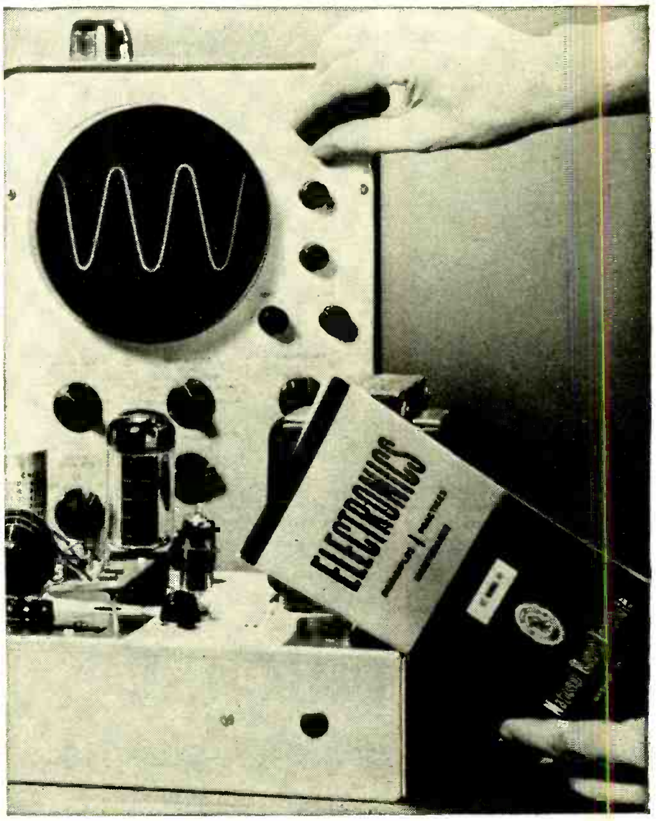
SIMPLIFIED, WELL-ILLUSTRATED "BITE-SIZE" LESSON TEXTS PROGRAM YOUR TRAINING

Lesson texts are a necessary part of training, but only a part. NRI's "bite-size" texts are as simplified, direct and well-illustrated as half a century of teaching experience can make them. The amount of material in each text, the length and design, is precisely right for home-study. NRI texts are programmed with NRI training kits to make things you read come alive. As you learn, you'll experience all the excitement of original discovery. Texts and equipment vary with the course. Choose from major training programs in TV-Radio Servicing, Industrial Electronics and Complete Communications. Or select one of seven special courses to meet specific needs. Check the courses of most interest to you on the postage-free card and mail it today for your free catalog.

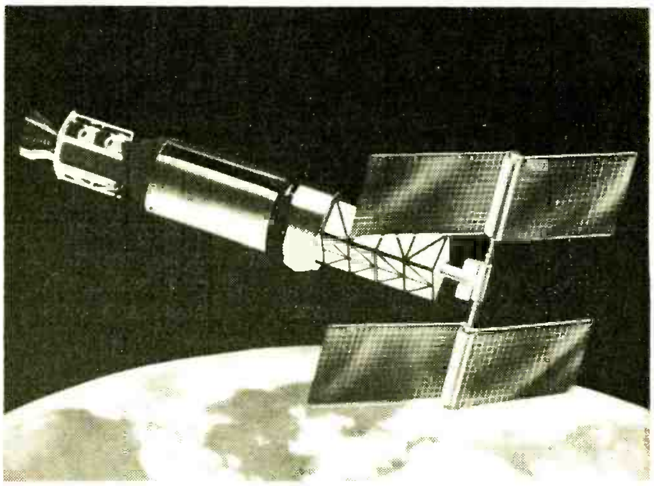
Available Under NEW GI BILL. If you served since January 31, 1955, or are in service, check GI line in postage-free card.

custom training kits "bite-size" texts





(continued from page 6)



SOLAR PANELS UNROLL IN SPACE

Huge retractable solar array panels that can be carried into space rolled up like a window shade are being developed for tests late next year. When unfurled in space, the 5½ x 16-foot panels could deliver 1500 watts of power for orbiting satellites and interplanetary spacecraft.

When a spacecraft maneuvers in orbit or passes through radiation belts, the panels can be rolled up for storage on their drums. The T-shaped mechanism on which the array will be mounted keeps the silicon solar cells perpendicular to the sun line. Units for the system being built by Hughes Aircraft Co. for the Air Force provide for energy storage, power control and sun tracking. Power output of the panels is 28 volts at 54 amperes.

SECURITY WITH CERAMIC

New space gun? No—a new type of piezoelectric lock being held by a pretty member of Sandia Corp., part of the Bell System, where it was developed. The ceramic rings expand or contract, depending on the direction of applied current. Once the rings are positioned in the cylinder, you need the right combination of electrical signals to remove them. "Picking" this lock with the wrong signals only makes it more difficult to open. Unlike electronic memory locks, this one is not sensitive to magnetic fields.

Circle 15 on reader service card

LOOKING AHEAD

(continued from page 6)

continuous tuner to locate any channel not preset. The new tuner, said to be competitive in price with continuous-tuning uhf types, is being made for set manufacturers by Sarkes Tarzian Inc.

Ready, cassette, go

The tiny two-reel cassette tape cartridge, which has blazed a hot trail in the portable recorder field, will soon gain new prestige as a medium for recorded music when RCA Records and Columbia Records make available their first pre-recorded releases in this format. These two major companies were the last of the big recording firms to join the cassette parade.

This new boost for the cassette makes it a formidable competitor to the eight-track continuous-loop cartridge which now dominates the tape-player field through its success in the automobile market. The greater flexibility of the cassette—its easy recording capability and adaptability to lightweight portables—is a big point in its favor. However, it may have a demerit in terms of somewhat lower frequency response at its 1⅞-ips speed.

Tape history has shown that fidelity has gradually improved at all speeds, and it's a good bet that the cassette some day will be promoted as a hi-fi medium. At any rate, it has now become a recognized playback as well as recording system, and could be preparing to challenge the Stereo-8 as a standard low-cost taped-music player.

Color from monochrome film

By early 1970, some television stations will be broadcasting in color from black-and-white film. They'll be using a system known as Broadcast Electronic Video Recording (BEVR for short) developed by CBS Laboratories, an offshoot of CBS's cartridge-loading film-scanner system designed for educational and home use, but not yet in production (R-E, February 1969).

The BEVR film equipment, being made in different versions by General Electric and Cohu Electronics, uses 16mm film containing two sets of frames side-by-side—one set looking like a conventional black-and-white film image, the other containing encoded impulses to supply the color electronically. The film masters are made by an electronic process from standard color film, while multiple "release prints" used by the TV stations are processed optically exactly the same as any black-and-white film.

The 16mm broadcast film system is said to provide the resolution of 35mm color equipment, but costs considerably less. Other advantages are claimed to be the low cost of black-and-white prints as compared to 35mm color film, and lack of fading and inconsistency characteristic of color prints.

Who's ahead?

Japan, which took over from the United States as the largest producer of radios, now says it's ready to challenge us in color TV. The Ministry of International Trade and Industry there says that by 1970 Japan could be the world's largest supplier of color sets. Current expansion plans will increase its total manufacturing capacity to nearly 6.8 million sets next year, although it made only 2.7 million last year and is preparing to turn out 4 million in 1969. American manufacturers made nearly 6 million color sets last year, expect to make about 10% more this year. R-E

Correspondence

CURRENT FLOW—WHICH WAY?

A statement in the August issue by Matthew Mandl ("Trouble Shooting TV Detector Diodes") is misleading. He states that the cathode of a tube is negative while the cathode of a diode is positive. He does admit the cathode of a tube emits electrons.

Someone should inform Matt that the polarity of a vacuum tube and a diode are identical. Current enters both at the cathode and exits at the anode or plate. Used as a rectifier, the cathode of both would connect to the positive side of the filter capacitor.

U. DUDLEY
Denison, Texas

Actually, the article did not *say "the cathode of a diode is positive." I did mention that the* symbol *has a plus sign at the cathode side and that the actual unit itself may be* so *marked. I also pointed out that this might be confusing if the "plus" marking is compared to the negative polarity of a vacuum tube. Later I indicated the direction of electron flow as being identical to that of a tube (cathode to anode).*

Unfortunately the confusion will continue as long as we have divided groups among our engineers regarding the direction of current flow (electron-flow theory vs. conventional current-flow theory). Thus, it might surprise Mr. Dudley to learn that many engineers will disagree with his statement that "current enters at the cathode and exits at the anode." I prefer to say "electron flow is from cathode to anode" to avoid misunderstanding.

Matthew Mandl

SURGEON FOR A WART?

Having read Mr. Paprocki's letter in the January 1969 R-E, I take offense at his statement that "anyone who can perform surgery on a solid-state color TV can surely figure out a simple 50-watt amplifier."

First, there's a terrific shortage of qualified technicians and we all have (*continued on page 16*)

CORRESPONDENCE
(continued from page 15)

more work than we can possibly handle. We do not pick the "easy ones," but rather the work that will show us a profit. The technician who can perform "major surgery" on color TV isn't going to mess around with a simple amplifier any more than a doctor who can perform open heart surgery is going to remove warts!

If he could only see the amount of work involved in completely disassembling a "simple" amplifier to resolder a poor connection on a PC board that some engineer swore would never go bad.

Service customers bring the problem on themselves when they are not willing to pay for the work involved. The owner of a color TV realizes that his set is a piece of sophisticated electronic equipment and is willing to pay for its repair. The "simple amplifier" owner doesn't, even though the time and skills are equal!

C. MILTON LOWELL, CET
Beloit, Wisconsin

MORE ON CET

The February issue carried a letter from David L. Downing mentioning the Certified Electronic Technician program. Mr. Downing outlines the "image" and "competency" problems that the service profession faces and offers some solutions that he feels might eliminate them.

His solutions show good thinking. Certainly licensing has been a goal of nearly all the service associations for years. Several states are presently working to obtain licensing. Also, Mr. Downing's dislike for multiple choice questions is understandable. The first version of the NEA CET 120 Question was an essay style test.

To explain the CET test procedure a little better: The CET program does not offer a "mail order" license. Only the CET information is obtained by mail. The test is given under direct supervision, mostly by electronic service associations.

Multiple choice questions are used so that it is not necessary for a tech to grade every test. The CET test does show drawings and asks for answers to troubleshooting problems.

The CET program is doing great things for the individual tech. I urge Mr. Downing to take the exam and see what we mean. **R-E**

DICK GLASS,
CET President
National Electronic Assns., Inc.
5302 W. 10th St.
Indianapolis, Indiana 46224

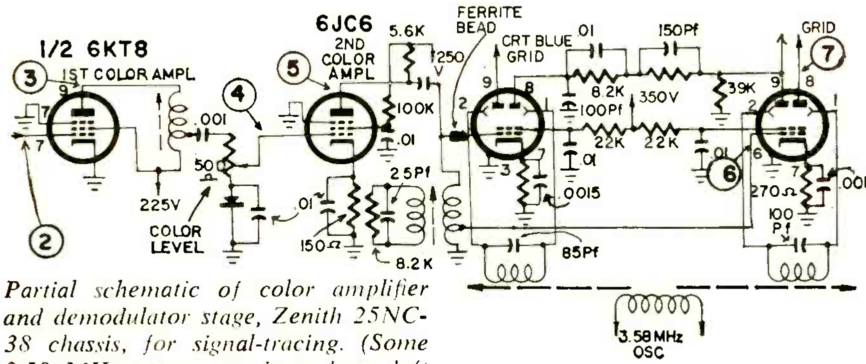
In the Shop . . . With Jack

By **JACK DARR**

SERVICE EDITOR

SIGNAL-TRACING COLOR WITH "SHOP" EQUIPMENT

The idea was to find out if I could signal-trace color signals, with "ordinary shop test equipment." Translation: a Precision scope old enough to vote, a bar–dot generator too old for Operation Head Start, etc. Having a Zenith 25NC38 chassis on the bench, I used that for the guinea pig.



Partial schematic of color amplifier and demodulator stage, Zenith 25NC-38 chassis, for signal-tracing. (Some 3.58 MHz traps, etc. have been left out.) Numbers in circles indicate waveforms found at these points in corresponding figure numbers.

The circuits are in Fig. 1 (I left out a few 3.58-MHz traps and things to make it clearer). There are two bandpass or "color amplifiers," as they're called in this one. These feed the color signals to a pair of high-level demodulator tubes. The plates of these drive the CRT grids directly. The phase-shifted R–Y and B–Y signals, mixed with the 3.58-MHz oscillator, are fed to the beam-deflector plates of the special 6JH8's. The demodulated color signals show up on the "regular plates" of these tubes.

So, away I went. I fed the bar-dot generator to the antenna input of the set, on its color bar pattern. This showed up on the screen, so the video or Y-channel was OK. Putting the low-capacitance probe on the scope, I checked the signal on the control grid of the first color amplifier, ½ of the 6KT8 tube. I got the

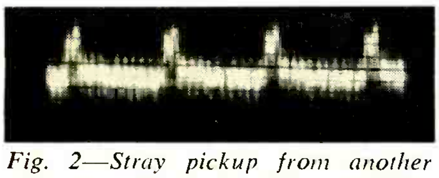


Fig. 2—Stray pickup from another tube on grid of 1st color amplifier.

pattern of Fig. 2. (A little while later, I found out that this *wasn't* the signal, but stray pickup from another tube! Oh, well——)

Fig. 3—A fuzzy sawtooth (6-7 volts p–p) on 6KT8 color amplifier plate.

Anyhow, on the plate of the 6KT8 I got the pattern of Fig. 3, sawtoothed and a bit fuzzy, but the bars were there. This meant that color signals were getting this far, at least. The color-level control has no effect at this point.

On the control grid of the 6JC6

(continued on page 22)

Fig. 4—Grid of 6JC6 (3–5 volts p–p).

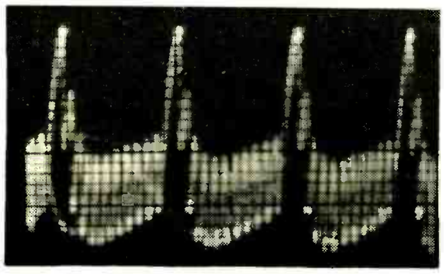
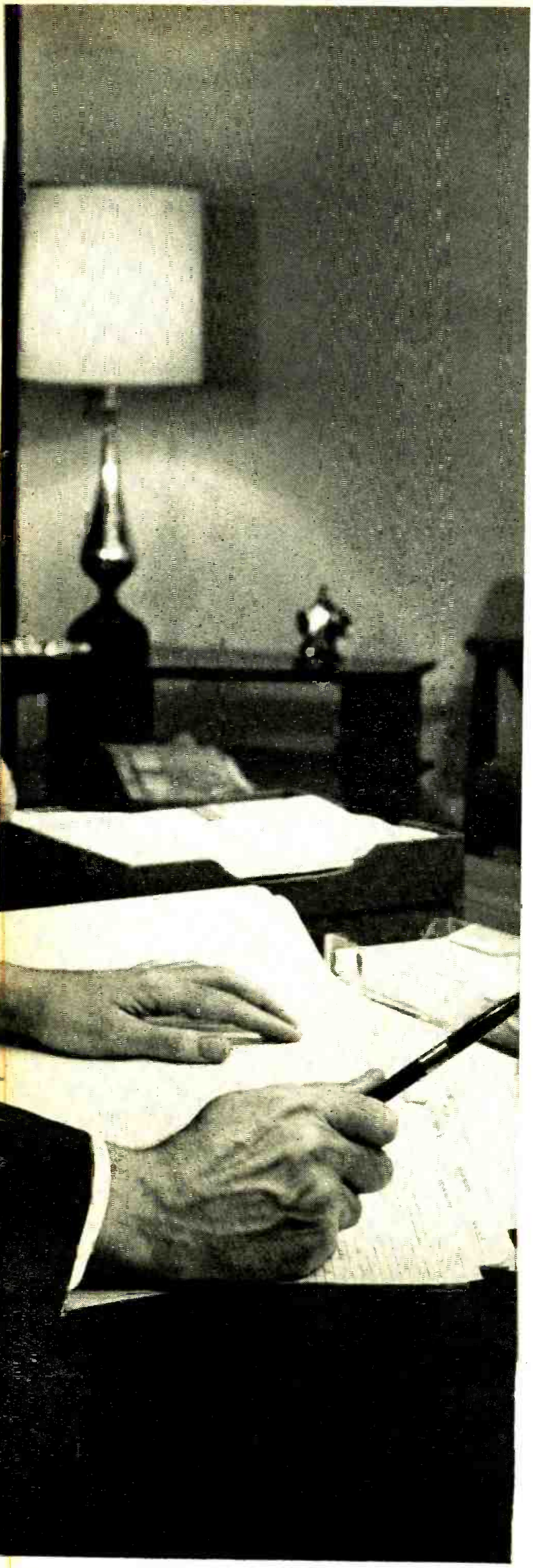


Fig. 5—Plate of 6JC6 (17 volts p–p).

"Get more education or get out of electronics

...that's my advice."



IN THE SHOP
(continued from page 17)

second color amplifier, I got a slightly clearer pattern (Fig. 4) and on the 6JC6 plate, the waveform of Fig. 5. Now, the horizontal blanking had been added, and the color-level control affected both grid and plate signal amplitude. So, all OK so far.

On to the control grid of the R–Y demodulator, one of the 6JH8's, there was a nice flat-topped

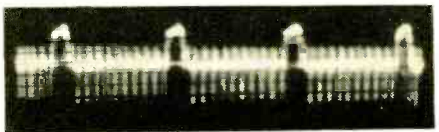


Fig. 6—At the grid of R–Y demod.

comb pattern, with blanking, at about 5 volts p–p (Fig. 6). Marching on to the pin-8 plate of the same tube, there was the same pattern, inverted

Fig. 7—At the plate of R–Y demod.

and amplified; about 70 volts p–p (Fig. 7).

So, ho! There it wuz! The color bar signal was going through all the stages and getting to the grids of the picture tube with plenty of amplification. We *can* follow this signal through the bandpass amplifiers and demodulators, and tell right where it stops, using only regular shop equipment.

This is fine; this is dandy. But! There's one little thing wrong. It's very plainly shown in certain waveforms, and all clues are given. Can you spot it right away, without looking at the answer?

ANSWER

SURPRISE! This set has absolutely *no color* on the screen! Nothing but nice clean black-and-white bars.

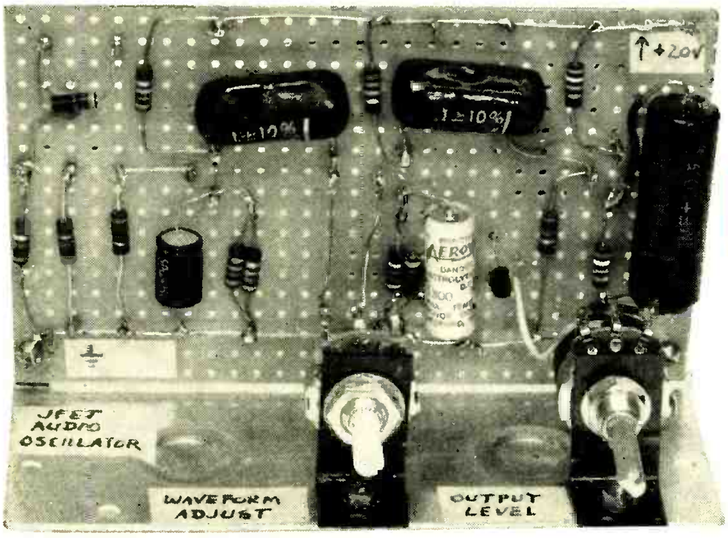
The 3.58-MHz color oscillator is not running at all, as you can see by the perfectly flat-topped waveform of Fig. 7, which is the red grid of the CRT. If the demodulator had been

Fig. 8—A R–Y demodulator signal.

working, you'd have the "rocker" pattern of Fig. 8. This will apply to all color output stages, low- or high-level demodulators; you must have the rockers at the grids of the CRT. (In this case, the 6KT8 reactance tube/color oscillator was shorted.) **R-E**

COVER STORY

Field-effect transistors have revolutionized solid-state circuit design. Find out why in this fact-filled series—Part 1



JFETS

How they work How to use them

By THOMAS R. HASKETT

IN ALL ELECTRONICS, NOT MANY DEVICES have been so long awaited or so enthusiastically welcomed as the Field-Effect Transistor (FET). Many die-hard fire-bottle men (like me) have been reluctant to use transistors except where they clearly did a better job than tubes, or where size and portability were major considerations.

Conventional transistors, unlike vacuum tubes, don't provide good input–output isolation. Their internal feedback causes distortion and requires complex circuits to deliver fidelity. Further, drift is a problem, and ordinary transistors are highly susceptible to zapping (burnout).

The FET has overcome many of the disadvantages of the conventional transistor, and tube lovers who learn about FET's are happy once again. Perhaps you don't realize that at this moment nearly three dozen different FET's can be had for less than $2.50 each—many for only a buck. They'll do most of the jobs of vacuum tubes and many of conventional transistors. In some cases, they'll do better jobs than any other amplifying devices.

Where FET's have an edge

The first thing most people seem to learn about the FET is that its high impedance—like a tube—rather than low impedance—like a conventional transistor. Typical FET input impedance (Z) is 100 megohms, with an output Z of 100,000 ohms.

Why such high impedance? The FET is a voltage-controlled device—like a tube—rather than a current-controlled device—like an ordinary transistor. That is, input voltage controls output current. Because of the FET's high impedance, it can be used in vacuum-tube circuit designs with little change in components. For one thing, you don't have to use electrolytics as coupling capacitors, and you can drive an FET directly from a high-impedance microphone or phono cartridge.

As a dc amplifier, the FET has a zero temperature coefficient. Unlike a tube or ordinary transistor, it does not drift.

As a general-purpose amplifier, the FET has the high power gain of a vacuum tube and less noise than either tube or transistor. Of course, it has no filament or heater, and power requirements are small.

As a vhf mixer, the FET has less noise and cross-modulation than either a tube or an ordinary transistor. This is due to the FET's nearly perfect square-law transfer characteristic. Output current varies with the square of the input voltage; hence the FET produces only second harmonics. Tubes and conventional transistors produce higher-order harmonics, causing more interference.

Other FET pluses include nearly constant current-output characteristic (flat drain-current/drain-voltage curves); almost completely unilateral gain function (nearly perfect input–output isolation), and it can be used as a voltage-controlled variable resistor (attenuator) when operated at low supply voltages.

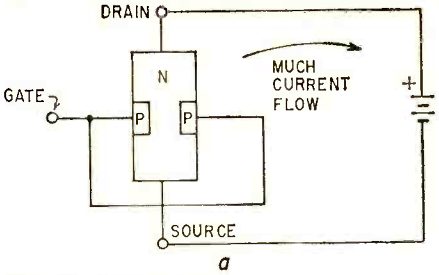
One unfortunate disadvantage of today's FET's is that they cannot produce much output power. The present limit seems to be a few hundred milliwatts. Some manufacturers, however, are working on power FET's. Such devices would be welcome, and would probably replace ordinary transistors in output stages.

How the FET works

There are two basic FET types: this article deals only with the first—the Junction FET. (The other type will be covered in a later article.) A basic JFET is shown in Fig. 1-a. It is made up of a bar of n-type semiconductor material with two p-type junctions diffused in its sides. The p-type junctions are connected together and called the *gate*. At one end of the n-type bar is a terminal called the *source*, which is connected to the negative pole of the battery. (This terminal is the *source* of current.) At the other end of the bar is a terminal called the *drain*, connected to the positive pole of the battery. (This terminal *drains* off current.) Thus current flows from the negative battery terminal, through the source and the bar (or channel), out the drain and to the positive battery terminal. The bar acts like a resistor, for it limits current flow. The schematic symbol for this basic n-channel JFET is in Fig. 1-b. (It is called an n-channel JFET because the bar, or channel, is made of n-type material.)

In Fig. 2-a, you see the same hookup as before, except that now another battery (with lower voltage than the first) has been connected between the *gate* and *source*. Note that the gate is made negative with respect to the source. As shown, little current flows from source to drain. Why? Because the reverse voltage bias applied to the gate causes electric fields, or *depletion zones*, to form around the p-type gate junctions. These fields oppose and decrease current flow through the channel, or bar.

If the gate-to-source voltage is increased enough, as in Fig. 3-a, current flow from source to drain stops entirely. This level of gate-to-source potential is known as *pinchoff* or *cutoff* voltage. Thus the bar of semiconductor material has become a variable resistor.



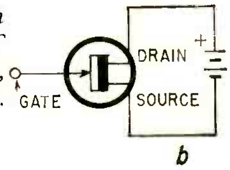
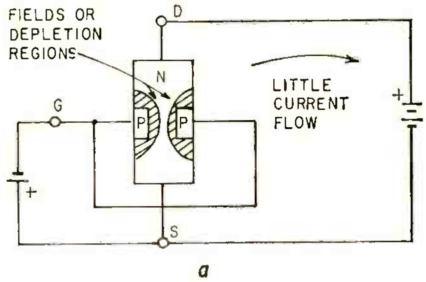


Fig. 1—Large current flows when gate is open. JFET pictorial at a, schematic is at b.



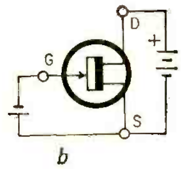
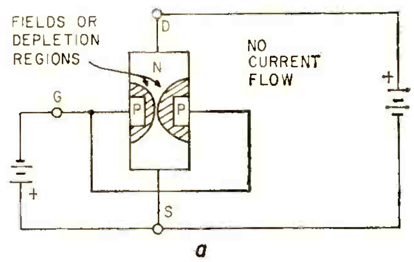


Fig. 2-a,-b—Low negative gate bias reduces the current flowing between drain and source.



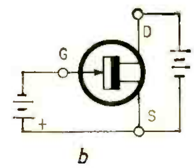


Fig. 3-a,-b—Increasing gate bias enlarges fields and pinches off the drain current.

Usually JFET's are made with symmetrical geometry. The symbol for such a device is shown in Fig. 4-a. Thus it makes no difference which end of the channel you call the drain or which you call the source—current can flow in either direction. On the other hand, some manufacturers make nonsymmetrical JFET's. The symbol for such a device is shown in Fig. 4-b. In this type of JFET, drain and source terminals are *not* interchangeable.

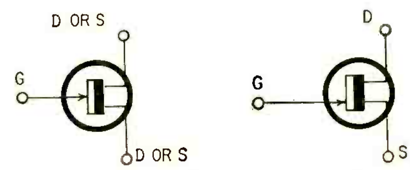
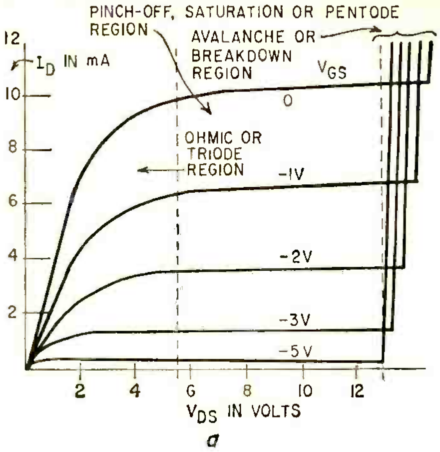
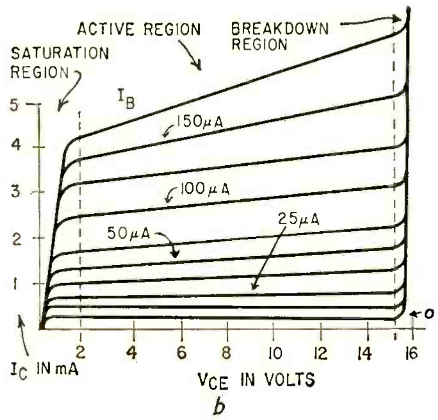


Fig. 4—JFET's are of two types: a—symmetrical and (b) nonsymmetrical.





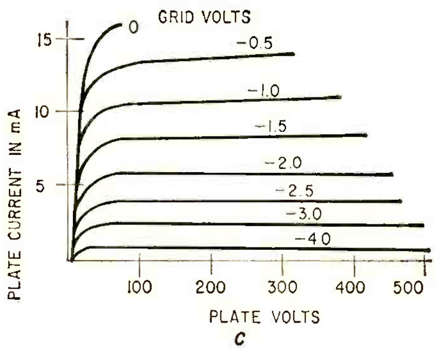


Fig. 5—Typical curves (a) for JFET, (b) for bipolar transistor, (c) pentode.

Operating characteristics

A bipolar junction transistor uses both majority and minority current carriers. In an npn version, for instance, most of the electrons flow from emitter to collector; they are the majority carriers. Holes flow the other way, and are the minority carriers. In a pnp bipolar, everything is just the reverse. Bipolars are also called *injection* transistors, because of electron-hole injection at the base.

Table I—Low-Cost JFET's

Manufacturer	Type No.	Chan. Type	BV_{DGO} or BV_{GSS} (max) volts	P_D (max) mw	I_{DSS} (min-max) mA	y_{fs} (min-max) μmhos	V_P or $V_{GS(OFF)}$ (max) volts	C_{iss} (max) pF	I_{GSS} (max) nA	Single quantity price
Amelco	2N4302	N	30	300	0.5-5.0	1000-	4	6	1	$0.97
	2N4303	N	30	300	4-10	2000-	6	6	1	1.12
	2N4304	N	30	300	0.5-15.0	1000-	10	6	1	0.90
Dickson	D1101	N	25	400	0.8-4.0	400-2000	10	2	10	1.85
	D1102	N	25	400	0.2-1.0	300-1000	5	2	10	2.15
	D1201	N	25	400	2-10	1000-4000	10	5	10	2.30
	D1420	N	25	400	0.5-5.0	1000-	4	5	1	2.15
	D1422	N	25	400	0.5-15.0	1000-	10	5	5	1.70
Fairchild	2N4342	P	25	200	4-12	2000-6000	5.5	20	10	2.15
	2N4343	P	25	200	10-30	4000-8000	10	20	10	1.90
	2N4360	P	20	200	3-30	2000-8000	10	20	10	0.95
	2N5033	P	20	200	0.3-3.5	1000-5000	2.5	25	10	1.80
	2N5163	N	25	200	1-40	2000-9000	8	12	10	0.50
	FT3820	P	20	200	0.3-15	800-5000	8	32	20	2.40
Motorola	MPF102	N	25	200	2-20	2000-7500	8	7	2	0.90
	MPF103	N	25	200	1-5	1000-5000	6	7	1	1.00
	MPF104	N	25	200	2-9	1500-5500	7	7	1	1.00
	MPF105	N	25	200	4-16	2000-6000	8	7	1	1.00
	MPF106	N	25	200	4-10	2500-6000	4	5	1	1.34
	MPF107	N	25	200	8-20	4000-8000	6	5	1	1.50
	MPF151	P	40	200	1-5	1000-4000	4	7	10	1.00
	MPF152	P	40	200	2-9	1500-5000	4.5	7	10	0.75
	MPF153	P	40	200	4-16	2000-6000	6	7	10	1.00
	MPF154	P	60	200	1-5	1000-4000	4	7	10	1.50
	MPF155	P	60	200	2-9	1500-5000	4.5	7	10	1.20
	MPF156	P	60	200	4-16	2000-6000	6	7	10	1.50
	HEP802	N	25	200	2-20	2000-	—	—	1	1.59
Siliconix	E100	N	30	250	0.2-20	500-	10	8	0.5	1.25
	E101	N	30	250	0.2-1	500-	1.5	8	0.5	2.30
	E102	N	30	250	0.9-4.5	1000-	4	8	0.5	1.85
	E103	N	30	250	4-20	1500-	10	8	0.5	1.50
Texas Instrument	2N3819	N	25	200	2-20	2000-6500	8	8	2	0.90
	TIS34	N	30	200	4-20	3500-6500	8	6	5	1.10
	TIS58	N	25	200	2.5-8	1300-4000	5	6	4	0.99
	TIS59	N	25	200	6-25	2300-5000	9	6	4	0.96

Note: With five exceptions, all devices listed are furnished in epoxy cases. The five Dickson JFET's are furnished in TO-18 metal cases. In these devices, the gate is internally connected to the case.

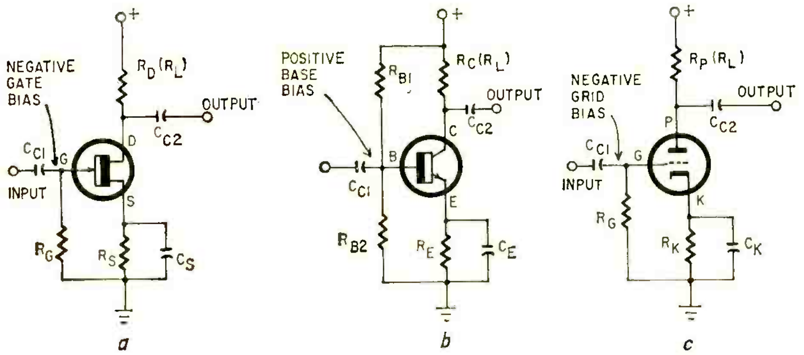


Fig. 6-a—N-channel JFET requires negative gate bias. b—Npn bipolar transistor requires positive base bias and triode tube (c) needs negative grid bias.

The FET, on the other hand, is a unipolar device. It uses *only* majority carriers—electrons in the n-channel version, holes in the p-channel type. (During manufacture, impurity atoms are mixed into the channel in such density that only one type of current carriers is available.) And because the gate junction is reverse-biased, neither holes nor electrons are injected into the channel.

All three types of amplifying devices mentioned above employ some type of input bias. The gate of a FET is biased by a voltage with respect to the source. The base of a bipolar transistor is biased by a voltage with respect to the emitter. And the grid of a vacuum tube is biased by a voltage with respect to the cathode. Note that a JFET is normally *on* until reverse-biased at the gate; a bipolar transistor is normally *off* until forward-biased at the base, and a vacuum tube is normally *on* until reverse-biased at the grid.

Characteristic curves for each of the three devices under discussion appear in Fig. 5. The JFET drain-voltage/drain-current curves for various values of base bias are in Fig. 5-b. Bipolar transistor collector-voltage/collector-current curves for various values of base bias are in Fig. 5-6. Pentode vacuum-tube plate-voltage/plate-current curves for various values of grid bias are in Fig. 5-c.

Look at Fig. 5-a again and you'll see one important aspect of JFET operation. As drain-to-source voltage increases from zero, current flows through the channel. Channel current is approximately proportional to drain-source voltage—up to a point. This portion of the curve is known as the *ohmic region*, because the channel resistance is varied linearly by the current flowing through it. It's also called the *triode region* because the curve looks like that of a triode tube. (Near the bottom of the ohmic region of the curve, channel resistance is several megohms in a typical JFET.)

But at the knee of the curve, the current has become so great that it sets up a reverse bias between the gate junctions which acts the same as external gate bias—it depletes the channel. The curve flattens out because additional increase in drain-source voltage has little effect on drain current. (The channel resistance has decreased to about 1000 ohms.)

Since this action resembles pinchoff voltage at the gate, this portion of the curve is known as the *pinchoff region*. The channel is saturated with current flow, so this part of the curve is also known as the *saturation region*. And since the curve is flat, like that of a pentode, this area is also called the *pentode region*.

By operating the JFET in the pinchoff region, with drain-source (V_{ds}) voltage between about 6 and 12 (referring to Fig. 5-a), small changes in gate voltage (V_{gs}) produce large changes in drain current (I_d). Thus the JFET is useful as an amplifier.

Beyond the pinchoff region is the *avalanche* or *breakdown region*. It's similar to the breakdown region in a bipolar transistor. If total device power dissipation (P_D) is not limited to a safe value, the JFET will be destroyed.

Comparison with other amplifiers

The similarity between the JFET, the bipolar transistor and the vacuum tube, when each is used as a simple af amplifier is shown in Fig. 6. In each case, input is through coupling capacitor C_{C1} to the FET gate, the bipolar base and the tube grid.

The FET gate is biased (with respect to the source) by the voltage drop across R_S, the source dropping resistor (Fig. 6-a). The tube grid is also biased by the same method, by the voltage drop across cathode resistor R_K (Fig.

6-c). The bipolar transistor is biased by the drop across voltage divider R_{B1}–R_{B2} between the collector supply and ground (Fig. 6-b). (Some bias also occurs because of emitter resistor R_E, but this resistor is also used for stability.)

In each case a bypass capacitor is used across the lower element—C_S across the FET source resistor; C_E across the bipolar emitter resistor, and C_K across the tube cathode resistor. This bypass capacitor allows its associated resistor to act as a voltage dropper for dc, but not for ac.

Output is taken, in each example, across load resistor R_L—which is called R_D for the FET, R_C for the bipolar and R_P for the tube. Output is through coupling capacitor C_{C2}.

Now you've seen the similarities of the FET, the bipolar transistor and the vacuum tube. What about differences? Well. FET's are also made with p-type channels (see Fig. 7). Everything here is just the opposite from the n-channel version above. The channel is p-type material, and the gate junction is n-type material. Drain voltage is negative and source voltage (ground) is positive. The gate is biased positive with respect to the source. This is similar to a pnp bipolar transistor, as Fig. 7-b shows, where the collector is negative, the emitter positive and the base biased positive with respect to the emitter.

Of course, there is no such thing as a p-channel vacuum tube. If you make the plate negative with respect to the cathode the tube simply won't conduct.

There are some differences between n- and p-channel FET's. For one thing, the mobility of electrons is greater than that of holes. Since electrons are the majority current carriers —which is all that FET's use—in n-channel devices, they are better than their p-channel counterparts in several respects. The n's have more gain (for a given input capacitance) than p's. They also have lower *on* resistance and lower noise figures. As a matter of fact, n-channel JFET's have the best low-frequency noise figures of *any* amplifying device.

All these benefits aren't achieved without a drawback or two. Like all semiconductor devices, JFET's are manufactured with a rather wide spread of specifications. Table I lists 35 low-cost JFET's and Table II explains their parameters. Nearly all are subject to some variation from one device to the next (of the same type number). For this reason, minimum and/or maximum values are shown. Base terminals for the listed JFET's are in Fig. 8.

Two parameters aren't shown in Table I because they are somewhat

Table II

Important JFET Parameters and What They Mean

BV_{DGO}—Drain-to-gate breakdown voltage, with source open. A maximum rating, this voltage must not be exceeded or the device will be permanently damaged (unless power dissipation is limited to a safe level).

BV_{GSS}—Gate-to-source breakdown voltage, with drain shorted to source. Also a maximum rating which must not be exceeded or else permanent damage results (unless power dissipation is held to a safe level).

P_D—Total device power dissipation at ambient temperature of 25°C (77°F). This absolute maximum rating must not be exceeded or the device will be destroyed.

I_{DSS}—Drain-to-source current, with gate shorted to source (zero gate voltage). Also called pinchoff or saturation current. This rating indicates the maximum useful current which can flow through an output load resistor. Exceeding the maximum I_{DSS} rating causes avalanche in the device, resulting in permanent damage (unless power dissipation is held to a safe level).

y_{fs}—Small-signal, common-source, forward transadmittance (sometimes called g_{fs}—transconductance) at 1 kHz. This is the key dynamic figure of merit for FET's, for it indicates how much gain is available.

V_P or $V_{GS(OFF)}$—Gate-to-source pinchoff (or cutoff) voltage. That value of gate bias voltage which reduces drain-to-source current to a very small amount (usually somewhat greater than the I_{GSS} leakage-current value).

C_{iss}—Input (gate-to-source or common-source) capacitance at 1 MHz. (Also called C_{gss} and measured with drain shorted to source.) This rating is particularly important in rf and switching applications.

I_{GSS}—Reverse-bias gate-to-source leakage current, with drain shorted to source. This leakage current, which is usually low (due to the reverse-biased gate junction) determines input impedance, which is usually high (several hundred megohms).

similar for most of the devices listed. The first is the resistance of the channel: $r_{ds(ON)}$, or drain-to-source *on* resistance, with gate shorted to source, at 1 kHz. The values range from about 100 to 3000 ohms, depending on the device, and are useful when designing a voltage-controlled attenuator. The *off* resistance is much greater, of course.

The other parameter not shown in Table I is the noise figure, usually a rating of spot noise at one frequency. Values range from about 0.1 to 4 dB, but this depends pretty much on the specified frequency, which can be 1 kHz for af JFET's and 100 MHz for vhf devices.

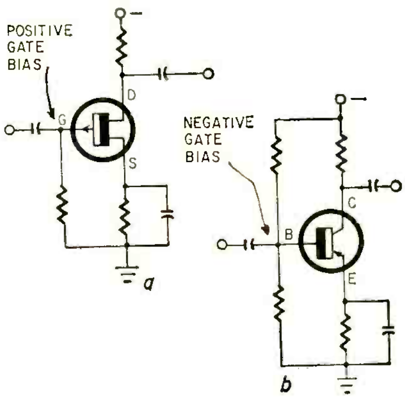


Fig. 7 (above)—Polarities of p-channel JFET (a) and pnp transistor (b) are opposite from those in Fig. 6.

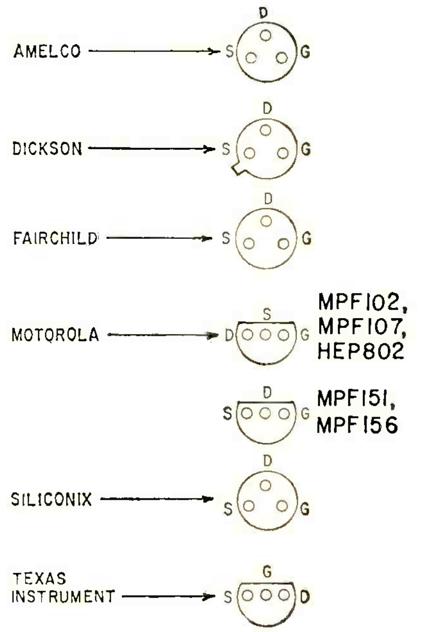
Fig. 8 (top right)—Basing diagrams for the JFET's listed in Table I, page 25.

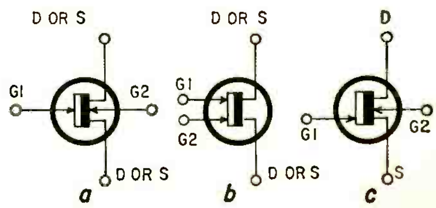
Fig. 9-a, -b (right)—Symbols used for dual-gate symmetrical JFET's. Nonsymmetrical dual-gate JFET uses **c.**

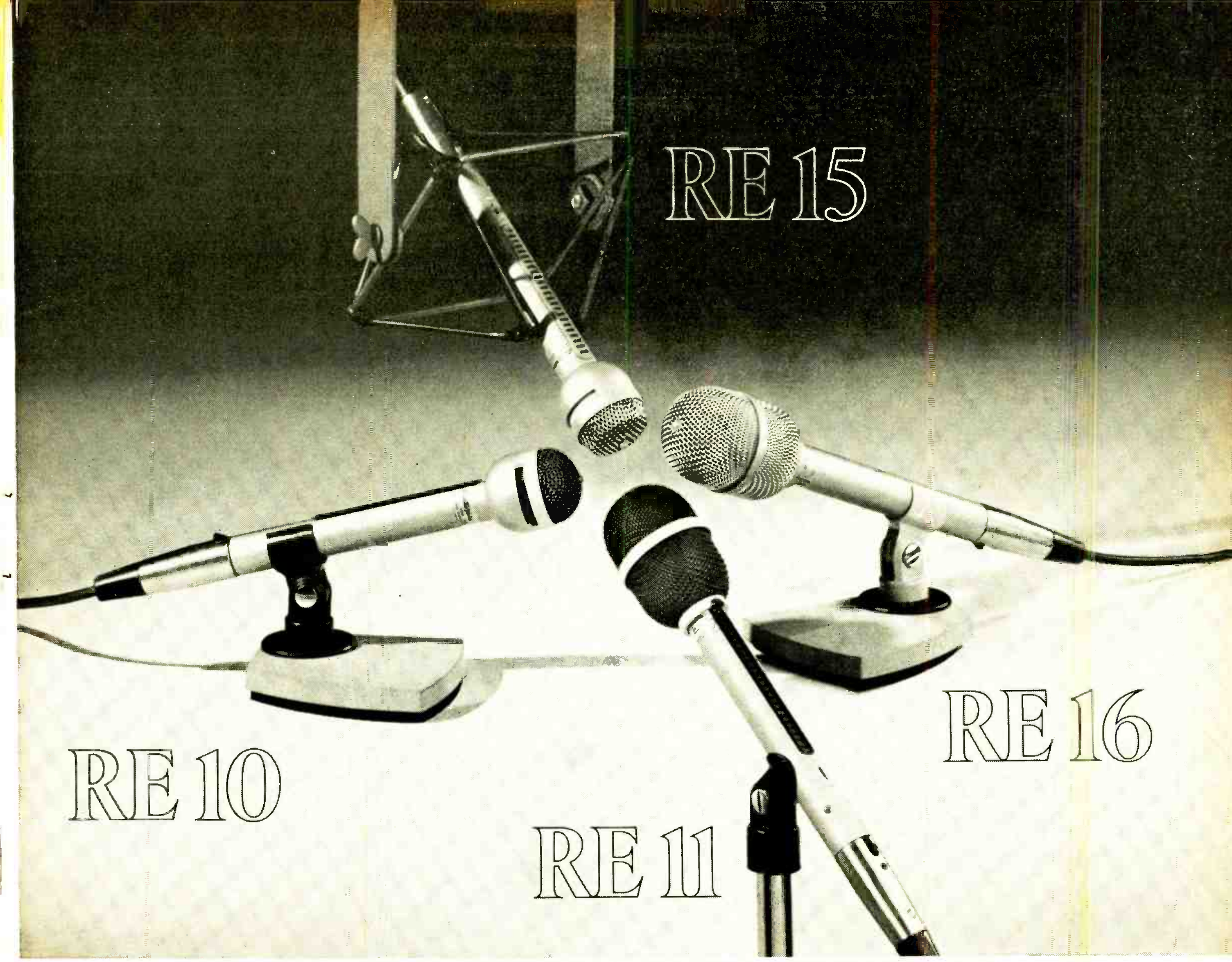
Dual-gate JFET's

Just as multigrid vacuum tubes are useful for mixing two signals, dual-gate or tetrode JFET's are used as mixers, converters, and in agc service. Schematic symbols in current use are in Fig. 9; (a) and (b) being symmetrical and (c) nonsymmetrical. No dual-gate JFET's are listed in Table I because there aren't any which cost less than $2.50.

There it is, the complete JFET operating theory. Next month we'll put this theory to practice. We'll show you how to build a JFET preamp for a ceramic microphone and a simple JFET audio oscillator. **R-E**







NEW Model RE10 $90.00, shown on Model 421 desk stand $10.50. Model RE15 $153.00, shown with Model 307 suspension mount $20.70. NEW Model RE11 $96.00, shown with Model 311 snap-out stand adapter $3.90. NEW Model RE16 $159.00, shown on Model 421 desk stand $10.50. All prices suggested net.

Freedom of choice!

Professional sound has entered a new era. It started with the Electro-Voice Model RE15. And now there are four E-V dynamic cardioid microphones that share its distinctive advantages — with some unique benefits of their own.

Unaffected by Distance . . . Angle

Basic to all of these microphones is Exclusive Electro-Voice Continuously Variable-D* construction. Now it offers something you've never heard before with any microphone: no matter what you do, microphone response never varies!

Whether performers almost swallow the microphone, wander far off-mike . . . or even move around to the back . . . you'll still get the same smooth response. Only the level changes.

Once you set equalization it remains constant. You have full assurance that tonal balance won't change between the dress rehearsal and the final performance, no matter what the talent does.

Improved Cardioid Pattern

Only acoustics and noise can limit you. Yet even here these new E-V microphones gain an advantage from the super-cardioid pattern that provides better sound control than ordinary cardioids. With maximum rejection 150° off axis, it is easier to eliminate unwanted sound while maintaining normal stand or boom microphone positions. There's also an integral bass-tilt circuit to cut rumble below 100 Hz. when needed.

Now Select from Four Models

In addition to the original RE15, we've added the RE16. The same fine microphone with an external "pop" filter to solve the problems of ultra-close miking.

The new RE10 is the economy version of the RE15. The same concept and quality, but for slightly less rigid requirements. And the RE11 is the lower cost twin to the RE16.

These four great cardioid microphones give you new freedom to head off sound problems before they start. Your E-V microphone headquarters has them waiting. Choose today.

*U.S. Patent No. 3,115,207. Trade mark registered.

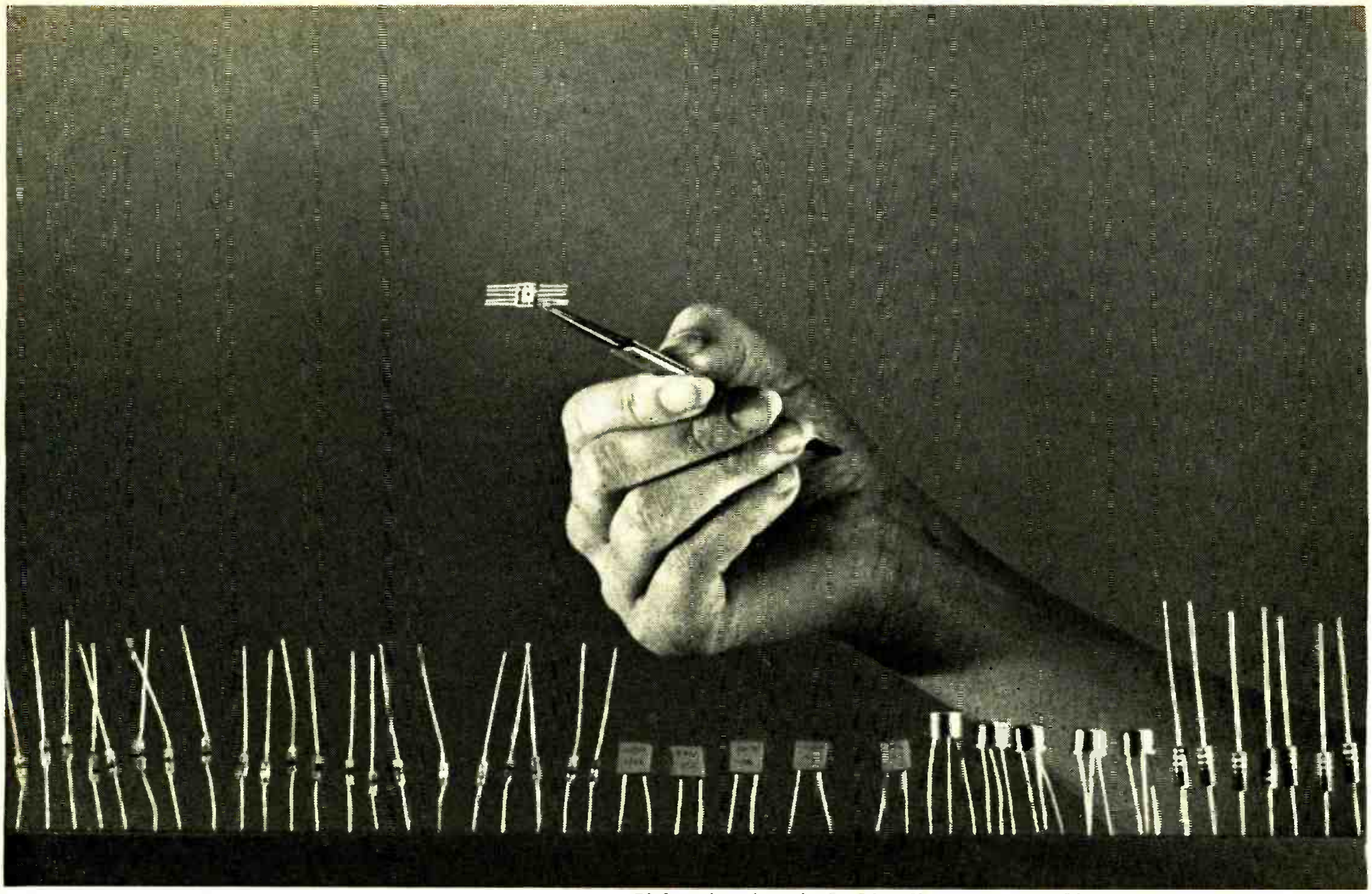
ELECTRO-VOICE, INC., Dept. 591E
613 Cecil Street, Buchanan, Michigan 49107

high fidelity systems and speakers • tuners, amplifiers, receivers • public address loudspeakers
microphones • phono needles and cartridges • space and defense electronics

Electro-Voice®

A SUBSIDIARY OF GULTON INDUSTRIES, INC.

Circle 24 on reader service card



50 functions in a single chip. *The functions of 50 separate transistors, diodes, resistors and capacitors can now be performed by the tiny dot in the center of the integrated circuit held by the tweezers.*

The "Chip" ...will it make or break your future job?

THE DEVELOPMENT OF INTEGRATED CIRCUITRY is the dawn of a new age of electronic miracles. It means that many of today's job skills soon will be no longer needed. At the same time it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the gigantic coming boom, and how you can learn it right at home.

TINY ELECTRONIC "CHIPS," each no bigger than the head of a pin, are bringing about a fantastic new Industrial Revolution. The time is near at hand when "chips" may save your life, balance your checkbook, and land a man on the moon.

Chips may also put you out of a job... or into a better one.

"One thing is certain," said *The New York Times* recently. "Chips will unalterably change our lives and the lives of our children probably far beyond recognition."

A single chip or miniature integrated circuit can perform the function of 20 transistors, 18 resistors, and 2 capacitors. Yet it is so small that a thimbleful can hold enough circuitry for a dozen computers or a thousand radios.

Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new desk-top computer, no bigger than a typewriter yet capable of 166,000 operations per second. And it is almost possible to put the entire circuitry of a color television set inside a man's wristwatch case.

And this is only the beginning!

Soon kitchen computers may keep the housewife's refrigerator stocked, her menus planned, and her calories counted.

Money may become obsolete. Instead you will simply carry an electronic charge account card. Your employer will credit your account after each week's work and merchants will charge each of your purchases against it.

When your telephone rings and nobody's home, your call will automatically be switched to the phone where you can be reached.

Doctors will be able to examine you internally by watching a TV screen while a pill-size camera passes through your digestive tract.

New Opportunities for Trained Men

What does all this mean to someone working in Electronics who never went beyond high school? It means the opportunity of a lifetime—if you take advantage of it.

It's true that the "chip" may make a lot of manual skills no longer necessary.

But at the same time the booming sales of articles and equipment using integrated circuitry has created a tremendous demand for trained electronics personnel to help design, manufacture, test, operate, and service all these marvels.

There simply aren't enough college-trained engineers to go around. So men with a high school education who have mastered the fundamentals of electronics theory are being begged to accept really interesting, high-pay jobs as engineering aides, junior engineers, and field engineers.

How To Get the Training You Need

You can get the up-to-date training in electronics fundamentals that you need through a carefully chosen home study course. In fact, some authorities feel that a home study course is the best way. "By its very nature," stated one electronics publication recently, "home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative." These are qualities every employer is always looking for.

If you do decide to advance your career through spare-time study at home, it makes sense to pick an electronics school that specializes in the home study method. Electronics is complicated enough without trying to learn it from lessons designed for the classroom instead of correspondence training.

The Cleveland Institute of Electronics has everything you're looking for. We teach only Electronics—no other subjects. And our courses are designed especially for home study. We have spent over 30 years perfecting techniques that make learning Electronics at home easy, even for those who previously had trouble studying.

Your instructor gives your assignments his undivided personal attention. He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

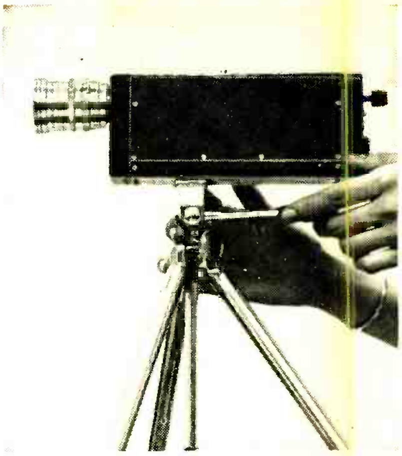
Always Up-to-Date

Because of rapid developments in Electronics, CIE courses are constantly being revised. Students receive the most recent revised material as they progress through their courses. This year, for example, CIE students are receiving exclusive up-to-the-minute lessons in Microminiaturization, Logical Troubleshooting, Laser Theory and Application, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra. For this reason CIE courses are invaluable not only to newcomers in Electronics but also for "old timers" who need a refresher course in current developments.

ENROLL UNDER NEW G.I. BILL

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

Tiny TV camera *for space and military use is one of the miracles of integrated circuitry. This one weighs 27 ounces, uses a one-inch vidicon camera tube, and requires only four watts of power.*



Get FCC License or Money Back

No matter what kind of job you want in Electronics, you ought to have your Government FCC License. It's accepted everywhere as proof of your education in Electronics. And no wonder—the Government licensing exam is tough. So tough, in fact, that without CIE training, two out of every three men who take the exam fail.

But better than 9 out of every 10 CIE graduates who take the exam pass it.

This has made it possible to back our FCC License courses with this famous Warranty: you *must* pass your FCC exam upon completion of the course or your tuition is refunded in full.

Mail Card for Two FREE Books

Want to know more? The postpaid reply card bound in here will bring you a FREE copy of our school catalog describing today's opportunities in Electronics, our teaching methods, and our courses, together with our special booklet on how to get a commercial FCC License. If card is missing, use the coupon below.

CIE Cleveland Institute of Electronics

1776 East 17th Street, Cleveland Ohio 44114

NEW COLLEGE-LEVEL COURSE IN ELECTRONICS ENGINEERING

for men with prior experience in Electronics. Covers steady-state and transient network theory, solid state physics and circuitry pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

Cleveland Institute of Electronics
1776 East 17th St., Cleveland, Ohio 44114

Please send me without cost or obligation:

1. Your 44-page book "How To Succeed In Electronics" describing the job opportunities in Electronics today, and how your courses can prepare me for them.
2. Your book on "How To Get A Commercial FCC License."

I am especially interested in:

- ☐ Electronics Technology
- ☐ Electronic Communications
- ☐ Broadcast Engineering
- ☐ Industrial Electronics and Automation
- ☐ First-Class FCC License
- ☐ Electronics Engineering

Name ____________________
(please print)

Address ____________________

City ____________________

State __________ Zip __________ Age ____

☐ Check here for G.I. Bill Information.

Accredited Member National Home Study Council
A Leader in Electronics Training... Since 1934

RE-60

Circle 25 on reader service card

HOW IC LOGIC

Low-cost computer logic gates

By DONALD LANCASTER

PRICE REDUCTIONS ON MANY DIGITAL INTEGRATED CIRCUITS have made the logic gate practical for many "everyday" circuits. Besides their obvious use as computer logic elements, these gates readily form the active elements needed for conventional pulse and digital circuits, multivibrators, triggers and a host of other circuits.

By adding a biasing resistor, logic gates may be made into class-A linear amplifiers, useful in many low-level applications. Let's look at some of the more popular gates.

What's available

There are many advantages in using IC logic gates to replace conventional transistors, resistors and diodes. Foremost is cost. One $1.08 package, for example, contains *six* complete integrated gates—only 18¢ per gate. This is far less than the price of a single transistor or diode.

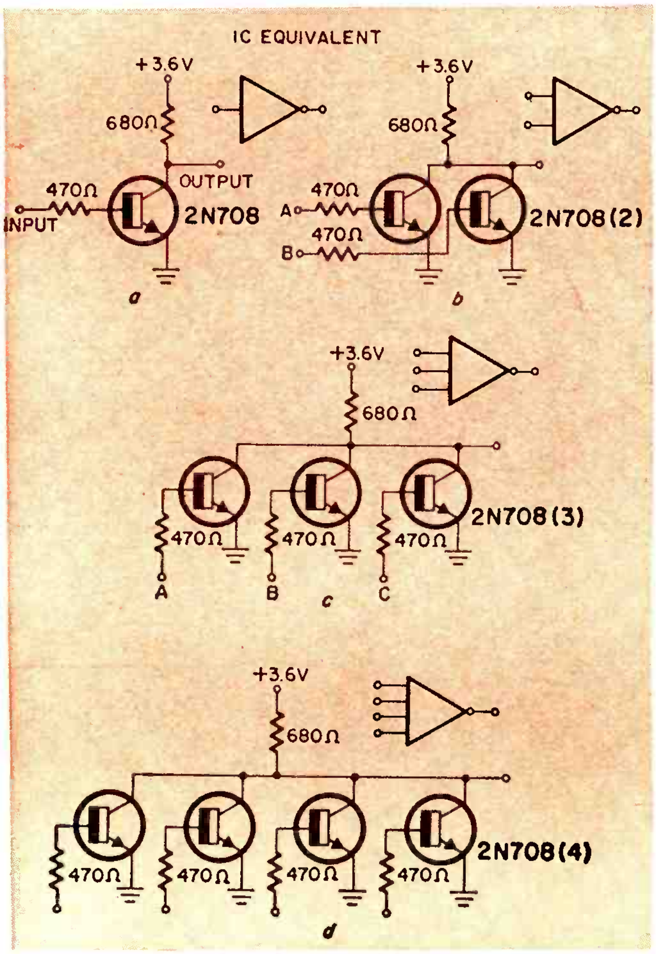
As logic gates may be directly connected together and require no biasing or coupling circuitry, the need for external resistors and capacitors is greatly reduced. Logic gates are very compact, with two to six in a single plastic package. Circuit design is greatly simplified, since you know operating temperature range, speed, drive capability and power requirements ahead of time. For many applications, one or two penlight cells operate the circuit.

A logic gate obeys certain rules to turn an output off or on upon some coincidence of signals at its input. A kitchen sink faucet is a logic gate—it gives you an output if *either* the hot or cold input is provided with an on signal. This is an example of an OR circuit. A garden hose is an example of an AND logic gate, since both the outdoor faucet and the nozzle valve must be on to get an output.

There are many forms of logic gates: mechanical, hydraulic, chemical, pneumatic, optic, electric and electronic. The electronic logic is far and away the most prevalent; millions upon millions of gates are used in the computer industry. Integrated circuits were called upon a decade ago to reduce the size, cost and power consumption of computers.

As a result, many forms of IC logic gates are available today. Those we'll talk about are called RTL gates, because they are the integrated equivalent of Resistor Transistor Logic. Fig. 1 shows the discrete equivalent circuits for the one-, two-, three- and four-input RTL gates and their integrated equivalents.

The two-input gate consists of two npn transistors sharing a common-collector resistor. Each base has a cur-



◄ *Fig. 1-a—This is a one-input RTL logic gate and its IC equivalent symbol. Parts* b, c *and* d *are two- three- and four-input gates respectively with their IC symbols. All circuits run as saturated-logic switches. When any base receives current, the output of that gate goes near ground. If all bases do not receive current, the output goes positive to 3.6 volts.*

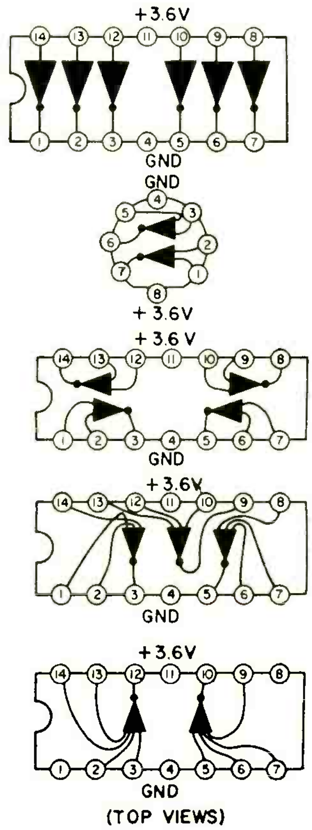


Table 1—A few of the gate combinations available in 14-lead "caterpillar" and 8-lead TO-5 cases. Top to bottom: Hex inverter, dual two-input, quad two-input, triple three-input, dual four-point. In each case, gates are independent.

CIRCUITS WORK

make 'everyday' circuits easy to build

rent-limiting resistor attached to an input. If *either* input receives base current, the output goes to ground. If *neither* input receives base current, the output goes positive to the supply voltage.

Using this basic configuration and choosing our definitions carefully, we can interconnect logic gates to perform all computer functions, and any set of logic rules we wish.

A few of the more popular gates available are IC's that come in an eight-pin TO-5-size epoxy package or a 14-lead in-line "caterpillar" package. Both types are interchangeable and operate from a single +3.6-volt supply. For many applications 1.5—4.5-volt battery supplies will work as well. The gates have a transition time around 15 nanoseconds. This is very slow as computer circuits go, but for everyday applications the gates are useful from dc to beyond 10 MHz.

Note that all the packages contain more than one gate. All the gates are independent, and the only common connections are supply voltage and ground. For instance, a quad two-input gate contains four independent gates, each gate being the two-input variety. A dual four-input gate has two separate gates, each of which has four separate inputs.

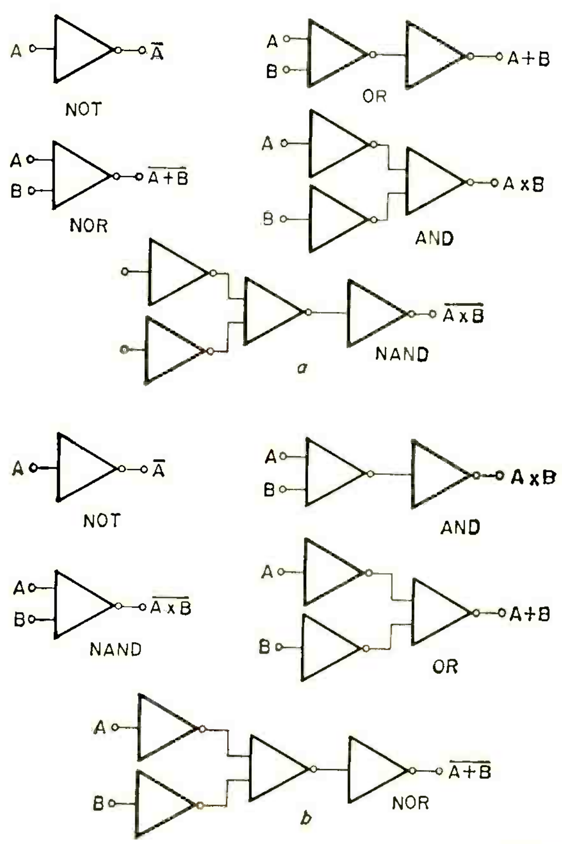


Fig. 2—Computer logic functions depend on definitions. Top (a) *drawings show positive logic: "1" is positive and "O" is ground. In negative logic* (b), *"1" is ground and "O" is positive.*

Pin conventions are shown in Table I. The eight-pin version has a flat or color dot adjacent to pin 8, while the in-line package has an identifying notch and top-view pin connections as shown. IC's are good over a +15°–55°C temperature range. Each gate consumes about 12 mW of supply power. Each gate's output can drive *five* similar gate inputs; where more output power, or *fanout*, is required, a different IC, called a *buffer*, is needed.

Logic circuits

What integrated logic gates will do in computer applications depends, not only on the circuit connection, but also on definitions. For example, if we define "+" as "1" and ground as "0," we are using a *positive* logic gate, and the NOT, NOR, NAND, OR, AND logic gates are built up with circuits of Fig. 2-a. If, on the other hand, we define ground as "1" and "+" as "0," we are using *negative* logic, and the NOT, NAND, AND, OR and NOR functions are generated with the *different* gate connections shown in Fig. 2-b.

To analyze any logic function, consider what the actual gate does. The NAND coincidence is based upon *neither* transistor receiving base current, thus allowing the output junction to swing *positive*. The NOR coincidence is based upon *any* gate transistor receiving base current and thus forcing the output junction to *ground*.

As an example of a more complicated computer logic circuit, the EXCLUSIVE OR circuit, also known as a *half-adder*, is shown in Fig. 3. This circuit directly performs binary addition. Usually two half-adders are used together, one to add two binary numbers and a second to handle a possible *carry* from the previous addition. Note that a considerable number of inverting gates may be eliminated, if the *complements* of the input and output are available or useful elsewhere in the circuit.

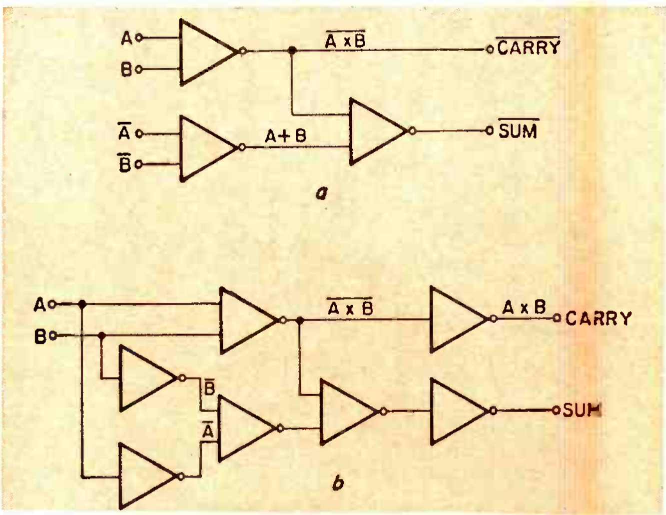


Fig. 3—The EXCLUSIVE OR circuit (half adder) is one of the more complex computer functions. Part a *shows arrangement with usable complements available;* b *has self-generated complements.*

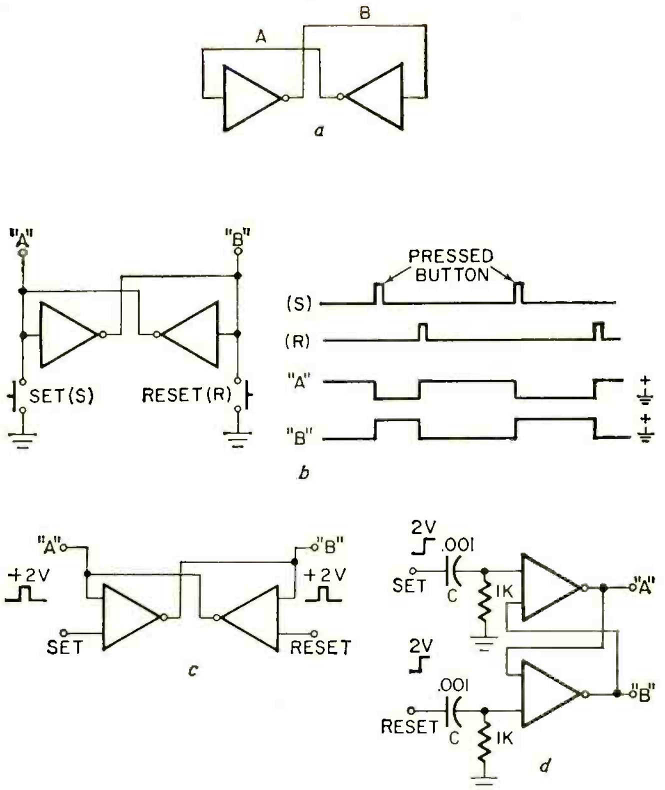


Fig. 4—Various configurations of bistable multivibrators. In a, *two one-input gates are back to back. Part* b *shows same circuit wired for pushbutton operation. Circuit in* c *uses two-input gate for a pulse set-reset latch. The pulse-coupling, set-reset flip-flop in* d *triggers with long input pulse.*

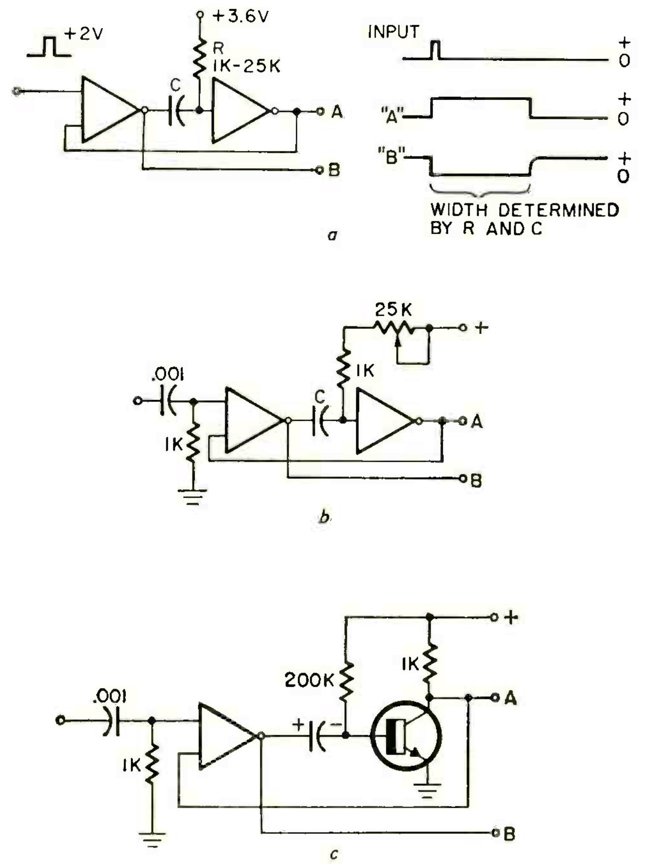


Fig. 5—These are monostable multivibrator and delay circuits. Basic circuit in a *requires a brief, dc-coupled input. With circuit in* b, *the output is variable over a 10:1 range. High-gain transistor in* c *permits long time delays of output.*

Suppose we connect two one-input gates back to back as in Fig. 4-a. If the left gate's output happened to be grounded, it would allow the right gate's output to be positive, which in turn would provide the base current to keep the left gate's output grounded. The circuit is stable and, if undisturbed, will stay in either of the two possible states. This is called a *bistable multivibrator*.

The circuit is more useful if we force the bistable to go into either of the two states upon command. This is done by adding two pushbuttons as in Fig. 4-b. Push the SET pushbutton, and point A goes to ground and stays there after the button is released. Push the RESET button and point A goes "+" and point B goes to ground, and stays there after the button is released. We can use this circuit as a memory or latch; it is somewhat similar to a relay latching itself on its own make contact.

It is often desirable to change states upon electrical command. For this, we go to the two-input gate configuration of Fig. 4-c. Here one gate input on each side is used for feedback; the other for an input. A short positive pulse at either input then sets or resets the latch, depending upon the input selected.

For the circuit to operate properly, the inputs must "see" a dc return path and the input pulses must be brief. To ac-couple signals, or to trigger on the leading edge of a long input pulse, requires the pulse coupling circuit of Fig. 4-d. The 1000-ohm resistors are essential; if they are omitted, the gate's base–emitter pn junction will act as a dc restorer and charge up the input capacitor after one or two operating cycles.

If input signals appear simultaneously, *both* outputs will go to ground and the last input to disappear determines the state the bistable will go into.

The circuits shown will *not* count and will not automatically steer input pulses from one side to the other if the inputs are connected together. To do this, an integrated circuit called a JK flip-flop is needed.

Monostable circuits

Suppose we break one of the feedback connections of the latch and insert a capacitor and recharging resistor (Fig. 5-a). If we let the circuit sit long enough, it will go into the state in which the left gate's output is positive and the right output is grounded. Capacitor C will charge to roughly the supply voltage.

Now, if an input trigger pulse is delivered, the left gate's output will immediately go to ground. Since the charge on a capacitor cannot immediately change, the right end of C abruptly drops *negative*, removing base current from the right gate. The right gate's output swings positive, and thus provides base current for the left gate, holding the circuit in the new state.

So far things have gone just as they did in the bistable circuit. But resistor R now starts charging the right end of C positively, until the voltage on the right end of C is positive enough to provide base current for the right gate. The right gate's output starts to ground, and the circuit snaps back to the original state.

This is another form of multivibrator. It has one stable state and one unstable one. Called a *monostable multivibrator*, it is used to generate a time delay or a rectangular pulse of controlled width upon command. To vary the output width or delay, R or C is varied. A 10:1 range is obtained by the circuit of Fig. 5-b. Here we have also added input capacitors for ac coupling or for triggering an input that is long compared to the delay time.

There are several important design considerations. The input signal (either directly or through the capacitor differentiation network) must be brief compared to the delay time, or the circuit will not operate properly. As with the bistable circuit, the 100-ohm resistor on the input is essential if capacitor coupling is used. The timing resistor may vary from 1000 to 25,000 ohms, while C may range from 200 pF up to several hundred microfarads. The time constant of RC roughly equals the delay time, with intervals from 200 nsecs to several seconds possible.

The monostable has a recovery time. It cannot be immediately retriggered, since C must recharge completely to the supply voltage. Constant-width operation may be obtained with a duty cycle less than 30%, while a duty cycle as great as 75% may be used if considerable change in timing is permissible. The generated pulse width does not vary greatly with small changes in temperature or supply voltage.

Time intervals longer than a fraction of a second require unreasonably large values of C as resistor R cannot be made larger than 25,000 ohms without running out of gain in the second gate. For long time intervals, a gate may be combined with a very-high-gain transistor to allow a much larger value of R, and a resultant reduction in capacitor size. (Fig. 5-c).

Other trigger circuits

Figure 6-a shows a nonregenerative pulse stretcher that provides a monostable output with a single, one-input gate. It produces a rectangular output pulse upon command, and is used only when the input is dc-coupled and *goes to ground and stays there* for a time longer than the pulse period. Since there is no feedback, the fall time is not nearly as good as can be obtained with a true monostable.

To trigger the circuit, the input is made positive long enough to charge C. The input is then abruptly brought to ground *and held there*. Since the charge on C cannot change instantaneously, the right end of C swings negative, turns off the gate and produces a positive output. Resistor R then charges C just as in the conventional monostable.

A monostable circuit with "negative" recovery time is shown in Fig. 6-b. Here the output goes positive immediately upon an input command and stays positive for a time delay determined after the *last* pulse or input command chain is received. An input pulse discharges C, which then recharges through the internal collector resistor of the right gate until it is positive enough to allow the right gate to turn on. As C is "emptied" each time an input pulse arrives, the time delay begins anew with each input pulse.

The output fall time is not very good, and very large C values are required for millisecond pulse intervals. The circuit is also rather dependent on supply and temperature and requires input pulses long enough to discharge C completely. One interesting application for this circuit is with voice-operated relays. Another is for missing-pulse detection or producing an output only after an entire string of input pulses has passed.

A Schmitt trigger is shown in Fig. 6-c. This is an emitter-coupled multivibrator that is sensitive to input voltage. As the voltage exceeds a given level, the Schmitt circuit snaps into one state. As the voltage drops below a second level, the circuit snaps back into the original state.

The two levels are made different, producing hysteresis and eliminating chatter or noise sensitivity. The circuit shown snaps on with an input exceeding 1.5 volts, and off with the input voltage dropping below 1.1 volts.

Since the ground lead must be broken and a 27-ohm resistor inserted in series with the negative return on the IC, the circuit will work only with a dual two-input gate. The 27-ohm resistor determines the trip points, while the output resistor determines the amount of hysteresis obtained. The circuit is used as an alarm or a voltage-level

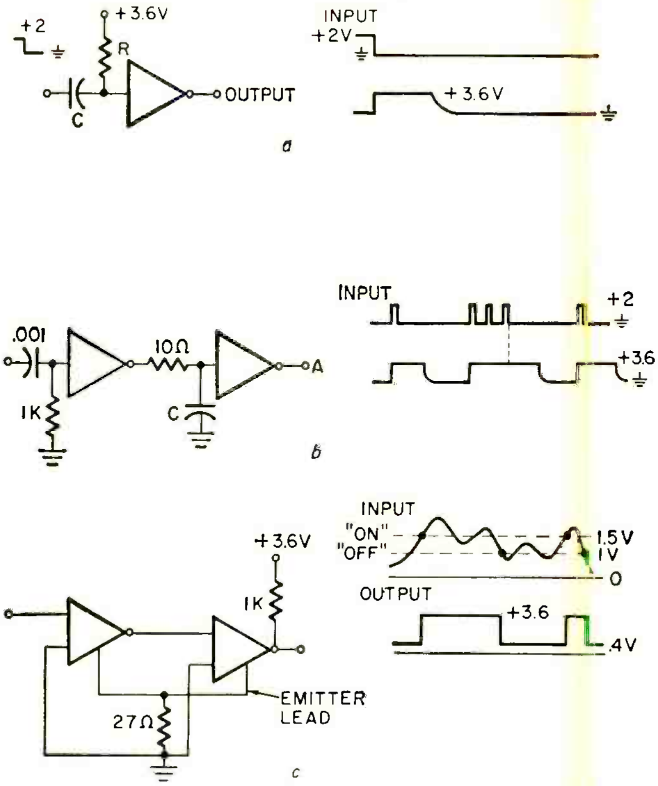


Fig. 6-a—Nonregenerative pulse stretcher in this circuit requires an input staying at ground for duration of the output. The nonregenerative monostable in b is controlled by last pulse in input chain. A Schmitt trigger is shown in d.

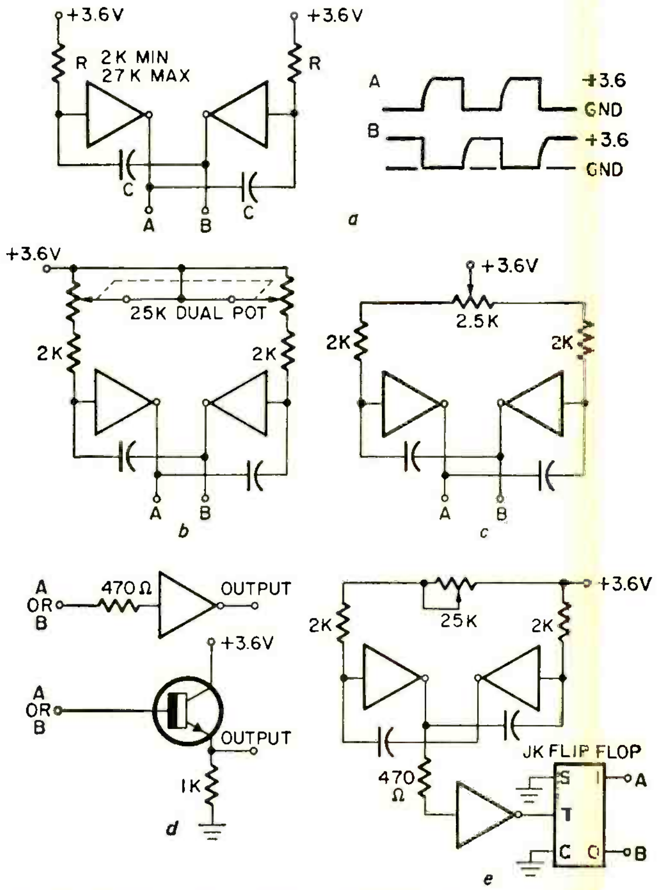


Fig. 7—Various free-running multivibrators: Circuit a is a basic astable, b is astable with dual-pot frequency control, c has variable symmetry output. Part d shows resistor and transistor load isolation; e shows JK flip-flop division by 2.

detector. Signal conditioning of the output may be required before driving additional logic gates.

An astable multivibrator has no stable state and is thus free-running, forming a square-wave oscillator circuit (Fig. 7-a). Once again, timing is determined by the RC products. The waveform will be asymmetrical unless the RC products are equal. Fig. 7-b adds a *dual* 25,000-ohm potentiometer to obtain a 10:1 control range. For wider ranges, various values of C are switched in.

The circuit of Fig. 7-c provides a fixed output with variable symmetry. The minimum recommended value of R is 2000 ohms; the maximum, 25,000 ohms. Capacitor C may vary from 200 pF up to several tens of microfarads.

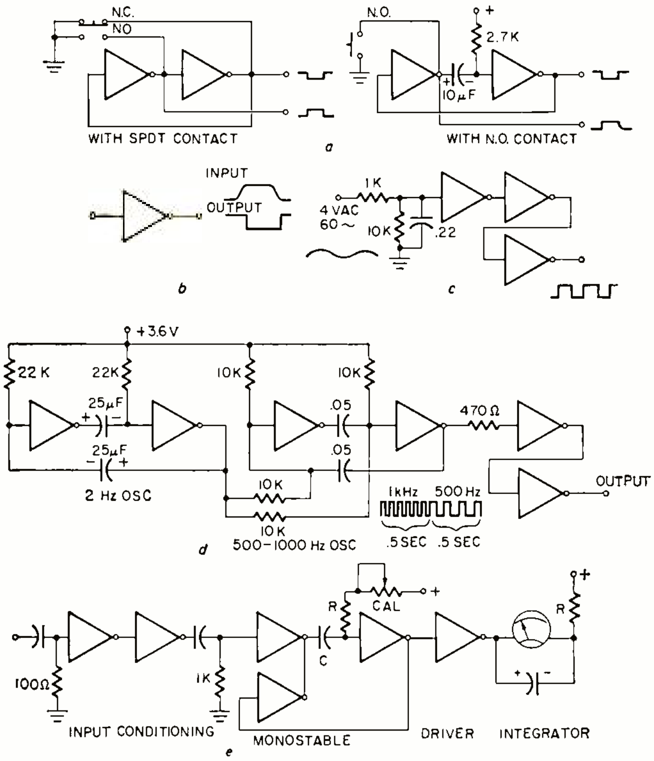


Fig. 8—Here are a few practical applications. Part a *shows bounceless pushbuttons (spdt on left, and n.o. on right). A squaring circuit is in* b, *and a 60-Hz driver for high-speed JK's is in* c. *Single IC in* d *can be two-tone oscillator or alarm. A hex-inverter tachometer is shown in circuit* e.

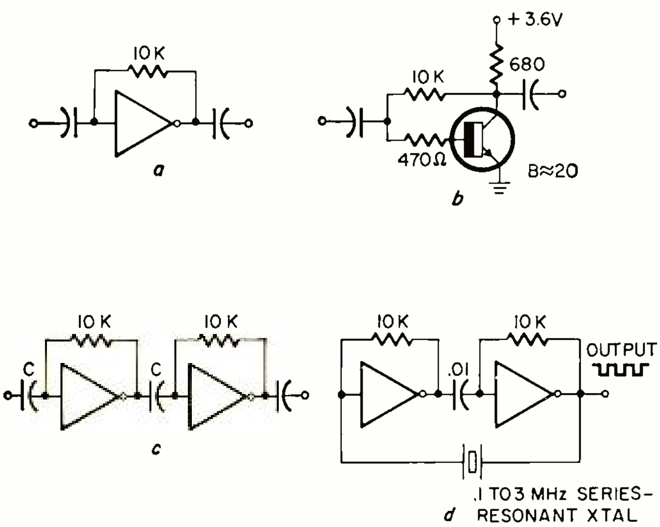


Fig. 9—Biasing scheme for class-A amplifier operation of gates is shown in a *and the equivalent circuit in* b. *Circuit in* c *is gain-of-400 amplifier, and* d *is a crystal oscillator.*

There does not seem to be any starting problem with an IC astable of this type.

The circuit operates properly only if lightly loaded. Two load-isolating techniques are shown in Fig. 7-d, one of which requires a resistor and a gate, the other a transistor emitter follower and a resistor.

Single-potentiometer operation will result in a highly asymmeterical waveform. A very nearly square wave with excellent symmetry may be obtained by dividing the astable multivibrator's output by 2 with a JK flip-flop; the flip-flop's output is perfectly symmetrical, except for a possible small transition time (Fig. 7-e).

Some applications

Let's look at how we can use these logic gates in other useful circuits. Fig. 8-a shows two bounceless pushbutton circuits, essential whenever mechanical contacts are used with high-speed integrated counter circuits. A dual circuit or an spdt pushbutton may be used to drive a set-reset bistable multivibrator directly. This circuit requires two one-input gates. If an spst or make contact is the only one available, the 15-msec multivibrator circuit may be used. This requires an additional resistor and capacitor.

A single one-input gate is used as a squaring circuit to sharpen rise and fall times of an input signal (Fig. 8-b). Around 20 nsecs of delay will also be picked up, and a single gate can be used as an ultra-short delay line. Fig. 8-c shows a filter and three cascaded one-input gates. This circuit is used to square 60-Hz power-line or other low-frequency audio sine waves. The output is a square wave with a very fast fall time, a feature essential when integrated JK flip-flops are to be used in low-frequency circuit applications.

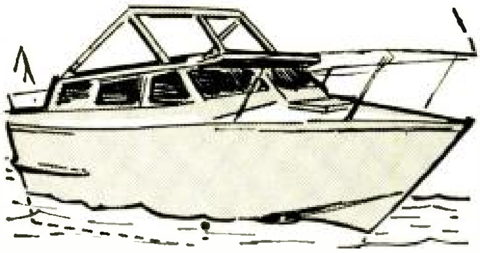
The dual-tone oscillator of Fig. 8-d produces a commanding alarm that switches between 500 and 100 Hz twice each second. In operation, the left two gates operate as a 2-Hz oscillator that alters the charging current and hence the frequency of the high-frequency astable formed by the middle two gates. The remaining gates serve as load isolation. The circuit drives any amplifier; with a companion driver transistor, it will directly drive a speaker to ear-splitting volume. Note the extreme simplicity possible by using a hex inverter—only *one* active component is needed for the circuit.

The same hex inverter is useful in tachometer circuits, again with a significant parts reduction. Fig. 8-e shows the technique. By keeping the monostable duty cycle well under 30% and isolating the indicating meter from the monostable, a considerable improvement in stability over simpler circuits is obtained. As with any pulse duty-cycle-type tachometer, the supply must be regulated and a suitable input network must be chosen to isolate ignition spikes and noise.

Linear operation

Gates may be biased up into the class-A region to produce a very-low-cost linear amplifier. Fig. 9-a shows the biasing scheme, while Fig. 9-b shows the approximate equivalent circuit. Discrete versions of this circuit are not often seen as the input impedance is rather low—even though the configuration has good gain and bias stability. The stages may be cascaded.

A gain-of-400 amplifier is shown in Fig. 9-c. Note that coupling capacitors are essential to keep the proper bias levels on each stage. Up to three stages may be cascaded, producing gains above 60 dB. Maximum linear peak-to-peak output is around 1 volt. A practical application of the class-A technique is the crystal oscillator of Fig. 9-d, which produces square waves at the fundamental resonant frequency of a series-resonant crystal. **R-E**



Electronics For Weekend Sailors

by **CHARLES WURTSWORTH**

ALTHOUGH IT IS 969 YEARS LATER, the small-boat owner may still enjoy the adventures of a Leif Ericsson. He can founder in a squall, run aground, get lost, swamp or collide. Pirates may strip his spars at midnight. He'll meet fog, rough seas and unidentified floating objects. Propulsion systems run out of wind, oar or (today) gasoline. The only good news, according to the Coast and Geodetic Survey, is that when sailing beyond sight of land there is absolutely no risk of falling off the edge.

The dangers, though, may be diminishing. There are now enough electronic devices for anyone from a Sunday skipper to Lloyd Bridges. We count more than a dozen different seagoing goodies being marketed to make boating less risky, more fun. Thanks to solid-state circuits, items once fit only for an Onassis are now scaled down in size and price. Let's consider some electronic items to outfit a rowboat, then work up to hardware for the well-heeled commodore.

Marine monitoring

If the call of the sea is irresistible, you won't have to wait to arrive at the water's edge. A car-radio converter, such as Pearce-Simpson's Monitor (Fig. 1), snares marine signals and converts them to the broadcast band. Drive within about 20 miles of radio-equipped boats and you can eavesdrop on their captains to learn where the fish are biting.

Monitoring the band is also possible with a transistor portable while aboard your boat. There's a trend toward multiband reception in today's small sets, and many (Fig. 2) include marine frequencies. Some spell it out with the letters "MB," but others conceal it as part of a short-wave band. You can easily determine whether a set includes the desired frequencies by examining the dial: it should cover 2 to 3 MHz.

There's been a recent proliferation of new marine monitors because there are now two distinct sites for marine radio activity. The new one is "marine FM," a vhf band from 156–162 MHz. One reason it's generating much interest among boatmen is that, unlike its lower-frequency brother, it has a continuous weather channel.

Before this service took to the air the only place you could obtain instant weather via radio was the low-frequency aeronautical navigation band. Trouble was, few boatmen really cared about rime icing while flying through cumuloform clouds at 10,000 feet. And altimeter readings for boats are as useful as anchors for airplanes.

The new weather channel, on 162.55 MHz in some areas, is a blessing to boatmen. Not only does it continuously report general weather, but sea conditions, visibility and wind as reported from key points in the local area. It announces radar summaries of squalls and precipitation, as well as marine forecasts and warnings. There are almost 24 such continuous weather stations around the country, each with a transmitting radius of 25–50 miles.

An example of what manufacturers are producing for the band is Sonar's VHF Sentry (Fig. 3). A complete shirt-pocket-size receiver, it operates on any two crystal-controlled channels between 150–174 MHz. Its usefulness is enhanced by coverage on the standard broadcast band. A portable self-powered unit like this one can easily be carried aboard a dink or a dhow to good advantage. Other manufacturers offer similar portables, some with a continuously tunable dial.

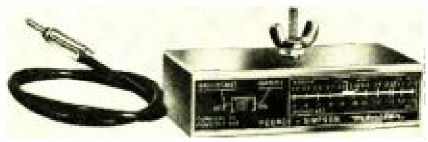


Fig. 1—This marine-band converter lets you hear marine transmissions over your car radio. (Monitor, by Pearce-Simpson).

Although slightly more critical to tune, they offer total, continuous coverage of weather and marine bands.

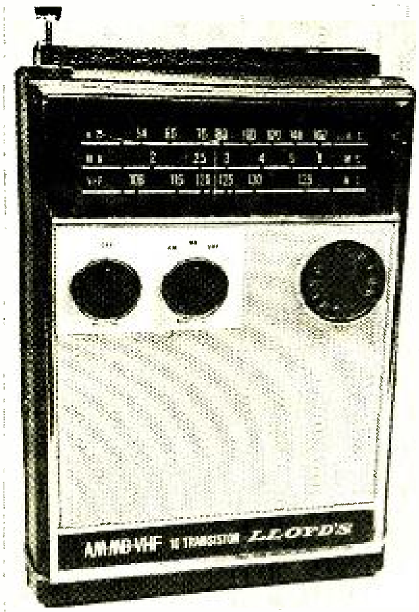
Higher up the price scale are elaborate monitors that include a simple form of RDF, for radio-direction finding. The Hallicrafters CR-44 shown in Fig. 4 is an AM–FM broadcast portable that also includes the LF/MF band (185–400 kHz), the regular 2–3-MHz marine band, plus FM from 152–174 MHz. Thus the boatman can monitor just about anything of marine interest, including continuous weather. The set also has a swingable antenna for direction finding in the LF/MF band (which contains marine and aeronautical beacons) or on standard broadcast stations. A DF'ing antenna on this kind of receiver is more clearly apparent in Nova Tech's Action model, another complete monitor with a DF function (Fig. 5).

What can you do with these receivers? Even the smallest craft can enjoy a basic, but valuable, navigational facility. It could prove handy even if you don't do offshore cruising. When fog shuts off sight of land you can tune a known station and "home" in on it. It's easily done by steering a course that keeps a meter needle in a null (minimum) position.

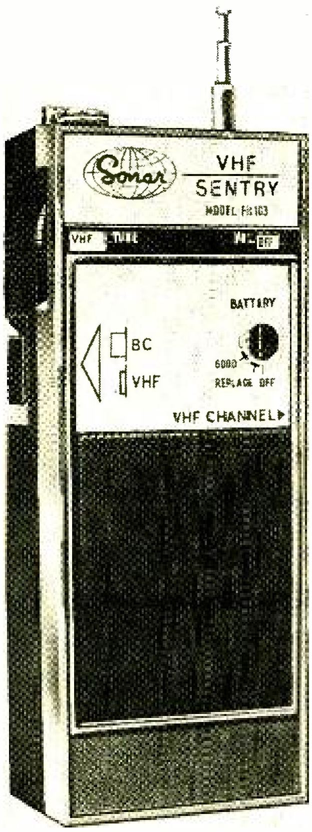
There's one pitfall in using these receivers: their rotating ferrite antennas have a 180° ambiguity, meaning there's a null reading in *two* (exactly opposite) directions. This is solved by tuning a second station. With a chart you can quickly take a radio fix and pinpoint your position.

Seafarers who venture beyond the sound of the breakers may want to step up to a niftier RDF. By adding a sensing circuit and additional circuitry, higher-cost models resolve the 180° ambiguity and make DF'ing faster and more convenient.

Notice the telescoping whip on the Pearce-Simpson DF-765 (Fig. 6). It is the sense antenna. When you want to obtain a line of position to a station, the whip is extended and the loop antenna (in the circular hous-



2

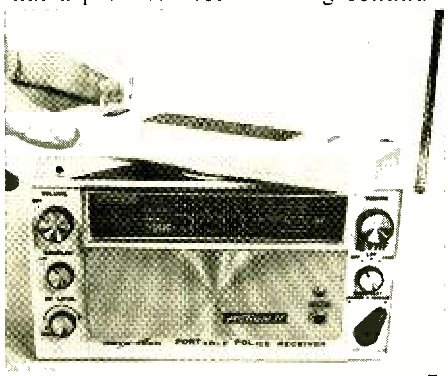


3 4

ing) turned by hand. The meter will read unequal signal peaks to reveal which of two directional possibilities is correct. The sense antenna is then collapsed and the loop used alone.

You can tune a low-frequency beacon or standard BC station for the "homer". Thus you might receive a standard AM station and steer the DF needle while listening to a few choruses of "Downtown" in the radio speaker. You can also arrive downtown because of one peculiarity of an RDF. It inexorably points to the station and ignores any intervening land between you and the transmitter. It's wise to observe this limitation unless your boat has wheels.

Another RDF for boatmen is Sonar's DF-1301 (Fig. 7). Besides the functions just mentioned, this model has a provision for receiving continu-



5

6

Many portable multiband receivers now include marine frequencies: Fig. 2 is a three-band unit by Lloyd's, and Sonar's VHF Sentry ($40) in Fig. 3 covers new continuous weather channels (150–174 MHz), plus standard BC. Fig. 4 is Hallicrafter's five-band CR-44 ($120 net) with a directional antenna. The $130 Nova Tech Action receiver in Fig. 5 has a more elaborate DF'ing antenna. Circuits in Pearce-Simpson's DF-765 (Fig. 6) eliminate the dual-null problem in DF'ing.

ous weather reports on vhf. Sonar does it by including a two-transistor converter with a crystal-controlled oscillator. When the operator switches to vhf, the weather channel is heterodyned down to the standard BC band.

These higher-priced RDF's will also include a bfo for making a CW signal audible. It's handy when a signal is too weak to move the signal-strength needle; you can still listen for a null in the audio tone.

The bfo is also used for Consolan. This is a relatively recent navigation system based on very simple receiving equipment. There's no manual antenna turning because Consolan stations rotate their patterns for you. All you do is count the number of dots or dashes heard within a 1-minute period, then find yourself on a chart with the aid of a published table. There are only three Consolan stations (Massachusetts, Florida and California), but their 1000-mile range should give most boatmen adequate signals for navigation.

If you're seeking the truly deluxe direction finder, there's the Yachtsman marketed by Kett Avionics for $495. It's classed as an "ADF," for *automatic* direction finding. A needle on a compass rose points continuously to the station you've tuned, even if you're sailing off in another direction. It's all automatic, with no manual loop turning required.

Sounding the depths

Once you know where you are, it's useful to know something about the nearest land—which lies immediately below the boat. A depth finder supplies the information, plus some other functions which depend on operating skill.

Most small-boat depth finders, like Ray Jefferson's 510 shown in Fig. 8, emit bursts of ultrasound at about 200 kHz from a barium titanate transducer on the hull. A whirling neon lamp flashes at the start of the burst, then again on the returning echo. As the lamp advances around the scale, depth is indicated in feet.

An important development in current units is compactness and low power draw. That Ray Jefferson unit is less than 5 inches square and, despite a dc motor drive, consumes a mere 100 mA at 12 volts dc. It's practical to power the unit on a hot-shot battery.

The sharp eye can make other underwater discoveries with a depth finder. A series of weak flashes (Fig. 9) may indicate a school of fish. Limited navigation is possible with a finder and a chart of local waters showing depth. Others report they can stay centered in a channel of known depth by observing the finder and avoiding shallower water.

You might also "see" fish talking! One manufacturer states in his instruction book that unexplainable flashes could be from marine life. If you detect intelligible communication of fishy origin, do not attempt to talk back. Contact the Scripps Oceanographic Institute immediately.

Combination units

The next two items reveal a trend by some companies to combine several functions in a single box. Sonar's HA-1 Hailer (Fig. 10) begins with a useful function: a 16-watt public-address system. You can hail other boats or talk to swimmers and skiers hundreds of yards away.

Since the instrument contains an audio amplifier, it can double as an intercom. Or, when the fog rolls in, you can switch to a mode that automatically repeats a 5-sec on, 15-sec off foghorn.

The unit offers a range of alarm possibilities. By adding optional detectors the system warns of fire, theft or a flooded bilge.

Another all-in-one unit is Ray Jefferson's Safety Center (Fig. 11). It can monitor and signal such conditions as potentially explosive vapors below deck, fire aboard, too watery a bilge and abnormal water temperature or oil pressure. You don't have to pay constant attention to the monitoring panel either. If a dangerous condition develops, the circuit sounds a warning buzzer and illuminates a red warning light to identify the specific problem.

Two-way radio

Any craft displacing more water than a floating log can now have two-way radio. A license-free, 100-mW walkie-talkie will communicate some 3 or more miles over water. Further up the scale is CB, described elsewhere in this issue.

But it is the standard marine frequencies which offer maximum safety and convenience on the water. All marine radiotelephones in the 2–3-MHz band must be equipped to operate on 2182 kHz, an international distress and calling frequency monitored continuously by the Coast Guard.

FCC rules also require that two-way-equipped boats monitor 2182 kHz when the receiver is on (and not in communication). It assures that many ears will be alerted to a "Mayday" call. The band contains ship-to-ship channels, as well as a link to the marine telephone operator.

Marine radiotelephones can be expected to operate at ranges of about 1 mile per watt (a 100-watter should communicate to 100 miles). This rule of thumb applies to salt-water operations, with about 30% less range over fresh water (and shorter distances when channels are crowded with signals).

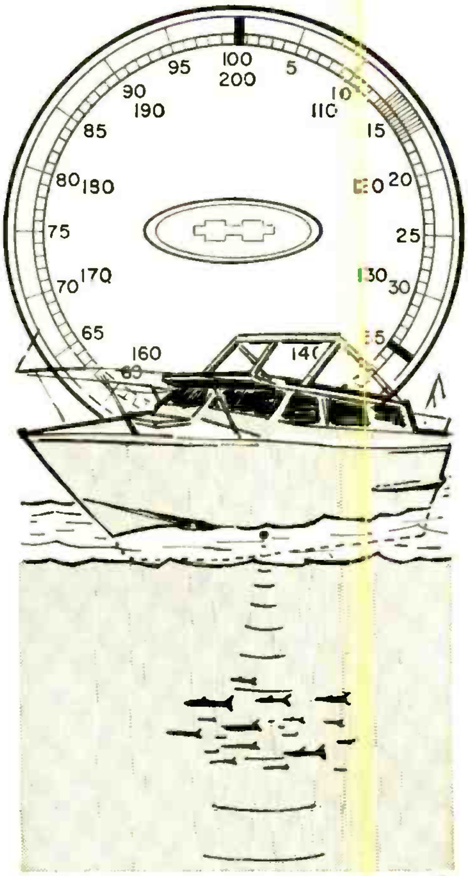
One recent marine transceiver of moderate power is Pearce-Simpson's Bimini 550 (Fig. 12). It's a 50-watt set with four-channel capability and a telephone handset. Its circuits follow the general practice of marine radio: solid state throughout the receiver and modulator, while the transmitter oscillator and final stages remain vacuum tubes.

A notable feature of the 550 is factory pretuning and a seal on each crystal attesting to a factory frequency check. This allows the buyer to install his set (which is supplied with an antenna) without the services of an

7

8

Another sophisticated radio direction finder is the Sonar DF-1301 in Fig. 7. The Model 510 depth finder by Ray Jefferson ($95) in Fig. 8 uses a hull-mounted, ultrasonic transducer. Fig. 9 shows how the neon lamp on a depth finder may indicate marine life (35 feet) as well as depth (100 feet). The $125 Sonar HA-1 in Fig. 10 has a combination two-way hailer, intercom, fog horn and alarm. And, Ray Jefferson's Safety Center in Fig. 11 monitors five safety conditions and sounds an alarm. Fig. 12 shows Pearce-Simpson's 50-watt marine radiotelephone unit.



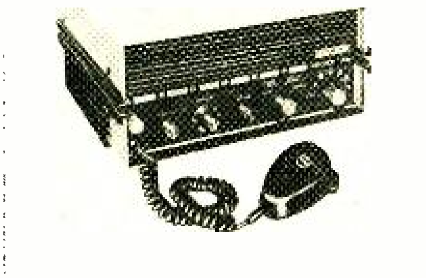
9

10

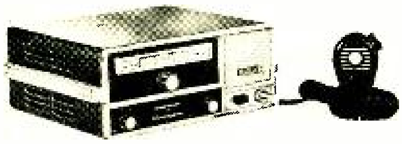
11

12

13



14



15

16

A six-channel, 75-watt radiotelephone (Sonar's 75AW, Fig. 13) also receives AM BC stations and vhf FM, and a 100-watt unit, Ray Jefferson's 4100, is shown in Fig. 14 ($330). The Pearce-Simpson MRT50 in Fig. 15 is a 12-channel unit for the newer vhf/FM band. By 1977, most small-boat transceivers should be on vhf. Emergency Beacon Corp. makes the unit in Fig. 16 that transmits on two international distress frequencies, which can be picked up by aircraft up to 150 miles away. For large pleasure boats, there's a $1075 Model LJ-11 Loran for precise navigation (Fig. 17), and a $2698 radar, the ETA Challenger (Fig. 18), both made by Kelvin Hughes America Corporation.

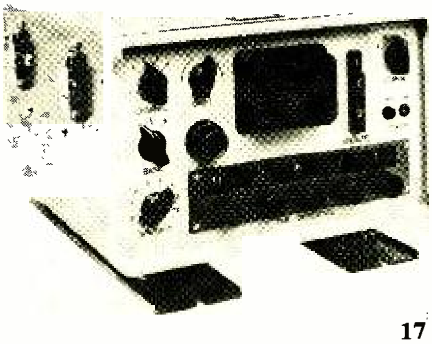
FCC-licensed technician. The manufacturer urges that a ground plate be installed on the boat and states that, if any crystal changes are required in the future, a licensed technician would be needed.

Sonar's 75AW, a 75-watt six-channel set, is also shown (Fig. 13). A special feature of this set is a built-in vhf converter for receiving continuous marine weather on the vhf FM band mentioned earlier. The receiver, as in most marine radios, also picks up standard AM broadcast stations for entertainment. Ray Jefferson's 100-watt set (Fig. 14) should appeal to larger-boat owners requiring greater range than is possible with the low-powered units.

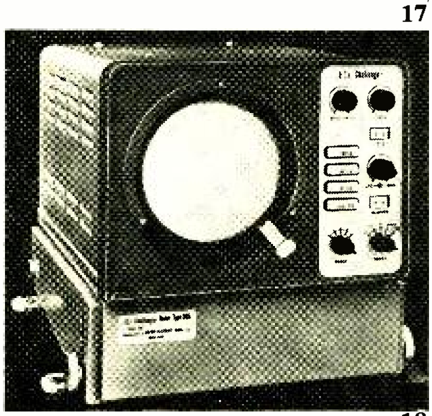
New marine band

Some sweeping changes are due for the marine band. Although FCC rules are not final at this time, any buying decisions should take this proposed schedule into account: There will probably be no more new AM marine radios sold for the 2–3-MHz band after January 1971. If you buy one now, however, you should be able to use it until January 1977. This yields about 8 years to amortize your investment.

After January 1977 it's the vhf/FM band for most pleasure-boat owners. As 156–162-MHz becomes fully activated, the lower band on 2–3 MHz will be reserved for single-sideband equipment. Another proposal is that any boat operating on 2–3 MHz with sideband would also be required to have vhf/FM. These proposals mean that vhf will be the only practical marine band for most small boats.



17



18

Confusing? There are several reasons for the changeover. The congestion and interference of 2–3 MHz should be less on vhf since propagation is line-of-sight. Signals will be confined to about 30 or so miles, which should be sufficient for most pleasure boats. Commercial and bluewater sailors would get the longer range they require on 2–3 MHz with sideband (which also relieves band congestion).

At the moment there is no significant activity on marine vhf, though equipment is reaching the market (Fig. 15). Prices are higher because of more complex circuits, including dual-conversion receivers and transmitter frequency multipliers. When vhf/FM becomes the rule, you can generally expect less ignition and skip interference. Antennas shrink from towering poles to small whips of less than 2 feet. No ground plate will be needed under the boat because vhf antennas can supply an electrical ground or counterpoise within a narrow space.

Emergency beacon

One of the latest items to appear in the boating field is the device by Emergency Beacon Corp. shown in Fig. 16. A pocket-size device, it can transmit a distress call to aircraft as far as 150 miles away. When switched on, the circuit simultaneously transmits carriers on two international distress frequencies: 121.5 MHz and 243 MHz. The latter frequency is continuously monitored by most military aircraft. If an aircraft detects the special audio signal—a wobbling tone sweeping from 1000 Hz to 300 Hz—the aircraft receiver is tripped open by a selective squelch. Search-and-rescue authorities can then locate the party in distress by a "build-and-fade" method of direction finding. The emergency beacon will transmit continuously for more than 2 days.

As we've shown, there are electronic items for the yachtsman that can cost as much as a runabout—including radar and loran (Figs. 17 & 18). If the marine electronics industry keeps up with recent developments, it could be watching a new system now under test by the Navy. Three orbiting satellites enable ships to fix their positions to within 1/10 mile. When the receiving system can fit in a pocket, and be sold at a price, you'll locate your favorite fishing spot with computerlike accuracy. **R-E**

ALL ABOUT OVONICS

Glassy semiconductor switch! Is it new? Is it a breakthrough? Or is it nonsense?

by FRED SHUNAMAN

"THE NEWEST, THE BIGGEST, THE MOST exciting discovery in solid-state physics at the moment" was heralded in front-page articles in the daily press a few months ago. The transistor, the articles screamed, was about to be superseded by a new, smaller, lower-cost, and more reliable device; a device that would make it possible to have computers so small and so inexpensive that every two-car family could have one: a device that would finally make the picture-on-the-wall TV set a reality.

A self-educated inventor, Stanford R. Ovshinsky of Troy, Mich., had announced that he had obtained patents on a new type of semiconductor switch, one that did not have to use crystalline semiconductors, but was made of disordered (amorphous or formless) materials or glasses. These switches could be operated by any voltage from about 2.5 to 300 or more, would switch in picoseconds, and—unlike transistors—were bilateral (would work both ways).

Even more important, the new devices were insensitive to radiation and could be used in space equipment. Another possible use was on nuclear warheads. Most antimissile weapons depend on paralyzing the electronics of a warhead with radiation. Warheads equipped with Ovshinsky's devices would ride right through a strong radiation field without noticing it.

A few days later, the same papers came out with more subdued stories. Reporters sent out to interview large electronics companies found little enthusiasm. "Yeah," the manufacturers said in effect, "we know about them. They work—after a fashion." One large company reported using the devices experimentally; another had been a licensee of Ovshinsky's firm for a few years. One outfit even claimed to have invented the device—years ago!

So, what is the truth? What is this Ovshinsky device? Will it work? How? What can we expect from it? Is it new? Is it revolutionary? Is it even Ovshinsky's?

A true semiconductor device

First of all, it *is* a semiconductor. It is a two-terminal device, so it might be called a diode—except it is a two-way device, conducting equally well both ways. Physically, it has a very thin "glass" film. (One formula is 48% tellurium, 30% arsenic, 12% silicon and 10% germanium.) If a voltage is connected across this semiconductor, it acts like a high resistance (hundreds of megohms) until the voltage reaches a certain point. Then the resistance drops suddenly to as little as 6 ohms or less.

Depending on the thickness of the layer and its composition, the trigger or threshold voltage varies from about 2.5 to over 300 volts. Since the semiconductor is practically an open circuit until it is triggered, almost no power is needed to turn it on, even at the 300-volt threshold. And since the resistance can drop to a few ohms once triggered, it can handle large amounts of current—in the order of amperes.

Why does it work that way?

This is one of those "good" questions. Strangely enough, less is known about noncrystalline (amorphous) solids than crystals. This is largely because the orderly and symmetrical arrangement of the crystal structure lends itself to mathematical treatment. A few theoretical physicists have devoted themselves to the more rugged and less popular task of studying amorphous solids. The ovonic device is one of the first fruits of their efforts.

One of the things researchers of "disordered structures" found out is that (in the words of Jan Tauc of the Czechoslovak Academy of Sciences): "In an amorphous body or in a liquid the atomic arrangement is not totally chaotic. The chemical forces between the atoms tend to bind the atoms in the same way they are bound in a crystal. The consequence of these forces is that *the arrangement of the nearest and next-nearest neighbors of a given atom is not very different from that in a crystal.*" This finding has added some order to an otherwise disordered subject.

Mr. Ovshinsky looked for materials that would trap many carriers of electric charge and yet, upon application of an electric field, release the carriers so that the material can be reversibly and selectively transformed from a nonconductor to a conductor.

In other words, if ovonic material is placed between two electrodes and a voltage is applied, as in Fig. 1, the voltage exerts a "pull" on the trapped carriers (shown as electrons, marked "e" in the figure). At a certain (threshold voltage) many carriers are pulled out of the traps and give the previously insulating material a metal-like quality,—it has many free carriers. This permits easy movement of carriers from one electrode, into the semiconductor material and out into the other electrode.

Once a path is established, an avalanche of carriers starts, and the resistance of the semiconductor drops to a few ohms. The whole process may take only about 150 picoseconds (0.000000000150 second). The conducting state is maintained until the current drops below a given level (0.5 mA), then the material switches back to the high-resistance condition. If the voltage is alternating, current starts in the opposite direction as soon as threshold voltage has been reached on the opposite alternation.

Note that when the switch goes

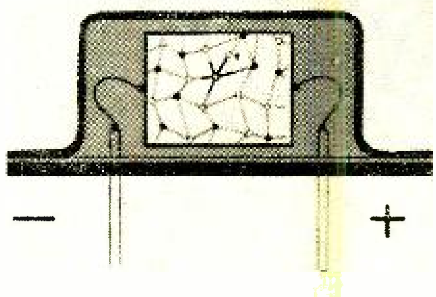


Fig. 1—If ovonic material is placed between two electrodes and a voltage is applied, the voltage exerts a pull on the trapped carriers, marked e in figure.

"on" it immediately passes full current. Thus a scope photo of the action looks like Fig. 2. (This pattern, by the way, is used as the graphical symbol for the device, which no one so far has dared to call an "ovistor.")

A memory cell

Ovonic devices may be made in two main types. Besides the off–on switch, a unit can be made that, once it is conductive, remains conductive even after the voltage is removed. This effect is achieved by reducing the amount of arsenic in the material to about 5%.

Since such a unit can remain in either one of two stages—conducting or nonconducting—it can be used to store binary numbers. It is, in fact, a near-perfect memory cell for computers. It can be "read out" by sending through it a current just strong enough to determine whether it is conductive or not. This can be done without destroying the information it carries (changing its state). The device will remain indefinitely in its conductive or nonconductive state without any power; it can be reached immediately to retrieve information, and can be erased by another pulse.

Indeed, a complete digital computer could be built with just these two elements (the off–on switch and the memory device, replacing all the transistors and diodes of a present-generation computer. This was the basis for newspaper reports of "desk-top computers for use in homes."

What can we do with it?

What can we do with a unit that has two terminals, will turn on when voltage reaches a certain point and then conducts almost like a piece of wire? A mere voltage-operated switch?

Not quite. Even if it were simply a voltage-operated switch, it would have (and does have) an important application in computers. And this switch can be smaller than the diodes now used, and is bilateral.

But it can control far more than the amount of power that switches it on. Suppose, for example, we want to light a 6.3-volt lamp using about 2 watts of power, and have a 1-volt signal (say an audio tone or the amplified signal from a vibration transducer) with current in the milliamperes to turn it on with. We could supply a steady 6.5 volts (ac or dc) and put our trigger signal in series with it, as in Fig. 3. Now, when the signal voltage is added to the regular "bias" we have more than 7 volts. An ovonic device with a 7-volt threshold will turn and supply the full 6.5 volts (minus circuit drops) to the lamp.

The device can be made to have almost any desired threshold between 3 and 300 volts. Therefore, it can be used to release very large amounts of power with a triggering impulse in the milliwatt range. It can also be used as a phase control to cut the power to a circuit or appliance. If a device with a threshold of 70 volts were used in a 120-volt line, it would work exactly like a silicon controlled recifier (SCR) set to turn on at 70 volts (except that it would work on both halves of the cycle). Or a phase control somewhat similar to those used with thyratrons or SCR's could be used to supply the turn-on pulse at a desired point in the cycle.

And that TV on the wall? (Some work along this line has already been done for the Air Force.) By building up a laminated "sandwich" structure (closely packed transparent vertical conductors on one side, a thin film of ovonic threshold switching material and electroluminiscent phosphors in the middle, and closely packed horizontal conductors on the other side—see Fig. 4) it would be possible to build a flat TV display.

Correct negative voltage applied to a horizontal conductor and positive voltage to a vertical conductor would cause the ovonic material to "fire" at the crossover point, creating a dot of light. By scanning, a complete picture could be built up. Simple, but not too easy to work out for entertainment-type picture quality, though it might do very well for a low-resolution display.

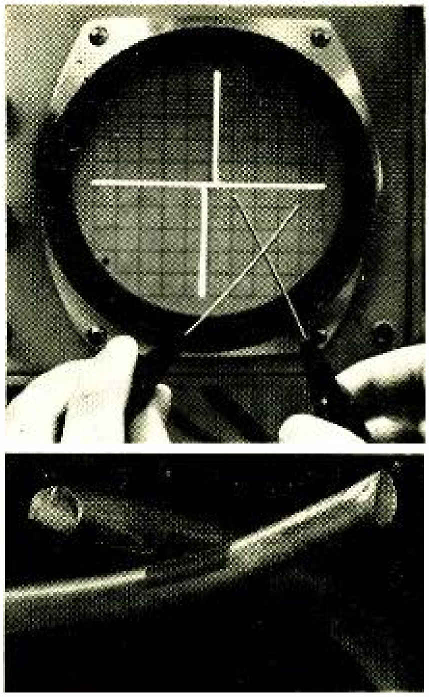


Fig. 2—Two wires coated with thin film of ovonic semiconducting material may indicate the ultimate in solid-state switching. Cost reflects simplicity.

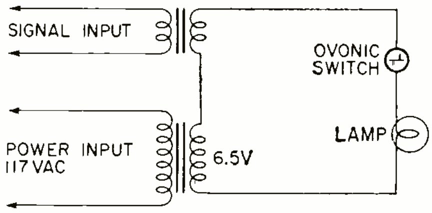


Fig. 3—Typical application uses ovonic switch to control basic lamp circuit.

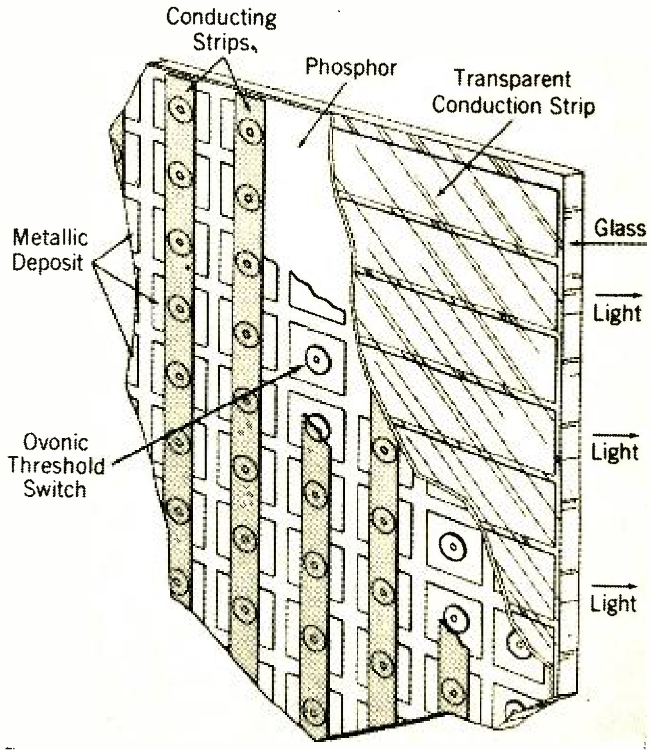


Fig. 4—Flat TV display using ovonics might take the form shown here. Laminated sandwich structure (closely packed transparent vertical conductors on one side, ovonic material and phosphors in the middle, and horizontal conductors on other side) is secret.

Linear amplification

At first glance, it would seem that an all-or-nothing device like this would be useless in any application—an audio amplifier, for example—where the amplified signal must be varied continuously in strength. There are, however, ways to amplify variable-amplitude signals with fixed-output devices. Pulse-code modulation is one method: another is pulse-width modulation. The class-D or two-state audio amplifier (RADIO-ELECTRONICS, July 1965, page 54) switches transistors from cutoff to full pwoer, varying the width of pulses presented to the final or switching ampifier to obtain the variable audio output.

An oscillator?

Ovshinsky says: "Even in a circuit stabilized with a 100-megohm load resistor, the unit cannot be held at an operating point between the highly resistive and the conducting state. In some cases relaxation oscillations governed by the load resistor and the unit's capacitance have been observed."

Anyone who has ever worked with a neon-bulb stabilized power supply of the type popular in amateur circles some years ago will understand the above perfectly. The voltage rises till the unit just becomes conductive. Then (unless you have a perfect zero-impedance power supply) the sudden rush of current drops the voltage slightly, and the unit goes into the nonconductive state. This causes the voltage to rise again, the unit becomes conductive . . . and so on.

It might be interesting to see what could happen with an inductor substituted for the load resistor. With a switching time in the picosecond range and an internal capacitance of only 3 pF, some pretty high frequencies should be attainable.

An important feature of the ovonic unit is that—unlike other solid-state devices—it is uniquely adapted to thin-film circuitry. There is no problem in integrating it onto a thin-film substrate—it is thin-film itself! This is very important, and may be a decisive factor in large-scale integration.

Another feature is its invulnerability to X-rays or other radiation from antimissile missiles. In a crystal structure, such as a transistor, radiation may knock the arrangement out. But since the atomic arrangement inside the ovonic device is already that of a "perturbed crystal" radiation doesn't bother it. The radiation merely rearranges the atoms without making it any harder (or easier) for charge carriers to get through the structure.

This disordered arrangement is also a key to the low cost of producing the device. No careful crystal growing, purifying or doping is needed. And not being harmed by factors that might break down the structure of a crystal and disable it, the ovonic device can be more reliable.

Is it really new?

It *is* new to the general public. If it is new to the engineer or technician, it is partly his own fault. Mr. Ovshinsky has been talking about it since the early '60's without attracting too much attention. He had two handicaps: First, to avoid patent interferences, he avoided giving details until his patents were issued recently. (A person who says, "I have a great discovery," then fails to tell how it works is usually suspect.) Second, although Mr. Ovshinsky has gone far in the fields of mechanical engineering, neurophysiology and electronics, he is self-educated—has no Ph.D. And unfortunately too many scientists are inclined to pay little attention to a paper not authored by a Dr.

Mr. Ovshinsky's first patent on an amorphous semiconductor was granted in 1961. However, he gives credit for the discovery of the intrinsic behavior of amorphous semiconductors to the physicists A. F. Ioffe and B. T. Kolomiets, and much work in the field has been done by Russian physicists. On the other hand, all his colleagues appear to give him full credit for the voltage-switching, or Ovshinsky effect in disordered materials.

The magazine *Electronics* printed an article describing the experimental use of ovonic devices in computer circuitry in July, 1967. The story contained four pages of color pictures of Ovshinsky's Energy Conversion Devices factory at Troy, Mich.

Will it work?

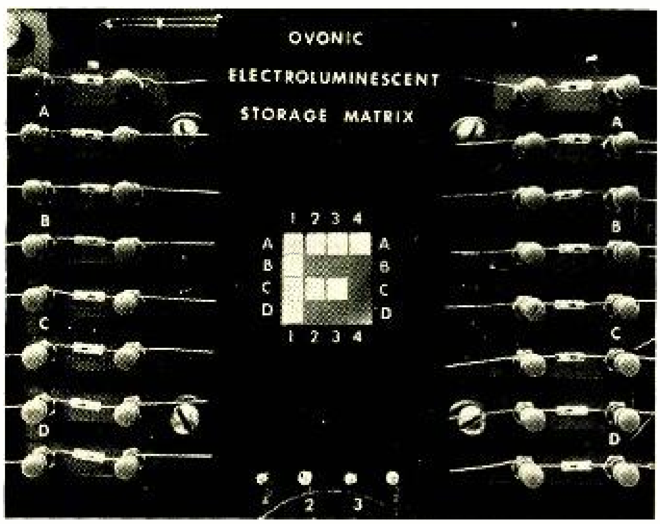
It is already working, and in certain specialized uses, such as radiation-resistant applications, probably better than other available devices. How far it will go in other fields in which present-day transistors and diodes are firmly established (or in areas totally unforseen today) is a matter for the future to determine. Most of those who are well acquainted with the devices tend to agree with the Air Force expert who two years ago offered his personal opinion that the glassy devices, though still in their infancy, "will become as important as the transistor and the diode." R-E

IMPORTANT!

Don't rush out and sell all your old transistor equipment, just to get rid of it while it's still marketable! True, some of the reports seem to say that ovonic devices are going to replace the transistor immediately, and that kitchen computers and picture-on-the-wall TV are just around the corner. Those stories were written by reporters without too much technical knowledge and published by newspapers more interested in circulation than technology.

According to Mr. Ovshinsky: "Most of the operational applications of this new field of electronics are still in the future."

However, there appears to be little doubt, in the minds of engineers and scientists who have studied the new switching devices that—as Government scientists have written—"they will become as important as the transistor and the diode . . . will undoubtedly open new applications so extensive they cannot even be imagined today."



Demonstration model of ovonic electroluminescent display. In later models, switches will be integrated with the lamps to form a fully integrated flat panel visual display. Perhaps this will be a route to thin-screen hang-on-wall color TV.

THE PICTURE THAT WENT TO JAIL

How to arrest troublesome bars and spikes

By JACK DARR

"YOU 'VE NEVER SEEN ANYTHING like this before!" bragged Ernie. "Come look at it." Bernie chimed in, as usual: "Yeah!" They were my dealer's two novice technicians, and they were never happier than when they found something that could stick the Old Man. So, I followed them into the back room. A Zenith color portable sat on its wheeled cart.

The picture was good, plenty of color, brightness, focus and so on, but something new had been added—thick, very black vertical bars, five of them, equally spaced across the screen. The picture looked like the view from the window of a jail (Fig. 1)!

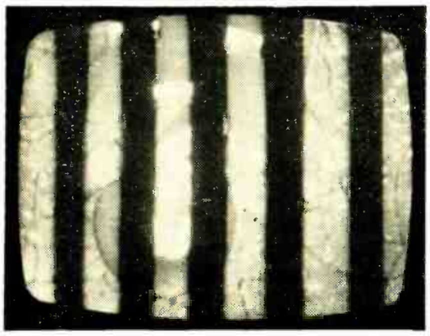


Fig. 1

It had color all right. but it was a very odd off-color—almost purplish, or too reddish. The background was darker than it should have been. too. I turned to a station that had a news commentator sitting still. When I turned the color control all the way off I said, "Does that look all right?"

They admitted that it didn't, now. They had to—the picture was obviously negative (Fig. 2). You could see it much more easily on the black-and-white picture. I thought a minute. "Did you guys take that transistor video amplifier out?" I asked.

"Yeah," they both said at once.

"Well. take it out again, and turn it halfway around and put it back."

Ernie pulled the cheater cord, and they reversed the video-driver transistor. This was a plug-in type and very easy to get at on the back of the chassis. Turning it on again, we still had our jailhouse bars, but the picture was now positive. (Actually, I had been pretty sure that reversing the transistor would blow it out, but apparently it didn't. Only the emitter and collector had been reversed, since the base was in the middle. Oh well, you learn something every day.)

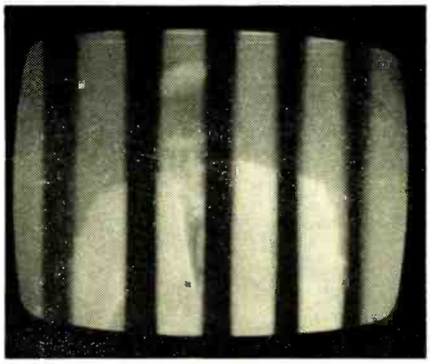


Fig. 2

I took the back off, and turned the set on. Bars still there. I wondered for a minute what it'd look like if I put a crosshatch pattern on it, and then stopped the foolishness and got the schematic out (20Y1C37 chassis).

The bars were apparently being caused by something in the Y-channel or "video." I could cut their intensity by turning the brightness or contrast control down. Turning the color control higher made it "slop over" into the black bars. So, this was apparently something in only the Y-channel, not affecting the color. Tint control worked, and so did the color control.

Up scope! Putting a test clip on my low-capacitance probe, I set up the scope for a look at the horizontal sweep frequency. This was obviously something like ringing, getting into the video and making bars by blacking out the signal at a rate of about 75 kHz or the fifth harmonic of the horizontal sweep.

The video amplifier was visible, but the wires were close together. I had to pick up a short piece of wire clipped off a capacitor lead, and hold it in the end of the test clip. Shakily, I touched the collector of the transistor. Yep. There was the signal I'd expected to see (Fig. 3).

Fig. 3

However, on the transistor base, there was nothing but video. No bars or spikes at all. Hmm. Turning the set off, I pulled the transistor. Turning it back on, I got video on the base terminal again, nothing on the collector (which I'd expected) but a nice collection of bars and spikes on the emitter. Here it is!

Tracing the circuit on the schematic, I could see a couple of things that might be causing the confusion. The blanking was fed to the emitter of this transistor, with a couple of diodes in there (Fig. 4). One went to

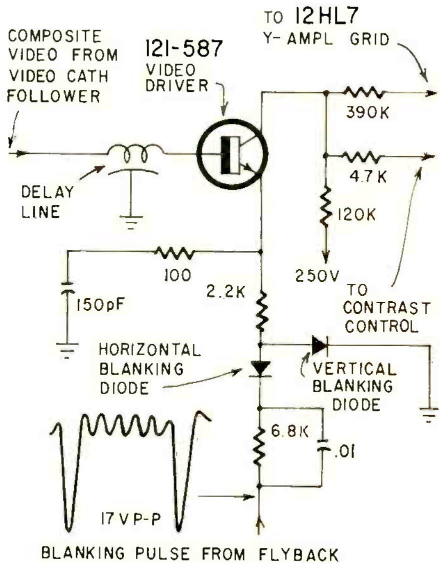


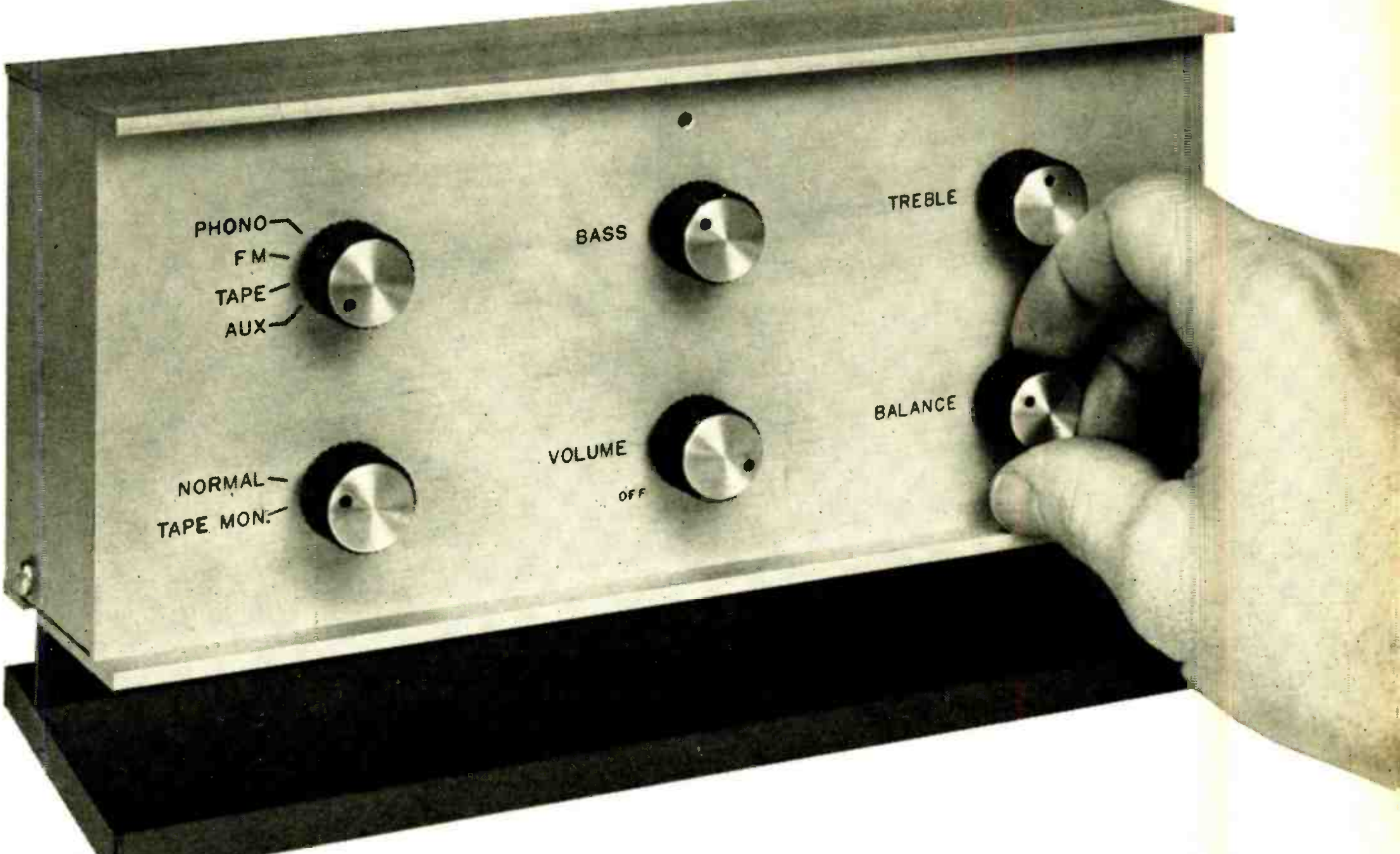
Fig. 4

ground, and the other went back to a winding on the flyback. The waveform from the flyback had a very high horizontal-blanking spike, and several much smaller "rings" along its base line (Fig. 5).

Fig. 5

The scope showed a very large pulse waveform at the end of the 6800-ohm resistor, and also on the other side of the series diode. Turning the set off, I lifted one end of the diode and slapped the ohmmeter across it. Oh, ho! The little reascal was shorted. This allowed the whole blanking waveform to get through, instead of only the blanking pulse. The rings along the base line were causing those thick black jailhouse bars!

Putting in a replacement diode, a 1N64, which was the only one I had, I tried it. Evidently this made the jailbreak good, the bars were gone. **R-E**



BUILD—R-E EXCLUSIVE

STEREO IC PREAMP

Dual operational amplifiers give you top hi-fi performance

by **KEN BUEGEL**

THIS PREAMPLIFIER IS A COMPANION unit to the stereo power amplifier which appeared last month. Dual operational amplifiers packaged on a single chip provide left and right channels for each of the preamplifier stages. The Motorola MC1303P is two separate amplifiers sharing common power supply terminals.

The package layout is exceptionally easy to use. All input signals are applied to the non-inverting input (pin 9) in Fig. 1. Since this input has high impedance, in the order of many megohms, the input impedance required for any application is easily set by connecting an appropriate resistance between this terminal and ground.

Returning the inverting input (pin 8) to ground through a capacitor keeps the dc gain of all packages at unity. Thus, the maximum dc output voltage can never exceed the input offset voltage—less than 10 mV.

The total power supply requirements are plus and minus 13 volts at 45 mA. This amount of current is drawn from the power amplifier power supply through dropping resistors. Zener diodes across the inputs hold the voltages within the IC ratings. A 40-mA lamp in series with the positive supply current is used as a pilot light. A Zener diode across this lamp holds it to a 13-volt operating voltage.

Three IC's are used. IC1 provides amplification and the RIAA equalization required for a magnetic phono cartridge. Its output is a high-level signal which, with the other input signals, is connected to the contacts of SELECTOR switch S1.

Switch S1's wiper feeds the volume control. IC2 provides amplification and the low output impedance drive for the bass and treble tone controls. The wipers of S1 also connect directly to the tape output emitter followers. The tape recorder output jacks are a low-impedance output and have not been altered by any control action within the preamplifier. Since the tone controls, when in their FLAT position, attenuate all frequencies about 18 db, IC3 operates at moderate gain to boost the output voltage. Maximum output voltage, at less than 0.1% distortion, is 4.5-volt rms, which will drive any available power amplifier on the market.

Frequency response of the complete preamplifier is 3 Hz to 34 KHz ±6 dB. The required magnetic cartridge load, usually 47,000 ohms, is connected directly across the phono input jacks. Each IC has a 100-ohm resistor in series with its output terminal. This value is adequate for driving a signal through up to 50 feet of shielded cable. If longer output cables are needed, increase resistor values at the output of IC3.

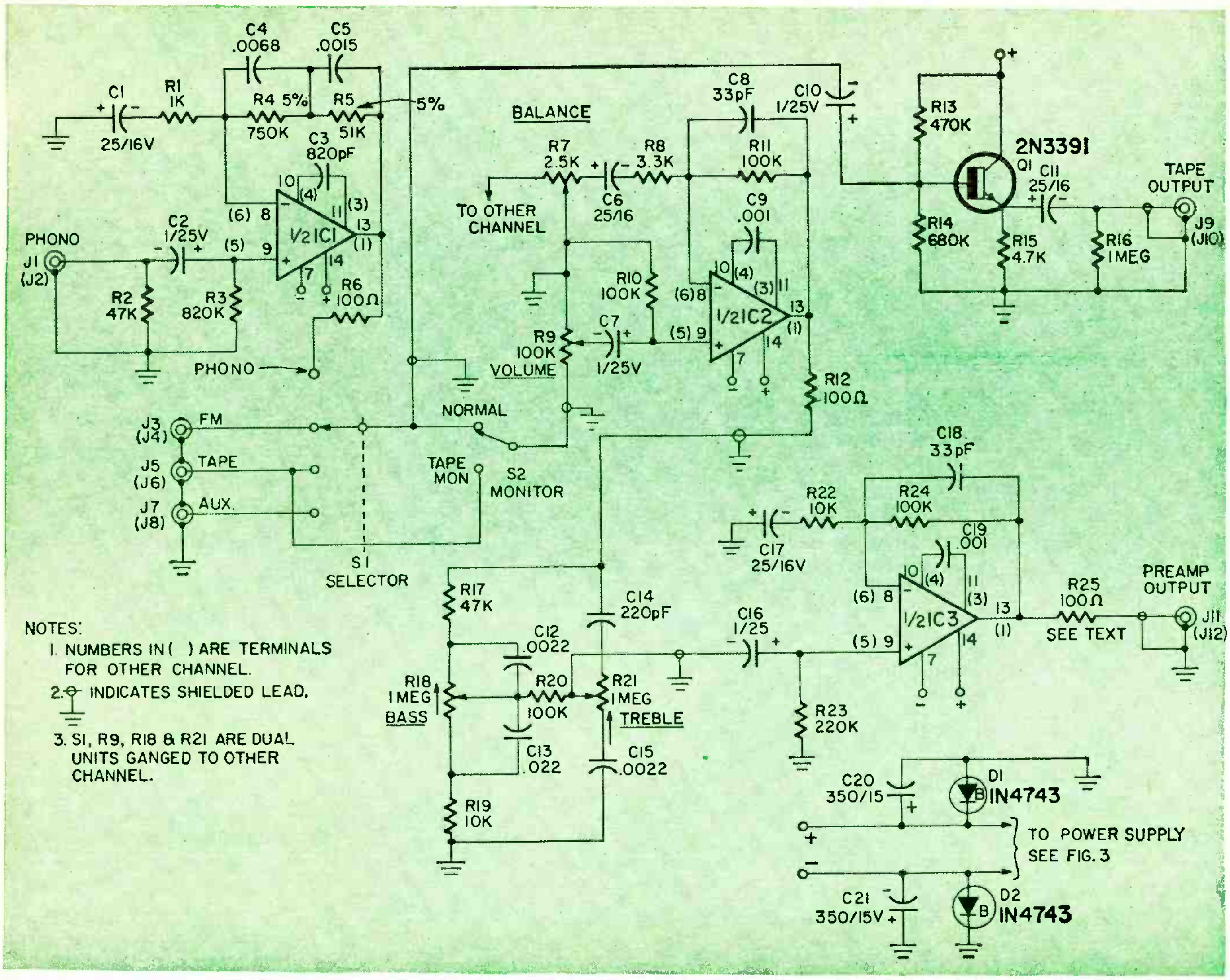


Fig. 1—One channel of the stereo preamp is shown above. The second half of the three op amp IC's is used identically in the other channel. Frequency response of the circuit is essentially flat over the audible range: ±6 dB from 3 Hz out to 34 kHz.

Building the preamp

The first step is to mount components to the printed-circuit board. A half-size layout is shown for those who wish to make their own boards. A 30-40 watt soldering iron with a small chisel tip is best for soldering leads to the board. After inserting a part bend the leads outward, cut off 1/16 inch above the board and solder.

If you accidentally fill a hole with solder, touch the iron to the hole and insert a toothpick through the hole. Mount the IC's on the board last. The small notch in one end of each IC should point to the right or output end of the PC board and should be above the tiny copper dot if you buy your board.

After the PC board is complete, make all connections to the front panel controls. Wiring will be easier if the controls are first assembled to a sub-panel. A small 4-terminal tiepoint placed between the tone controls will provide input mountings for the tone control components.

PARTS LIST

The following parts are for a single channel only. You will need two of each for a stereo preamplifier

Capacitors

C1, C6, C11, C17—25 μF, 16 V electrolytic (Sprague TL1157.1 or equiv.)
C2, C7, C10, C16—1 μF, 25 V electrolytic (Sprague TL1200 or equiv.)
C3—820 pF, disc ceramic, 10%
C4—.0068 μF, 80 V (Sprague 192P6829R8 or equiv.)
C5—.0015 μF, 200 V (Sprague 192P15292 or equiv.)
C8, C18—33 pF, disc ceramic, 10%
C9, C19—.001 μF, disc ceramic, 10%
C12, C15—.0022 μF, 80 V (Sprague 192P229R8 or equiv.)
C13—.022-μF, 80 V (Sprague 192P2239R8 or equiv.)
C-14—220 pF, disc ceramic, 10%

All resistors ½-watt 10% unless noted

R1—1000 ohms
R2—usually 47,000 ohms (see cartridge data sheet for suggested value)
R3—820,000 ohms
R4—750,000 ohms, 5%
R5—51,000 ohms, 5%
R6, R12, R25—100 ohms
R8—3,300 ohms
R10, R11, R20, R24—100,000 ohms
R13—470,000 ohms
R14—680,000 ohms
R15—4,700 ohms
R16—1 megohm
R17—47,000 ohms
R19, R22—10,000 ohms
R23—220,000 ohms

Following parts are used one per preamplifier

C20, C21—350 μF, 15V (Mallory MTA350F15 or equiv.)
R7—2,500 ohms, linear potentiometer
R9—dual 100,000 ohms, audio taper potentiometer (IRC-CTS type 45A104MA104S17 or equiv., includes spst switch)
R18, R21—dual 1 megohm, audio taper potentiometer (IRC-CTS type 45A105MA105 or equiv.)
J1, J2, J3, J5, J6, J7, J8, J9, J10, J11, J12—phono jacks, single-hole mounting
IC1, IC2, IC3—MC1303 (Motorola)
Q1, Q2—2N3381 (G-E)
D1, D2—1 W, 13 V, 10% Zener diode (1N4743 or equal)
S1—2-pole, 4-position miniature rotary switch
S2—2-pole, 2-position miniature rotary switch
Case, knobs, miscellaneous hardware
1 printed circuit board, etched and drilled No. PRE-1 $7.10 postpaid. Order from: Transitek Co. P.O. Box 98205 Des Moines, Wash. 98016
Kit of semiconductors including IC1, IC2, IC3, Q1, Q2, D1 & D2 also available from Transitek. $19.75 postpaid.

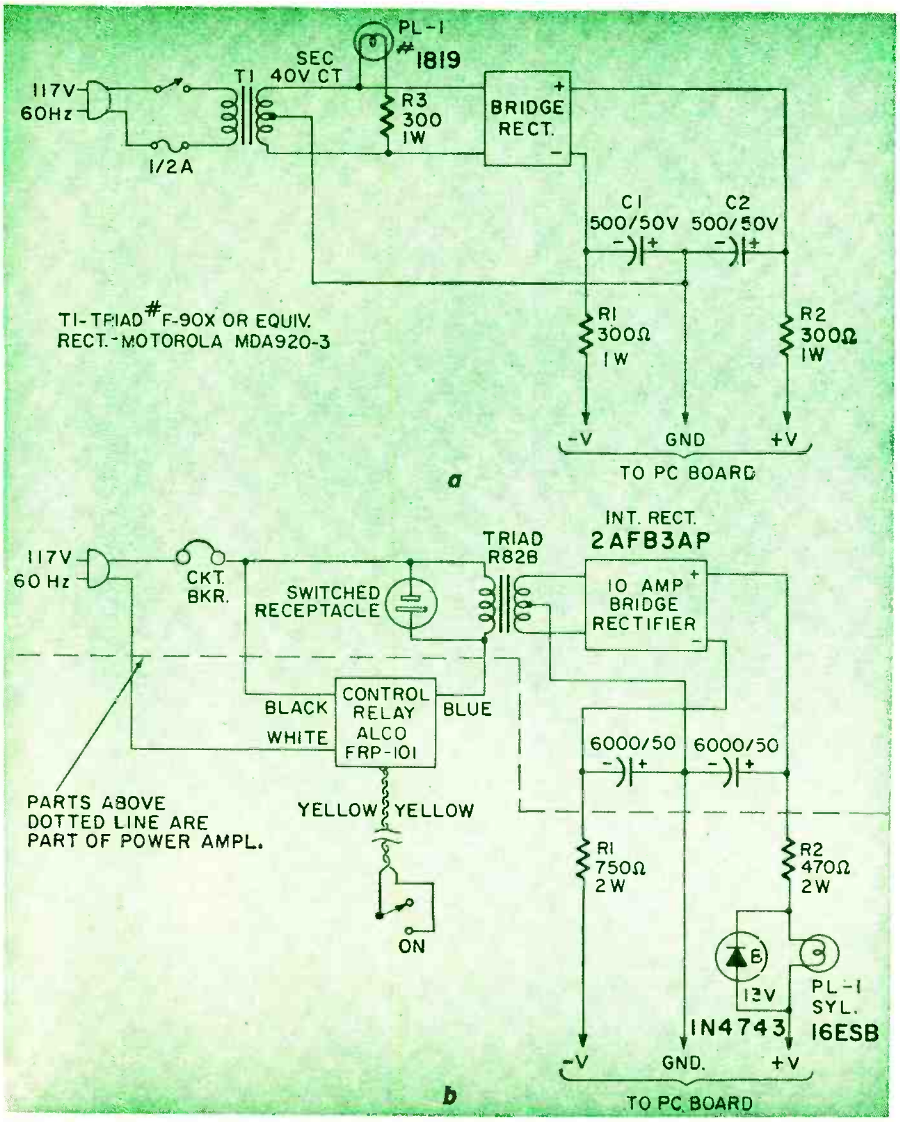
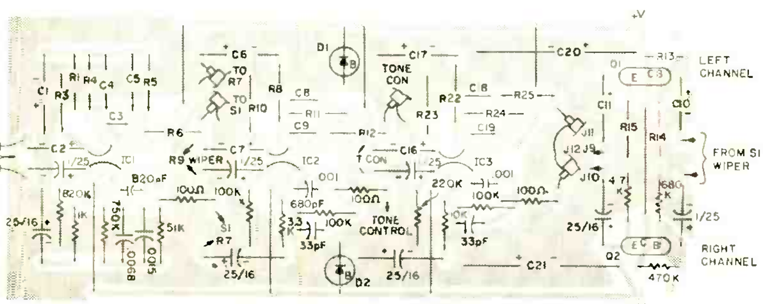
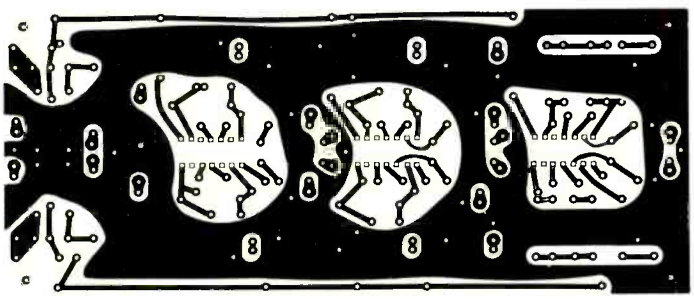


Fig. 2-a—Use this circuit to build a separate power supply if you are not building the pwr amp described last month. (Connections to this amp are in b.*)*



SOLID LINES ARE JUMPERS ON COMPONENT SIDE OF THE PC BOARD



Parts placement on the printed circuit board is illustrated from the component side. The PC pattern is shown one-half size. Enlarge photographically to 7 inches.

The capacitor shown in the parts list for C12 and C13 is small enough to mount directly across the control terminals. Be careful soldering in this area as parts are tightly spaced.

Control panel hookup

Use shielded cable for all wiring between the panel controls and circuit board. Connect the grounds on the signal input jacks together with No. 20 stranded wire and make a solid connection to the circuit board.

Connect the phono input jacks to the inputs of IC1 with a 2-wire shielded cable. The specified loads for the phono cartridge, usually 47,000 ohms, are connected across the phono input jacks.

Route the ON-OFF switch leads away from the inputs of IC1. The power cable to the preamplifier is a 5-conductor No. 20 cable. Since power supply filter capacitors C20 and C21 are on the circuit board, this cable is not shielded. A power supply for the preamplifier should it be used as a separate component is shown in Fig. 2-a.

Test before using

After the unit is completed, it must be tested. Use a scope to monitor the output signals as well as to measure their level.

Apply a signal from an audio generator to each high-level input jack on the left channel. Connect the scope to the preamp left output jack. You should get an undistorted audio output of at least 4 volts rms with the tone controls in the flat position, and a 0.2-volt rms input signal. Rotating the balance control should increase and decrease the left channel output signal. Check the effect of the tone controls with test frequencies of 50 Hz and 10 KHz. After all high level input jacks are checked out, apply a 5-mv signal at 1 KHz to the phono input jack. With S1 in the phono position, the output signal should appear at the preamp left output jack.

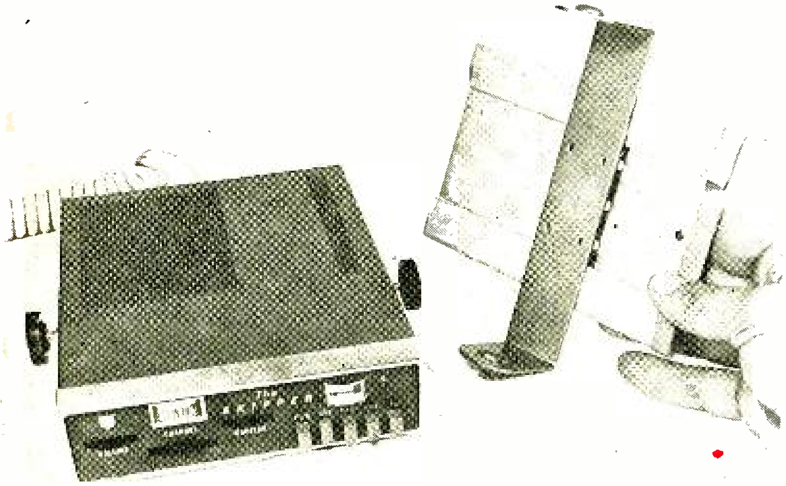
The left tape output jack should deliver the input signal selected by S1. Tone, volume, and balance controls should have no effect on the tape output signal.

Repeat this procedure for the right channel.

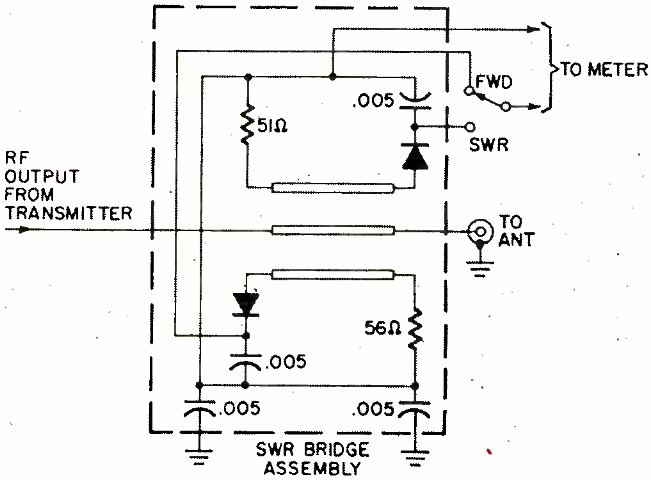
Make a further check by measuring the output on the left channel with a maximum output level signal appearing on the right channel. You should read less than 10 mV on the left channel. Make this check in both directions.

Any hum or noise appearing at the outputs should be completely inaudible at normal listening levels. **R-E**

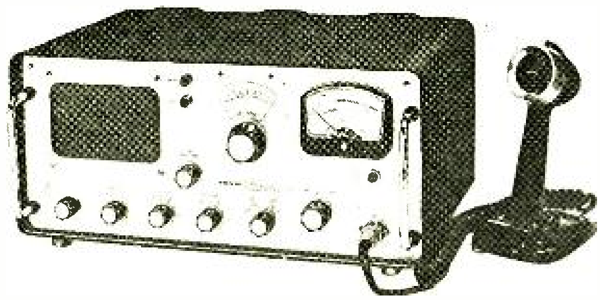
What's New in 5-Watt



1

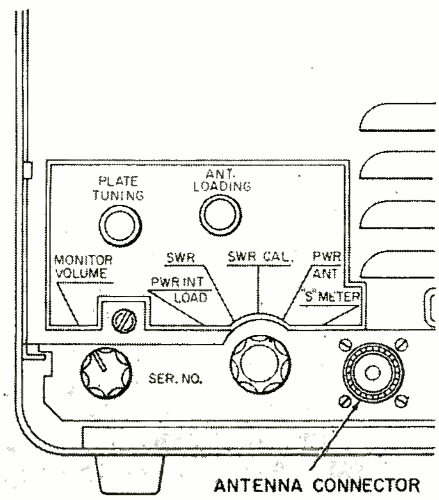


4

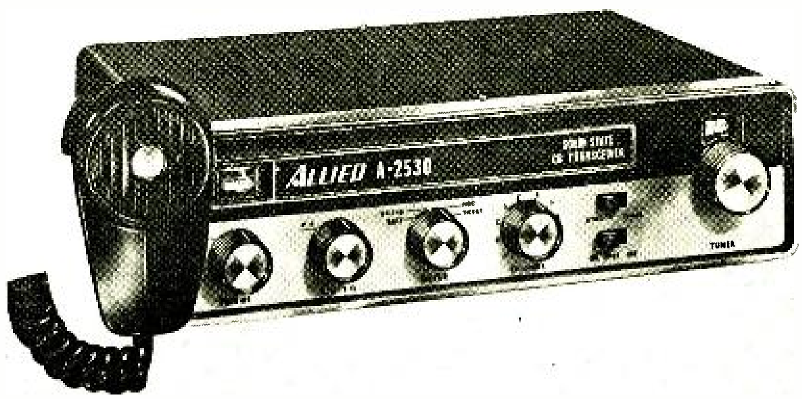


2

Fig. 1 (top left)—The Squire-Sanders Skipper, a book-size mobile CB rig, features roller knobs, pushbuttons and a break-away mounting for passenger safety. Fig. 2 (center left)—Tram's Titan II is a full-size vacuum-tube model with many features found in low-power ham transceivers. Meter on front panel can be used to measure SWR on the transmission line, signal strength in S-units and power output. Fig. 3 (lower left) is sketch of meter selector switch on the rear panel. Fig. 4 (above) is the circuit of the SWR bridge in B&K's model Cobra 98. It is similar to units sold as a CB accessory. The Allied Radio model A-2350 (Fig. 5, below) transmits on ten crystal controlled channels. Its dual-conversion receiver with manual tuning covers the full band.



3



5

CB Gear

By LEN BUCKWALTER

JUDGING BY THE 1969 EQUIPMENT, CB ENGINEERS HAVE moved quickly to exploit recent gains in technology. They now build full-power transceivers barely larger than last year's handie-talkie. The package may contain a noise "silencer" similar to one in a $700 police radio, 23 crystal-controlled channels and a built-in PA system. A new CB set may boast features usually associated with costly amateur equipment, like a mechanical filter or a dual-conversion receiver. Fortunately, these advances are being introduced without significant price increases.

It's now possible, for example, to buy a CB transceiver for under $200 that includes most of these recent design improvements:

- Field-Effect Transistors—FET's are being quickly adopted for the front ends of CB receivers. They improve selectivity and reduce cross talk when operating on strong input signals.
- Integrated Circuits—IC's are now liberally applied in transceiver design. They'll appear in an i.f. strip or in audio stages. IC's make the rig smaller or economically supply the designer with more stages.
- Mechanical Filters—This component, which alone once cost more than some transceivers, has been scaled down for application by CB manufacturers. It improves receiver selectivity by slicing away adjacent-channel interference. Ceramic filters also find their way into more equipment to enhance selectivity.
- Frequency Synthesis—This mathematical mixing of about 14 crystals to create 46 crystal-controlled frequencies is nearly standard in many new sets. The rig with fewer than 10 channels is hard to find.
- Noise Silencers—This one is an improvement over the conventional noise "limiter". Now appearing on more transceivers, the silencer reduces noise at an early point in the receiver, where the signal occurs at a radio frequency. A silencer provides better action than simple limiters, which function mainly on the audio signal. It attacks noise voltage before it "rings" and broadens in the i.f. stages.
- Silicon Transistors—The changeover to silicon circuitry is proving a boon to mobile operation. Earlier germanium types could succumb to heat developed under the automobile dash.

These are some of the major advances in the recent crop of CB transceivers. Although the emphasis is on solid state, the equipment is changing in other ways, too.

One is that the trend toward miniaturization has seemingly reached a crossroads. Although the tiny transceiver is often welcomed by the CBer for his mobile rig, the physically large set persists in popularity for the home, or base-station rig. These preferences have led to more splitting of lines by many manufacturers into the "base" and "mobile" rig.

In earlier years, one transceiver model with a dual power supply could be a base or mobile unit. Today, however, a large transceiver may operate solely on house current; while small, solid-state sets are powered from 12-volt dc. (Some manufacturers offer an accessory power source for operating the mobile set at home.)

Big power, small package

Thus you can expect more differences in the physical packaging of 5-watt CB gear this year. An important factor, though, is that even in extremely small mobile sets, it's still possible to obtain the elaborate circuitry found in the big base station. It's due to the high circuit density possible with solid-state components. Let's consider some actual examples of what's happening to CB equipment.

An example of one manufacturer's effort to produce a compact rig with considerable circuitry is the Squire-Sanders Skipper shown in Fig. 1. Despite its size—about that of a book—the set operates on all 23 channels, delivers full 5-watt transmitter power and has a dual-conversion receiver. An innovation in this set is a break-away mounting bracket. If a passenger is thrown against the dash during an unscheduled stop, the set is shoved back harmlessly. Another accommodation to auto safety is the absence of fierce knobs or sharp edges. Instead there are roller knobs and flat pushbuttons.

The Skipper, with its miniscule proportions, resides at one end of the size spectrum. It is clearly a mobile; the power source must be 12-volt dc. At the opposite end is the big base station. Not only is it physically large, but several popular makes still contain vacuum tubes. The recent Titan II by Tram is one example of a set strictly for base-station work. It weighs 26 pounds (vs 3½ for a tiny mobile), has vacuum-tube circuits and is housed in a substantial cabinet (Fig. 2).

AM or double sideband

The Titan II has several interesting features. For one, its transmitter can operate on either conventional AM or, by suppressing its rf carrier, on double sideband. In the sideband mode, a range increase is possible since additional wattage is injected into the signal's audio-bearing sidebands. Another feature of this transceiver is the use of the S-meter for additional signal measurements. In the Tram unit, the S-meter reads incoming signal strength in conventional fashion. Then it may be switched to indicate relative transmitter power being applied to the transmission line. In another position, the meter indicates standing-wave ratio of the antenna system. This can be valuable. For example, if SWR is measured at a low value (less than 2:1, for example) it's excellent evidence that the transmission line and antenna are operating at high efficiency. The final meter value which the operator can select is the true rf power output of the transmitter. This is done by measuring the output signal across a built-in dummy load. Most transceivers which read power indicate it in relative values. The Tram arrangement provides a numerical reading in actual watts. Given SWR and power readings, the operator has a continuous check on system performance. How he selects the various meter functions is shown in Fig. 3.

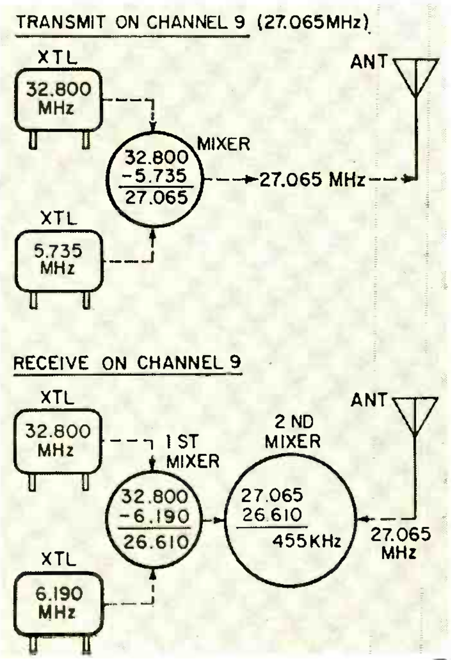
Built-in SWR

Another manufacturer also includes a built-in SWR meter in his transceiver. It's the B&K Cobra 98 model. The partial schematic in Fig. 4 reveals how this feature is

CB is looking at some changes.

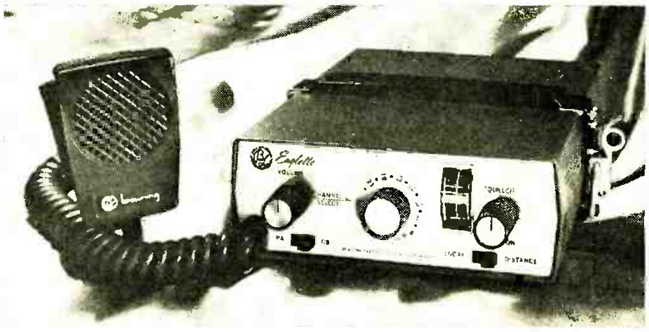
story on what's

6

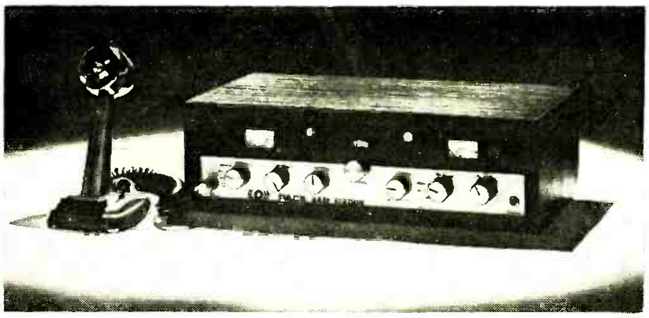


7

8



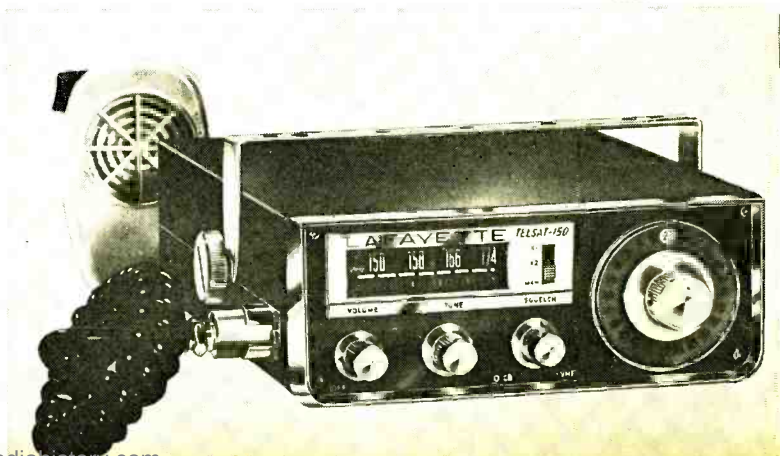
9



10

Fig. 6 (top left)—Johnson Messenger 223 transmits and receives on 23 channels. By using frequency synthesis, the engineers make 14 crystals do the work of 46. Fig. 7 (center left) shows two crystal frequencies heterodyned to transmit on 27.065 MHz. To receive, two crystals beat, producing a voltage 455 kHz below the signal frequency. Fig. 8 (lower left)—Sonar's model J-23 is another all-channel rig featuring frequency synthesis. Fig. 9 (top right)—The Eaglette, by Browning Laboratories, is a 23-channel mobile transceiver with local-distance switch to cut down on noise and skip interference. Fig. 10 (above)—The Pace Base Station, in its low-profile walnut cabinet, is sure to make a hit with lady CB'ers. Fig. 11 (below)—Lafayette's Telsat 150 rig also receives FM in the 150-174-MHz police and fire bands and includes crystals for receiving US weather broadcasts.

11



Here's the inside

happening today.

added. The circuit closely resembles that of a conventional SWR meter that might be purchased as an external accessory. Another manufacturer who uses the S-meter for more than the usual function is Allied Radio. As shown by the company's Model A-2530 (Fig. 5) the meter is calibrated on several scales. By turning the meter switch on the front panel, the operator can read signal strength (S-meter), voltage of the car battery, transmitter modulation and relative output power.

One trend in the recent lines of CB makers is the increasing number of channels being offered. A high percentage of new equipment includes all 23 frequencies. The frequency synthesis approach is used in the new Johnson Messenger 223 (Fig. 6). With 14 crystals on strategic frequencies, it synthesizes a total of 46 CB frequencies (23 for receive, 23 for transmit). We've illustrated in Fig. 7 how channel 9 would be created. Note that two crystals subtract to generate the transmitted signal on 27.065 MHz. When the operator wishes to receive this channel, another crystal combination takes effect. As shown, it provides the local oscillator signal for channel 9 (26.610 MHz). One crystal—32.800 MHz—participates during both transmit and receive. It's this kind of dual service that enables only 14 crystals to create 46 different frequencies. This is not the only system for obtaining all channels. Sonar, in its all-channel J-23 (Fig. 8), does it with 25 crystals, instead of 14.

Novel twists and tricks

Which system is best? In early frequency synthesis circuits there was a problem of "birdies" heard in the receiver. These were spurious signals created by the complex mixing process needed to make a few crystals do the work of many. Today, however, these problems have been largely solved and any system from a reputable manufacturer should function properly.

In other developments, transceivers turn up with a novel twist or two. Browning's new Eaglette (Fig. 9), a 23-channel mobile rig, is fitted with a LOCAL–DISTANCE switch. The manufacturer states that in the LOCAL position receiver sensitivity is reduced so noise and skip interference are minimized when the desired signal is strong. In the DISTANCE position, the set operates at highest sensitivity for weak-signal reception. A counterpart of this feature is the rf gain control found in some large base-station sets. By manipulating the knob, the operator might optimize reception under certain conditions of interference and signal strength.

An effort to please the lady of the house is evident in the Pace's new Base Station. As you can see in the photo (Fig. 10) the set is housed in a walnut cabinet. With a low panel silhouette and clean knob layout the set could pass as a stereo receiver. The Pace unit can be a fitting addition to a living room without clashing with the decor. Besides high styling, it has a built-in SWR indicating system, an rf gain control and full coverage on 23 channels. Another new wrinkle; instead of a fuse, there's a circuit breaker.

Thus, 1969 is a year which has, so far, witnessed no spectacular breakthrough in CB equipment. But it's a time that can boast of solid improvement. A good sign is that special circuits once offered at a premium are now apt to be standard items. The gingerbread and chrome which once festooned CB transceivers are now largely replaced by business-like, functional, panels. This could be in anticipation of "type acceptance," a government proposal which would require manufacturers to certify to the FCC that equipment meets minimum technical specifications. If the proposal becomes law (and it's generally believed that it will) the CB operator will have some recourse if he is cited for a technical violation due to poorly designed equipment. According to existing law, the equipment owner, not the manufacturer, is responsible when a rig fails to meet specifications. If type acceptance becomes law, it is not expected to have any significant effect on the performance or appearance of transceivers.

Trends in trouble

Several trends in CB equipment, on the other hand, have failed to materialize. One is any speedy changeover to single sideband as a mode of transmission. When several manufacturers were queried about sideband plans last year, at least three declared they would soon market SSB transceivers. None has yet delivered any hardware. Sideband equipment, however, is available from at least one manufacturer.

Another factor which has failed to materialize is the HELP program (Highway Emergency Locating Plan). In this proposal two frequencies would be created within the band, mainly for attracting assistance by stranded motorists. When HELP was presented several years ago (by the auto industry), CB manufacturers responded with the so-called "HELP-type" rig. It was extremely small, easy to operate and intended to appeal to the general public. Price was held to under $100. Since HELP has languished at the FCC, it is generally considered a dying issue. This might explain the reduced activity by CB manufacturers in the category of simple, stripped-down rigs.

CB and business band

One development, however, may trigger a new round of "combination" CB transceivers. There have been attempts in the past to combine the CB band with other services; the business band, for example. Also, several earlier transceivers had a power-reducing switch so the rig could be operated in CB or in the less-restricted 100-milliwatt unlicensed category (Part 15 of FCC rules). In other sets, manufacturers left empty channel switch positions in anticipation of new frequencies (such as HELP). Now there's a new "combination" circuit. It's in a newly introduced transceiver by Lafayette Radio (Fig. 11). Called Telsat 150, it is mainly a small 23-channel mobile CB transceiver. But it also has a built-in police and fire monitor receiver with a continuously tunable dial covering 150-174 MHz (the "high" vhf-FM band). For easy switch-selection of any two receive frequencies, there is provision for two crystals. The set could hold considerable appeal for the pleasure boat owner contemplating a CB rig for marine use. By plugging a suitable crystal into Telsat 150 he'll hear continuous broadcasts of marine weather. The new weather service also falls within the high vhf-FM band, on 162.55 MHz. R-E

Make Your Own ELECTRONIC

Musique concrete percussive sounds might be mixed with sound of tearing paper, shattering glass, the human voice, street and traffic noise by splicing and recording sound-on-sound. Here Nikolais marks the beginning of a sound with white grease pencil. The tape is then passed over playback head and the part wanted is edited out and spliced with electronic sounds.

By ROBERT C. EHLE

TO SOME PEOPLE ELECTRONIC MUSIC means any music employing electronics in any phase of its production. On the other hand, electronic music means certain things to people who work in this medium. Of primary importance here is "science fiction" music, "psychedelic" music, "electronic rock," "aleatoric" music, "stochastic" music, "chance" music and other forms totally unlike the old ordinary, pre-electronic music. The new electronic music stands for new experiences in sound, for other-worldly, way-out sounds.

Electronic music is being used as background music for science fiction movies, as sound for the new psychedelic nightclubs and by the most successful rock'n'roll groups.

The diversity of electronic music is exemplified by the fact that, while acclaimed on college campuses as the latest in "intellectual" music by advanced music students and faculty composers, it is also embraced by the Beatles and by a host of hippie and underground music groups, many of whom began in San Francisco's Haight-Ashbury nightclubs.

Electronic music techniques

Two basic types of electronic music are *musique concrète,* which involves hooking electronic instruments up with regular musical instruments, and "pure" electronic music which involves only sounds generated and processed by electronic instruments. Both are popular and both can be combined for an even more impressive array of possibilities than either can offer alone.

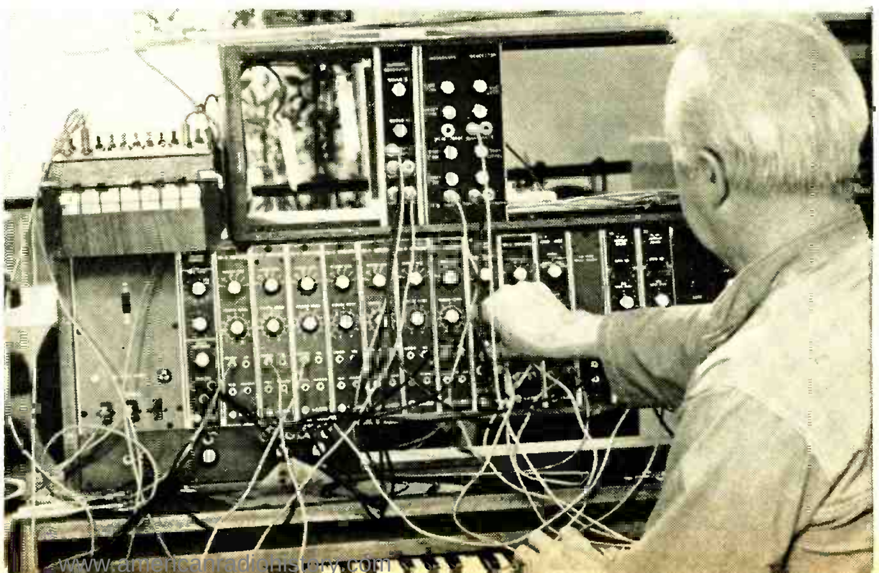
The important thing to remember about *musique concrète* is that it is an "anything goes" style. If you can hook on a microphone to anything, do so. This includes the electronic organ, the electric guitar, electrified pianos, amplified voices, oriental gongs, chimes, the sounds of wood breaking —any sound ever heard by the human ear. The *musique concrète* composer or performer tries to make ordinary sounds louder, more intense, deeper, higher, richer and so forth. He wants you to hear sounds freshly, and with his particular emphasis placed on certain sounds.

When highly intensified sounds are linked with the sounds of a popular singing group, the result is apt to be "the heavy sound," or some other variety which is so popular today. Serious composers tend to stay with "pure" electronic music by rejecting the use of microphones, contact pick-ups and recordings of natural sounds.

The really successful techniques of both *musique concrète* and pure electronic music involve basic principles of audio signal manipulation and processing. Recording engineers are called upon to produce these effects, as are sound effects departments and the special sounds departments and studios of motion picture manufacturers, record producers, experimental music laboratories of colleges and universities and any other organizations responsible for the production of sound tracks and specialties.

The basic instrument for pure electronic music and for *musique concrète* processing is the sound synthesizer, which is, in reality, a collection of individual components or modules for various functions. No two synthesizers are exactly alike. Several excellent synthesizers are available commercially today, and every one is dif-

A custom-built instrument using 10 oscillators to create pure electronic sounds. The knobs on each oscillator control the pitch, except for the unit beneath the small keyboard (upper left). This controls sound "color," providing a range from a harsh rasping to flutelike tones. Output may be spliced with percussive sounds.



MUSIC

Percussive sounds from around the world are used for musique concrete—one form of electronic music—by Alwin Nikolais, a choreographer who creates music for his dance group. Chinese gongs and cymbals, primitive drums from Africa and modern metal drums from the West Indies are a few of the instruments recorded on up to five tape machines via a standing mike.

ferent from all others.

There are, however, many common functions, and electronic music processing may be broken down into a number of them:

1. Sound generation.
2. Modulation, gating or envelope control.
3. Filtering.
4. Reverberation.
5. Tape recording and tape techniques (splicing, dubbing, tape loops, overlays, echo and reverberation).
6. High-fidelity reproduction techniques (stereo, moving sound sources, etc.).
7. Control devices (keyboards, linear controllers, potentiometers).

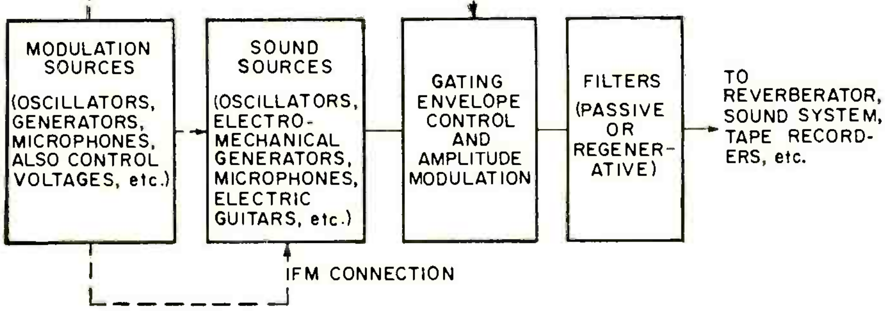
Next we'll look at these techniques one at a time. An earlier article (January 1969 RADIO-ELECTRONICS) covered some simple devices available to the home experimenter for performing many of these functions. A future article will discuss specific electronic music generating and processing systems, and some of the operations performed in schools, laboratories and studios across the country.

First, look at a block diagram of a typical electronic music system (Fig. 1). One or more sound sources send signals to modulators, filters and reverberators. Frequency-modulation signal sources may be used to frequency-modulate some types of sound sources. The output of the process is mixed, taped and then subjected to the various tape recording techniques listed above.

Audio generators

There are two basic categories of generators: oscillators and electromechanical generators. An oscillator generates an electrical signal that is a replica of an audible sound. When amplified and fed into a loudspeaker, the sound generated will be the equivalent of the electrical signal.

Fig. 1—Only a few of the infinite range of sound sources that may be amplitude or frequency modulated are shown in this block diagram of an electronic music system. Tape editing and recording techniques broaden finished sound even more.



Electromechanical generators are devices such as vibrating strings, reeds or membranes to which an electrical transducer (pickup) has been attached. This transducer will deliver an electrical signal with a waveform similar to the pattern which the mechanical device describes.

Four simple types of waveforms obtainable from oscillators and generators are:

- Sine wave (a pure tone containing only one frequency).
- Square wave (so called because of its appearance on the oscilloscope; a fundamental frequency plus the odd-numbered harmonics up to the twelfth or higher).
- Triangular and sawtooth waves (so called because of their appearance on the oscilloscope; a fundamental frequency plus all odd and even harmonics).
- White noise contains equal amounts of all audible frequencies; when some frequencies are missing the result is sometimes considered to be incomplete white noise and is sometimes called "pink" noise.

Gating, envelope control modulation

All these oscillators are continuous-wave oscillators. Once turned on they continue to produce an output until they are turned off.

With mechanical generating devices such as strings, reeds or membranes, the source of power, such as the motion of a rosined bow or wind pressure, may be stopped. When we are deriving sound material from electronic oscillators, however, we cannot just turn off the power with a switch to stop the tone. This is because electronic oscillators require a relatively long period of warmup time for stabilization.

For this reason, electronic oscillators must be left running constantly while in use. To start or stop the sound we use a switch to disconnect the output. If we use an *electronic* switch (called a gate) we can turn the sound on and off much faster than we can mechanically.

In addition, we will want to control the volume. This can be done with a simple volume control or potentiometer. However, if we want to change the volume faster than we can turn a knob, we must use an automatic device called an *amplitude modulator*. This is an automatic volume control that may be operated remotely by another control signal. (A common form of amplitude modulator uses a photocell as the volume-control element; the photocell is driven by the control signal through an amplifier driving a light source.)

In better modulators the control signal is balanced out so that it does not appear directly in the output (only its effects on the input signal are present). The need for this type of circuit may be made clear by realizing that we may want to change a volume at 500 times per second. Although 500 Hz is normally audible, we can balance it out of the output with a balanced modulator.

If a gating device has a frequency response down to dc, a direct-current control signal may be used. The dc level will set the volume of the audio signal. A really flexible amplitude modulator will have a frequency range extending to above audibility. Thus, the ideal unit will be a complete *gate and amplitude modulator* with a control frequency response from dc to supersonic frequencies. It's clear such units must have direct-coupled control amplifiers, since capacitors would remove the dc control element.

Frequency modulation, unlike amplitude modulation, must be performed on the oscillators themselves rather than in external units. Thus, the ability to be frequency-modulated is a basic characteristic of oscillators. It is a desirable addition, but adds to the cost of the units.

Frequency modulation, although sounding very similar to amplitude modulation, is much more audible. This is because the human ear is much more sensitive to changes in frequency than changes in volume. Of course, if the sound source is nonelectronic, amplitude modulation must be used since it is too late to modulate a sound source's frequency once it has been generated.

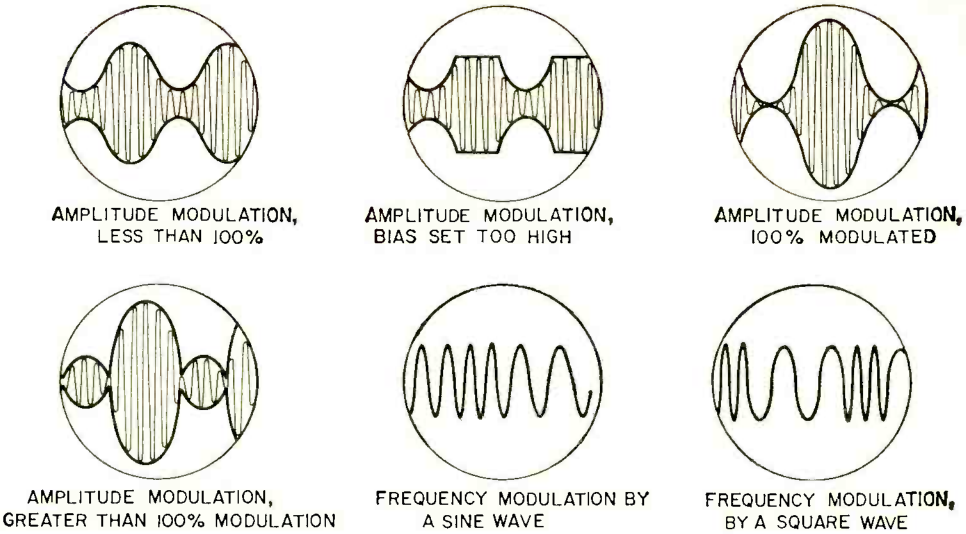


Fig. 2—Various types of modulation as they appear on a scope. Typical source of amplitude modulation is a photocell used in conjunction with a low-amperage, amplifier-driven bulb. Human ear detects FM changes more quickly than AM levels.

The actual sound of modulated tones varies from a slightly colored sound to a sound which is practically noise. One of the most attractive techniques in electronic music is to begin with the modulation off and gradually increase the percentage of modulation (Fig. 2). As the percentage increases the tone becomes gradually more complex, and the original sounds become inundated in a web of related but new sounds.

Many variables exist in the tones used as sources and control frequencies, and an extremely wide range of modulation possibilities exist. Easiest to comprehend are the low-frequency controlled modulations, the trills, glissandi, vibrati, etc. High-frequency modulations are unique in that they are not found in traditional musical instruments. This quality makes them attractive to the experimenter who desires new sounds to work with.

Filtering techniques

Another technique available to the experimenter for electronic music applications is filtering. Filters have the function of depressing the amplitude of certain frequencies with respect to others. They can be used to change the tone color of many sounds.

Although the sine wave cannot be changed by filters (it has only one frequency), the square wave or the sawtooth wave as well as natural sounds can be usefully filtered. Three or four different oscillator waveforms can be given an infinite variety of tone color by different types of filtering.

Filters have four basic forms: high pass, low pass, bandpass, and band reject, all of which do exactly what their names imply: they pass or reject certain groups of frequencies. Each of these characteristics may also be variable.

A special class of filters, of special importance in electronic music, is resonant filters. These, in addition to removing certain frequencies, accentuate the resonant frequencies of the filter. They have effects similar to musical instruments that contain resonant sounding boards.

Resonant filters are usually made by taking a passive filter such as a bandpass filter and adding an amplifier with positive feedback. (Fig. 3). The positive feedback, and thus the resonance, is usually variable.

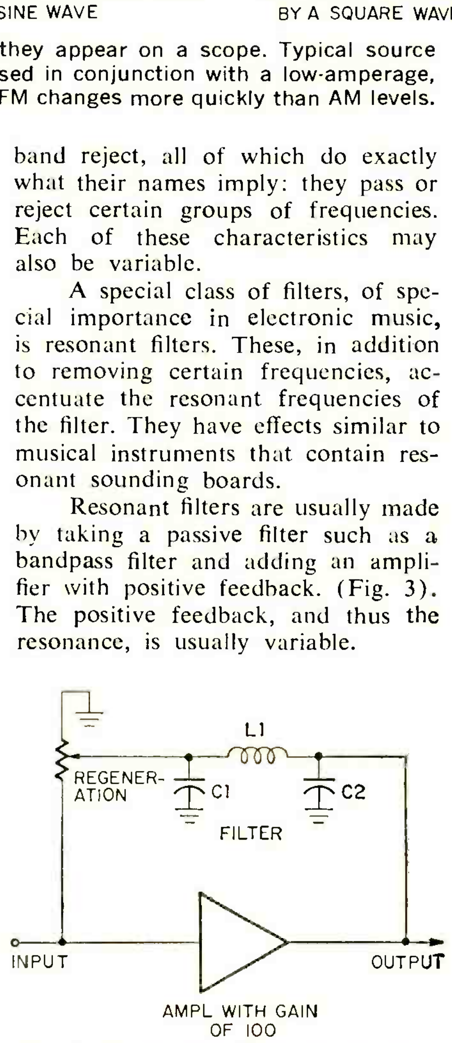


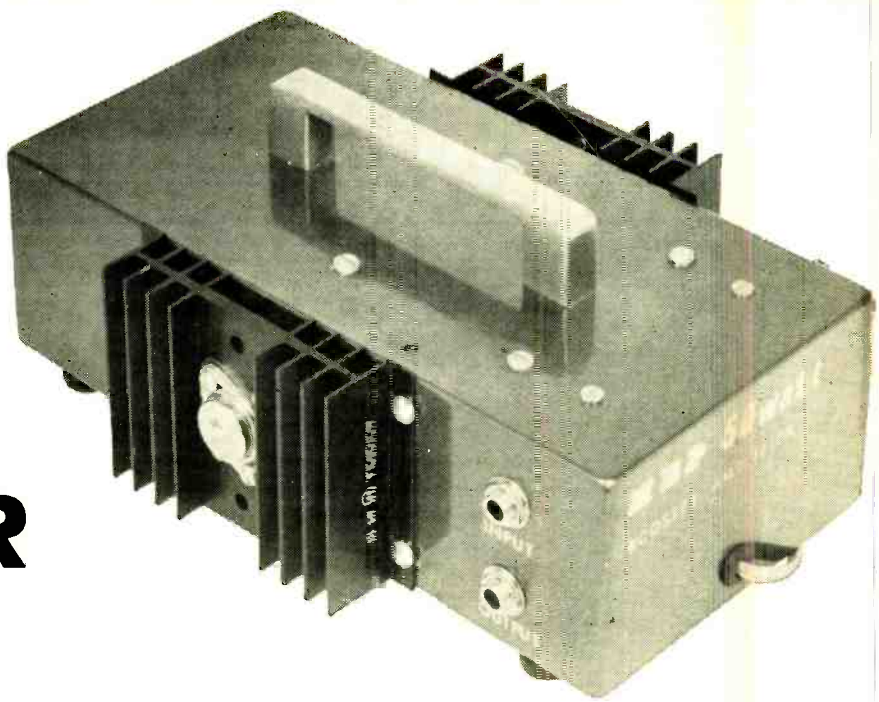
Fig. 3—A resonant filter can be made from a passive filter by adding amplifier with positive feedback. When gain exceeds circuit attenuation, oscillation occurs at filter's resonant frequency.

Reverberation

Anyone who has heard sounds in an anechoic chamber (acoustically dead room) knows how important reverberation is to sound perception. We make judgments as to room size

(*continued on page 91*)

50-WATT BOOSTER AMPLIFIER



Add wall-shaking power to your low-power amp

By JACK JAQUES

TO GIVE THAT HEP GUITAR AMPLIFIER some real sock you've just got to build this 50-watt booster amplifier. It will also work with any other low-power amplifier. Actually this amplifier is an optimized version of an original Delco circuit, but has been matched to the specific HEP transistors and Triad transformers listed in the parts list.

* HEP Technical Manager
Motorola Inc., Phoenix, Ariz.

When the amplifier is set up to work into an 8-ohm resistive load with 1-volt peak-to-peak input signal, frequency response is flat from 20 Hz to 15 kHz and is down only 1 dB at 20 kHz. With an 8-volt input signal, output is down 6 dB at 20 kHz.

Assembly is easy

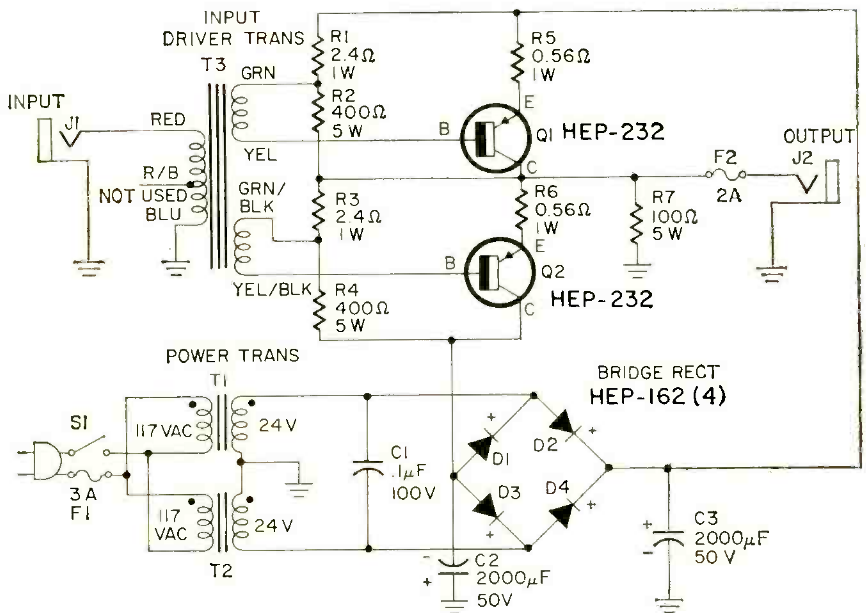
To put the booster amplifier together, physically lay out all the parts (filter capacitor, mounting brackets,

PARTS LIST

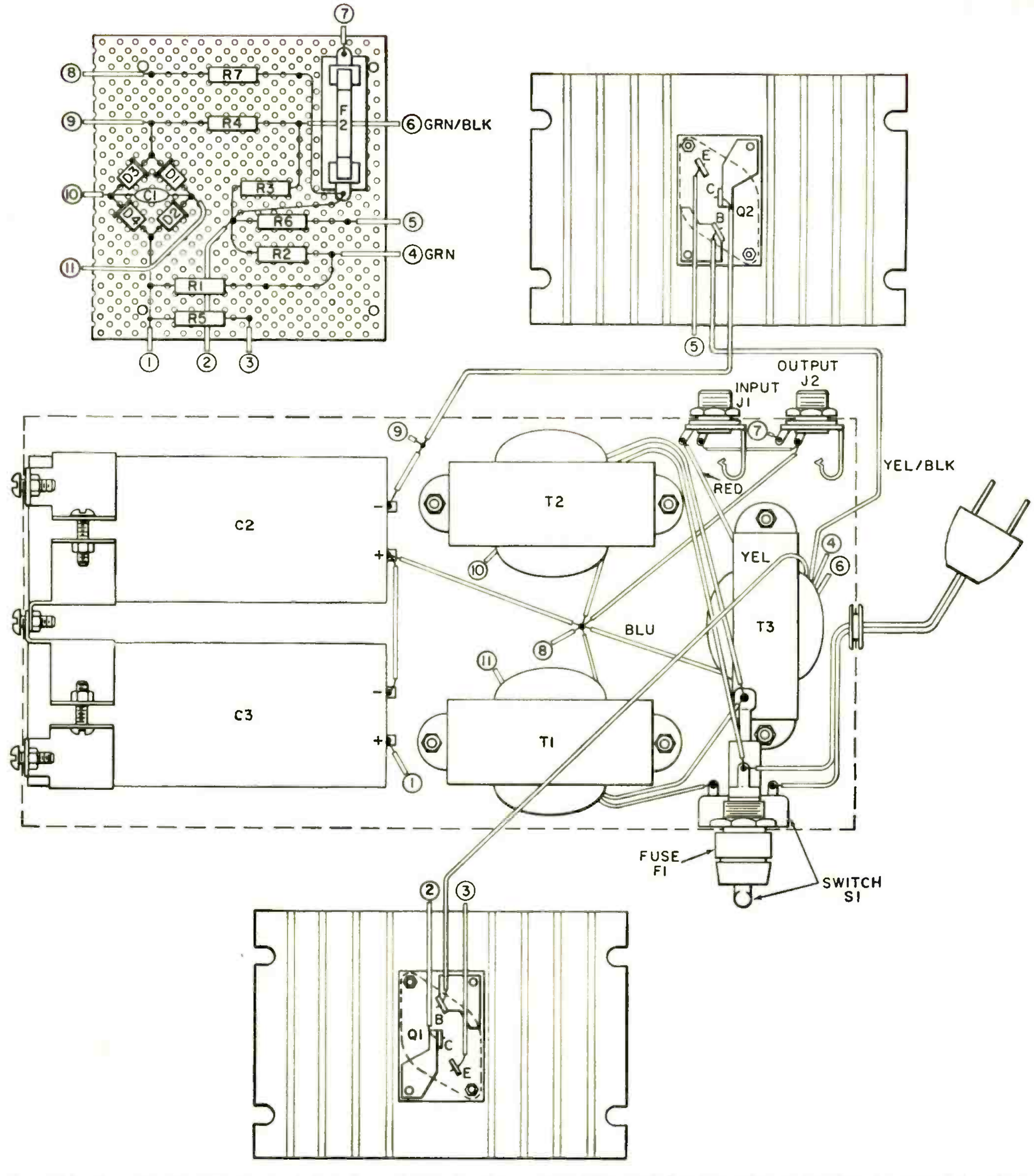
C1—0.1 μF, 100 V, ceramic disc
C2, C3—2000 μF, 50 V, electrolytic
D1, D2, D3, D4—3 A, 200 piV, silicon rectifier (HEP-162 or equiv.)
F1—3 A, 250 V, 3AG fuse
F2—2 A, 250 V, 3AG fuse
J1, J2—Phone jack
Q1, Q2—HEP-232
R1, R3—2.4 ohms, 2 watts, 5%
R2, R4—400 ohms, 5 watts, 5%
R5, R6—0.56 ohm, 5 watts, 5%
R7—100 ohms, 5 watts, 10%
S1—spst toggle switch
T1, T2—Filament transformer: primary 117 Vac; secondary 24 V, 1 A (Triad F-45X or equiv.)
T3—Driver transformer: 6:1:1 (Triad TY-160X or equiv.)

Miscellaneous Parts

Chassis; 3" x 5" x 10"
Terminal board; 3½" x 3½" (Keystone 1753 or equiv.)
Push in terminals (17) (Keystone 1499-FT or equiv.)
Heat sinks (2) (HEP-500)
TO-3 transistor mounting kit (2) (HEP-450)
Fuse holder for F1
Fuse holder for F2
Mounting base for C2-C3 (2)
Rubber feet (4)
Line cord set
Pan head machine screws 8-32 x ¼" (8)
Pan head machine screws 8-32 x 3" (4)
Pan head machine screws 6-32 x ¼" (8)
Nuts 8-32 (20)
Nuts 6-32 (8)
Metal handle (Bud H-9115 or equiv.)
Speaker (Utah MI-12RC or equiv.)



The circuit is designed to be driven directly from the output of the 10-watt HEP guitar amplifer described in the November 1968 RADIO-ELECTRONICS, *or any low-power amplifier you want to use. For best transfer of heat from the output transistors to the heat sink, use silicone grease coating on the mica insulators.*



Assemble the components on perf board as shown in the drawing (upper left). Connect this board to other circuit assemblies with hookup wire, following the coded tiepoints. Mount the perf board on the bolts supporting T1 and T2.

transformers, heat sinks, etc.) and carefully mark and drill the chassis. Cut two large holes in the chassis (approximately 1-inch diameter) immediately underneath each power transistor. Make all interconnections following the pictorial diagram.

Before wiring in the power transformers, try hooking them up on the bench and check the output voltage. If you've got them right you'll measure 48 volts. As indicated in the schematic, the beginning and end of the secondary windings must be connected in a series-aiding configuration. Get them backwards and output voltage will be zero.

The 10-watt guitar amplifier described in the November 1968 R-E is equipped with a speaker-output phone jack, making it easy to connect to this 50-watt booster.

That's all it takes in instructions. Follow the diagrams carefully and you'll have a 50-watt booster amplifier that will rattle the walls and drive your neighbors mad. **R-E**

"HOUSE OF THE SINGING DRIFTWOOD"

by **DAVID K. FULTON**

A three-door magnolia cabinet containing author's hi-fi components is located across the room from the speaker wall. AM-FM stereo tuner is mounted above 40-watt amplifier. Slide-out rack supports Miracord turntable, and tape deck is on the right hand side.

A 3-INCH STONE WALL SERVES AS A speaker baffle in an unusual home audio installation. The wall, a false interior curtain standing 15 inches from the load-bearing wall, was designed and installed when we remodeled our 30-year-old frame-and-stucco dwelling.

Our purpose for constructing the wall was twofold: to create a flowing horizontal line when three rooms were combined into one: to serve as a large, if not infinite, baffle for the music system. As the picture shows, the stone work covers a vertical area 10 x 14 feet surrounding the fireplace and extends back to decorate the proscenium which encloses the planter.

Speakers are mounted in the two small window wells flanking the fireplace. They sit at an angle of 50° from the vertical 7.5 feet above the floor, centered 8 feet, 9 inches apart.

We were not professional sound technicians, but we knew one thing almost instinctively: the speaker installation must not contain anything that could rattle, buzz, tinkle, flutter or vibrate sympathetically.

Weight was no problem. The largest and heaviest portion of the wall stands on the mantel, part of a solid mass of brick and stone that goes down to solid ground.

For the framing, we first lag-bolted a 4 x 4 to the floor full length, except across the raised hearth, on a line flush with the front of the fireplace. Directly above this, we installed a ceiling plate, 2 x 4, with plenty of toggle bolts. Lag screws were set into the ceiling joists. The vertical framing was then placed on centers never greater than 16 inches, with plenty of cross braces doweled and glued in place.

While we still had access to the interior of the void, we lined the space with conventional insulating pads. We also installed several recessed electric outlets and the furnace thermostat.

To prepare for the stone work, we proceeded as we would have for a stucco job. A double layer of black building paper was laid on tight and smooth with roofing nails, then covered with a layer of metal-mesh lath, heavily stapled. On the stone face of the old fireplace, the lath was held with small concrete bolts. Then came a layer of "scratch"—mortar troweled on about an inch thick and combed rough before it set. Two lag bolts were then placed in premeasured positions to carry the weight of the driftwood. The pictures do not show the electric outlets behind the heavy part of the driftwood, in both windows and in both ends of the planter.

Next came the brick facing. These bricks were about 1½ inches thick, 2 inches wide, and 12, 18 or 24 inches long. Color ranged from muted yellows and reds to deep, rich brown. They were set in place with brown mortar.

Speakers were mounted in the usual manner on ¾-inch plywood without bass-reflex ports. Small casement windows below and behind the speakers were closed permanently with weather stripping and heavy screws. The Japanese *shoji* screens covering the interior of the window are fitted tightly with foam-rubber gasketing, but are removable for servicing the lights mounted between them and the permanent sash. Translucent Fiberglass instead of rice paper was used in the screens.

The cedar-wood mantel is a cap fitted over the old stone mantel. Vibration was avoided by careful fitting of the cap, a few small wedges, and muscle —pressing the cap into place.

The technical expert may wince at the unorthodox shape of our sound box, and we regret that it's impossible to tune for perfect speaker balance without moving away from the controls. But neither of these anomalies could be avoided —and neither spoils our fun. We are music lovers, not lab workers, and the music is rich and warm as it blends across the face of the sturdy wall.

High notes are true and clean, and the bass rolls smooth and mellow from the gnarled old wood. It took a lot of work and patience, but only ordinary skill and experience, to create a unique speaker baffle that gives us so much pleasure and satisfaction in the "House of the Singing Driftwood." **R-E**

Troubleshooter's Casebook

Low B+ is a common clue to bad components.
Knowing these six reasons why can save valuable bench time

By ART MARGOLIS

WHEN YOU HAVE A PIECE OF ELECTRONIC gear that has failed in one way or another, first off you reach for a voltmeter. In tube circuits you begin to test plate voltages. In many cases you may smile, thinking here is a clue: the B+ is low. Instead of +300 volts, there is only about 50.

This is the most common voltage clue, and seems to indicate you're going to discover the troublesome component very shortly. Perhaps you will, but maybe you won't.

Since there are six common ways for plate B+ voltage to drop in value, unless you are aware of all six you might spend hours pinpointing a bad resistor, capacitor or coil.

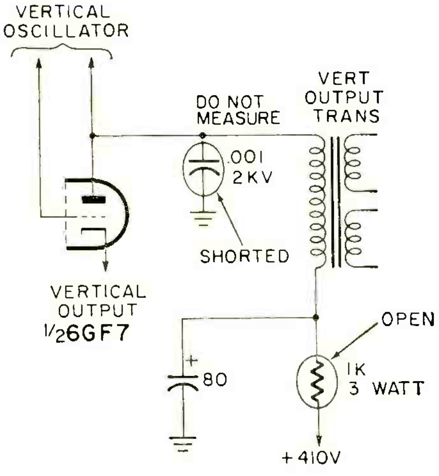


Fig. 1—Overheating 1000-ohm resistor in plate circuit of 6GF7 was caused by a shorted capacitor in the same B+ line. The open resistor was the result, not cause, of the trouble and symptoms.

Let me describe six repairs from my service-bench casebook to demonstrate what I mean.

The bright-line caper

Last week I looked down on the bench at an RCA color chassis. I hooked it up to a test jig and turned it on. Instead of a picture, the only thing that appeared was a bright horizontal line. There was no vertical sweep.

The first thing I did was turn the brightness down, so that the beam wouldn't burn a trace on the picture tube.

Then I reached for my voltmeter. I always make a few quick checks before going into full-dress techniques. I touched down momentarily on the plate of the vertical output tube. Ah ha, only a few volts B+.

(Even though the schematic states, "do not measure" on the vertical-output plate, it's a test point and if you just touch it momentarily you won't damage your voltmeter.)

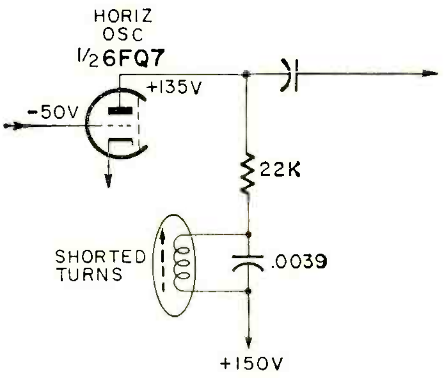


Fig. 2—Low B+ here was result of lowered bias on oscillator grid, which in turn was caused by a faulty plate-circuit component. Shorted coil had changed oscillator frequency.

My quick check paid off. I could skip the signal-injection procedure. I looked at the schematic. In the B+ line was the vertical-output transformer, a 3-watt resistor and a bypass capacitor (Fig. 1). The resistor was indicated as the cause of low B+.

I took my ohmmeter and measured the resistor. Instead of reading 1000 ohms, it read 500,000 ohms. I replaced it.

But when I turned on the TV, the resistor immediately began to overheat. I quickly turned off the set.

While the resistor was the cause of the low B+, something was causing the resistor to burn up.

I took a resistance reading from the plate side of the resistor to chassis ground. Practically zero ohms. There should have been a reading above 100,000 ohms. What was causing it? There were two other components in the line to check: the transformer and the capacitor.

I disconnected one end of the capacitor and took a resistance reading. Good! It was shorted. When I installed a new one, the vertical sweep returned and the 3-watt resistor began running cool.

Case of the whining oscillator

The other day a 14-inch Admiral portable faced me on the bench. I turned it on. Instead of a picture, a loud whine sounded off. There was audio, too.

The whine was not coming out

of the speaker, it was mechanical. It sounded like a 9- or 10-kHz note. The only place such a note could come from is the horizontal oscillator, which should run at an almost silent 15,750 Hz. This tied in with the screen symptom of: blackout—audio OK.

As a quick check I reached for my voltmeter and took a reading on the oscillator plate. Instead of +135 volts, it read only about 50.

I checked at the schematic of the TV, especially in that plate circuit where the B+ was low. There was a 22,000-ohm plate-dropping resistor, and a horizontal-oscillator tank ringing circuit consisting of a horizontal-oscillator coil and 0.0039 μF in parallel (Fig. 2.).

I turned off the TV and began checking their resistances. They were all OK.

Then I switched the TV back on and began reading the voltages again. As I touched down on the control grid of the oscillator, I discovered that the grid bias was down to −4 volts instead of −50 volts.

That made the low plate B+ a false clue. With the lowered grid bias, the tube conducted heavily, dragging current through the 22,000-ohm plate-dropping resistor. This caused the resistor to drop more voltage, bringing about the lowered B+. The lower grid bias voltage was now the valid clue.

Now the question was, what could cause the lowered bias? The wrong horizontal frequency—the symptom—was a good bet. What were the frequency-controlling components? Number one was the horizontal-oscillator coil in the plate circuit of the tube.

I tacked a new one in place, and the oscillator and the picture came on. A horizontal oscillator coil in the plate circuit had caused a change in the control grid voltage that lowered B+ on the plate. You have to be careful with these low B+ clues.

I brought my faithful old clock radio in with me after my wife declared, "Either fix that foggy sound or I'm going to throw it out!"

The radio came on loud and clear, but after a few minutes the sound lowered and developed squawking. It had been doing this a few years.

First I read the audio output plate for B+. There it was. Instead of +125 volts, there was about +30. I looked for plate components. There was the audio output transformer, a 5-watt plate-dropping resistor and a couple of bypass capacitors (Fig. 3).

The squawk sounded like Donald Duck now, so before I went for the plate components I decided to check other tube elements just in case the low B+ was a false clue.

It was. The control grid had about +20 volts on it instead of zero volts. This high positive bias was driving the tube hard, causing a large drop across the plate resistor, lowering the plate voltage. Again the low plate B+ was a false clue.

I looked at the schematic. Where was this unwanted +dc coming from? The only possibility was the plate circuit of the previous stage, the audio amplifier. Between the two stages was a 0.05-μF blocking capacitor to prevent the audio amplifier B+ from getting to the audio-output control grid.

I snipped the output end of the capacitor and read the voltage on the open end. Where I should have been reading zero volts, I was getting a good positive dc reading. The capacitor had sprung a leak and was causing the false clue. A new 0.05 μF cured the squawking.

(My wife let me keep my old favorite, although it didn't sound the same with the clear tones.)

Double-trouble syndrome

The portable TV had two distinct troubles: low sound and no lock-in. The video was there, but it was rolling all over the place.

I decided to check out the sound circuit first, since it's not as complex as the sync circuit. I took a dc voltage reading at the audio-output plate. A clue right off!

Instead of +230 volts, there was only about 10. I looked at the schematic in the plate leg. The leg was being fed B+ from a +290-volt supply point in the power supply (Fig. 4-a). A quick check at the supply test point and the plate circuit was exonerated. There was only about 20 volts there. The audio plate couldn't possibly have 230 volts if its supply was producing only 20.

In the power supply was a tapped bleeder resistor. Off one of the taps was a 10-watt 2200-ohm resistor. The +290 was supposed to emerge from this 10-watt resistor.

I tested the resistor. To my surprise it was OK—2200 ohms.

Then I remembered the other clue: no sync. Following the leads from the +290 supply point, I noticed one headed toward the sync separator. There were a bunch of resistors and some bypass capacitors in the sync supply line. The schematic showed a 0.0047-μF bypass hooked in immediately before the first series resistor (Fig. 4-b). I checked it in the circuit. Its resistance appeared to be about 10,000 ohms.

Since capacitors shouldn't have any resistance, I unhooked one end of it and checked it again. Voilà! It still read 10,000 ohms—a high-resistance short. I changed it and turned

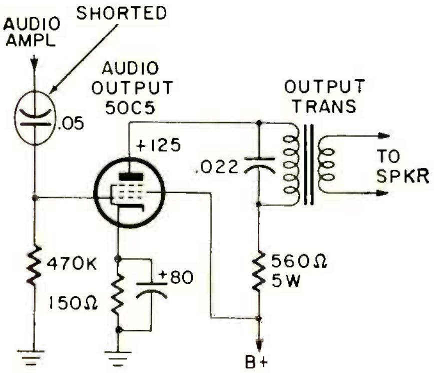


Fig. 3—Shorted blocking capacitor on control grid cut B+ to about 20 volts.

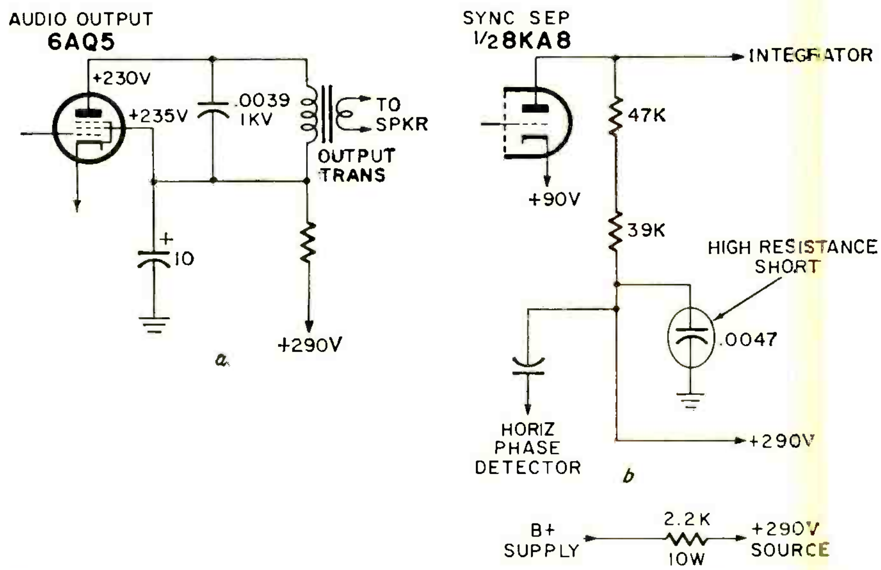


Fig. 4—Single bad component caused sound and sync trouble. The 6AQ5 in a had a very low B+ since a shorted capacitor in b shunted B+ to ground.

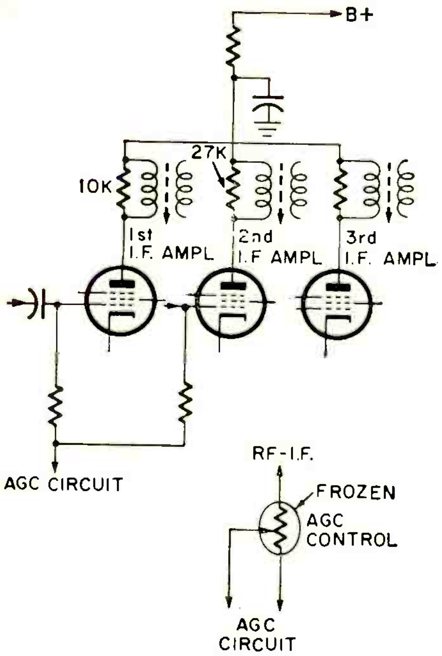


Fig. 5—Low B+ in the i.f. circuit may indicate a bad component in the agc line. Trouble here was found with bias box, pointing to a bad agc control.

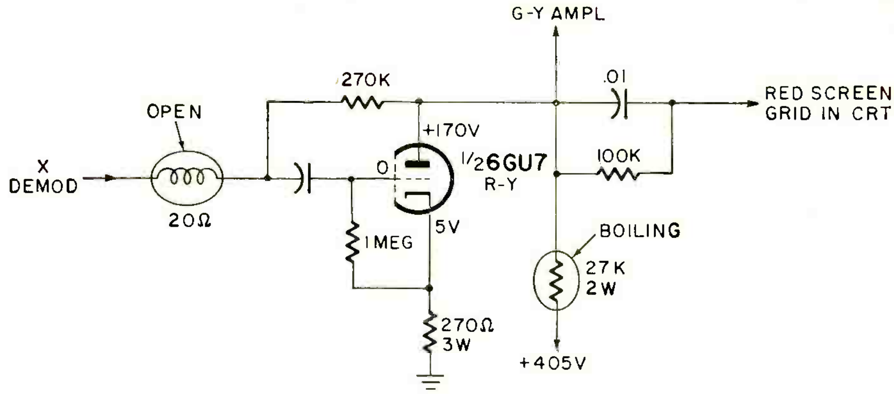


Fig. 6—A low B+ reading on the grid of the R—Y amplifier indicated the CRT was not causing loss of red in the picture. Changing the boiling 27,000-ohm resistor in plate circuit did not correct the problem. When the tube was pulled, no voltage was present on cathode or grid socket pin, indicating no voltage bleed from the previous stage. Open peaking coil upset bias and circuit operation.

on the TV. The sync locked in tight and the audio blasted loud and clear.

The shorted capacitor was shunting off to chassis ground about 80% of the B+ meant to power the audio-output and sync-separator plates. That's why the double trouble.

A false i.f. clue

When a technician is faced with a no-video-no-sound-but-good-brightness problem, his first job is to isolate the circuit in trouble. The possible bad circuits are many, from tuner to video output, plus adjoining circuits.

One quick check to aid in the isolation is to look for lowered B+ on the first two i.f. plates. Low B+ here makes the agc circuit suspect number one.

I had such a case the other day. It was a 13-year-old Crosley chassis with no picture or sound, but good brightness. First off I tested the first and second i.f. plates for B+. Instead of +135, there was about +40 volts on each.

This meant there was no control grid bias, which turned the two tubes on full blast. The high plate current caused the plate voltage to drop.

These two i.f. tubes get their bias from the agc circuit (Fig. 5). The bias is adjusted automatically according to the strength of the incoming signal. Strong signal, high bias; weak signal, low bias, and the tube conducts without overloading. When the agc circuit stops biasing the i.f.'s, the tubes run wild and all sound and picture is lost.

Once I find this classic i.f. false clue, I substitute for the agc circuit. I connected an outside bias from my bias box into the i.f. control grids. In this case, the sound and picture came on immediately. That meant a defective agc circuit. Also, with the correct bias reinstated, the i.f. plate B+ was back to its normal +135.

The agc circuit repair turned out to be easy. As I tried adjusting the agc control I found it frozen. A new control cured the problem.

When red goes . . .

A symptom that strikes terror into a color TV set owner's heart is loss of one color, especially red. In past years the red phosphor of the color CRT was weaker than the other two colors, the red electron gun had to be turned up higher, and consequently it burned out sooner. As a result, the symptom, no red, signaled a bad color CRT.

However, a certain quick check can often indicate the CRT is okay. The quick check is a reading of lowered B+ on the difference amplifier that feeds the picture the red signal.

The first time I ran into it, I was unusually concerned since I had replaced this CRT a few months earlier. The symptom then, too, had been no red. The symptom now was no red.

I began poking around the R—Y difference amplifier. The first thing I noticed was that instead of +170 volts on the plate there was only about 80. As I looked over the plate circuit I saw a problem. The 27,000-ohm, 2-watt plate-load resistor was boiling (Fig. 6).

I checked its resistance. Ah ha, it was about 1 million ohms. I changed it and turned on the TV again. I shook my head, the resistor was overheating again. The TV was turned off before the new one burned.

I looked over the schematic. There were a few other components in the plate circuit. I checked them one by one, but they were all perfect.

This was a confusing one. I decided to sacrifice the new resistor, since I had to take voltage readings at the other tube elements. I turned on the set and quickly read the cathode and control grid. They both read exactly the same thing: +9 volts.

According to the schematic, the cathode should have read 9 volts, but the control grid was supposed to read zero dc.

I pulled the tube out and read the cathode and grid again. This time they both read zero. This indicated that no +dc was bleeding through from the previous stage. These two voltages were being developed by the tube's electron flow.

Proceeding on the assumption that the control-grid circuit was open, I began testing all the series components. The blocking capacitor was good, the blocking resistor was good, but the series peaking coil was open!

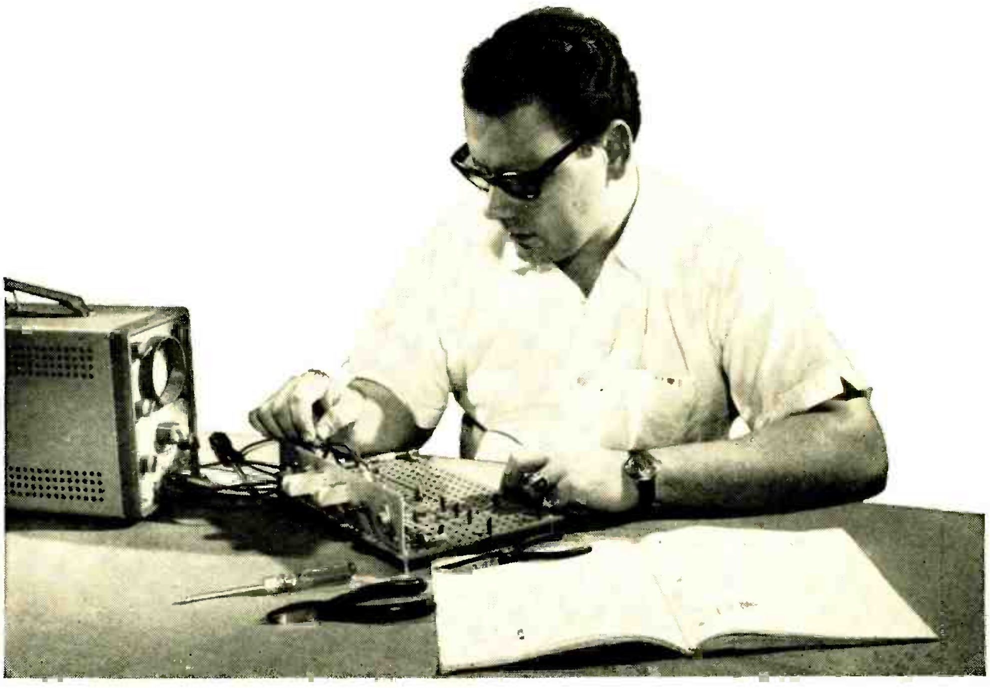
A new peaking coil restored the correct tube conduction, the plate resistor stopped boiling and red appeared on the screen once more.

As you can see from my casebook, a lowered plate B+ can indicate several trouble areas. Check out the plate circuit and change any obviously bad parts.

Often the plate voltage is lowered because the control-grid circuit is in trouble. And the control-grid circuit can be snafued by other circuits. Knowing this makes your servicing more effective. **R-E**

10 Reasons why RCA Home Training is

your best investment for a rewarding career in electronics:



Performing transistor experiments on programmed breadboard — using oscilloscope.

1 LEADER IN ELECTRONICS TRAINING

When you think of electronics, you immediately think of RCA...a name that stands for dependability, integrity and pioneering scientific advances. For over a half century, RCA Institutes, Inc., a service of Radio Corporation of America, has been a leader in technical training.

2 RCA AUTOTEXT TEACHES ELECTRONICS FASTER, EASIER, ALMOST AUTOMATICALLY

Beginner or refresher, AUTOTEXT, RCA Institutes' own method of programmed Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

3 THOUSANDS OF WELL PAID JOBS ARE NOW OPEN TO MEN SKILLED IN ELECTRONICS

RCA Institutes is doing something positive to help men with an interest in electronics to qualify for rewarding jobs in this fascinating field. Every year, literally thousands of high paying jobs in electronics go unfilled just because not enough men take the opportunity to train themselves for these openings.

4 WIDE CHOICE OF CAREER PROGRAMS

Start today on the electronics career of your choice. On the attached card is a list of "Career Programs", each of which starts with the amazing AUTOTEXT method of programmed instruction. Look the list over, pick the one best suited to you and check it off on the card.

5 SPECIALIZED ADVANCED TRAINING

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

6 PERSONAL SUPERVISION THROUGHOUT

All during your program of home study, your training is supervised by RCA Institutes experts who become personally involved in your efforts and help you over any "rough spots" that may develop.

7 VARIETY OF KITS YOURS TO KEEP

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in your program. Each kit is complete in itself. You never have to take apart one piece to build another. At no extra cost, they're yours to keep and use on the job.

8 FROM RCA INSTITUTES TRANSISTORIZED TV KIT, VALUABLE OSCILLOSCOPE

Those enrolled in RCA's television course or program receive complete transistorized TV Kit. All students receive a valuable oscilloscope—both at no extra cost and only from RCA Institutes.

9 CONVENIENT PAYMENT PLANS

RCA Institutes offers a unique tuition plan that lets you progress at your own pace. You only pay for lessons as you order them. You don't sign a contract obligating you to continue the course. There's no large down-payment to lose if you decide not to continue. However, if you desire, RCA Institutes also offers a convenient monthly payment plan.

10 RCA INSTITUTES GRADUATES GET TOP RECOGNITION

Thousands of graduates of RCA Institutes are now working for leaders in the electronics field; many others have their own profitable businesses. This record is proof of the high quality of RCA Institutes' training.

CLASSROOM TRAINING ALSO AVAILABLE

If you prefer, you can attend classes at RCA Institutes Resident School, one of the largest of its kind in New York City. Coeducational classroom and laboratory training, day and evening sessions, start four times a year. Simply check "Classroom Training" on the attached card for full information.

JOB PLACEMENT SERVICE, TOO!

Companies like IBM, Bell Telephone Labs, GE, RCA, Xerox, Honeywell, Grumman, Westinghouse, and major Radio and TV Networks have regularly employed graduates through RCA Institutes' own placement service.

SEND ATTACHED POSTAGE PAID CARD TODAY! FREE DESCRIPTIVE BOOK YOURS WITHOUT OBLIGATION! NO SALESMAN WILL CALL!

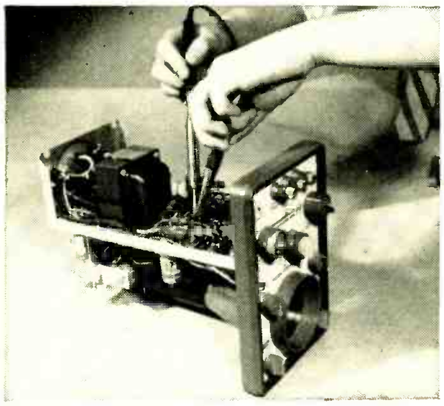
All RCA Institutes courses and programs are approved for veterans under the New G.I. Bill.

RCA INSTITUTES, DEPT. RE-59
320 West 31st Street,
New York, N.Y. 10001

Accredited Member National Home Study Council

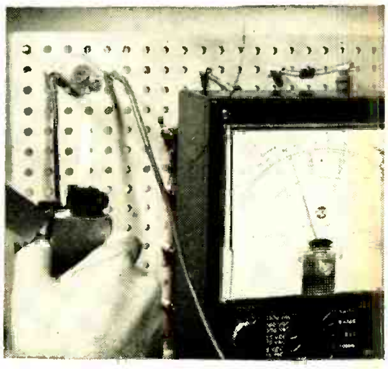
RCA

Construction of Multimeter.



Construction of Oscilloscope.

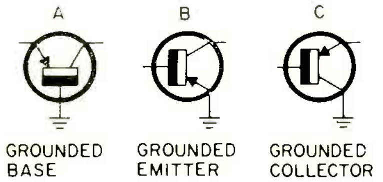
Temperature experiment with transistors.



ABC's of Transistors

CIRCUITS & POWER SUPPLIES

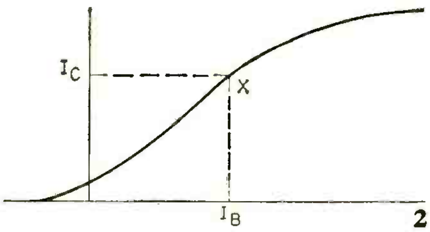
Transistors are connected in three basic ways—grounded emitter, grounded base, or grounded collector. To determine which configuration is being used note which element of the transistor is common to both input and output circuits. (These configurations are also called common emitter, common base and common collector (Fig. 1).



1

Transistor power amplifiers

Transistor amplifiers are classified like tube amplifiers, into class A, B, AB, and C. The output current considerations for classification, refer to base driving signal and collector output current. The transfer characteristic curve would be as shown in Fig. 2. The point

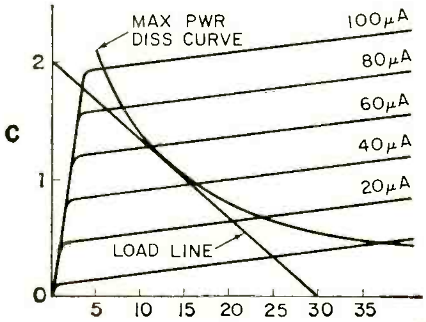


2

marked "X" would be the best bias.

Power dissipation considerations

Transistors are very sensitive to changes in temperature, and must be operated in an environment conducive to maintaining proper temperature limits. Power transistors in particular must have heat protection. Three common heat dissipation methods include using radiating fins—enclosing in a metal case and allowing the chassis to serve as a heat sink



3

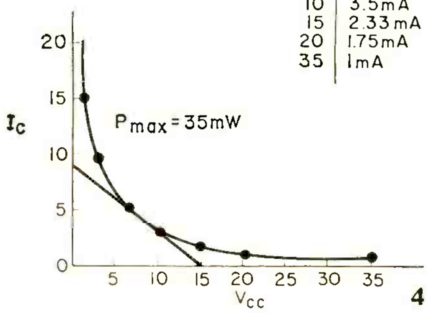
—and assuring the circuit will not allow excessive power dissipation.

To determine if a transistor is operating within safe limits, draw the load line and maximum power dissipation curve (Fig. 3). If the curve and line do not intersect, then theoretically maximum power is not being exceeded. In switching circuits with low duty cycles, these lines may be allowed to intersect to some extent.

Load lines can be established on any set of curves by connecting all points on the graph from "0" collector current, full collector voltage, to maximum collector current with emitter shorted to the collector. Transistor operation should follow the load line plotted. Best base current values can be selected, and collector voltage and current swing can be plotted.

The maximum power dissipation curve may be drawn on the family of curves, by plotting points of collector current vs collector voltage that are equal to the maximum power allowed by the transistor application, as shown in Fig. 4. This curve is for a transistor with a

V_{CC}	I_C
1	20mA
3.5	10mA
5	7mA
10	3.5mA
15	2.33mA
20	1.75mA
35	1mA



4

maximum power rating of 35 mW.

Troubleshooting battery power supplies

One of the first things to check in an electronic instrument poweerd by batteries is the batteries themselves. Some questions to be answered are: 1. Can the batteries maintain specified voltages under rated load? 2. Is the instrument overloading the battery? 3. Does the battery have excessively high internal resistance? 4. Does the battery show signs of leaking?

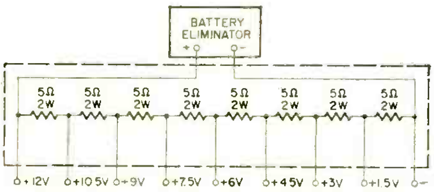
Here are some measurements and checks that answer these questions.

Question 1—Can the batteries maintain specified voltages under rated load? Connect a voltmeter across the battery terminals for a reading and then alternately connect and disconnect the battery to the instrument. Large changes in readings indicate a defective battery or a short in the equipment. Most manufacturers specify minimum battery voltage for satisfactory operation. Consult the related literature for minimum values. Of course low applied power supply voltages result in reduced gain, less sensitivity and increased interference problems.

Question 2—Is the instrument overloading the battery? If the answer to Question 1 is "no" the fault may not be due to the battery. A partial short may have taken place in the circuitry. Measure the actual current supplied by the battery and compare to manufacturer's data. They will usually indicate maximum and minimum values and with or without signal.

Excessive current drain can indicate a leaky electrolytic capacitor, shorted transistor or lead which could lower the voltage supplied to the circuit. This will show up in a current measurement.

Question 3—Does the battery have excessively high internal resistance? Batteries used to check circuit operation should be in new condition. A battery eliminator should be a low-impedance type. Battery eliminators with high impedance can introduce the same trouble as a weak battery even though the voltage is correct. If the impedance of the battery eliminator is not known, an impedance matching device (see Fig. 5) can



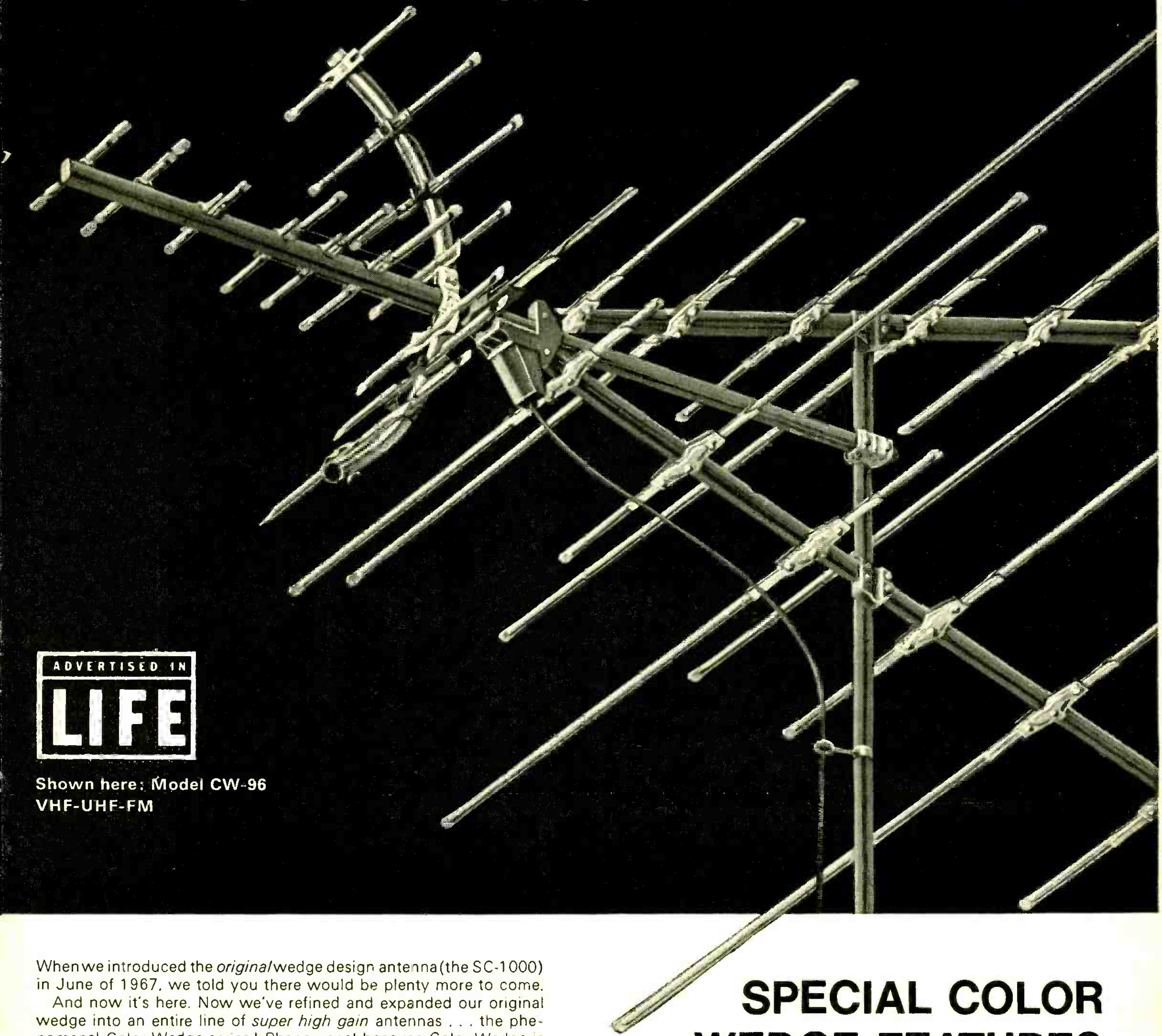
5

be made up. The battery eliminator is fed into the device and it will deliver the proper voltage to supply the instrument under test. A schematic of an impedance matching device is shown below. This circuit may also contain a milliammeter so that the current drain may be measured directly. The device provides a nominal 5-ohm-per-cell resistance which is normal for a dry cell.

Question 4—Does the battery show signs of leaking? A leaky dry cell battery will show a salt-like residue which is a good sign of a defective battery. The chemicals will corrode battery contacts to the point where they may be unusable or not make connection. Wherever you find signs of leakage, clean the affected areas thoroughly. It is also advisable to check the voltages directly at the battery terminals and again at the buses on the board. This test will show up any poor or corroded battery contacts. **R-E**

Winegard introduces COLOR

...dramatically different in design, in performance and in construction!



Shown here: Model CW-96
VHF-UHF-FM

When we introduced the *original* wedge design antenna (the SC-1000) in June of 1967, we told you there would be plenty more to come.

And now it's here. Now we've refined and expanded our original wedge into an entire line of *super high gain* antennas . . . the phenomenal Color Wedge series! Phenomenal because Color Wedge is much more than a new antenna or a new shape. It's a dramatically different antenna. Dramatically different in design! Dramatically different in performance! And dramatically different in construction.

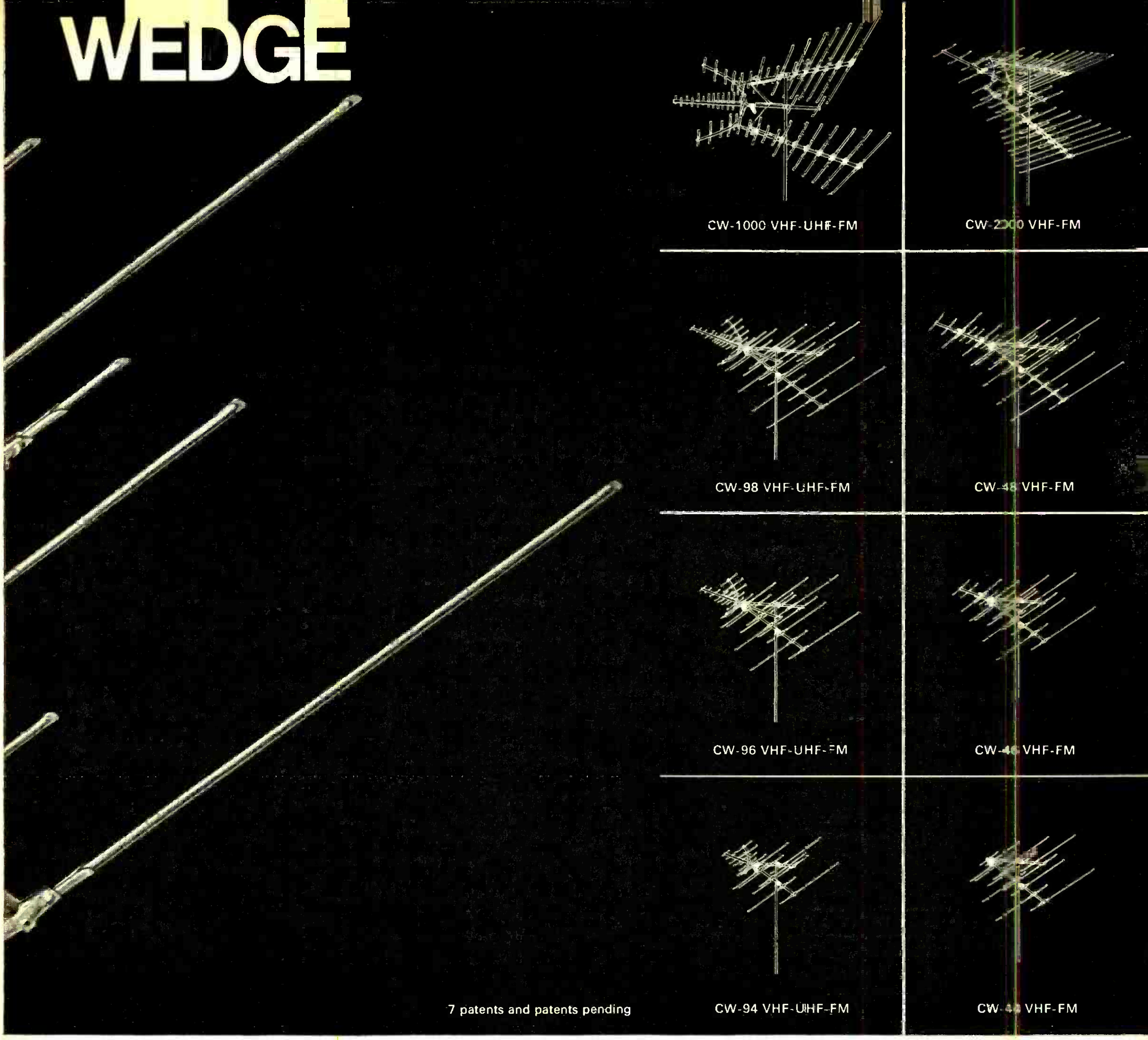
Look for yourself! Both high and low band elements are connected directly to the booms—so that the booms are actually used as phasing lines. Element insulators and harmonic parasitics are completely eliminated, making the Color Wedge much more mechanically rugged. All elements operate at their fundamental mode, assuring complete freedom of minor lobes on all channels, so pick-up of unwanted, interfering signals is reduced almost to zero.

And, of vital importance, Color Wedge has a built-in ferrite impedance stabilizer that enables us to tune the antenna driven elements longer than is possible in other antenna designs, resulting in 10% more gain and an automatic match at 300 ohms. And, incidentally, all that and more is achieved in an antenna that is up to 50% shorter and more compact than other antennas would have to be.

Other unique Color Wedge features? We've listed most of them here. When you see them, you'll know why Color Wedge is truly the most dramatically different antenna ever designed.

SPECIAL COLOR WEDGE FEATURES

- Unique Wedge design provides greatly increased vertical capture area (36°) . . . prevents pick-up of interfering signals from above and below . . . and enables antenna to work at peak performance because booms act as phasing lines.
- Patented UHF driven element assembly on 82-channel models and patented parabolic reflector screen provide unprecedented gain in an all band antenna.
- Special lightning protection circuit prevents static electricity build-up and arching.
- Ferrite impedance stabilizer enables antenna elements to be slightly longer for greater capture area and an increase in gain of 10% . . . assures perfect impedance match to downlead.



- Built-in transparent cartridge housing accepts solid state preamplifiers, and provides permanent weather protection for downlead terminals right at feed point of antenna, resulting in maximum signal transfer.
- FM control elements allow attenuation of strong FM signals where they interfere with TV reception.
- 82-channel models have special UHF control elements permitting antenna to be peaked for channels 70 to 83 in translator areas.
- New truss construction, with three mast clamps, makes this the most rugged, strongest antenna made. Two special Cycolac tuned mast clamps have built-in anti-resonant circuit to prevent signal leakage to antenna mast.
- Boom cone, made of unbreakable Cycolac, automatically positions upper and lower booms at 36° for maximum efficiency and rigidity.
- Super strong ellipsoidal booms and attached elements are of a special aluminum alloy for greater strength and resistance to bend and distortion.

Circle 34 on reader service card

- High tensile aluminum elements are made of alloy with PSI rating of 38,000 compared to 27,000 PSI for alloys used in other antennas. More than 49% stronger and 29% more resistant to bend and wind distortion.
- All aluminum parts are permanently weather and corrosion proofed with attractive, genuine gold and blue anodized finish.
- One-year factory guarantee of performance satisfaction and two-year unconditional replacement warranty.
- Beautiful new display-type shipping carton features wedge motif in color . . . attractive full-color wrap-around label on each antenna.
- Nationally advertised in Life, Sports Illustrated and Popular Mechanics.

Winegard
® ANTENNA SYSTEMS

WINEGARD CO. • 3013-3 KIRKWOOD ST. • BURLINGTON, IOWA 52601

COMING NEXT MONTH

June is IC month for RADIO-ELECTRONICS. *You'll find next month's issue packed with projects and features on these space-age microcircuits.*

- **IC's—What Makes Them Tick**—An expert describes how IC's are made, and the solid-state theory that makes them work. First article in a series.

- **IC's in Push-button Phones**—The facts on IC's in the phone you may have at home or office.

- **Build an IC Tach**—Just one IC and a few components can help you get better performance from your car.

PLUS THESE FEATURES

- **IC-Diode Tuner**—Build this stereo tuner that uses variable-voltge diodes for remote tuning, plus an all-IC i.f. strip.

- **Kwik-Fix TV Repair**—A new R-E exclusive for easy trouble-shooting with photo symptoms and waveforms.

June Radio-Electronics

FIRE FIGHTERS RECORD THE ACTION

By R. DALE MAGEE

HAVE YOU EVER WANTED TO RIDE ON A big hook-and-ladder truck as it responds to a fire call, red lights flashing and siren screaming? Unless you are a professional fire fighter, your desire will probably never be fulfilled. However, you can do the next best thing—respond to fires via tape recordings. The tapes are made by a Los Angeles Fire Department fire-prevention officer, Capt. Robert Patterson.

He began in 1948, before the advent of modern compact transistorized recording equipment. In the years that have followed, Captain Patterson has developed unusual tape-recording techniques as a part of his department's fire-prevention program.

Patterson first designed a unit to convert 12 volts dc from the battery of a city fire engine to 110 volts ac. This unit, built in the Fire Department radio shop, was permanently mounted on an engine stationed in a busy downtown Los Angeles firehouse. Operating from

the inverter was a standard-model Ekotape recorder. Since the Ekotape was not portable (it weighed well over 60 pounds), Patterson left it on the fire engine. Using a microphone at the end of a 100-foot cord, he would charge into the fire zone with the "smoke-eaters" to give his eventual listeners an on-the-spot report of what happened.

This pioneering arrangement presented many problems, one of which was the lack of an on-off switch at the mike, necessitating a lot of tape editing. Another problem was background noise, especially from the fire apparatus siren, as Patterson tried to dictate an account of what was going on. He finally mounted a standard recorder microphone in a 6 x 8-inch padded and baffled box. After some trial and error, this arrangement proved successful, giving a directional microphone effect that was excellent for interviewing firemen and fire victims.

Later, as portable recorders became available, Captain Patterson changed to a more mobile setup. His earliest operated on a dozen flashlight batteries, and had approximately 15 minutes of recording time. This unit was not transistorized, but it was a definite improvement over the 100-foot-cord routine.

Today, Captain Patterson is using a tiny recorder that can tape up to 4 hours of material without changing tapes. With it he has done a remarkable job of taping fire-fighting action. Over the years, his daily 15-minute prerecorded program has been aired both locally and nationally. Through Patterson's efforts, his listening audience can slide down the brass pole with the firemen as the alarm bells sound, ride with the engine companies through the center of heavy downtown traffic, and rush right in behind the fire fighters as they enter smoke-filled buildings to go about the business of savings lives and property from the ravages of fire. R-E

RADIO-ELECTRONICS READER SERVICE

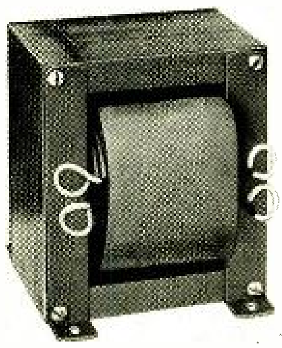
Here's how you can get manufacturers' literature fast:

1. Tear out the post card on the facing page. Clearly print or type your name and address. **Include zip code!**
2. Circle the number on the card that corresponds to the number appearing at the bottom of the **New Products, New Literature** or **Equipment Report** in which you are interested.
   For literature on products **advertised** in this issue, circle the number on the card that corresponds to the number appearing at the bottom of the advertisement in which you are interested. Use the convenient index below to locate quickly a particular advertisement.
3. Mail the card to us (no postage required in U.S.A.)

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 at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

HIGH-CURRENT CHOKE, *Stancor C-2692*, for filtering high-current power supplies in computer and business ma-



chines. Rated at 24 mH, 20 dc amps and 6 mH at 40 dc amps. 5½" x 4$^{7}/_{16}$" x 5¼". 21.2 lb.—**Essex Wire Corp.**

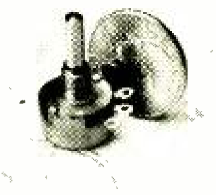
Circle 46 on reader service card

MICROPHONE, *Unidyne IV*. *Model 548* for stand or hand-held use. *Model 548S* for stand use; has on/off switch built into swivel mount. *Model 549* is a professional stage version with a vibration-iso-

lation shock mount. All provide dual impedance and Cannon-type connectors, and have frequency response of 40–15,000 Hz. $100 to $150.—**Shure Brothers Inc.**

Circle 47 on reader service card

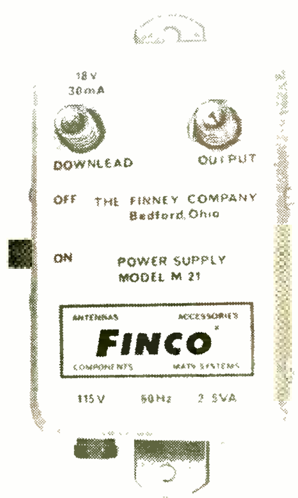
POTENTIOMETER. *Model 381* is a ⅜" 1-W unit with 1% max. dynamic noise and 5% max. independent linearity. Resistances: 100 ohms to 5 megohms linear; 500 ohms to 2 megohms tapered. Resistance tolerance, ±10% through 0.5 megohm; ±20% over 0.5



megohm. Effective rotation, 270°. Electrical rotation, 300° without switch; 320° with switch.—**Clarostat Mfg. Co.**

Circle 48 on reader service card

ANTENNA PREAMPS, solid-state, single-channel. Remotely powered by indoor power supply. 5 models: *M-13* to *M-18*, with 300-ohm or 75-ohm inputs



and outputs for FM bands as well as for vhf channels. Low band: 30 dB gain, 3.5 dB noise figure. High band: 20 dB gain and 4.5 dB noise figure. Designed to fit on the antenna boom close to antenna terminals.—**Finney Co.**

Circle 49 on reader service card

4-WAY RADIOTELEPHONES. *Model 2 x 2* has 6 crystal-controlled radio channels, 5 marine band channels. Power input: 101 watts. *Model RAY-1135* has 135 watts input and 8 crystal-controlled channels plus AM broadcast band. *Model RAY-42*, 10 vhf channels, 3 FM channels, operates at a max. power of 25

watts with miniature antenna. Narrow bandwidth plus power stepdown for close-range operation. No ground plate needed. $389–$595.—**Raytheon Co.**

Circle 50 on reader service card

HARDWARE PACKAGE is plastic see-through container. Features on the label a large silhouette of the item it contains. Each unit is color-coded. Pack-

aged items include 132 types of electronic/electrical hardware. 59¢ per package.—**Waldom Electronics Inc.**

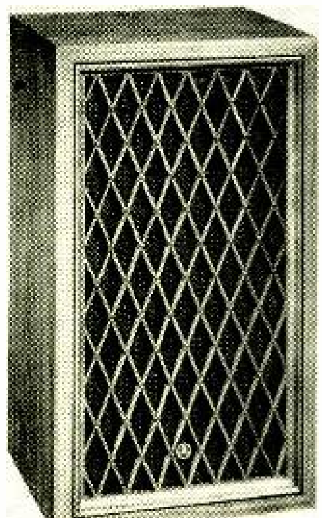
Circle 51 on reader service card

CARTRIDGE RECORDER, *Adapt-a-Corder Rosette*, operates on 117 V and handles all standard 4- and 8-track stereo cartridges. Converts any 4- or 8-

track player to playback and record. Hi-fi recordings can be made from phono, tape deck, radio, TV or mike through phono plug jacks. Level meters included. $99.95.—**Dictation Products Ltd.**

Circle 52 on reader service card

TWO-WAY SPEAKER SYSTEM, *Model GS-44.* Bookshelf unit has wood lattice grille. Features 8" high-compliance woofer with a long-throw voice coil and a 2½" wide-angle-dispersion cone type



tweeter. Audio range extends from 35 Hz to 20,000 Hz, with crossover at 2500 Hz. Unit accepts input of up to 25 watts with a sensitivity of 96 dB per watt. Dimensions: 19" x 11" x 9⅝". $67.50. —**Pioneer Electronics** USA Corp.

Circle 53 on reader service card

WIRELESS ALARM SYSTEM, closed-loop, solid-state. Utilizes frequencies from 265–285 MHz. Can be triggered

by tiny transmitters concealed in pocket or purse. If ac power fails, unit switches automatically to built-in battery operation. $199.50.—**Selectron Corp.**

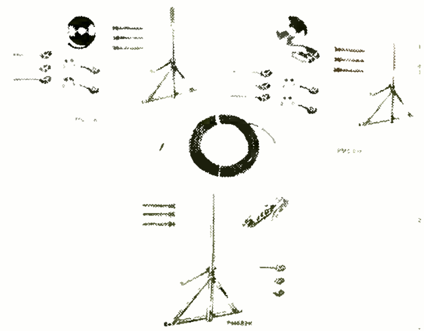
Circle 54 on reader service card

BENCH SUPPLY, *Model BP-89*, has an output of 0–34 V at 0.5 A. Supply regulation is 0.01% and ripple is 250 μV. Short-circuit and overload protection is provided. Dual-range meter for voltage and current readings. Fine and coarse voltage controls; 5-way binding posts, on–off switch and pilot light. Circuit is

all-silicon solid-state and uses an input differential amplifier to maintain constant voltage over a wide range of temperature variations. $89.—**Power/Mate Corp.**

Circle 55 on reader service card

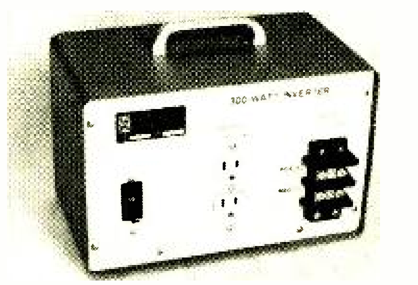
ANTENNA MOUNTING KITS. Each includes a universal tri-mount and a 5' 1¼" O.D. mast (both are gold adonized), 3 self-sealing drive-in nails, and three 3½" screw-in standoffs. *Model PM600K*, uhf/vhf/FM, has 50' lead-in. *Model*



PM613K, vhf/FM, has a 50' lead-in. Both include mast snap-on standoffs. *Model PM682K*, vhf/FM, has 50' of coax cable plus a matching transformer. *MT-60*, with single vhf/FM output. Prices range from $9.50 to $23.75.—**JFD Electronics Co.**

Circle 56 on reader service card

DC-AC INVERTER, *Model 1057*, solid-state unit, turns dc input voltages of 11–14.5 into 117 Vac, 60 Hz, single phase. Delivers up to 300 watts. Frequency regulation: ±0.25% for line and



load; 0.005%/°F temperature coefficient and overall efficiency of 85–90% for half load to full load. Protected against overloads, short circuits and accidental reversal of input voltage. Typical uses include remote operation of oscilloscopes, videotape recorders, and other scientific instruments. $196.—**Wilmore Electronics Co.**

Circle 57 on reader service card

AM/FM STEREO SYSTEM, *Scottie,* is complete with two speaker systems. Operates on a 12-volt battery for use in a car

or boat. Can also be operated on a 117-volt current. $199.95. Optional turntable with magnetic cartridge and diamond stylus. $59.95.—**H. H. Scott Inc.**

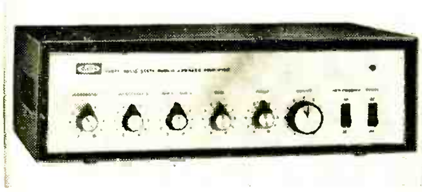
Circle 58 on reader service card

DC MICROVOLTMETER PLUG-IN, *Model DP 110,* provides digital display of dc voltage measurements from 1 μV–1000 V with an accuracy of ±0.05% of reading ±1 digit. Pushbutton scale expansion gives full 4-digit (0.01% resolution) to any voltage measurement. Input

circuitry is fully floating, with more than 10,000 megohms isolation between input ground and chassis or power-line ground. Automatic polarity displays on the main frame readout on all ranges when measurement is made. $450.—**Hickok Electrical Instrument Co.**

Circle 59 on reader service card

PA AMPLIFIER, *Model 3281T,* all-silicon, solid-state, 80-watt unit. Response, 40-10,000 Hz. Inputs, 2 mikes, hi/low



impedance, 2 auxiliary. Gain: mike 118 dB; aux. 89 dB. Hum and noise: mike

Circle 100 on reader service card

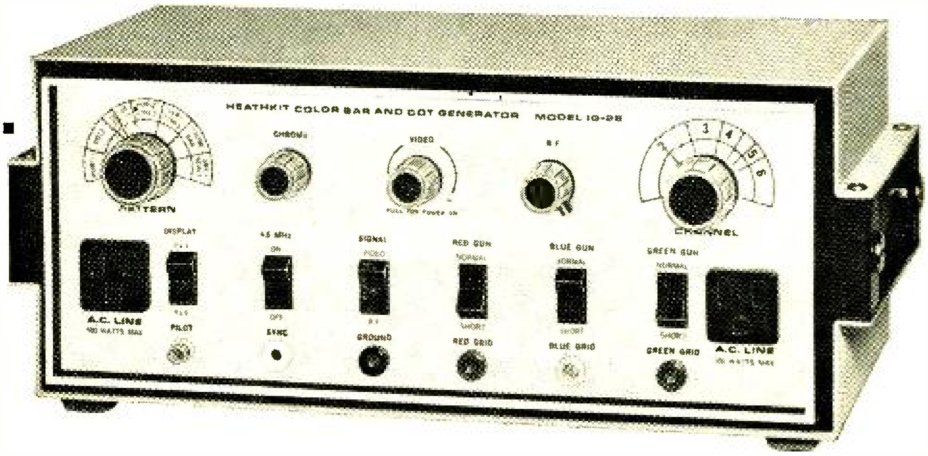
Circle 108 on reader service card

For Top Performance And Value In Electronics —

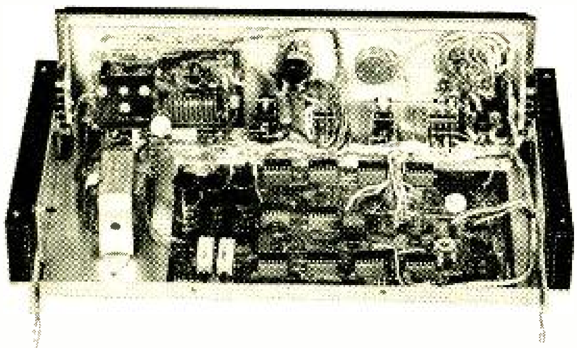
Introducing The NEW Heathkit® IG-28

Color Bar — Dot Generator...

Advanced IC Design Gives 12 Patterns Plus Clear Raster Display & Eliminates Divider Chain Instability Forever!

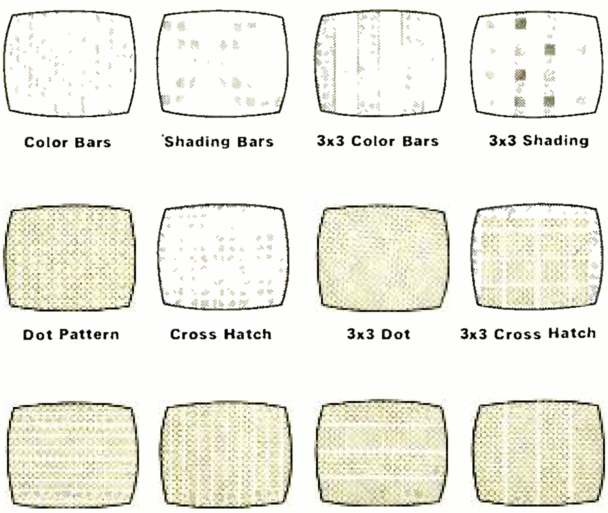


Stable Integrated Circuitry And Well-Engineered Layout



Circuit Board-Wiring Harness Construction. Note the extremely clean, open layout — another advantage of integrated circuitry. The Video board is upper left, the Divider board mounts on the chassis.

Fast Switch Selection Of Either Standard 9 x 9 Display OR Exclusive Heath "3 x 3" Display



Color Bars, Shading Bars, 3x3 Color Bars, 3x3 Shading

Dot Pattern, Cross Hatch, 3x3 Dot, 3x3 Cross Hatch

Horizontal Bars, Vertical Bars, 3x3 Horizontal, 3x3 Vertical

The Most Advanced Instrument In Color TV Service

• All solid-state construction using Integrated Circuitry • No divider chain adjustments • Stable pattern display — no flicker, bounce or jitter • Produces 12 patterns plus clear raster • Instant switch selection of all functions • Exclusive 3x3 display plus standard 9x9 display of all patterns • Horizontal lines only one raster thick for added accuracy • Variable front panel tuning for channels 2 through 6 • Variable front panel positive and negative video output • Front panel negative going sync output • Two handy AC outlets on front panel • Built-in gun shorting circuit with lead piercing connectors • Front panel switchable crystal controlled sound carrier • Copper-banded transformer to reduce stray fields • Safe three-wire line cord • Fast, easy construction with two circuit boards and two wiring harnesses

The new Heathkit IG-28 is the ultimate signal source for all Color and B&W TV servicing. No other instrument at any price will give you as much stable, versatile TV servicing capability. Here are the details:

All Solid-State Circuitry produces dots, cross-hatch, vertical and horizontal lines, color bars and shading bars in the familiar 9x9 display . . . plus the exclusive Heath 3x3 display of all these patterns so necessary for static convergence, linearity and color demodulator phase adjustments . . . plus a clear raster that lets you adjust purity without upsetting AGC adjustments. Fifteen J-K Flip-Flops and associated gates count down from a crystal controlled oscillator, eliminating divider chain instability and adjustments.

Time-Saving Versatility. While many generators only give you one or two channel capability, the new IG-28 has variable front panel tuning for channels 2 through 6. The RF tank coil is actually etched into the circuit board for extra stability. Plus and minus going video signals are available at the turn of a front panel control. And for sync, in-circuit video or chroma problems, there's a front panel sync output. Convenient AC outlets are provided for degaussing coil, test instruments, TV set etc. Built-in gun shorting circuits and grid jacks are also included. Add any service type scope (with horizontal input) to the IG-28 and you have vectorscope display capability too. Other features include a crystal controlled sound carrier oscillator, a well regulated full wave power supply with dual primary copper-banded transformer, safe three-wire line cord, and rugged, compact Heath instrument styling. Two circuit boards and two wiring harnesses provide easy construction in about ten hours. Start enjoying the versatility you couldn't get before . . . put the remarkable new Heathkit IG-28 on your service bench now.

Kit IG-28, 8 lbs..**$79.95***

Look To The Leader

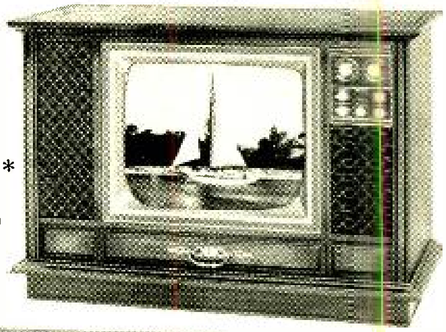
HEATHKIT

Now There are 4 Heathkit Color TV's . . . All With 2-Year Picture Tube Warranty

NEW Deluxe "681" Color TV With Automatic Fine Tuning

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn't one available for any price that has all these features. Automatic Fine Tuning on all 83 channels . . . just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set for any price . . . plus all the features of the famous "295" below. Compare the "681" against the others . . . and be convinced.

GRA-295-4, Mediterranean cabinet shown **$119.50***
Other cabinets from $62.95*



kit GR-681
$499.95*
(less cabinet)

Deluxe "295" Color TV . . . Model GR-295

Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B + for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over the life of your set in service calls. For the best color picture around, order your "295" now.

GRA-295-1, Walnut cabinet shown **$62.95***
Other cabinets from $99.95*

kit GR-295
now only
$449.95*
(less cabinet)

Deluxe "227" Color TV . . . Model GR-227

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown **$59.95***
Mediterranean style also available at $99.50*

kit GR-227
now only
$399.95*
(less cabinet)

Deluxe "180" Color TV . . . Model GR-180

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

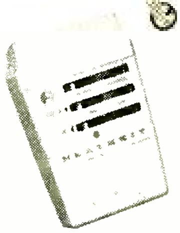
GRS-180-5, table model cabinet and cart **$39.95***
Other cabinets from $24.95*

kit GR-180
now only
$349.95*
(less cabinet)

Now, Wireless Remote Control For Heathkit Color TV's

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's **$59.95***
kit GRA-295-6, 9 lbs., for Heathkit GR-295 & GR-25 TV's **$69.95***
kit GRA-227-6, 9 lbs., for Heathkit GR-227 & GR-180 TV's . . . **$69.95***



New Wireless TV Remote Control
For GR-295, GR-227 & GR-180
$69.95*

New Wireless TV Remote Control
For GR-681
$59.95*

NEW
FREE 1969 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATHKIT

HEATH COMPANY, Dept. 20-5
Benton Harbor, Michigan 49022

☐ Enclosed is $__________, plus shipping.

Please send model (s)__________
☐ Please send FREE Heathkit Catalog. ☐ Please send Credit Application.

Name__________

Address__________

City__________ State__________ Zip__________

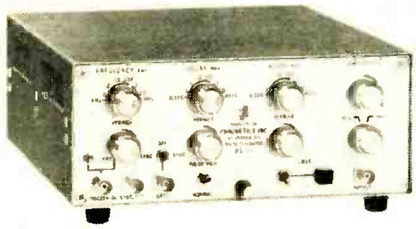
Prices & specifications subject to change without notice. *Mail order prices; F.O.B. factory. CL-354

Circle 109 on reader service card

43 dB below rated output; aux. 66 dB below. Outputs: 4, 8, 16 ohms; 25, 70.7 V. Power consumption, 150 watts. $114.95.—**Allied Radio Corp.**, Chicago, Ill.

Circle 60 on reader service card

PULSE GENERATOR, *PG-11*, solid-state circuits, glass-base epoxy printed-circuit boards. For bench or rack mounting. Unit provides single/double pulses, pulse pairs, pulse bursts or one-shot output and may be gated synchro-



nously or asynchronously. Repetition rate: 10 Hz–20 MHz in the double-pulse mode and to 10 MHz in the single-pulse mode. Rise and fall times are 5 nsec max. at full ±15-V output amplitude. External trigger: dc to 20 MHz. $375.—**Chronetics Inc.**

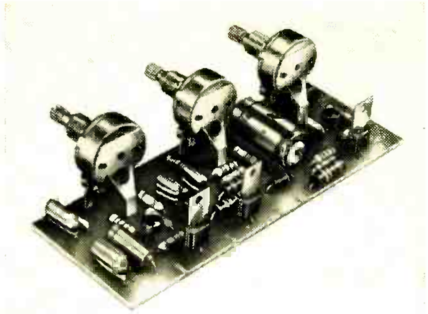
Circle 61 on reader service card

LEVEL-LIMITER MICROPHONE, *Model 500-PS*, contains a silicon solid-state circuit that provides 40-dB dynamic range low distortion compression. Operates from 10.5-18 Vdc between —30

and +65°C, has attack time of 1 msec, release time of 0.25 sec. Harmonic distortion is less than 5%. Frequency response automatically controlled by voice level to stop garbling.—**Vega Electronics Corp.**, Santa Clara, Calif.

Circle 62 on reader service card

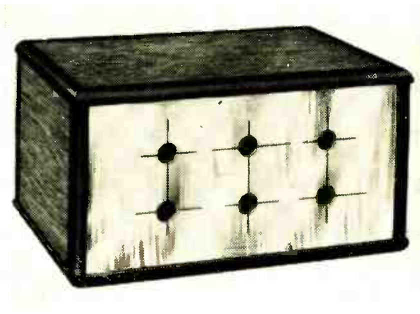
COLOR ORGAN KIT, *Model LO-103*, utilizes frequency-selective networks to divide audio spectrum into 3 channels. Each has own intensity control plus a silicon controlled rectifier which controls the intensity of a color lamp (not included) connected at its output terminals. Mixture of colors, synchronized with the music, produces psychedelic light effects. Sensitivity 300 mV; impedance 3000



ohms; input power 16 Vac @ 3 amps. $12.95.—**Science Workshop,** Bethpage, N.Y.

Circle 63 on reader service card

CUSTOM CABINETS, *Flexi-Cab*, for kit builders, experimenters and hobbyists come in 3 sizes; 3″ x 4″ x 4″, 3″ x 4″ x 6″ and 3″ x 6″ x 9″. Each consists of six panels made from rugged 26 gauge



vinylclad steel and 12 slides. Can be assembled in minutes by joining the panels with the slides. From $2.98.—**Bell Educational Lab Div.,** Beltronix Systems Inc. Hauppauge, N.Y.

Circle 64 on reader service card

BURGLAR/FIRE ALARM protects home, office and vehicles. It's completely self-contained and needs no wiring or in-

stallation. Permits 24-hour unattended service. Size: 5¼″ x 2¾″ x 1¾″. $4.95 with batteries.—**Protect-Alarm,** Hollywood, Calif. R-E

Circle 65 on reader service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service Card facing page 72 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

RECORDING HEAD called *"Spot Check"* forewarns about 100 hours before the end of its useful life by a red indicating surface on its face. Useful to broadcasting and service industry, language labs and suppliers of background music where service contracts are used. Photos and description are contained in *"Spot Check Brochure."* 4 pages.—**Michigan Magnetics**, a Div. of VSI Corp., Vermontville, Mich.

Circle 76 on reader service card

PRECISION INSTRUMENT HAND TOOLS and power tools including three magnetizer–demagnetizer models, sets of counterbores and countersinks, flexible-shaft power units and accessories, several motorized units plus a number of new standard and special tools are featured with complete specs and price list in *Catalog T-691*, 16 pages. Fractional motors and watchmakers' tools are also illustrated.—**Kendrick & Davis Inc.**

Circle 77 on reader service card

TEST EQUIPMENT. *Form #458*, 12 pages feature five test instruments, including a sweep/marker generator, combination oscilloscope/vectorscope, color generator and two in/out circuit transistor and FET testers. A special reference section lists more than 12,000 different transistors and FETs plus information needed for testing. All complete with performance data and prices.—**Sencore Inc.**, Addison, Ill. 60101.

Circle 78 on reader service card

PRINTED CIRCUIT CHART compares technical specs of etched and die-stamped circuitry. Die-stamped circuit chart shows how thickness of conductors affects circuitry temperature at various voltage and current levels.—**GTI Corp.**, Leesburg, Ind.

Circle 79 on reader service card

ANTENNAS AND ANTENNA SYSTEMS for the frequency range of 2 MHz to 1100 MHz, covering vhf/uhf fixed and mobile antennas as well as accessories are described in a 64-page catalog. It also includes all antenna configuration necessary for field use.—**Hy-Gain Electronics Corp.**, Lincoln, Neb.

Circle 80 on reader service card

1969 HOME STUDY DIRECTORY, 8 pages. Provides names and addresses of 122 accredited schools and describes more than 500 courses of study. A cross-reference index by subject facilitates reading.—**National Home Study Council**, Washington, D.C.

Circle 81 on reader service card

COMMERCIAL SOUND SPEAKERS, *Models 8J4S7* and *12J4S7* are illustrated and defined as to performance characteristics, physical specs and related technical data in an easy to read tabular form in a 2-page Product Engineering Bulletin.—**Oxford Transducer Co.**, Chicago, Ill.

Circle 82 on reader service card

REED RELAYS. Over 160 types are covered in a 24-page catalog detailing information on life and reliability of the manufacturer's product. Reed relays listed include ultra-miniature, micro-miniature, miniature, standard and mercury-wetted types. Detailed electrical, mechanical and environmental specifications, dimensional drawings, photographs and ordering information are presented.—**Wheelock Signals**

Circle 83 on reader service card

LOUDSPEAKER GUIDE lists replacement speakers for equipment used in all American and foreign automobiles from 1960 through 1969.—**Jensen Manufacturing Div., The Muter Co.**

Circle 84 on reader service card

Write direct to the manufacturers for information on items listed below:

SCIENTIFIC INSTRUMENTS for research and development, in industry as well as for educational purposes, are described in a 68-page catalog, *#811/81*. Included are full specs, illustrations and many schematics for Malmstadt-Enke Spectros-copy System, Instrumentation Lab, Chart Recorders, Recording pH Electrometers, Polarography System, Berkeley Physics Lab, Heath Oscilloscopes, Power Supplies, Voltmeters, Signal Generators, Testers and Bridges etc.—**Heath Co.,** Benton Harbor, Mich. 49022.

NUTS AND BOLTS, lock washers and screw fastener units are described in 28-page catalog, *AS-800*. Screw thread data plus complete dimensions for the various types of head styles are included. In addition to standard types, information on a line of twisted tooth lock washers and many special metal and non-metallic washer designs for extraordinary applications is provided. Write to **Shakeproof**, Div. Illinois Tool Works Inc., St. Charles Rd., Elgin, Ill. 60120.

MOS/LSI INTEGRATED CIRCUITS and other forthcoming IC products are featured with charts and diagrams in 44-page catalog 70-BR-0012-108. Standard products section provides a series of one-page specs for the company's line of MOS circuits, and custom MOS arrays section includes Micromosaic arrays designed for low engineering cost and fast turnaround time requirements. Brief MOS historical development and technology plus Fairchild's MOS and LSI capabilities also outlined.—**Fairchild Semiconductor,** 313 Fairchild Dr., Mountain View, Calif. 94040

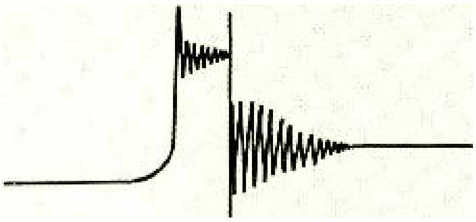
HARD-TO-FIND TOOLS is the title of a new 24-page catalog of interest to experimenters, lab technicians, modelmakers, hobbyists and others that do detailed work in wood and metals. Among the many items described and illustrated are electronic pliers and other electronic tools, wood-carving knives, jeweler's tools, precision tools, unusual solders, soldering jigs, glass drills, miniature files, rifflers, reamers and scores of other versatile, unusual small hand tools and small power tools. **25¢ each.—write to Brookstone Co.,** 98R River Road, Worthington, Mass. 01098. **R-E**

Circle 111 on reader service card

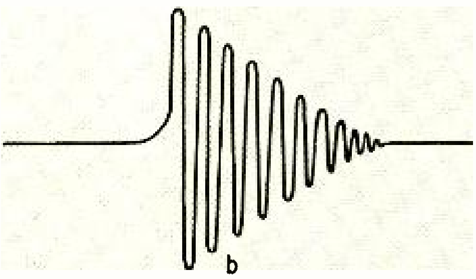
TECHNOTES

USING IGNITION ANALYZER

When using an oscilloscope-type ignition analyzer, the readings must be interpreted with care if the sparkplug wires are the resistive type used for radio-interference suppression. These wires limit the amount of energy fed to the plug and so reduce the effect of the spark characteristics on the coil waveforms. In particular, the "spark line" (*a*) commonly observed will not be seen. The observed pattern (*b*) will be that commonly considered characteristic of an open plug or some other malfunction that prevents sparking.—*Charles Erwin Cohn*



a



b

LAFAYETTE LA-226WX: INTERMITTENT, DISTORTED STEREO

Bad stereo in this receiver can be due to a short in the shielded cable that connects to the high side of the dimension control. Replace the cable, and redress it carefully to prevent future trouble.

To adjust the control, set it to the side that gives maximum level in the FM multiplex stereo mode. At this point, separation is zero (monaural sound). The correct operating point depends on the signal level and the multipath ("ghost") content of the signal at that frequency. Move the control back until you reach a point with good separation and minimum hiss. The best setting must be found by experiment.

If no multiplexed broadcast or test signal is available, set the control to the halfway point.—*Steve P. Dow*

INTERMITTENT LOSS OF FOCUS IN ZENITH 25MC36 & -46

If high voltage and focus voltage are normal, check the plastic pin stiffener on the base of the picture tube for signs of carbonization between the pins. We have come across several stiffeners where carbonizing caused leakage between the pins, upsetting focus.

Either replace or discard a defective stiffener. If you discard it, be sure that you install the socket correctly because the stiffener also serves as a pin locator.—*Jim Wilhelm*

FORD 94BF AUTO RADIO DEAD

Customer complained that the radio had just gone dead as he was driving home from work. He had removed it, checked tubes and replaced the fuse, without results.

On the bench, the set played normally for about 20 minutes and then stopped abruptly. My vtvm read 10 volts at the base of the 2N1008, but C16 was not shorted. Then I noted 10.1 volts on the 12FK6 cathode. Replacing C2 made the set operate normally.—*William Santora*

EICO 377: NO OSCILLATIONS

An Eico 377 audio generator would not oscillate V_2, a 6K6-GT, had a red-hot plate and screen. We checked voltages with a vtvm. The voltage on V2's control grid was 80—much too high. Replacing C7, the coupling capacitor, fixed the trouble.—*Pierre Cappaert*

OLYMPIC CT-910—LOW VIDEO GAIN

Video gain can be improved, if desired, by substituting a 10KR8 for V8, the 10JY8 video amplifier tube. It may then be necessary to readjust the red, blue and green screen controls to a higher level for a better brightness/contrast ratio.—*Olympic Service Bulletin*

REPAIR DAMAGED TUNING SLUGS

The slot in a ferrite tuning slug frequently appears damaged beyond repair by a metal tool. However, an inspection of the unit outside the can, before foraging in the junk box for a replacement, is often rewarding. Usually, there is an exact duplicate slot at the bottom end of the slug. It is only a matter of reversing it and the tuning slug will be back in business.

In case you are not so fortunate, clamp the slug in a clothespin (not vise) and with a dull hacksaw blade work in another slot at any convenient end. This applies whether the slot was originally for screwdriver or hex alignment tool, as it is now exclusively for screwdriver use. So, unless there is actual breakage, there is a definite cure for the trouble. The little dust lost in the process will not affect the magnetic properties of the core.—*Verginaud Richard*

ADMIRAL 17A4 STEREO CHASSIS

Low FM sensitivity may be due to incorrect adjustment of the RF BIAS control. This can be reset without removing the chassis from the cabinet. If readjustment does not correct the condition, you may have a bad FM i.f. transistor.

Tune in a local FM station and adjust the RF BIAS control to kill the FM rf amplifier. If the output is cut off completely instead of just being reduced, or if the tuning meter acts peculiarly as you tune near cutoff, replace Q4.

Improper operation of the FM stereo indicator is most likely due to a low setting of the STEREO THRESHOLD control. Advancing it another 10 degrees should permit the indicator to function correctly.—*Admiral Service News Letter* **R-E**

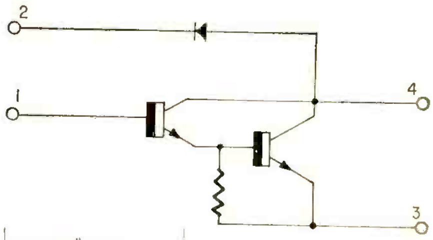
"Hurry it up!"

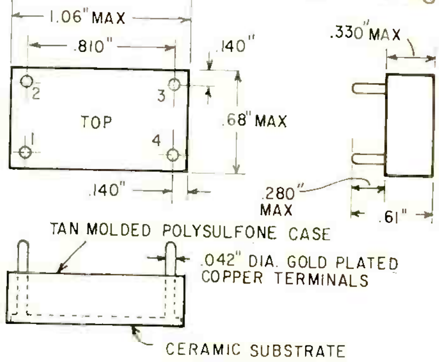
NEW TUBES AND

POWER DARLINGTON IC'S

Seven new Bendix power IC Darlington modules (types BHF0002 through BHF0008) offer 25 watts dissipation and 10 amperes output currents at voltages ranging from 25 to 80 volts. The units consist of two npn silicon devices on an alumina substrate. An integral commutating diode for load clamping and an internal base-emitter resistor are included. No external compensation is needed.

Treated as transistors, the power Darlingtons can be used as amplifiers and for power switching. A schematic and drawing of this new high-power IC module are shown. Absolute maximum ratings are:





	BHF0002	BHF0003 BHF0006	BHF0007	BHF0008
Open-base breakdown volts V_{4-3}	25V	40V	60V	80V
Collector-base breakdown V_{1-4}	40V	60V	80V	80V
Emitter-base breakdown V_{3-1}	5V	5V	5V	5V
Output current I_4	10A	10A	10A	10A
Input current I_1	250mA	250mA	250mA	250mA

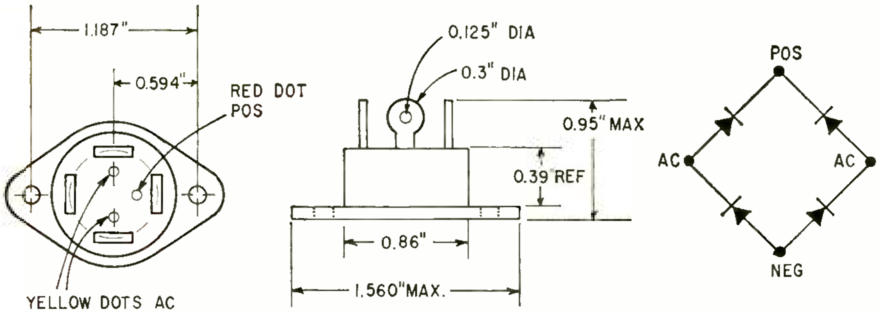
SEMICONDUCTORS

TV SCR's AND IC BRIDGE

The 40640 and 40641 are two new TO-66-packaged SCR's designed especially for use in the horizontal deflection circuits of large-screen color sets. These units have fast-recovery, short turn-off time, low switching dissipation and high-voltage characteristics needed for TV horizontal deflection and such applications as high-frequency lighting, ultrasonic power supplies, injection laser drivers and radar pulse modulators.

RCA 40642, 40643 and 40644 are three new silicon rectifiers designed for use in the deflection circuit with the SCR's. The 40460 SCR and 40642 rectifier are the sweep components. They provide bipolar switching for controlling forward-trace horizontal yoke current. Retrace current is controlled by the 40641 SCR and 40643 rectifier. The 40644 rectifier is used as a clamp in the sweep circuit to protect circuit components from excessively high voltage peaks which may result from possible arcing in the CRT or at the high-voltage rectifier.

The BHC-0001 through BHC-0005 make up a series of Bendix silicon full-wave bridge rectifiers with PRV ratings (per leg) ranging from 100 to 600 volts and working (rms) voltages from 70 to 420. Average output current is 10 amperes at T_c of 65°C. They are housed in TO-3 mountings; connections and dimensions are shown below. **R-E**



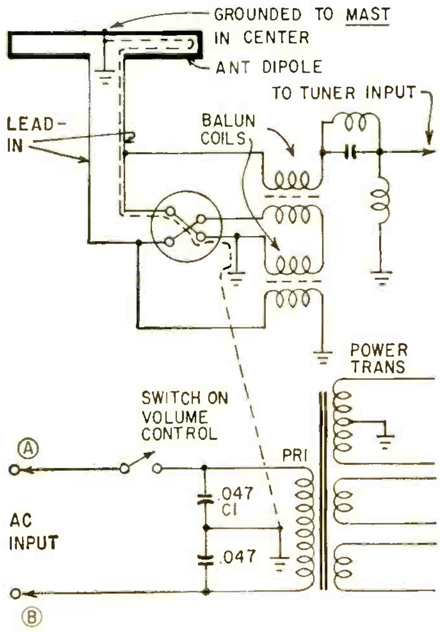
Service Clinic

By **JACK DARR**
SERVICE EDITOR

TV set won't turn off

When I turned the switch off, the TV set stayed on! The sound went off, but the picture stayed. When I unhooked the antenna, the picture went off. I reversed the ac plug, hooked the antenna up again, and bang! Now, one of the balun coils in the tuner is burned. What happened?—A. H., Brantford, Ontario, Canada

You have a "line-connected" chassis. Somehow, your ac input has shorted to the chassis. For instance, if line bypass C1 (see diagram) is shorted,



and the set is plugged in so that terminal A of the ac line is on the *ground side*, you have a complete circuit whether the switch is on or off. (All ac lines are ground on one side and

> 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. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

electrically "hot" on the other.)

So, your circuit would be: in at terminal B of the line, through the primary of the power transformer, through the shorted capacitor to the chassis, through the chassis to the antenna plug, then through the grounded mast back to earth.

If you reverse the ac line plug, terminal A will be "hot" (117 volts with respect to ground). You have a circuit which is, in effect, a direct short (without going through the power transformer) from the hot side to ground, through the balun coil. This, of course, simply blows, since its small wires will carry practically no current.

Check from both sides of the ac line to the TV chassis. You'll find a dead short somewhere in that circuit.

P-P Voltage off on VTVM.

I get odd readings on my vtvm when I try to read peak-to-peak voltages in the agc keyer circuit. Reads different voltages at the same point when I change meter ranges. Seems to read right on 60-Hz voltages, though.—A. A., Cumberland, Md.

Many ac voltmeters won't read exactly right on very narrow pulse voltages, which this is, in the ac keyer circuit. You're trying to read about a 4-5-μsec pulse! If the meter input time-constant isn't correct, the capacitor won't have time to charge up on such short pulses, and the meter will read low. (All p-p meters like this read the voltage by charging a capacitor.)

Many meters are calibrated for a 60-Hz sine-wave ac, and will read correctly with that frequency and waveform; however, when we get away from a pure sine wave, we can get into troubles. A scope is still best for this.

Gate switches under ice

At a local hospital, they use electrically operated gates. A pair of treadles work them, when a car passes over. The problem is that they're clogging with snow and ice! What kind of sensor will work?—B. L., Denver, Colo.

Any one of several kinds. You might try the pressure-sensitive, sealed *Tape-switch* kind; these are used in supermarkets, etc, to open doors when you step on them. Being sealed, they should not be affected too much by ice.

Alternate: Try a PE-cell device on the gateposts, set up about 4 feet off the ground. Because you need two sensors for each gate, a *proximity* sensor *might* give trouble due to having the pickup plates so close together. This would have to be checked experimentally. The PE-cell devices can work on very narrow beams.

(continued on page 88)

SERVICE CLINIC
(continued from page 87)

Field Adjustment of Color AFPC

If you replace the reactance tube in a color oscillator circuit and you find that the range of the hue control is affected, would you recommend touching up the oscillator frequency slug?—D.F., Reading, Pa.

Carefully, and using the right procedure, yes. However, I'd try one or two different tubes in that socket before I took any drastic steps! You may be able to find one that will not cause a hue shift.

You'll find the "Field Adjustment Procedure" for afpc in practically all color-TV service data. Briefly, this is what you have to do: short out the color afc, leaving the colors running free on the screen. Now, adjust the reactance coil core until you see the barber-pole effect slow down and the colors stop.

Now, the oscillator is exactly in step with the burst from the station signal. *Very carefully* move the core just a tiny bit more until you get the colors just exactly right: use flesh tones only, please, and make sure that the hue control is set to the center of its range. Now, take the short off the afpc and the color should snap in and stay when you change channels. (Always providing that the fine tuning isn't loose!)

You can use a color-bar generator for this, of course, and set up for stationary colors with the sixth bar blue, etc; the correct setup is given in the generator manual, so look it up to be sure.

In a very few sets, you may have to reset the reactance coil and the 3.58-MHz oscillator coil as well, if any amount of service work has been done in that circuit.

Ten-channel remote control on tape

I need a unit that will put 10 inaudible signals on a tape, for controlling a multiple-function remote-control device. They'd have to go on the regular sound track, along with the sound signals. This should be "wireless," for maximum usefulness.—D. F., La Habra, Calif.

Your best bet, probably, would be to use one of the ultrasonic control circuits now found in many remote-control TV sets. These operate in the 38–40-kHz region. For example, you could use one of RCA's 8-channel remote-control receivers, of the type used with some color TV's. If you need the full 10 channels, a couple of extras shouldn't be hard to add.

You will get into one problem, though, if you plan to record or superimpose these signals on a standard tape recorder: You'll probably have to work the amplifier and heads over to get enough response up in the ultrasonic region around 40 kHz. The average home tape recorder gets up to around 20,000 Hz, and even that's doing pretty good for some of them! You might get better results by using the original transmitter, which has a set of tuned bars struck by spring-loaded hammers.

Suggestion: Replace the original two-track head on the recorder with one of the four-track types. Use two of the tracks for sound, and the other two for control signals. A separate high-frequency amplifier and speaker may be necessary.

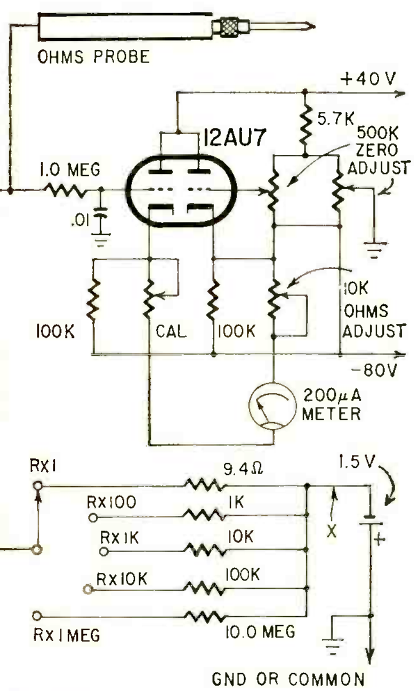
You might be able to get a complete remote-control unit, microphone and all, from RCA. As an alternative, look for a used TV set with one on it!

Vtvm ohm function out

I have an old vtvm, make unknown, and the ohms range won't work at all. I can't locate the maker. Can you help on this?—R. C., Blacksburg, Va.

We'll sure try! If it has anything like a standard ohmmeter circuit, it will look something like the basic ohmmeter in the diagram.

Pull the vtvm tube, and measure



the resistors, starting at the "ohms" probe and working toward the battery terminal. You can read the value of each resistor between the probe tip and the battery terminal at X by changing the range switch. The selector switch is not shown here, but connects to the tube grid, for dc volts tests, etc.

This is actually a simple voltage divider, with higher resistance for each range.

More "push" needed in antenna

I've got a set, located about 75 miles from channels 4, 5 and 8. The antenna is a conical, about ½ mile up on a hill, with open-wire transmission line. Low band stations are pretty good but channel 8 is pretty snowy. What would help this out?—L. M. Knoxville, Tenn.

I believe your best bet would be more gain in the antenna. Conicals are fine, but the maximum gain is about 4–5 dB. Try one of the later all-band Yagi types; these have gains up to 12–14dB all the way across the band.

Also, you're losing that high-channel station in the transmission line, most likely. Losses are much higher in highs than lows. Might try a small antenna-booster, either at the antenna site or cut into the line say about half-way up. Be sure to put a *good* lightning-arrester at the antenna.

Color-bar generator for use in Europe

I'm taking electronics training in Canada, and I'm going home to Belgium next year. I'd like to take a color-bar generator with me. What modifications would be necessary to US generators, such as Heathkits, to take care of the difference between the 4.5 MHz US sound and 5.5-MHz sound in the CCIR system? I can't get an answer from anyone on this—help!—G. B., St. Jean, Que.

Frankly, I agree with the people you've been asking! The color TV situation in Europe is in a state of total and utter confusion. After the failure of the Oslo conference, it looks as if Europe is going to be divided into *two* systems! SECAM IV for the French, Russians and the satellites: PAL for England and Germany, and some other transmission techniques.

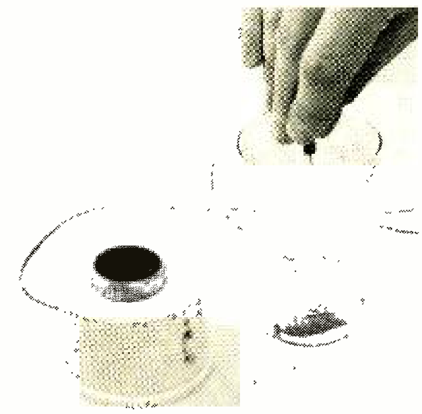
Since they can't even agree on a set of standards for black-and-white, goodness knows what they'll wind up with in color! Your best bet would be to wait and see. Actually, the *sound* frequency would be the very least of the problems!

Circuit descriptions, schematics and construction details on color-bar generators for use in Europe have been described in such French technical magazines as *Le Haut Parleur, Television, Radio et Télévision, Radio Constructeur*, and *Toute l'Electronique*. You may find some of these magazines in a library in Quebec. **R-E**

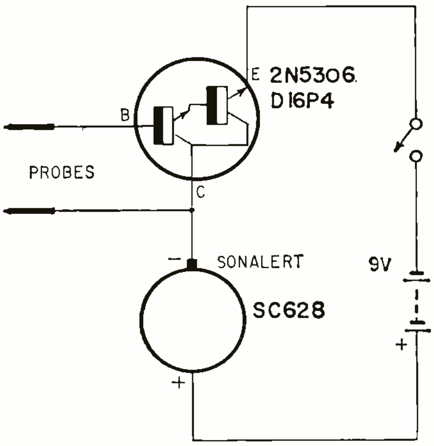
NOTEWORTHY CIRCUIT

LIQUID-LEVEL INDICATOR

This simple circuit produces an audible tone when its probes are touched by or immersed in a conductive liquid. It can be used to indicate when a bathtub is full, that someone has entered or fallen into a swimming pool. It can also be used by a blind person pouring a liquid—particularly something hot—to indicate when the container is full.



When used as a level indicator, the probes must be suspended so their tips are at the desired liquid level.



The circuit consists of a Darlington amplifier (G-E 2N5306/D16P4), a Sonalert, 9-volt battery and a spst switch in series as shown in the diagram. The plastic cap from a small spray can was used to house the switch, Sonalert and battery. A pair of thin flexible insulated leads go to the emitter and collector of the 2N-5306. The base and collector leads are used directly to form the probes.

The Sonalert is mounted with a force fit in a hole in the top of the case and a miniature slide switch is mounted on one side. The battery is held in place by rubber bands.

—*Rudolph F. Graf*

STEREO RECORDER HINT

The EM84/6FG6, single-bar recording level indicator cannot show program balance when used in a stereo recorder. With the new EMM-801 dual-bar indicator tube, the level of each channel can be watched separately. The EMM801 is the same size as the EM84, so the only changes needed are electrical.

A typical EM84 level indicator circuit is shown in Fig. 1 and the

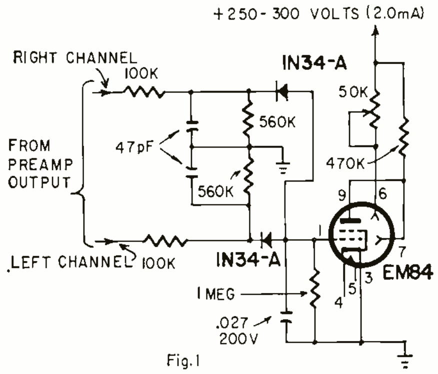


Fig. 1

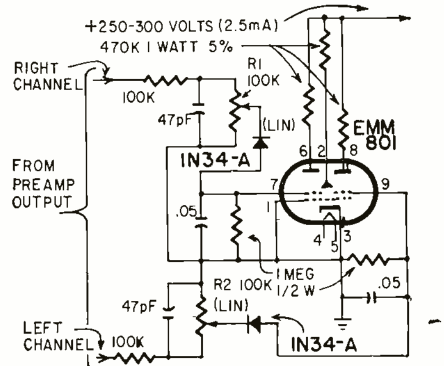


Fig. 2

EMM801 circuit is in Fig. 2.

Before removing the EM84, connect a 1-KHz source to both the right and left radio/phono inputs of your recorder and adjust the recording gain control for maximum level without overloading. Note carefully the position of the gain control and the output setting of the generator.

When the wiring changes are made set the generator output and record gain to the previous settings and adjust pots R1 and R2 until the two bands meet. The new indicator now shows the same level as the old one.—*Steve P. Dow* **R-E**

Electronic Music
(continued from page 54)

and shape by means of reverberation. Thus reverberation devices may be used in addition to musical performances to give the listener a sensation of cramped space, great spaciousness, unusual environments, etc.

Most common reverberation devices fall into four classes:

- Tape recorder reverberation units.
- Taut springs or sheets of metal with a driver and a pickup (Fig. 4).
- A hollow tube with a microphone at one end and a speaker at the other (the tube may actually be a room).
- An electrostatic recorder–reproducer.

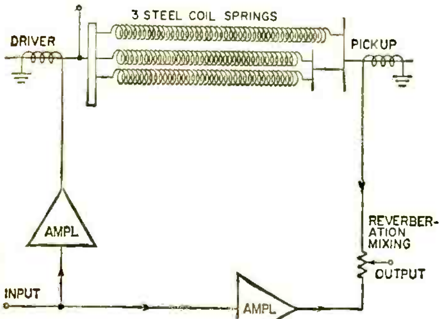


Fig. 4—A typical spring reverberator.

Through the use of the tape reverb unit, reverberation is easily obtained, making it one of the most popular electronic music techniques.

Most electronic music installations use high-quality tape recorders, amplifiers and speakers. In addition to this equipment, special synthesizers employ various control devices with oscillators, modulators and so forth. These may be electronic keyboards, linear controllers or hand-capacitance controllers.

In setting up components for generating electronic sounds or manipulating nonelectronic sounds, keep several points in mind.

First, the system should be flexible. This can be done easily if all components have front-panel connectors so they can be interconnected in many different ways. Second, a variety and large number of conventional hi-fi components may be obtained (used equipment, for example) and used for a variety of purposes.

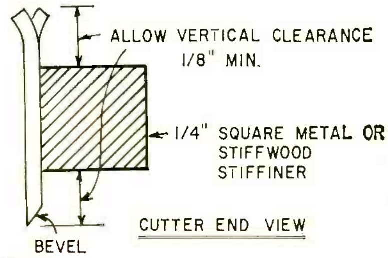
Third, keep the system portable if at all possible. It pays to be able to move gear to live performances. **R-E**

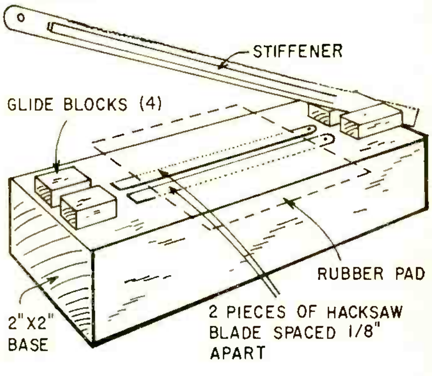
SCHOOL DIRECTORY

TRY THIS ONE

PHENOLIC CUTTER

Though not fancy enough to be called 'Shear Delight' this little 'shear' cuts 1/16-in. phenolic perforated board neatly, quickly, and with no waste. Two halves of a 12-in hacksaw blade are cemented with Duco or epoxy to a sturdy wood base 2 x 2 x 9 in. The smooth back edges form a shallow slot 1/8 in. wide. While the cement is drying, prepare the shear blade. It consists of a third piece of hacksaw blade 8 in. long with a bevel ground along the back edge and stiffened with a length of 1/4 in. square metal or stiff wood. Use a flexible cement (as from a hot-glue gun) to fasten the stiffener to the blade. Center the blade in the slot, and glue the four wood guide blocks to the base only, not to the blade. Be certain the shear blade is





straight, not bowed. A thicker power-hacksaw blade would probably be better, if the long back edge is ground to a chisel shape.

Next, tack or rubber-cement a 3 x 5½ in. piece of inner-tube rubber about 1/16 in. thick over the slot. (A pad of newspaper would probably also serve, but would have to be replaced periodically.) The bare hard edges of the slot seem to invite chipping of the brittle phenolic, hence the pad. Snap rubber bands around the base and blade near the guide-blocks.

Score a deep knife line on both sides of the perf-board midway between the holes. Small pieces may be scribed on the *under*-side only. Set the scribed line under the teeth-up shear blade, and hold gently in place. Rap along the blade with a light hammer from one end to the other until the board separates. The object is to crack the phenolic evenly along the score-line. Start with small pieces and light taps until you develop a feel for it; but 4-¾ in. wide perf-board can be cut into strips only one hole wide with 6 or 8 taps. Other thin materials such as acrylic (plastic-) or styrene can also be cut, as well as copper-clad board if the score mark cuts through the copper and into the phenolic base. Test a scrap piece first. *—Norman L. Justice*

SALVAGING PARTS FROM PRINTED BOARDS

Many surplus computer circuit boards contain valuable transistors and other components that can be salvaged for further use. But, the job of removing these components so they will still be useful is a difficult one. Usually, leads are very short and are likely to break off while the component is being removed. This is especially true of transistors.

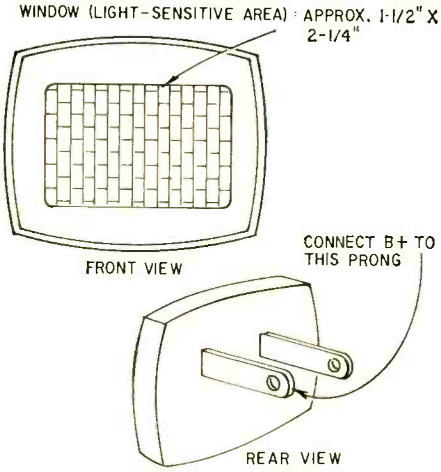
I solve this problem by soldering new leads to the connections *under* the board *before* removing the components. Then, I take a strong pair of wire or diagonal cutters and gradually chip away the insulating board until the components come free. By using this method, I have obtained many sensitive transistors and other parts.*—Joseph Amorose, K4IIW*

SOLDERING ALUMINUM

Soldering aluminum or to an aluminum chassis is not easy—even with special aluminum solder. However, I've used this trick successfully: Take a strip of aluminum solder and a piece of rosin-core solder and hold the two together. Use an iron or soldering gun of at least 135 watts and apply the solders simultaneously. They will fuse together at a lower melting point. Rosin is the flux. The aluminum being soldered must be hot enough to secure a good bond.*—Lee D. Fortun*

NIGHT LIGHT AS PHOTOCELL

The familiar electroluminescent nightlight is a good makeshift, large-scale photoconductive cell. And it is inexpensive too. Sylvania's PNL-7 "Panelescent Nite Light," for example, has a sensitive surface that measures approximately 1½ x 2¼ in., and it sells for 79 cents at supermarkets, hardware stores, etc.



When operated on 90 volts dc (battery or simple power supply), this device passes a dark current of 14 μA. When illumination is supplied by a 75-watt lamp 1½ ft. away, the light current is 200 μA. Bright sunlight gives 420 μA. This is ample current to close sensitive dc relays having internal resistance up to 2,000 ohms, and to provide a sensitive light meter.

The male prongs of the unit are unmarked. but one polarity gives higher output than the other—follow the polarity shown in the drawing. *Don't use ac:* it will make the nightlight glow and nullify the photoelectric action.*—Rufus P. Turner* **R-E**

MARKET CENTER

GENERAL

ROOM TO LIVE. Pleasant, peaceful, S. Utah Mtn. Valley. Hunting country. 40 ac. Level, rich soil $1600, $50 down, $31/mo., 6% int. **WEST LANDS**, Dept. RE, P.O. Box 17407, Holladay, Utah 84117

TREASURE HUNTERS! PROSPECTORS! Relco's new instruments detect buried gold, silver, coins. Kits, assembled models. Transistorized. Weighs 3 pounds. $19.95 up. Free catalog. **RELCO**-A25. Box 10839. Houston. Texas 77018

OPPORTUNITY AND ADVENTURE in Australia. Information $2.00. Box 911 A, Union City, California 94587

JAPANESE NEW PRODUCTS MONTHLY! $1.00. Refundable. **DEERE,** 10639 Riverside, North Hollywood, Calif.

CONVERT any television to sensitive Big-Screen Oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **RELCO**-A25, Box 10563, Houston, Texas 77018

INVENTIONS & PATENTS

INVENTORS: protect your ideas! Free "recommended procedure". **WASHINGTON INVENTORS SERVICE,** 422X Washington Building, Washington, D.C. 20005

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

INVENTIONS WANTED. Patented; Unpatented. **GLOBAL MARKETING,** 2420-AE 77th Ave., Oakland, Calif. 94605

FREE "Directory of 500 Corporations Seeking New Products." For information regarding developments, sale, licensing of your patented/unpatented invention. Write: **RAYMOND LEE ORGANIZATION,** 230-U Park Avenue, New York City 10017.

WANTED

QUICK CASH . . . for Electronic EQUIPMENT, COMPONENTS, unused TUBES. Send list now! **BARRY,** 512 Broadway, New York, N. Y. 10012, 212 WALKER 5-7000.

SELL-TRADE: Electronic test equipment, stereo items. **R. ZAHORCAK,** 29 Parker, Passaic, New Jersey 07055

ELECTRONICS

RADIO & TV TUBES 33¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL** 4217-E University, San Diego, California 92105

Discharge IGNITION, PHOTOFLASH. Free catalog parts, kits. **TRANSPARK,** Carlisle, Mass. 01741

EXPERIMENTERS. Grab bag parts. $2.00. **COURIER,** 37 Fitch Terr., Randolph, Mass. 02368

REGULATED POWER SUPPLY KITS, $2.75-$8.50. 10A flasher $3.98. Zeners, thermistors $.25. Photocell-triac kit $2.75. Nixie $5.00. Driver-DCU $4.50. Catalog. **MURPHY,** 204 Roslyn Ave., Carle Place, N.Y. 11514

ELECTRONIC BARGAIN CATALOG on unusual kits, parts, do-it-yourself, stereo, intercoms. **ALCON,** P. O. Box 1348R, Lawrence, Mass. 01843

RECEIVING & INDUSTRIAL TUBES, TRANSISTORS, All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request FREE Giant Catalog and SAVE! **ZALYTRON,** 469 Jericho Turnpike, Mineola, N.Y. 11501.

BUILD several sensitive metal detectors from our 20 page book. Fully transistorized circuitry. Easily followed diagrams and instructions, $4.00. **TRIONICS,** Box 164J, Brewer, Maine 04412

Ultra-sensitive and powerful METAL DETECTORS join the many who are finding buried coins, minerals, relics and artifacts. Don't buy till you see our free catalog of new models. Write **JETCO**—Box 132-RE, Huntsville, Texas 77340

SEMICONDUCTOR AND PARTS CATALOG over 100 pages free to Canadians. U.S. 50¢. **J & J ELECTRONICS,** Box 1437, Winnipeg, Manitoba, Canada

JAPAN DIRECTORY. Electronics products and parts. General merchandise and Asia trade information. Just $1.00 today. **IPPANO-KAISHA LTD.,** Box 6266, Spokane, Washington 99207

TEKTRONIX TYPE 570 curve tracer, good condition, $195.00. **MIKE STRAND,** 2343 Oakmont Ave., Santa Ana, Cal. 92706.

BRAND NEW TUBES. World's lowest prices on Radio, TV-industrial-special purpose tubes. Write for free parts catalog. **UNITED RADIO CO.,** Newark, N.J.

CUSTOM MADE FACES. Free details, estimates. **WEISS ELECTRONICS LABORATORY,** Box 464, New Milford, Conn. 06776

Circle 137 on reader service card

Circle 138 on reader service card

MARKET CENTER

EDUCATION/ INSTRUCTION

AUDIO — HI-FI

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). 70¢ per word . . . minimum 10 words.

NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items) 30¢ per word . . . no minimum.

Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for July issue must reach us before May 11.

WORD COUNT: Include name and address. Name of city (Des Moines) or state (New York) counts as one word each. Zone or Zip Code numbers not counted. (We reserve the right to omit Zip Code if space does not permit.) Count each abbreviation, initial, single figure or group of figures or letters as a word. Symbols or groups such as 8-10, COD, AC, etc., count as one word. Hyphenated words count as two words. Minor over-wordage will be edited to match advance payment.

CLASSIFIED ADVERTISING ORDER FORM

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

No. of Words { @ .30 Non-Commercial Rates / @ .70 Commercial Rate } =$______

Total Enclosed $________

Insert______time(s)

Starting with__________Issue

Payment must accompany order unless placed through accredited advertising agency 28

NAME______________________

ADDRESS______________________

CITY______________STATE________ZIP________

SIGNATURE______________________

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 200 PARK AVE. SOUTH, NEW YORK, N.Y. 10003

GOVERNMENT SURPLUS

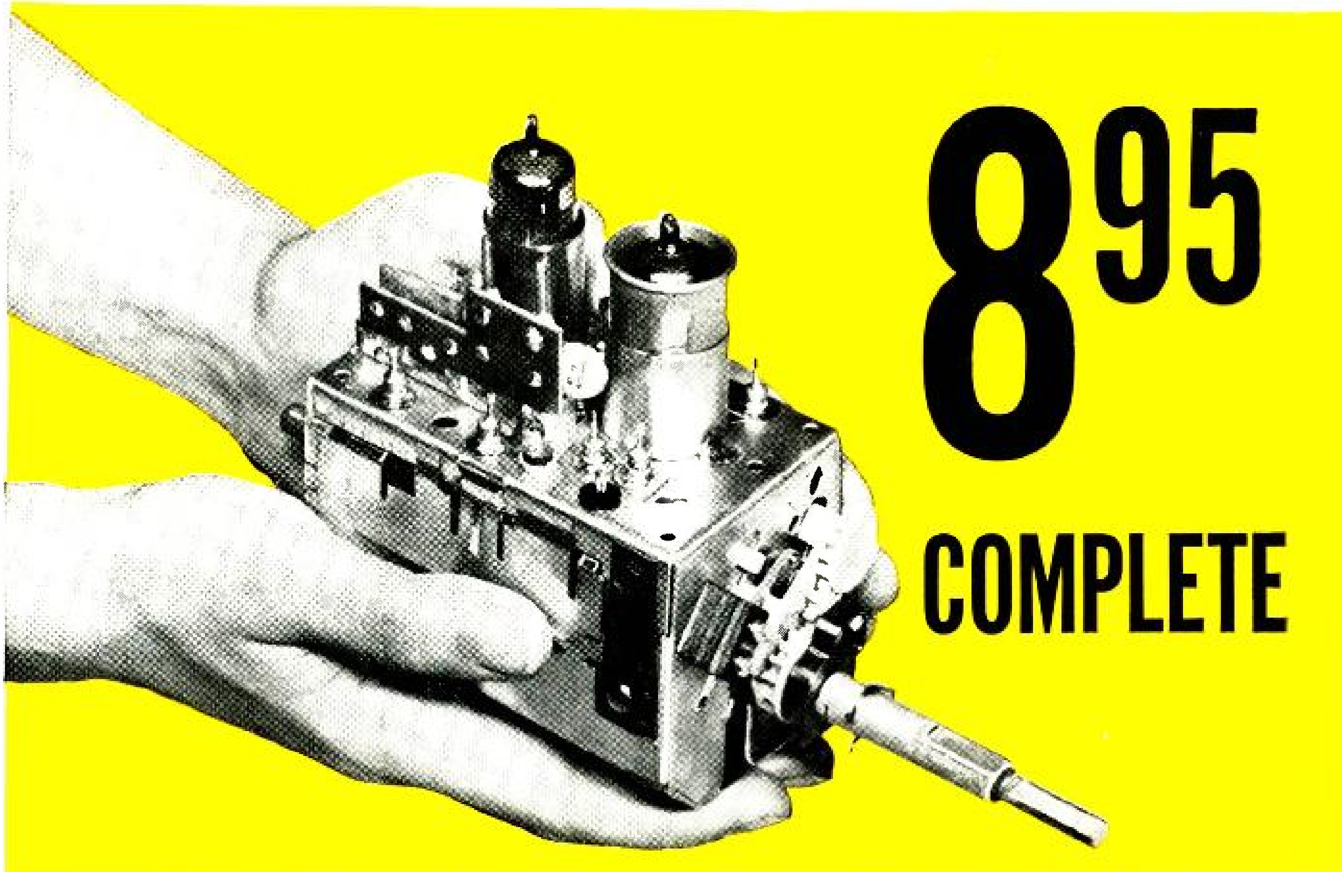
CB keying problem

I've got problems with a Utica CB set. When I turn it on, all tubes light up, power is okay, but I have to "pop" the mike button several times before it will come on. (Tried new mike, changed all tubes and checked the relays.) What do you think?—L. B., Racine, Wis.

Since you have audio problems on receiver and transmit, look for something common to both functions. The 6AQ5 is the audio output tube on receive, and the modulator on transmit. Also, the keying relay is operated by its cathode current!

Since the problems seem to be centered around this stage, it should be thoroughly checked out. The tube has been replaced, so that takes care of that. Voltages are evidently all right as far as the B+ supply is concerned.

I'd say this tube was blocked—cut off by excessive negative bias. Since it is biased by the resistance in its cathode circuit, these resistors must be checked. If any of them have increased in value, this could do it. Also, if there's any trouble in either of the two big electrolytic capacitors, this could cause the problem. If the 270,000-ohm resistor in the grid has gone up in value, or even opened, this could let the grid go so far negative that the tube would cut off. **R-E**



Castle, the pioneer of television tuner overhauling, offers the following services to solve ALL your television tuner problems.

● OVERHAUL SERVICE — All makes and models.

VHF or UHF tuner	$9.95
UHF-VHF combination (one piece chassis)	$9.95
TRANSISTOR tuner	$9.95
COLOR tuner (Guaranteed color alignment . . . no additional charge)	$9.95

Overhaul includes parts, except tubes and transistors.

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

And remember—for over a decade Castle has been the leader in this specialized field . . . your assurance of the best in TV tuner overhauling.

● CUSTOM REPLACEMENTS

Exact replacements are available for tuners that our inspection reveals are unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

● UNIVERSAL REPLACEMENTS

Prefer to do it yourself?

Castle universal replacement tuners are available with the following specifications.

STOCK No.	HEATERS	SHAFT Min.*	SHAFT Max.*	I.F. OUTPUT Snd.	I.F. OUTPUT Pic.	PRICE
CR6P	Parallel 6.3v	1¾″	3″	41.25	45.75	8.95
CR7S	Series 600mA	1¾″	3″	41.25	45.75	9.50
CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

These Castle replacement tuners are all equipped with memory fine tuning, UHF position with plug input for UHF tuner, rear shaft extension and switch for remote control motor drive . . . they come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

Order universal replacements out of Main Plant (Chicago) only.

CASTLE TV TUNER SERVICE, INC.

MAIN PLANT: 5715 N. Western Ave., Chicago, Illinois 60645
EAST: 41-96 Vernon Blvd., Long Island City, N.Y. 11101

Circle 149 on reader service card