ILD—$10 Experimenters' IC decimal readout

60c ■ NOV. 1968

Radio-Electronics

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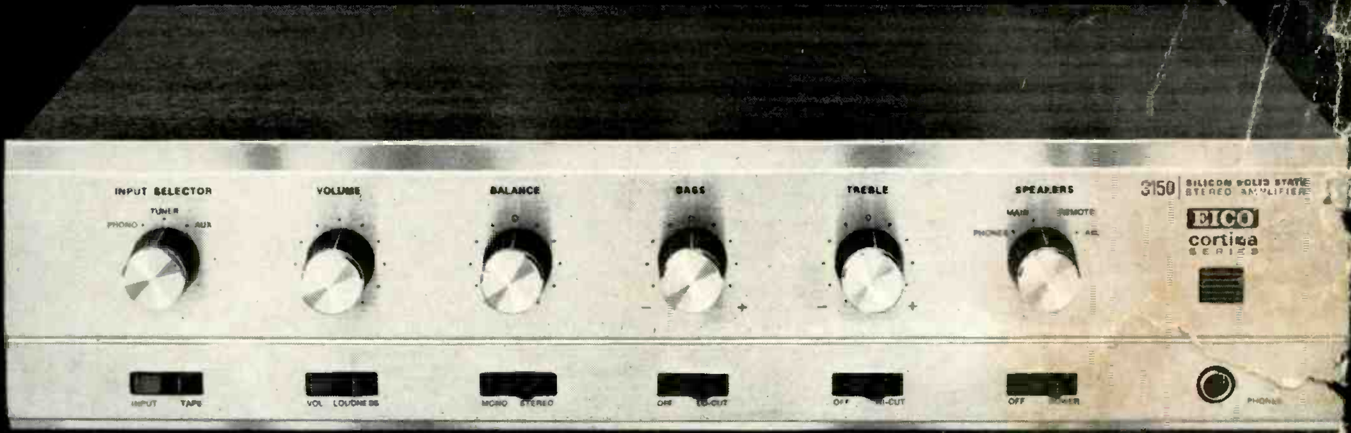
EXCLUSIVE...

ke Go-Go Music—

ld 8 solid-state instruments

This is more amplifier than you may think you need.

But after you see the price, why settle for less.



The EICO "Cortina 3150" all-silicon solid-state 150 watt stereo amplifier is truly a lot of amplifier. It combines wide-range preamplifiers, controls, and power amplifiers, all on one uniquely compact chassis. It delivers clean power to *two* sets of speaker systems, stereo headphones (for which there is a jack on the front panel) and a tape recorder. The Cortina "3150" gives you *complete* control facilities.

Most people think that, while all this would be very nice to have they don't want to pay a lot of extra money for it.

We agree. That's why we designed the "3150." Fully wired it costs $225.00. If you want to buy it as a kit — and it is a particularly easy kit to assemble because of our advanced modular circuitry techniques — It's a mere $149.95. The beautiful Danish walnut vinyl clad cabinet is included at no additional cost. At these prices, the "3150" is no longer a luxury. It's virtually a necessity. The power delivered by the "3150" is enough to give faithful reproduction of the highest peaks in music even when it is used with inefficient speaker systems.

The "3150" gives you more than just power. With *both* channels driven the harmonic distortion is *less* than 0.1%, IM distortion is less than 0.6%, frequency response is ±1.5db, 5Hz to 30 KHz, all at full output, hum and noise 75db below rated output; channel separation is more than 50db; input sensitivity is 4.7MV at magnetic phono input, 280MV at all other inputs.

Phase shift distortion is negligible due to the differential amplifier input circuit and the transformerless driver and output circuits. All electronic protection (no fuse of output transistors and speakers make overloads and shorts impossible.

The "3150" also provides ten versa control facilities volume, balance, bass and treble controls. Input (phono, tuner, aux), tape mo contour, low and high speakers s...

See an... th silicon sol... dealer. W... cor change yo... fier you really

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Designed, ma

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"The EICO Cortina Series are low-cost audio components that look and sound like high cost components."
Popular Science Magazine.

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

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

Sound n' Color is an exciting innovation in the home entertainment field. It adds a new dimension to your musical enjoyment. See the music you hear spring to life as a vibrant, ever shifting interplay of colors.

See every tone, every note, every combination of instruments create its own vivid pattern. EICO Model 3440—Kit $49.95, Wired $79.95.

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

Pre-assembled and pre-aligned front end, multiplex, and IF circuits speed and simplify assembly — you'll enjoy building this deluxe kit.

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Circle 7 on reader's service card

LOOKING AHEAD

By DAVID LACHENBRUCH
CONTRIBUTING EDITOR

'New' color tubes

A 21-inch (viewable diagonal) shadow-mask color tube which has proved popular in Europe is being introduced in the U.S. and Canada. Manufactured by Philips Lamp Works of the Netherlands, it differs from American 20-inch tubes in shape and contour, although its total viewing area is almost exactly the same. The new tube has a very square-cornered screen and a flatter face than American types. In addition, its aspect ratio (height-by-width) more closely approaches the 3-by-4 dimensions of home slides and movies than does the 4-by-5 ratio of most picture tubes. The new tube is featured in two sets made by Electrohome of Canada; demonstrations to U.S. television set manufacturers had just begun at press time.

General Electric's pioneer mini-color 10-inch picture tube has been redesigned to produce a picture sharper, brighter and more contrasty than its predecessor, which has been in service for more than three years. Resolution has been enhanced by increasing the number of aperture-mask holes per square inch to 1820 from 1080, and reducing phosphor dot size to 14.7 from 18.7 mils. A higher-contrast faceplate and brighter rare-earth phosphors have been added, along with a new electron gun. The in-line gun configuration has been retained. The new tube is physically and electrically interchangeable with the older version.

Taped music boom

Prerecorded music on tape is now becoming an important medium, and in terms of retail dollar volume it could be close to one-quarter the size of the phonograph record market this year. Ampex Stereo Tapes, which duplicates and distributes recorded tape, has raised its estimate of the 1968 market by 50% to $250 million from its previous forecast of $160 million.

The growing circulation of 8-track automobile stereo players is largely credited for the increase in sales. Ampex's estimates now indicate that 8-track cartridges alone will sharply exceed $160 million in sales this year, with 4-track cartridge sales running about the same as last year's $27 million, and reel-to-reel tapes declining a modest 5% from 1967 to $19 million. Sales of pre-recorded tape in the 2-reel cassette format is not a serious factor yet, according to Ampex.

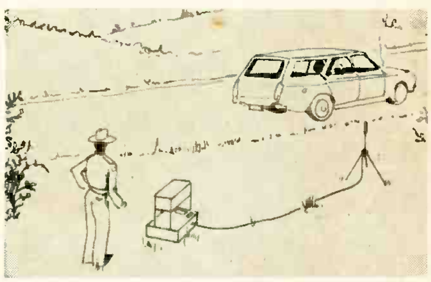
It's estimated that as many as three million 8-track tape players will be in use by the end of 1968, tripling the number in a single year. Most of them probably will be in automobiles, but sales of both home and battery-operated portable players are said to be rising. Although cassette recorder sales are picking up at an even faster pace, the principal use of the cassette machine so far is as a portable recording medium, while the 8-track cartridge unit—which can't record—relies solely on pre-recorded material.

Last year's recorded tape sales totaled about $160 million. Phonograph record sales in 1967 exceeded $1 billion.

While we're on the subject, the output of phonograph records has increased so rapidly that just keeping up with new releases would be a full-time job. If you spent eight hours a day, six days a week listening to every one of the 7,231 single discs and 4,328 LPs issued in the United States in 1967, it would take you exactly a year. (With Sunday off to replay favorites.)

Electronics vs. noise

Already beset by the radar speed trap, the careless motorist soon will have another worry—the electronic noise trap. Seeking a method to establish legal evidence of violations of its antinoise-pollution law, the state of Connecticut has awarded a $69,000 contract to CBS Laboratories to develop a vehicle noise detector-recorder whose readings will stand up in court and provide positive identification of offenders.



CBS Labs' design is for a suitcase-sized device that can be operated from a police car at roadside. A recording decibel meter makes a chart of the noise level of a passing vehicle. If the volume exceeds the legal limit, a camera snaps a picture of the offending vehicle's license plate and, on the same frame, a photo of the chart. The resulting split-screen photograph, in the opinion of the state's legal authorities, will be lawyer-proof.

Q-&-A via FM

You soon will be able to take courses at home from an FM set you can answer back to—and it will tell you whether your answer is right or wrong, and why. A new firm, Educasting Services Inc., has already tested such a system with approval of the FCC and now says it is ready for large-scale home teaching operations.

Educasting combines programmed learning techniques with teaching-by-radio. When a student signs up for a home study course, he receives his regular lesson books plus a special leased radio (the first 10,000 units have already been built by Sylvania). The fix-tuned FM set has four pushbuttons. With button number one depressed, the student hears the instructor give his lecture—and ask questions. The student can select one of three possible answers by pushing button number two, three or four. After he chooses and presses the answer button, he hears the instructor's voice tell him whether his answer was right or wrong and why. Button one then restarts the lesson.

Educasting courses can be broadcast by any FM station without interfering with regular monophonic programming. The system makes possible the simultaneous transmission of four multiplex subcarriers, one for each of the pushbutton channels, in addition to a regular entertainment program. The special receiver picks up only the multiplex subcarriers. In the studio, a four-track tape feeds lessons to the four subcarriers. **R-E**

Radio-Electronics

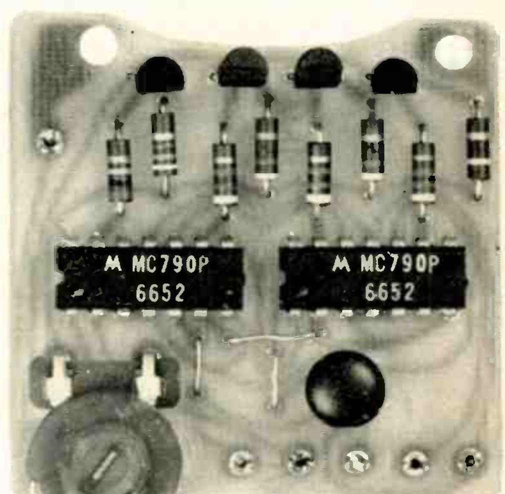
November 1968 • Over 60 Years of Electronics Publishing

Build a 10-watt guitar amplifier. First of an exclusive eight-part R-E series. See page 40 for more projects to come.

starts on page 37

Convert AM tuner for aircraft and weather reception.

see page 42



Decade counting module. A decimal readout that uses three IC's and costs only $10.

see page 60

EDITORIAL

BUILD ONE OF THESE

TELEVISION

AUDIO

GENERAL ELECTRONICS

DEPARTMENTS

RADIO-ELECTRONICS, NOVEMBER 1968, Volume XXXIX, No. 11
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NEWS BRIEFS

Low-Cost 8mm Sound Movie System

New camera system announced by Bell & Howell puts lip-sync sound in 8-mm home movies. The new Filmsound 8 system coordinates camera and projector with a portable cassette recorder that tapes sound accompanying the filming and plays back during projection. The cassette machine records and plays 4-minute tape cassettes, the filming time for a standard super 8 cartridge.

During filming, sounds from the microphone are recorded magnetically on the audio track of the cassette tape while an 18-frame-per-second pulsed signal is recorded on the synchronous control track of the tape. The pulsing signal serves as a speed control for the projector, keeping both picture and sound in frame-by-frame sync.

The complete system consists of the Autoload 442 camera ($159.95), Autoload 458 projector ($169.95) and Filmsound 450 recorder ($99.95).

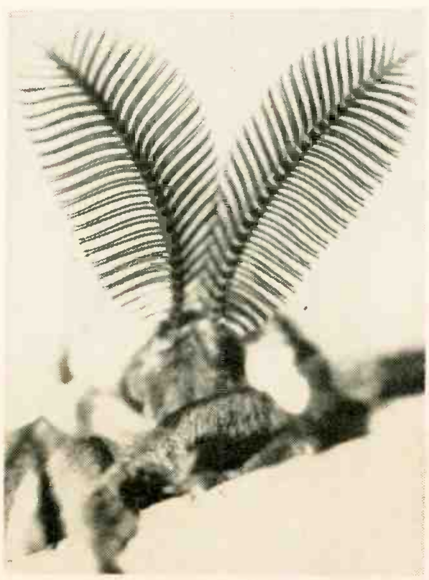
DEAFENING MUSIC?

The guinea pig says yes. Tests at the University of Tennessee subjected a guinea pig to go-go music recorded at a local discotheque, played at high levels (120 db) to duplicate the sound level of the discotheque. After 88 hours of listening, spread over a three-month time, the sound-sensitive cells in the guinea pigs ears began to deteriorate.

True, guinea pig ears are not human ears, but there is some evidence that there is a connection. A recently completed study at the University of Tennessee revealed an unusually high proportion of students with measurable hearing loss. The hearing of many freshman students had already deteriorated to a level of the average 65-year-old person.

MOTH JAMMING

Electronic sensors in the antennae on this night-flying Cecropia moth are remarkably similar to the radar detectors first used in World War II. Instead of reacting to radar, however,

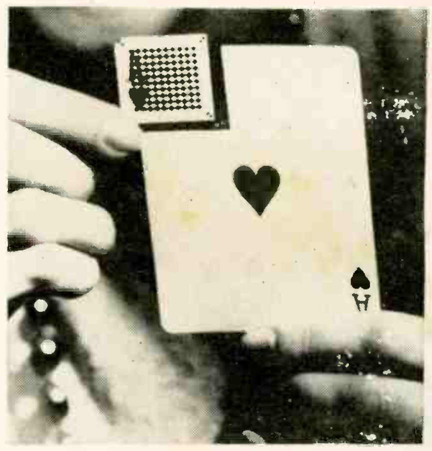


American Institute of Physics

the detectors are so microscopically small (0.0026″ long and 0.00026″ in diameter) they are sensitive to light waves. This property was discovered by Dr. Philip S. Callahan, a U.S. Department of Agriculture scientist, during studies to find a signal that would attract the crop-damaging corn earworm moth. The scientist found that moths drop to the ground as a defense when exposed to light because the light-sensitive detectors "short circuit" their antennas, blocking impulses from several other sensory antenna spines. Dr. Callahan reported his findings in the publication, Applied Optics.

TRANSISTORS ON PAPER

This array of 100 tellurium transistors deposited on a playing card may be the forerunner of mass-produced semiconductors costing a penny each or less. Experimentally produced in Westinghouse labs, these thin-film flexible transistors have been formed on a variety of substrate materials. They have stable operating characteristics and have worked at 60 MHz. Over 600 of the devices can be deposited in a one-square-inch area. Although commercial applications are several years off, the devices should greatly reduce the costs of toys, novelties, hobby kits, teaching aids and other items where high power, high temperature, and very high frequencies are not present. The company also predicts applications of highly flexible electronic circuits.



EYES FOR SPACE

Four viewing methods to permit future spacecraft crews to see earth during reentry are under test by NASA pilots. This system, produced by Kollsman Instrument Corp., mounts in a

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.

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Circle 9 on reader's service card

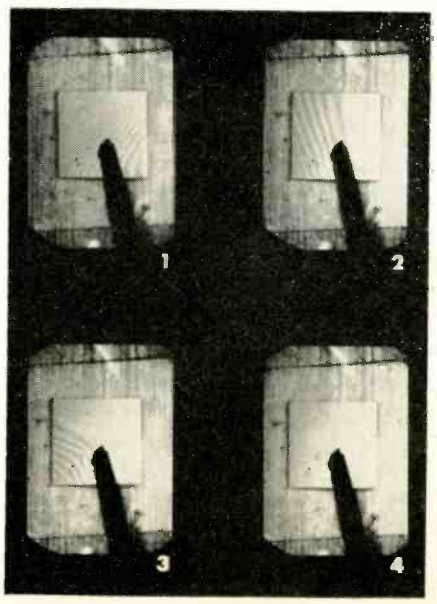
helicopter and lets pilots compare the effectiveness of an optical system, simulated fiber optics, color and black-and-white TV.

GIANT STEP IN GLASS TO METAL BONDING

Glass to metal seals have always been a problem. When the two materials to be sealed are placed on top of each other they normally touch at only a few points even if their surfaces are optically polished. But a new bonding process, discovered and developed by P. R. Mallory scientists solves this problem. Here's how it works.

The bond is formed by placing a flat piece of insulating material such as glass on a flat piece of metal. The sandwich is heated to a temperature well below the softening point of the glass and a dc potential is applied, for a short time, across the glass-metal sandwich. In most instances the glass

(continued on page 12)



Series of micro-graphs show the bonding of a piece of flat glass to a piece of flat silicon. The bonded area (beginning in photo 1) moves across the chip in a wave-like motion behind the light interference fringes—seen as dark wavy lines.

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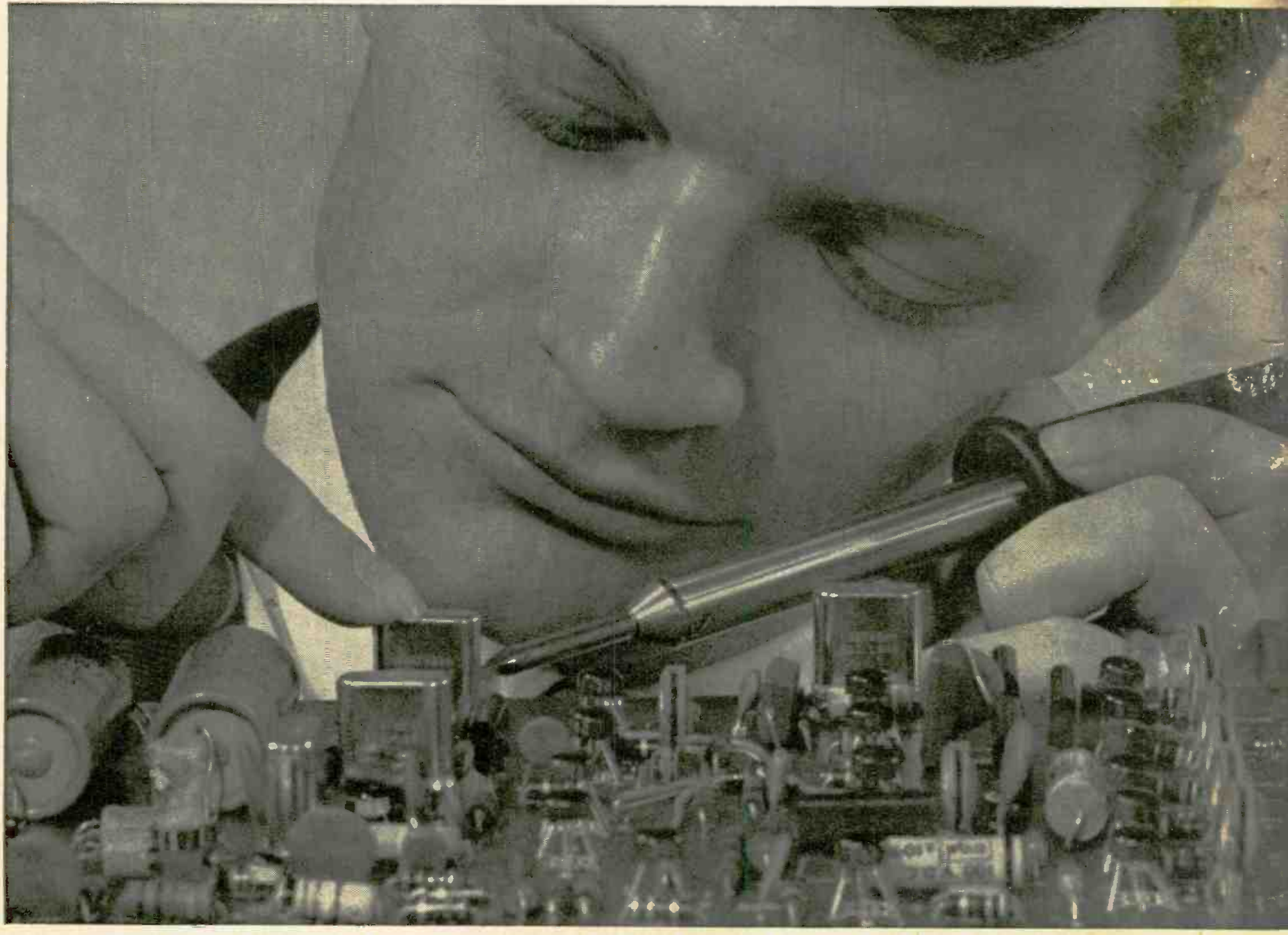

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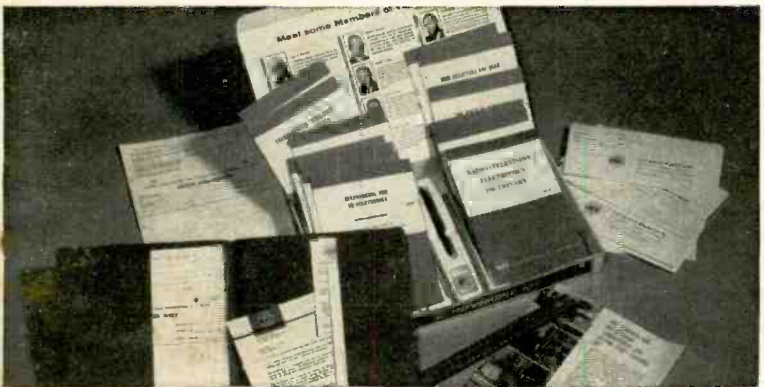
NRI Communications training programs will qualify you for a First Class Commercial Radiotelephone License issued by the FCC. If you fail to pass the FCC examinations for this license after successfully completing an NRI Communications course we will, on request, refund in full the tuition you have paid. This agreement is valid for the period of your active student membership and *for six months* after completion of your training. No school offers a more liberal FCC License agreement.

Experience is still your best teacher



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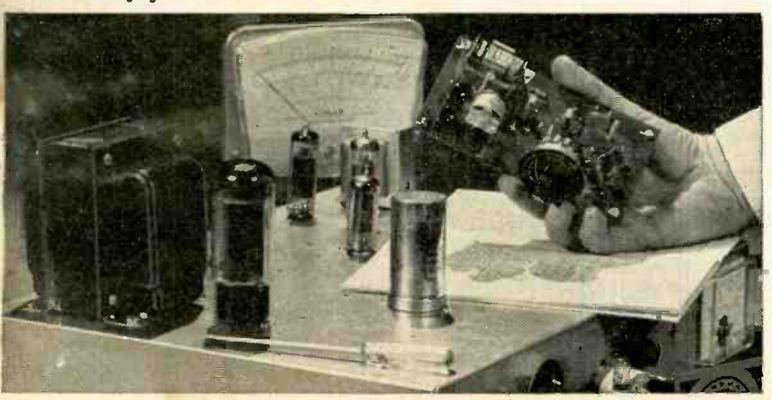

Designed-For-Learning Equipment

Like this phone-cw transmitter (Kit #7 in the Communications course) is engineered from chassis up to demonstrate principles you must know. NRI does not use modified hobby kits for training, but the finest parts money can buy, professionally and educationally applied.

...here's how you get it with unique NRI training at home

Ask any teacher, job counselor, engineer, technician or prospective employer about the need for practical application of theory in Electronics. He'll tell you Electronics is as much a "hands-on" profession as dentistry or chemistry. That's how you learn at home with NRI. You prove the theory you read in "bite-size" texts, by actual experimentation with the type of solid-state, transistor and tube circuits you'll find on the job today — *not* hardware or hobby kits. You introduce circuit defects, analyze results, discover quickly the kind of trouble-shooting and design techniques that will make you employable in Electronics.

Train with the leader—NRI

NRI lab equipment is designed from chassis up for effective, fascinating training — not for entertainment. The fact that end results are usable, quality products is a bonus. In Communications, for example, you build and analyze, stage by stage, your own 25-watt phone/cw transmitter. It's suitable for use on the 80-meter amateur band, if you have an interest in ham radio. In TV-Radio Servicing your practical training gives you your choice of monochrome or color TV sets. All training equipment is included in the low tuition — you pay nothing extra. Discover for yourself the ease, excitement and *value* of NRI training. Mail postage-free card today for new NRI Catalog . . . or use the coupon below. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

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NEWS BRIEFS

(continued from page 6)

should be biased negative with respect to the metal. An electrostatic attraction produced by the application of the dc potential is believed to result in the intimate surface contact required to bond the materials.

Since the bonding temperature is well below the softening point of the glass and the metal both materials remain solid and do not distort.

SUPER TRANSISTORS

Using a new laminated construction technology, RCA has developed transistors that can generate 1 MHz signals with a power output of 800 watts. Considerably higher powers and frequencies are expected as the experimental, walnut-size devices are refined. Ultrasonic cutting and glass hermetic sealing are used in the process. Two separate silicon wafers, the emitter-base and base-collector, are fused under heat and pressure into a single monolithic structure.

FIVE-SIDED TEACHING MACHINE

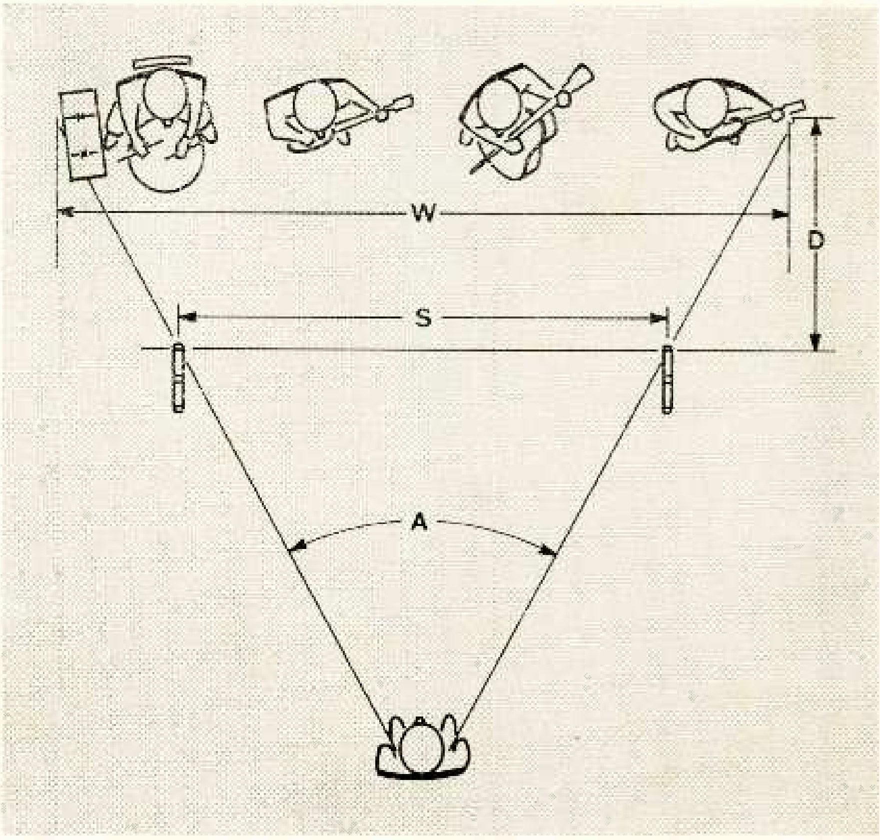
A random access audio information retrieval system has been installed by the Ampex Corporation at Oak Park and River Forest High School, Oak Park, Ill. Five pentagon shaped carrels enable 25 students at a time to listen to instructional material. Each student can select a separate audio program or all may listen to the same lesson. Future phases will extend the system to include random access video instructional material.

At the heart of the system are seven 32-track master tape transports which hold a total of 224 recorded lessons. A complete 15-minute lesson is recorded on each track. Programs are transferred from the master unit to the student buffer at 120 ips and are replayed for the student at 3 ips. Transferring the program takes less than 30 seconds. **R-E**

CURTAIN OF SOUND

Get the most out of a stereo recording session—put the mikes in the right places!

By WINSTON THARP



WHEN STEREOPHONIC RECORDING WAS first developed, one of the early theories tried was to place a number of unidirectional microphones in front of the musicians. The mikes formed a "curtain" and so did the playback speakers. Soon it was found that good space/sound illusion could be preserved with only two mikes. The only question—how far should they be separated?

Since then, several two-channel systems have been used. The *binaural* arrangement uses directional mikes spaced about 6 or 7 inches apart—approximately the distance between your ears. Playback is through headphones. Obviously 7-inch mike spacing is incorrect for material to be played back through relatively wide-spaced speakers. But how far apart to place the mikes then? A couple of feet might do for a small, three-piece band. A full symphony orchestra, on the other hand, might require 10 feet or more.

Moreover, loudspeaker spacing varies with each home listener. Good miking deals with this.

Critical stereo angle

To preserve the curtain of sound illusion, it's necessary to construct an imaginary isosceles triangle, with the performers along the base and the listener at the apex. The angle formed by the two equal sides should be between 30° and 45°. The mikes are then placed along the two equal sides and equidistant from the performers.

A bit of elementary trigonometry discloses that for an apex angle A, width of performing group W, distance from mike to group D, and mike spacing S

$S = W - 2D\tan A/2$

$D = (\frac{1}{2}\cot A/2)(W - S)$.

Taking the extreme values of A, we see that for A = 30°

$S = W - 0.5358D$

$D = 1.86605\ (W - S)$.

For A = 46° (a little easier to compute than 45°)

$S = W - 0.8490D$

$D = 1.17795\ (W - S)$.

For all practical purposes we may approximate these equations. For A = 30°

$S = W - D/2$

$D = 2(W - S)$.

For A = 46°

$S = W - D$

$D = W - S$.

For instance, if the sound source (the musicians) is spread across 10 feet of stage, and you want the mikes within 10 feet, simply plug these values in a formula: For an angle of 30°,

$$S = 10 - \frac{10}{2} = 10 - 5 = 5$$

Therefore, you would place the mikes 5′ apart, 10′ from the musicians.

Given a width of performing group and either distance from performers to mikes or mike spacing, you can easily compute the unknown dimension with these formulas. The recordist usually has little control over the width of the performing group. In many instances the distance from group to mikes or mike spacing may be fixed by such factors as availability of mike supports, esthetic considerations (some performers just don't like mikes), or desire on the part of the recordist to minimize audience noise.

Theoretically, the mikes should be spaced 6 to 10 feet apart to match the spacing of the speakers used for playback, but as long as the correct angular relationship is maintained the effect will be correct. Spacing the mikes closer than 3 feet or farther than 50 feet from each other may result in insufficient or excessive separation due to the time differences of sounds from opposite sides of the performing group hitting the mikes.

The value of angle A is determined by acoustical conditions and the type of group to be recorded, with the larger angle (and shorter D) for recordings emphasizing "presence" and the smaller angle (and longer D) more "liveness."

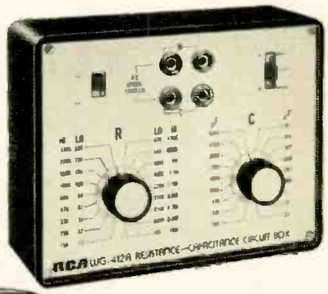
The preceding rules hold for ideal recording conditions. Note, however, that unless good cardioid mikes are used (and possibly even then) mikes will have to be closer than half the total distance from "width" line to apex. Otherwise, room noise and reverberation will probably degrade the recording—certainly the separation.

Remember also that, especially with omnidirectional mikes and in a small room, reproduced stereo may be "off center" because of absorption or reflection from the walls. This is particularly true if the recording setup is asymmetrical. R-E

measure

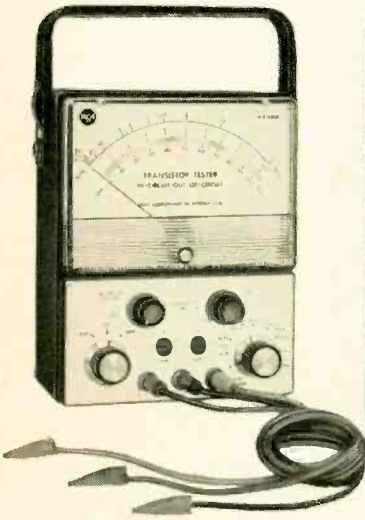
The RCA WV-38A Volt-Ohm Milliammeter is a rugged, accurate, and extremely versatile instrument. We think it's your best buy. Only $52.00.* Also available in easy to assemble kit, WV-38A (K).

The RCA WV-77E Volt-Ohmyst® can be used for countless measurements in all types of electronic circuits. Reliability for budget price. Only $52.00.* Also available in an easy to assemble kit, WV-77E (K).

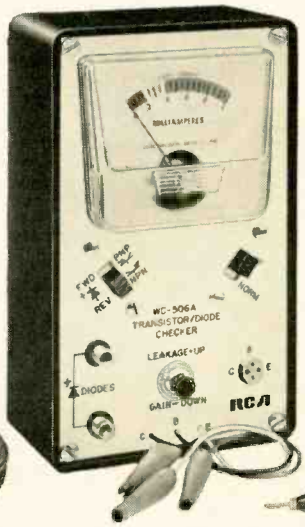


The RCA WG-412A R-C circuit box can help you speed the selection of standard values for resistors and capacitors, either separately or in series or parallel R C combinations. Only $30.00.* It's easy to use, rugged, and compact.

The RCA-500A all solid state, battery operated VoltOhmyst eliminates warm-up time, eliminates zero-shift that can occur in tube operated voltmeters. Completely portable. Only $75.00.* Comes with shielded AC/DC switch probe and cables.



The RCA-WT-501A in-circuit out-of-circuit transistor tester is battery operated, completely portable. It tests both low and high power transistors, has NPN and PNP sockets for convenient transistor matching for complementary symmetry applications. Only $66.75.*



The RCA WC-506A transistor-diode checker offers a fast, easy means of checking relative gain and leakage levels of out-of-circuit transistors. Compact and portable, it weighs 14 ounces, measures 3¾ by 6¼ by 2 inches. Only $18.00.*

The RCA WV-98C Senior VoltOhmyst is the finest vacuum-tube voltmeter in the broad line of famous RCA VoltOhmysts. Accurate, dependable, extremely versatile, it is a deluxe precision instrument. Only $88.50.* Also available in an easy to assemble kit, WV-98C (K).

For a complete catalog with descriptions and specifications for all RCA test instruments, write RCA Electronic Components, Commercial Engineering, Dept. K39WA, Harrison, N.J. 07029.

*Optional Distributor resale price. Prices may be slightly higher in Alaska, Hawaii, and the West.

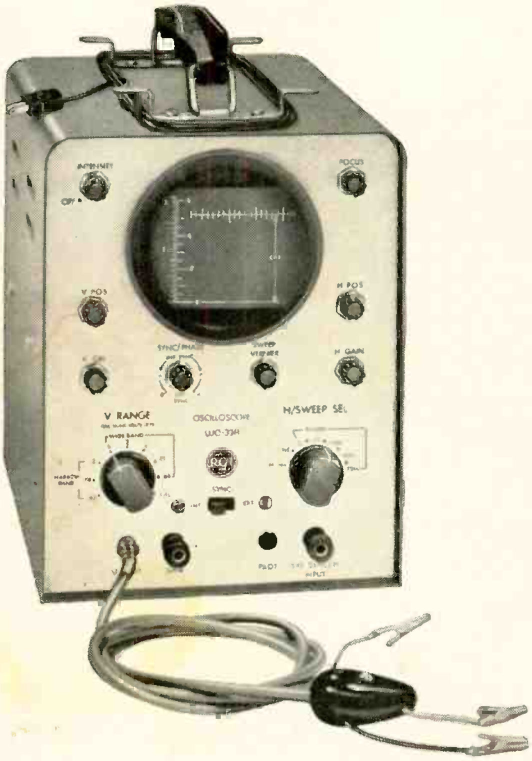
LOOK TO RCA FOR INSTRUMENTS TO TEST/MEASURE/VIEW/MONITOR/GENERATE

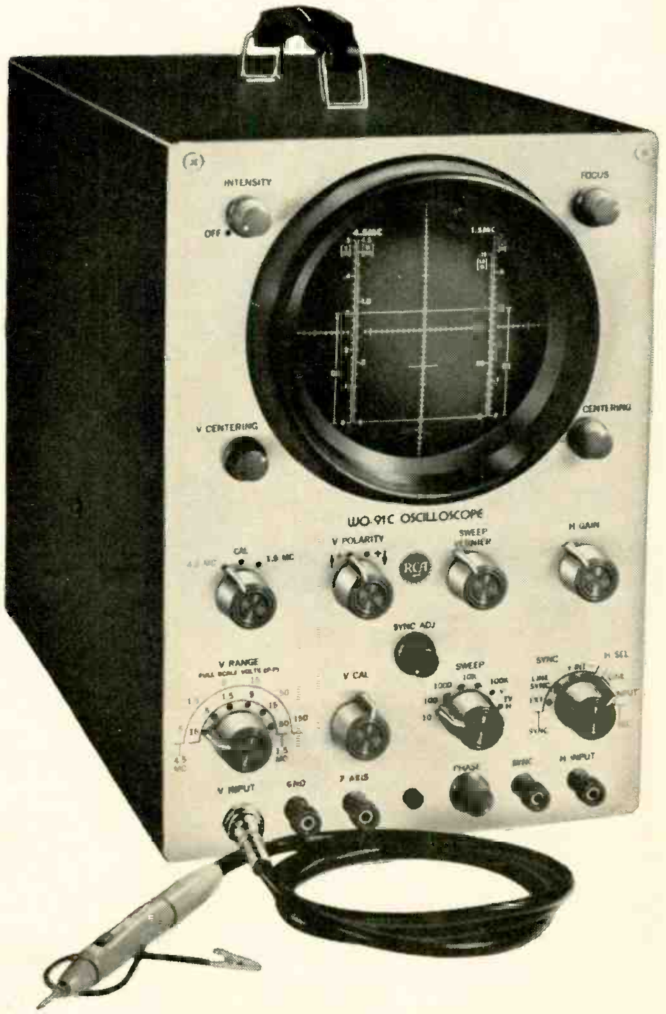
RCA

view

The RCA WO-33A Super-Portable 3-Inch Oscilloscope helps solve virtually any electronics servicing problem, inside or outside the shop. Its combination of exceptionally low cost and high performance have already made it popular as a monitoring and trouble shooting 'scope in black and white and color TV broadcasting studios, and in professional service. And why not? Here's a 3-inch 'scope that meets your requirements for gain, bandwidth, transient response, accuracy, versatility, and portability. AND IT'S ONLY $139.00.* Also available in an easy to assemble kit, WO-33A (K).

The RCA WO-91C 5-inch Dual Band Oscilloscope is a reliable, heavy-duty, precision 'scope in use in thousands of installations from classrooms to TV distribution systems...from service benches to broadcast stations. You probably can't find a better value. Applications include waveform analysis, peak-to-peak voltage measurement, square-wave testing, and observation of circuit characteristics. A front-panel switch gives you an easy choice of wide-band or narrow-band (high sensitivity) operation. It's easily portable, AND IT'S ONLY $269.00.* The WO-91C-V1 is available for 240V operation, no increase in price.





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LOOK TO RCA FOR INSTRUMENTS TO TEST/MEASURE/VIEW/MONITOR/GENERATE

RCA

Correspondence

TV DX-ER WANTS INFO

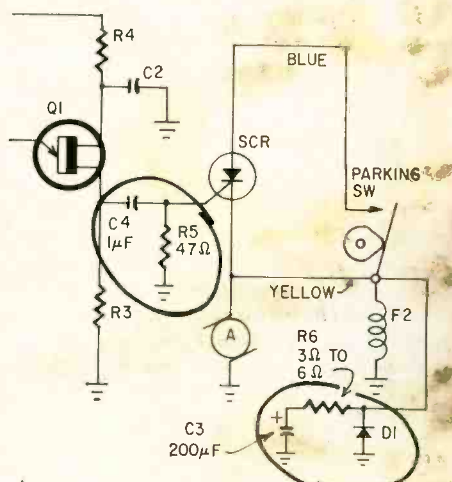
I have been dx'ing the television bands for about six months and I've been trying to collect information on TV dx'ing, TV dx'ers, antennas and equipment for use in TV dx'ing. Can any of your readers help?

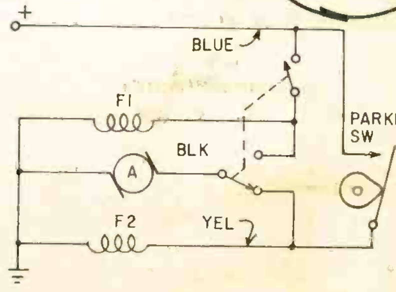
MARK J. KOZLOWSKI
306 Riverside Ave.
Buffalo, N.Y. 14270

Dx'ers, how about giving Mark a helping hand? We've sent him a list of dx'ing articles that have appeared in R-E. Now it's your turn to sock it to him.

MORE WINDSHIELD WIPER COMMENT

I read and enjoyed S. B. Grynkewicz's article in the July 1968 issue "Automatic Windshield Wiper Pause Controller." I built and installed the





unit in my car (a 1964 Valiant) and encountered a few problems. The car has variable windshield wipers. The parking switch is between the wiper motor and the battery. Some modifications were required to get the circuit operating properly for me. They are circled in the diagram.

C3, R6, and D1 filter out voltage transients from the wiper motor. C4 and R5 prevent the filter from interfering with proper operation of the timing network. Now the circuit works fine, except that the normal wiper cannot be turned on while the controller is operating.

HENRY L. HESS
Colorado Springs, Colo.

Ok, all you 1964 Valiant owners. Henry has shown you how to get the pause control to work for you. If you've been holding off waiting for this solution you can start building your pause controller now.

MINI-AMP IS HOT

From the announcement of the Guitar Amplifier that was presented in the September issue, I must confess that I visualized a 60-70-watt, transformerless, all-silicon job. But let's not minimize Mr. Gill's cute 2-watt mini-amp. It has a number of good points like the CA-3020 and the diode gimmick that saves a switch by blocking reverse current from half of the 12-volt battery.

But now, let's have that same CA-3020 followed by a good class-AB power silicon complementary pair with a 50-watt output into 8 ohms or 70 watts into 4 ohms.

TONY ROCCO
Bonita Springs, Fla.

Tony, elsewhere in this issue you'll find a step in the right direction—a higher-wattage guitar amplifier. And within the next few months we'll show you a flock of accessories you can build to use with it or most other guitar amplifiers. Included will be a vibrato, reverb, fuzz box, mixer, inverter, bongos and—you guessed it—a 50-watt booster amplifier. So all you guitar amplifier fans, watch these next issues of R-E closely.

READER SERVICE NOTES

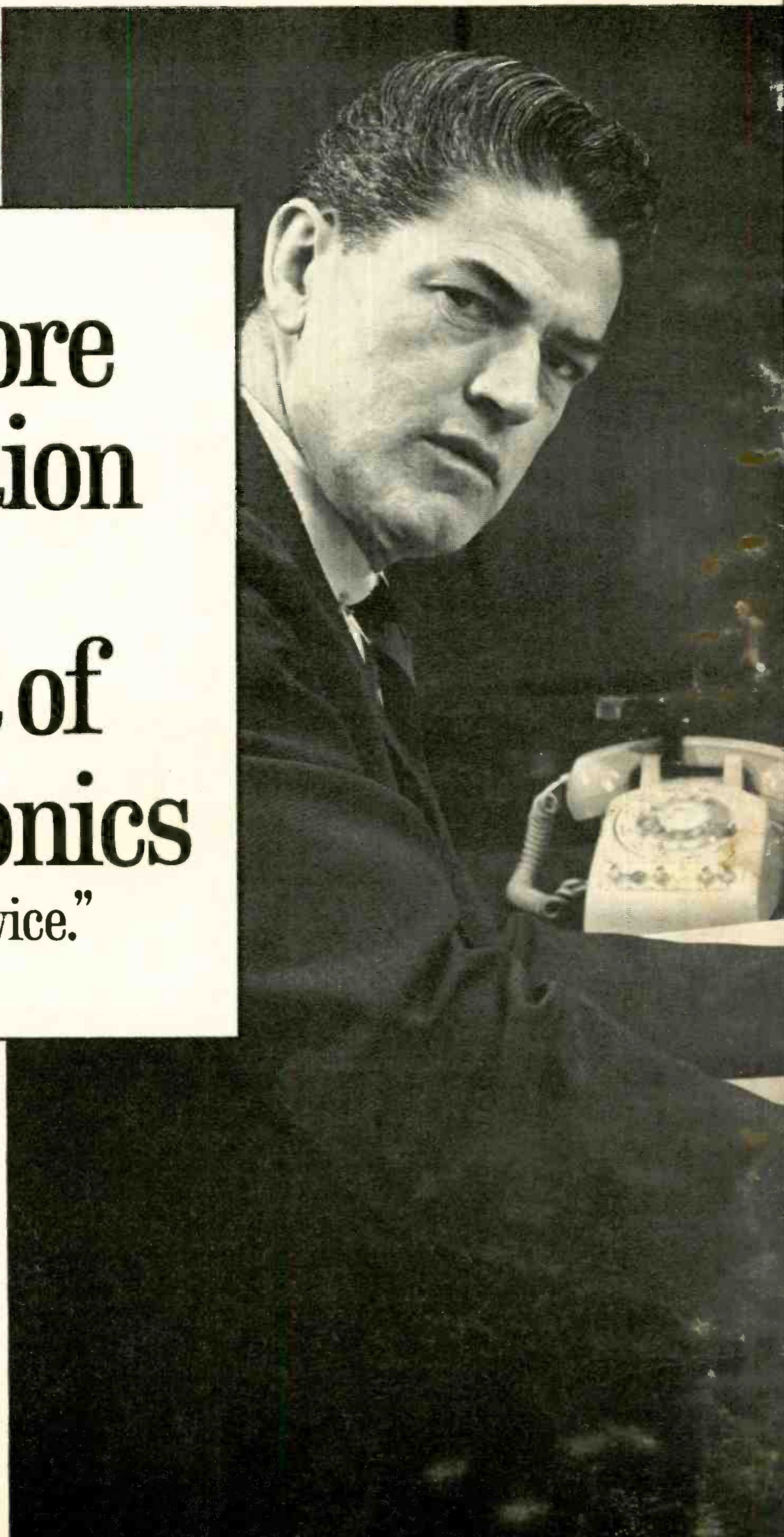
Why don't I always get replies from all the manufacturers whose product codes I circle on your Reader Service Card?

WARREN ROY
Brooklyn, N.Y.

It just takes time Warren. It takes time for us to get your name to the proper manufacturers. It takes them time to get out the necessary brochure. It takes time for the post office to get that brochure to you. So don't give up, you'll get all the material you requested. **R-E**

"Get more education or get out of electronics

...that's my advice."



Ask any man who really knows the electronics industry.

Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

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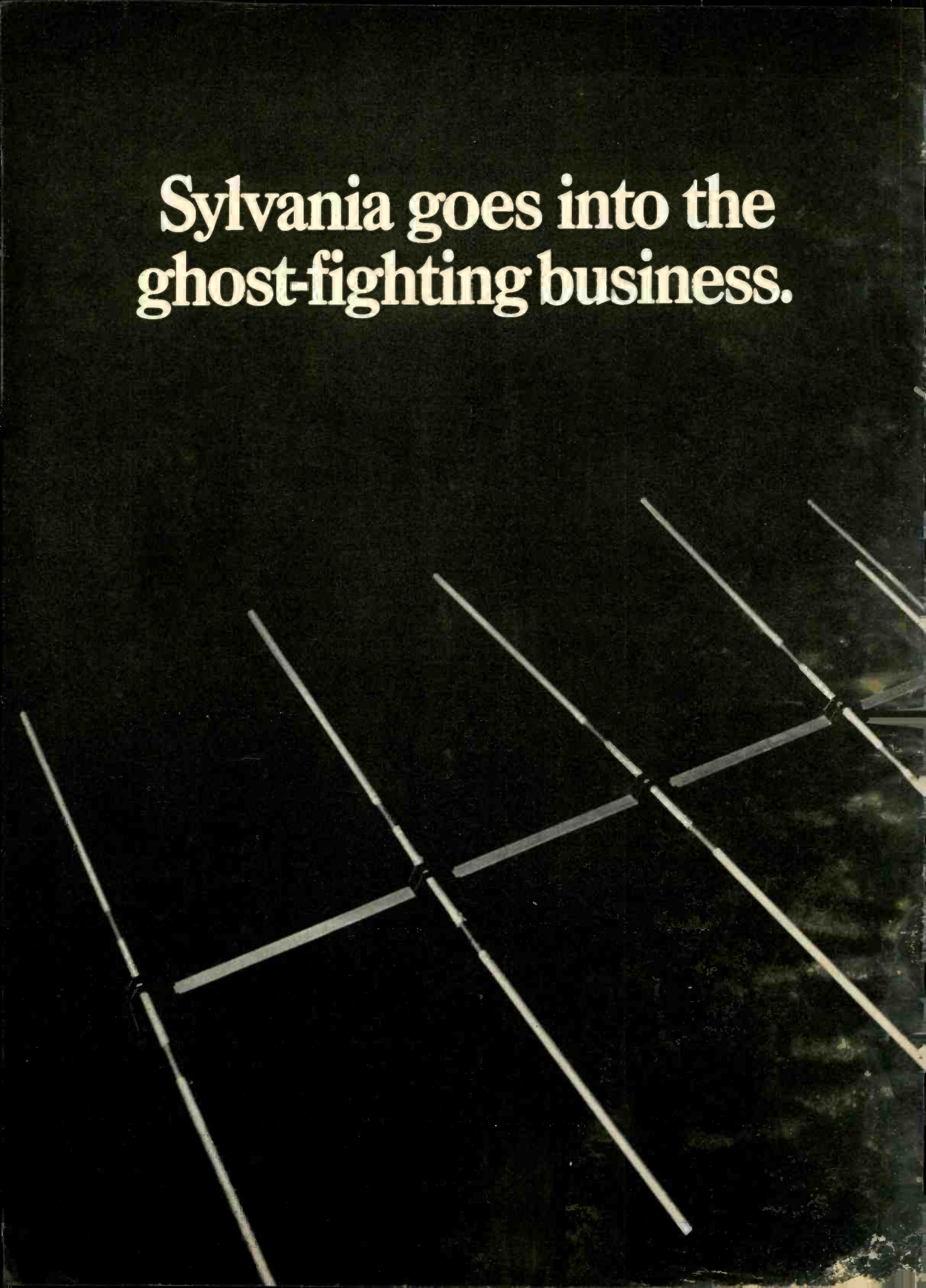
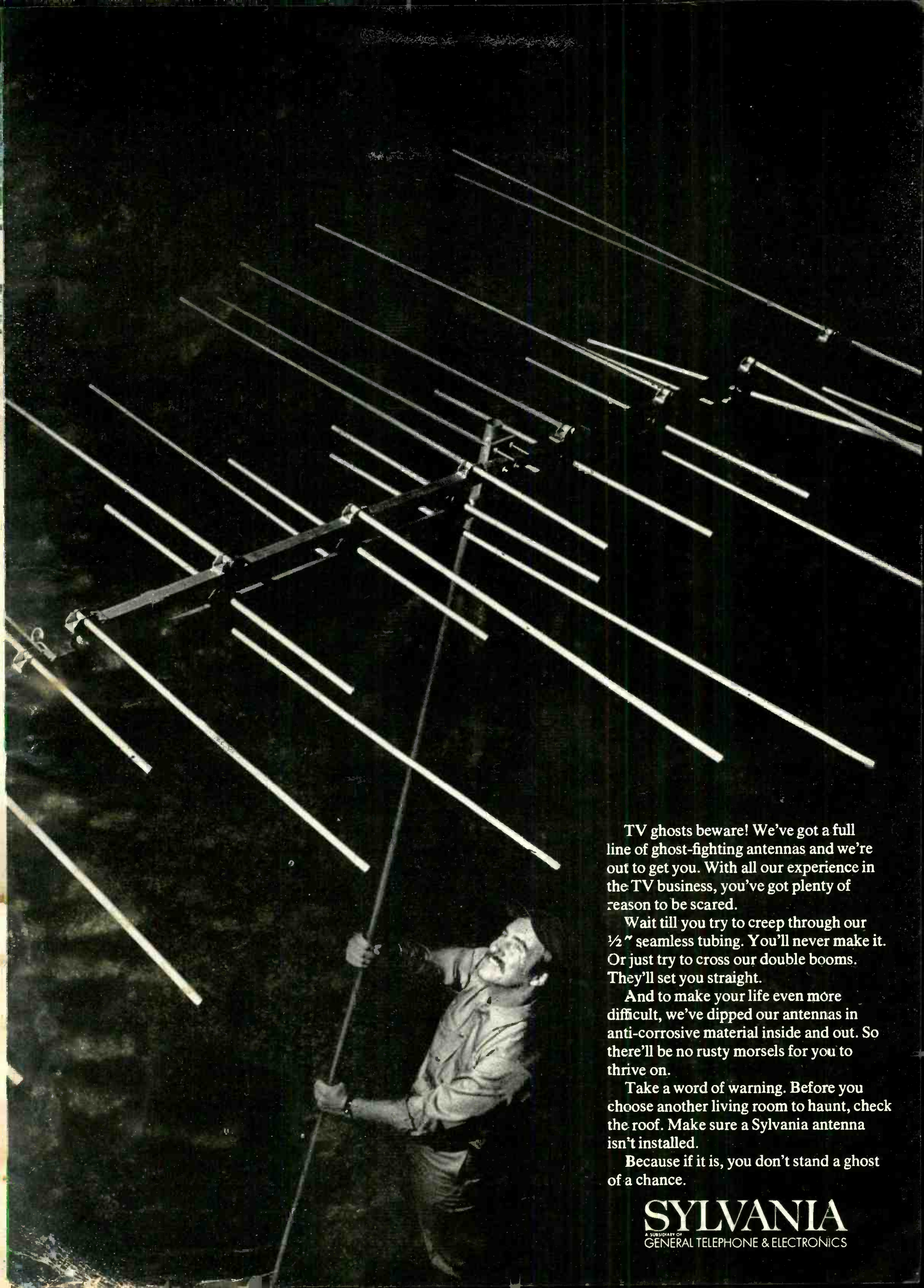

Sylvania goes into the
ghost-fighting business.


TV ghosts beware! We've got a full line of ghost-fighting antennas and we're out to get you. With all our experience in the TV business, you've got plenty of reason to be scared.
Wait till you try to creep through our ½" seamless tubing. You'll never make it. Or just try to cross our double booms. They'll set you straight.
And to make your life even more difficult, we've dipped our antennas in anti-corrosive material inside and out. So there'll be no rusty morsels for you to thrive on.
Take a word of warning. Before you choose another living room to haunt, check the roof. Make sure a Sylvania antenna isn't installed.
Because if it is, you don't stand a ghost of a chance.
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In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

Solid-State Rectifiers

AT REGULAR INTERVALS, TECHNICIANS come across funny-shaped components in radio, TV, stereo and other equipment. From their shape and size, you can't tell beans about them. But you can tell their purpose from what they're connected to. These "unidentifiables" are silicon rectifiers used in a solid-state power supply.

You may find one, two or four small units mounted on a terminal strip. Large stud-mounted rectifiers may have leads going off in all directions, or a unit may be just a featureless black blob in a rectangular case, tightly mounted on a PC board.

It doesn't matter what they look like, they all do the same thing: supply dc power for transistors or tubes. Trace the leads from an unknown unit to determine its function. If one lead goes to an electrolytic capacitor and others go to the ac source, it's the rectifier.

Three rectifier types are used in ordinary circuitry: half-wave, full-wave and bridge. You can tell which type it is by counting the number of leads on the "package." Two leads—it's a half-wave (single) rectifier. Three leads—it's a full-wave (two rectifiers with a common connection). A bridge will always have four leads. Fig. 1 shows the schematic of each.

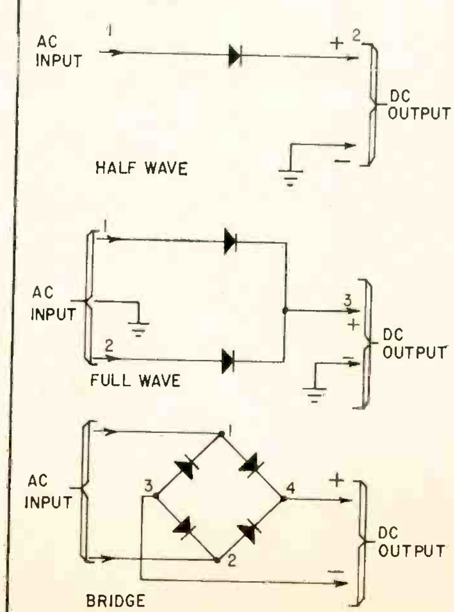

Fig. 1—Schematics of three basic rectifier types used in modern equipment.

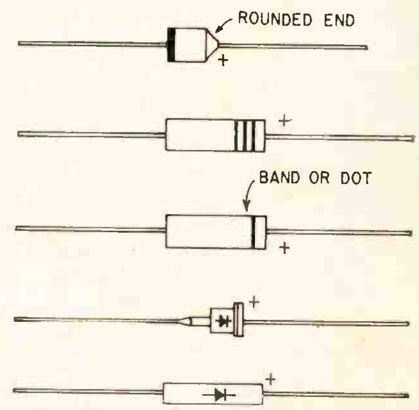

Fig. 2—Common types of rectifier cases. "Top hat" case is always the cathode.

The identification confusion results from packaging. Many rectifiers have unmarked cases with leads, prongs or studs. All you can do is look to see where they're connected.

Half-wave (2 leads): One lead will always go to the ac supply, and the other to a big electrolytic capacitor. From the capacitor, another lead will go on to the main B+ (dc) voltage circuits. Hint: Look for the power output stage. This is the point where the highest dc voltage will always be used (audio output in radios, stereo, horizontal output stage in TV, etc.

In tube equipment, the dc voltage output will always be positive. In transistor equipment, it can be positive, negative, or both, depending on the transistor types used. In a positive supply, the cathode of the diode will always go to the positive (insulated) end of the electrolytic capacitor that acts as a ripple filter.

On the very small silicon diodes now used, the *cathode* will be marked. This mark may be a rounded end, a band or dot of paint or, in some cases, the maker may have been thoughtful

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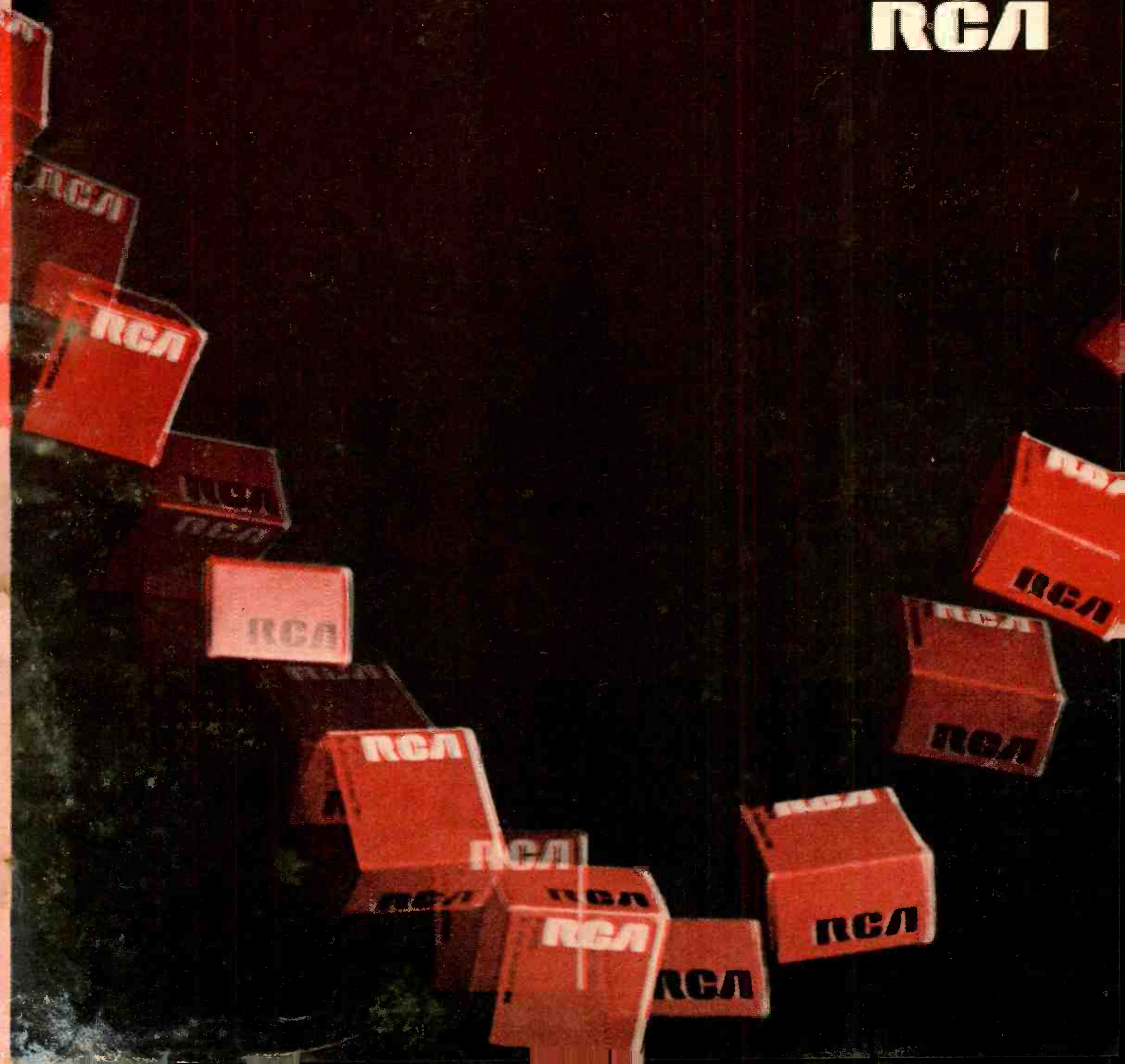


enough to put the diode symbol on the case. Fig. 2 shows the common types of single-rectifier cases. There *is* one "standard": the top hat case shown second from the bottom. The case of this unit is always the cathode. This holds true for a stud-mount rectifier, too; if it's reversed (anode to case), there will be an "R" suffix on the type number; *if* it's a JEDEC rectifier, the "R" has a "1N—" number.

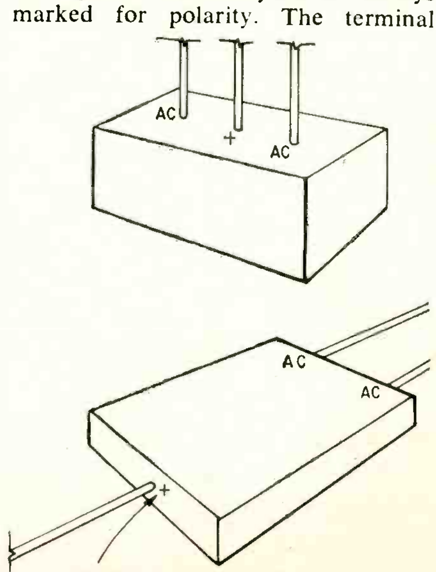
Full-wave rectifiers have 3 leads (Fig. 3). They may be in any type of case, but the 3 leads will be the clue. A three-lead type is a dual, full-wave rectifier, and the lead marked "+" is the output, the other leads go to the ac supply (always a power transformer). The output can be negative, of course, in which case the marking will be "—".

A full-wave bridge, when packed in a single case, may appear like those shown in Fig. 4. The tipoff is the four leads. A manufacturer may mark all four leads as shown. If only one or two are marked, you have to trace connections by finding the filter capacitor, etc. Look for the two terminals marked "ac" and the others marked "+" and "—".

In the stud-mounted type shown at the bottom of Fig. 4, the positive terminal is sometimes marked "+" and sometimes with only a red dot. The ac leads are *usually* identified.

Never disconnect the unit until you've drawn a rough sketch of the connections, including wire colors and the position of the unit. If necessary, mark the rectifier case—a piece of lettered tape will do.

The most valuable clue is the filter capacitor. Electrolytics are always marked for polarity. The terminal



COMMON CATHODE OR (-) COMMON ANODE

Fig. 3—Three leads designate a full-wave rectifier. Lead marked "+" is output; other leads go to ac transformer.

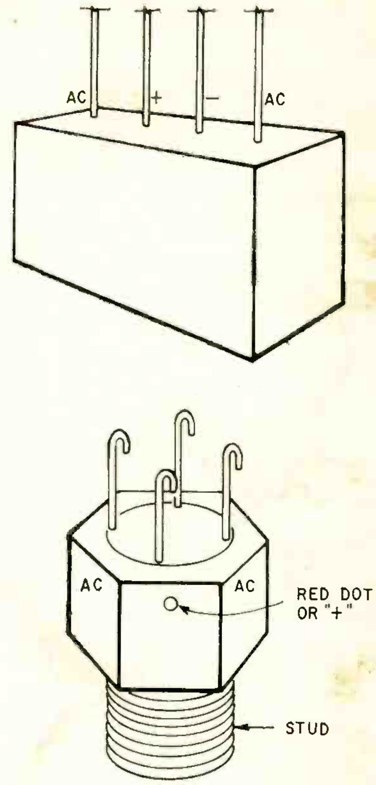


Fig. 4—Full-wave bridge rectifier always has 4 leads. This type has many case designs. The stud-mount case on bottom is for heat-sink purposes only.

connected directly to the rectifier will be the input filter, and you can determine polarity from this.

Rectifier size is an indicator of its current rating. You can get the PIV (peak inverse voltage) rating by measuring the applied ac voltage, even with the rectifier disconnected.

In small units, such as stereos, etc., you'll probably find 1-amp rectifiers. These are common; even small silicon rectifiers now have 1-amp ratings. Rectifiers such as the stud-mount type of Fig. 4, with a heat sink, will probably be from 2 to 4 amps.

To make sure of current ratings, you can disconnect the main dc voltage-supply lead from rectifier to filter capacitor, and read the full-load current. This is a good idea with "unknown" rectifiers. For instance, if you decide there should be 2-ampere rectifiers and you read a load current of about 2.5 amps, yank those rectifiers out of there and put in 4-amp types. Use an adequate safety factor.

For bridge rectifier replacements, you can always use separate units, mounted on a four-terminal strip. This doesn't take up too much room on even the most crowded chassis. If necessary, use top-hat types and put transistor heat sinks on them. However, a generous safety factor for current may eliminate heat-sinking. **R-E**

Service Clinic

By JACK DARR
SERVICE EDITOR

Pattern Bounce in dc scope

I'm thinking of buying a dc scope. Someone told me that the trace of his dc scope would bounce all the way off the screen when he touched the probe to any circuit carrying dc voltage. Is this normal?—B. F., Reading, Pa.

Sure is! The position of the trace on a *dc-coupled* scope depends on the dc voltage present at the probe tip! You can even use the scope for a dc voltmeter, if you've got it calibrated. The action you describe is perfectly normal.

In the ac-coupled scope, the type used in most service shops, the pattern will jump when the input blocking capacitor is being charged up. It *should* return to its original position *if* the capacitor isn't leaky.

Two-color convergence

We can't get an RCA 21CD7856 color TV chassis to converge properly. The green and blue lines are straight but the reds are curved. This happens on horizontal and vertical lines; beyond the range of the adjustments! What causes this and what can we do to correct it?—J. Z., Aliquippa, Pa.

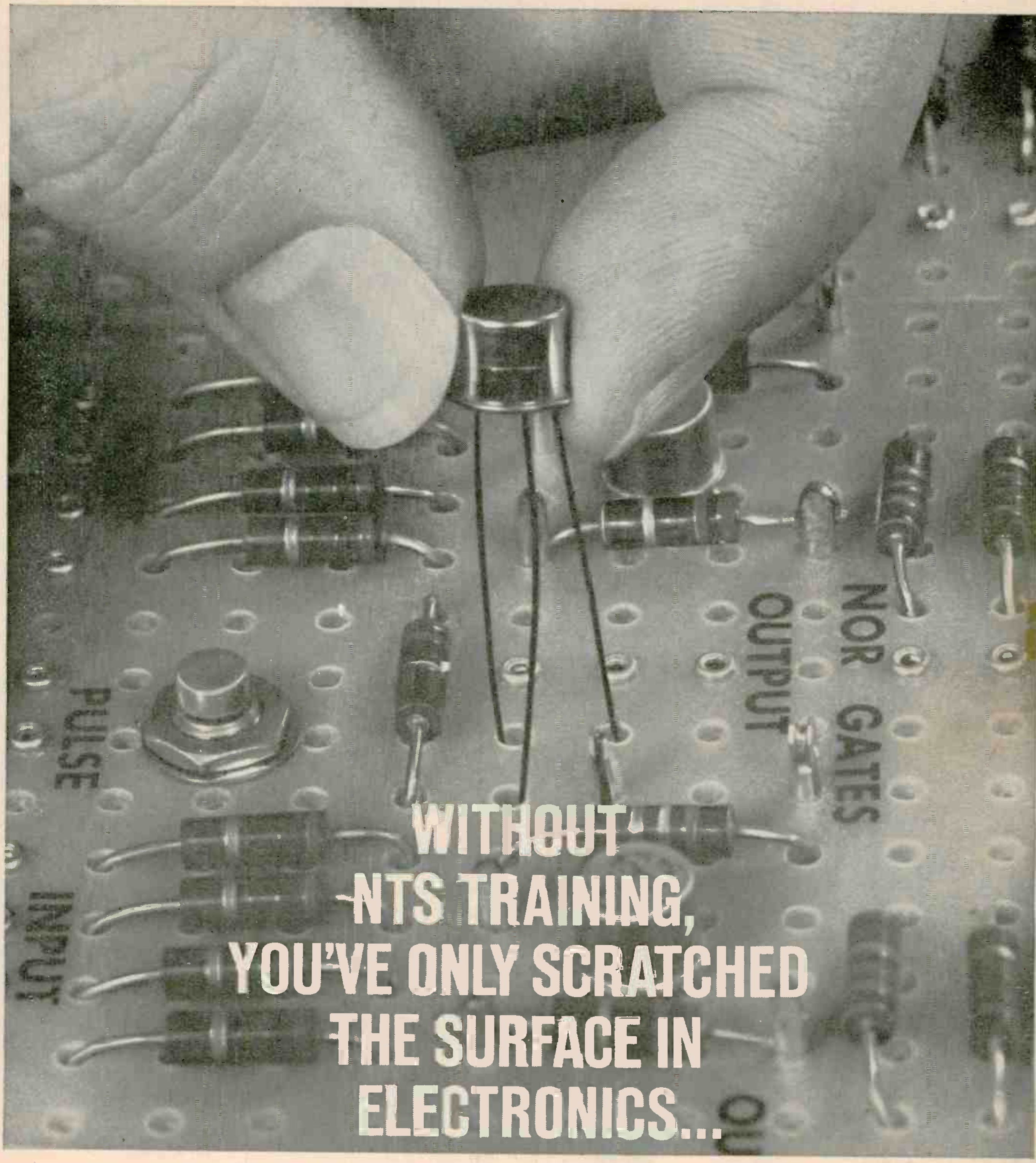
Try the red–green method. Turn the blue off, and work on getting the red and green to converge to yellow. You have many adjustments on the blue, so it's easier to pull it over than to move the other two.

Watch out for one thing (it happened to me not too long ago): The red was actually "one square too far over" on a fine crosshatch pattern! Cause: incorrect adjustment of static magnet. I

(continued on page 90)

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.



Only NTS penetrates below the surface. Digs deeper. Example? Take the above close-up of the first transistorized digital computer trainer ever offered by a home study school.

It's called The Compu-Trainer®—an NTS exclusive. Fascinating to assemble, it introduces you to the exciting world of computer electronics. Its design includes advanced solid-state NOR circuitry, flip-flops, astable multivibrators and reset circuits. Plus two zener and transistorized voltage-regulated power supplies. The NTS Compu-Trainer® is capable of performing 50,000 operations per second.

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X-Rays One Year Later

IT'S BEEN A FULL YEAR SINCE THE TV X-RAY SCARE STARTED AND THAT scare is just now fading away. Set makers were prompt in their reaction, and the new sets don't produce enough X-rays to worry about. Every manufacturer has taken drastic and thorough steps to avoid any possible recurrence. As a result, the danger to color TV viewers is almost nonexistent.

However, until color sets are built so that they produce no X-rays at all, the guy who gets into the guts of a TV receiver—the service technician, the hobbyist, the home-brew tube jockey—may find himself circumventing the protective schemes the set maker built into his product at the factory. Therefore, anyone thinking of working on color TV should observe the following rules.

- Never operate color picture tubes that do not have a bonded faceplate without a sheet of safety glass in front of the screen.
- Don't operate a black-and-white picture tube in a color set unless you use a sheet of safety glass in front of the faceplate.
- Don't operate a color picture tube with its purity shield removed.
- Never raise the high voltage above the manufacturer's recommendations.
- Don't operate receivers with the high-voltage shield removed.
- Always replace shielding and protective devices.

Follow these simple safety rules and you'll be safe from X-ray exposure.

X-Rays And Your Color Set

X-RAYS ARE DANGEROUS. COLOR TV PRODUCES X-RAYS. THEREFORE—COLOR TV IS DANGEROUS

Logical bit of logic, isn't it? Fortunately, it's not all that logical. For all-X-ray exposure is not hazardous. The real hazard depends upon the level of intensity. The National Council on Radiation Protection and Measurement has set up a minimum safe level of radiation from any TV set. It states that the maximum exposure rate at any readily accessible point 5 cm (about 2 inches) from the surface of any home TV receiver shall not exceed 0.5 mR (milliroentgens) per hour.

This radiation level is about *half* the output of most luminous dial watches. Obviously these are very conservative figures. Dr. Victor P. Bond, associate director of the Brookhaven National Laboratory, has said that these ratings "are deliberately conservative, and are set well below the levels of exposure that carry a significant probability of medical effects. . . ." In other words, there's not enough radiation to worry about.

But, and this is the big but, no one has ever demonstrated that X-rays can do us any good—other than those a doctor may use professionally for specific medical purposes. And it is my belief that the fewer X-rays I am exposed to, the better. None of us would care to discover, 20 years from now, that those low-level X-rays were dangerous after all.

Of course, the service technician who works on color sets a good part of the day and the hobbyist who gets a lot closer to his set than an ordinary viewer risk being exposed to much higher levels of radiation for longer periods of time than the average person.

What can be done? Quite a bit, and most of it has already been done. The major X-ray producer in TV is the high-voltage section. When a high-voltage vacuum tube is subjected to 20,000 volts or more, it becomes an X-ray source.

And should the voltage in the set jump from say, 25,000 volts, to 30,000 volts, X-ray output may jump 10 to 20 times.

To date, the biggest culprit in color sets has been the shunt regulator tube. But new circuits and tube designs have just about eliminated this problem. The high-voltage rectifier is another potential trouble spot. One solution is to replace the vacuum-tube rectifier with a solid-state rectifier that cannot produce radiation at any voltage level. Another alternative is proper shielding.

Another possible solution is color picture tubes, like the Sony Trinitron, that do not require the high-voltage levels that produce radiation.

In the meantime, TV service technicians must insure that the high voltage on each color set they repair is properly set. Manufacturers must continue taking steps to design sets that cannot produce X-rays.

Color TV's can produce X-rays. But the X-ray output of these sets is strictly limited and manufacturers are checking their sets carefully before they leave the factory. If and when the X-rays can be completely eliminated, and I believe that they can be, we won't have to think about them at all.

—*Larry Steckler, Managing Editor*

SIMPLE DETECTOR SPOTS TV X-RAYS

By RICHARD K. STOMS & EDWARD KUERZE

WE NEEDED AN INSTRUMENT TO measure X-ray emission from TV sets. It had to measure levels as low as the exposure rate listed in the NCRH (National Center for Radiological Health) recommendation which states: "The exposure dose rate at any readily accessible point 5 cm from the surface of any home TV receiver shall not exceed 0.5 mR per hour under normal operating conditions."

The detector had to be portable and make accurate measurements rapidly, under field conditions. To meet these requirements we developed the instrument described here. Several were built by the Cincinnati, Ohio, facility of Electronic Products Radiations Laboratory of the NCRH.

How it works

The detector directly integrates and measures the electrical current represented by the GM (Geiger Muller) tube pulses. Its circuit is shown in Figs. 1, 2 and 3. The main circuit is in Figs. 1 and 2 and the audio circuit is in Fig. 3.

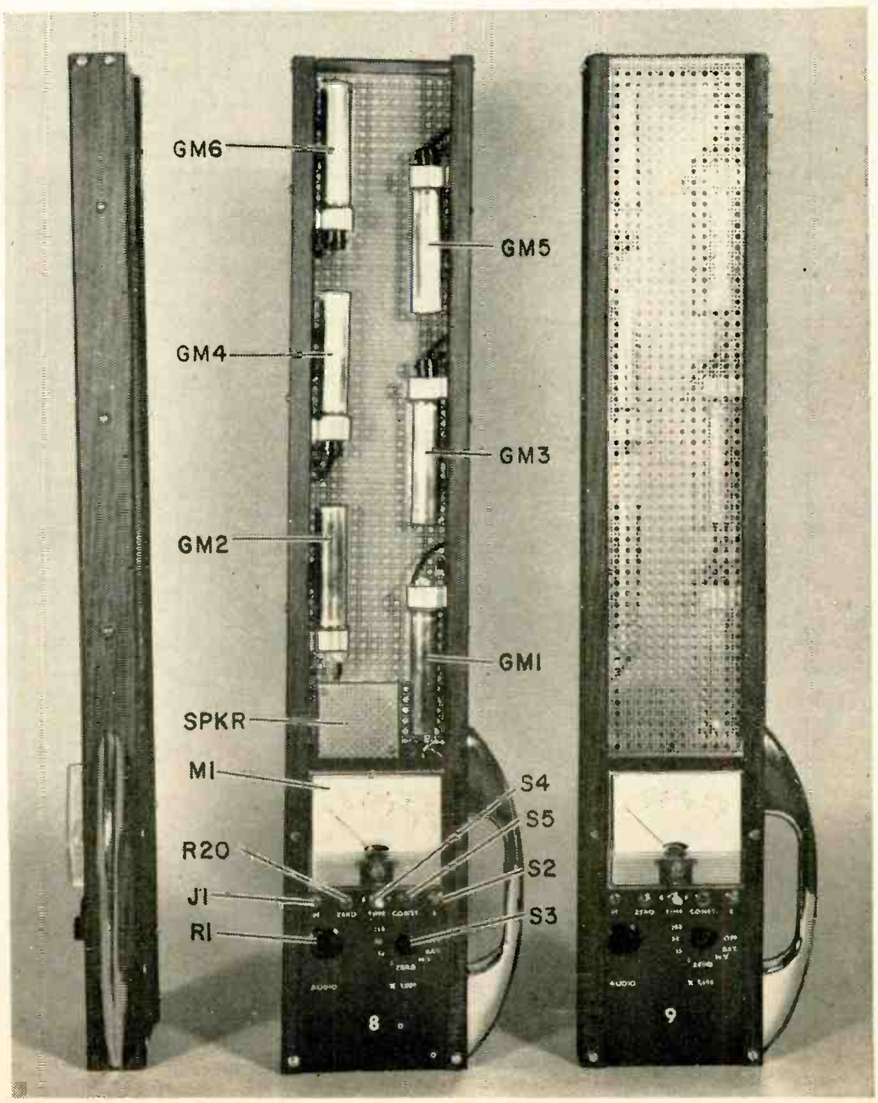
In Fig. 1, transistor Q8 is a constant-current generator that supplies a stable reference voltage for potentiometers R14 and R20. These pots equalize the steady-state zero-signal voltage at points B and C (about 3 volts). FET (field-effect transistor) Q4 and transistor Q5 and resistor R26 compose what amounts to a source follower with the voltage at point B following Q4's gate voltage. On all range settings, gate voltage is developed across the series combination of R12 and R13 shunted by C4 as a result of the electrical charge collected from the pulses in the 1B85 GM tube. The number of these pulses, and hence, gate voltage, is related to the X-ray field incident on the 1B85.

The calibration resistor (R12 and R13) is a series combination of a 3.3-megohm resistor and 5-megohm potentiometer or a selected resistor between 3.3 and 6.8 megohms and a 1-meg pot, depending on availability of potentiometers. The pot is adjusted so the base voltage range across the meter and its range resistor on the 3K range is 0.3 volt. Thus the 10K, 30K and 100K ranges have a voltage range of 1.0, 3.0 and 10.0 volts full scale (Fig. 2).

If voltages at B and C vary equal amounts in the same direction, there will be no meter deflection. If Q7's gate were made to follow the changes of point B, then point C would also follow these changes and the meter reading would not change. Time-constant capacitor C5 is connected between point B and Q7's gate. In conjunction with R17 it determines the time constant. This capacitor allows relatively fast changes to couple to the Q7 gate but not slow or dc voltages.

It is convenient when using this instrument, which has an appreciable time constant, to occasionally revert to a fast response for a short time to allow the meter to assume its approximate reading and then return the instrument to its longer time constant. This is done by pressing pushbutton switch S5 located on the front panel near the meter face. This shorts R17, reducing the time constant. Note that an additional "base" time constant is provided by R12 and R13 and C4.

Position 1 of RANGE switch S3 is



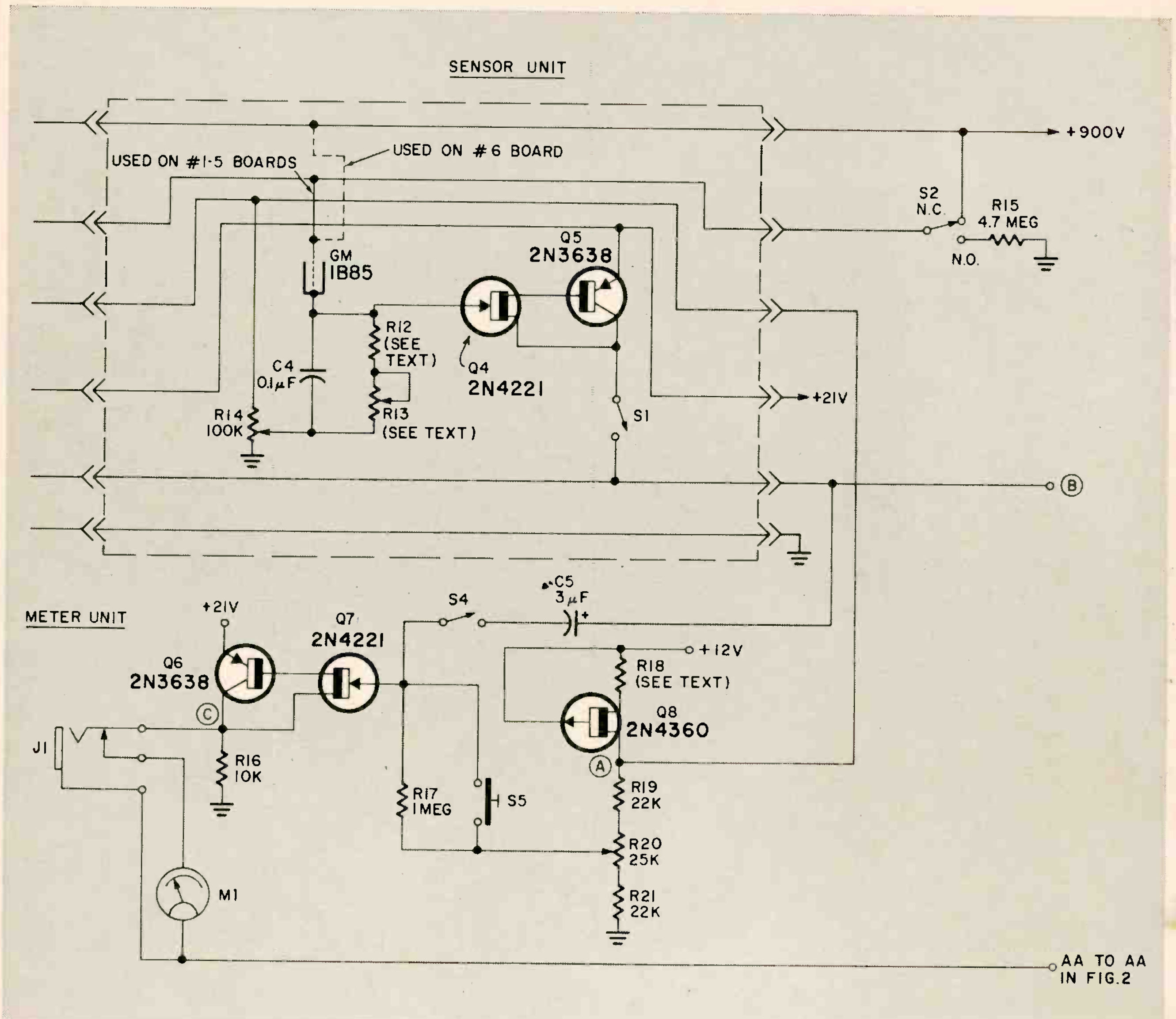


Fig. 1—In the sensor unit, Q5's gated output to B is determined by the output of the 1B85 radiation tube and calibration pot R13. Capacitor C5 in the meter section is connected between point B and Q7's gate, so only gated output pulses deflect meter.

the OFF position. Position 2 reads battery voltage under its normal load. Position 3 checks the high-voltage supply. The meter current is a portion of the GV3A 900-volt shunt regulator current. Any "on scale" reading indicates that there is shunt regulator current and that the high-voltage supply is on and regulating. Note that in this position all other circuits are off (battery voltage being blocked by D4). Positon 4 is the zero check position. In this position the high-voltage supply is disabled. Positions 5 through 8 are the ranges previously described.

At this point, operation with only one GM tube has been considered. If in Figs. 1 and 2 six units identical to the sensor unit shown are paralleled and proper adjustments made, the meter will indicate only the current in the tube seeing the highest X-ray exposure rate. This happens because the increase in voltage at point B due to an increase in gate voltage on one (or more) Q4 transistor will tend to cut off current through the remaining Q4, Q5 transistors. Switch S1 is provided on each of the sensor units so that each unit may be zero-set individually and also to facilitate troubleshooting.

GM tube No. 6 (tube farthest from meter) receives its high voltage directly from the high-voltage supply while tubes 1 through 5 are supplied through S2. Pushing S2 disconnects the high voltage from tubes 1 through 5 and discharges the stray capacitance so that only tube No. 6 is operational. S2 must be kept depressed by the operator to deactivate tubes 1 through 5. When released, it is spring-returned to normal. If cost is important a unit with only a single GM tube can be built. This slows down scanning time but cuts the cost by about $50.

The high-voltage circuit in Fig. 2 is fairly simple. A UJT (unijunction transistor), Q9, is operated as a relaxation oscillator. The ramp voltage at Q9's emitter is capacitively coupled to the base of the normally off Q10. The result is a series of square-wave current pulses through the primary of transformer T1, a UTC 0-2. The frequency is approximately 2 kHz. Use of the UJT oscillator provides a very reliable means of self-starting, compared to the usual methods of feed back oscillators using a transformer tap.

The secondary circuit uses a standard voltage doubler and a GV3A 900-volt Corotron (Victoreen Instrument Company) shunt regulator. R34 is in series with the shunt regulator so

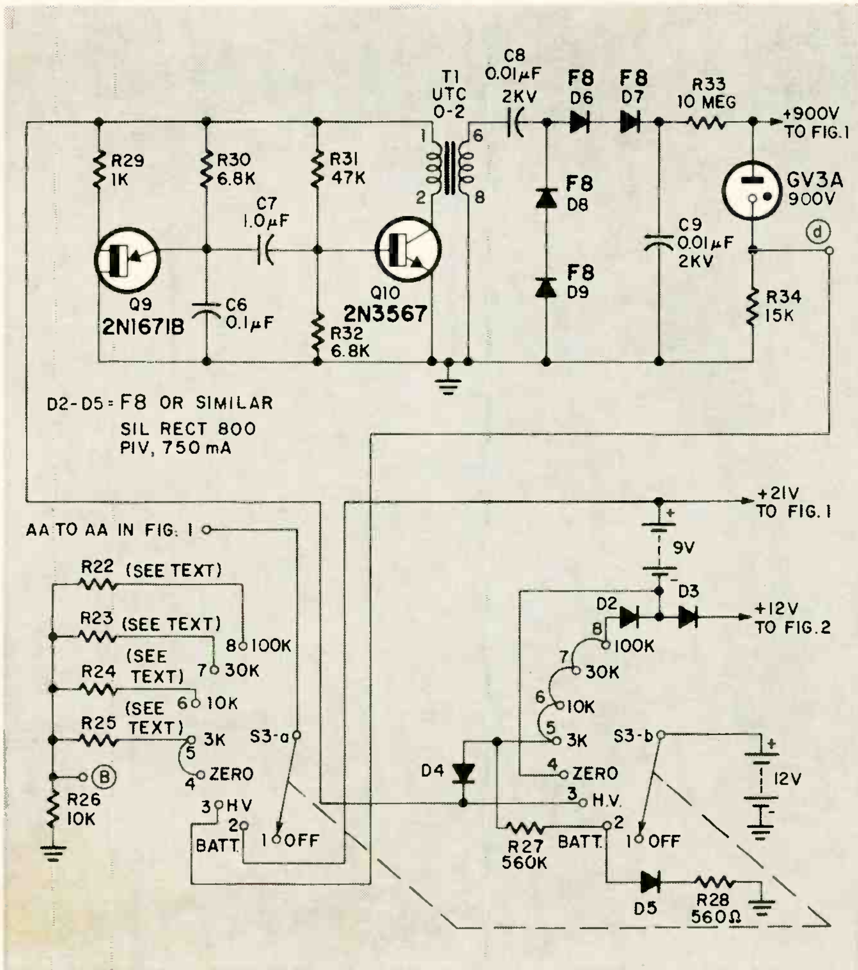


Fig. 2—High-voltage section supplies 6 GM tubes used by author. UJT oscillator Q9 provides 2-kHZ current pulses on T1's primary. Voltage doubler uses a GV3A regulator.

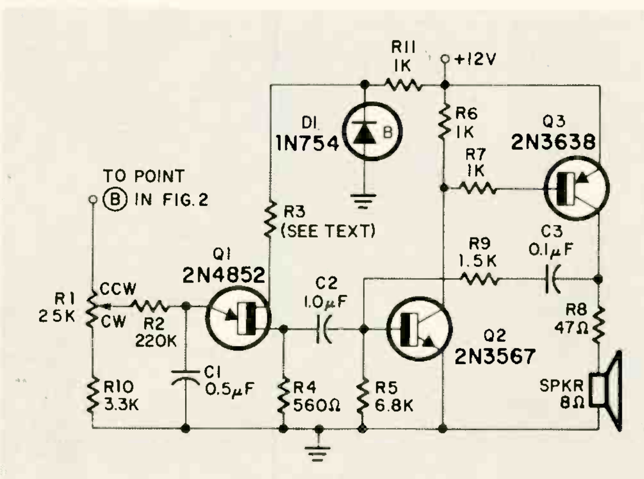


Fig. 3—Audio circuit can be added to indicate X-ray level. Emitter voltage on Q1 controls frequency of multivibrator Q2–Q3.

when S3 is in position 3, the meter will indicate a part of GV3A current.

An audible signal can be produced for a preselected X-ray level as shown in Fig. 3. This is not a mandatory part of the circuit but is useful. Potentiometer R1 is connected to point B of Fig. 1 so the emitter voltage of UJT Q1 is related to X-ray exposure. R3's value is selected so the maximum setting of R1 just barely keeps Q1 from oscillating when the zero-signal voltage at point B is present. Any increase in voltage at point B increases emitter voltage at Q1 and cause oscillation. The frequency is a function of emitter supply voltage, which results in an increasing audio tone as X-ray exposure increases. Q2 and Q3 comprise a monostable multivibrator. In its normal state, both Q2 and Q3 are off. A positive pulse from Q1 coupled into the base of Q2 will turn Q2 and Q3 on. Feedback network R9 and C3 provides the positive feedback required for monostable multivibrator action and controls the "on" time. The speaker receives a pulse of energy for every pulse produced by Q1.

Using the instrument

Start by turning the range switch to the battery check position. The meter should show a reading of 21 volts. Change the batteries if the reading is 18 volts or lower.

Turn next to the HV position. Any "on scale" reading indicates that the high-voltage supply is operating.

Now check the meter by placing the range switch on the zero position. Use the screwdriver adjust pot (R20) below the meter face.

Most readings will be made with the time-constant switch set to F. The longer time constant may be selected if desired. Depressing the button switch next to the time-constant selector switch reduces the time constant to its shortest value. This can substantially reduce the time required for a reading.

An audible signal is incorporated and may be used at the operator's discretion. The sound is turned off by turning the audio control completely clockwise. Other positions of the control determine the level or amount of X-ray exposure that the audio circuit will respond to. A radioactive check source emitting X-rays or gamma rays can be used to obtain any desired meter reading. The control can then be set so that an audible signal can just be obtained. A decrease in X-ray exposure below this value will produce no sound. Increasing exposure over this level will result in a sound of increasing frequency. The sound is not that obtained by producing a click or sound pulse for every Geiger-tube pulse. The time-constant selector does not affect the response time of the audio signal which always operates on the shortest time constant.

Field tests and maintenance

A radioactive source emitting X-rays or gamma rays can be used to check the operation of the instrument. When the source is successively placed adjacent to the GM tubes, fairly consistent readings should be obtained. Differences in readings between tubes or between readings taken on both sides of the same tube may be caused by small variations in the short "source to tube" distance. These differences are minimal when the source is more

(continued on page 91)

The Case of the Mysterious Glitch-Hausen

Some unusual TV ailments can be catching

By JACK DARR
SERVICE EDITOR

The set had what looked like the worst case of Barkhausen oscillation I'd seen.

CHARLEY SNARLED. I SNARLED BACK. Neither of us was in good humor at that moment. I'd been beating my brains out all morning on a G-E KC color TV chassis, and he'd been doing the same thing on a middle-aged Philco b-w.

I had colored "sparkles" on the right side of my picture. He had what looked like the worst case of Barkhausen oscillation I'd ever seen, though it didn't look just right. We stopped and went out for coffee, leaving the sets on.

In the coffee shop we moaned about our problems. "I'm danged if I can figure this thing out," I said. "I've got plenty of high voltage, and it looks for all the world like an arcing resistor in there. But this set hasn't got a filter resistor in the high-voltage lead! I can't see any corona, any arc-overs, or nothin'. I've been sitting there an hour trying to hear corona with that little plastic tube. Nothing. It just sits here and sparkles at me!"

"Me, too," said Charley. "That blankety-blank thing looks for all the world like Barkhausen, but I've changed horizontal output tubes three times, the damper and everything else I can think of. No corona on mine, either. It just sits there and makes bars at me!"

We went unwillingly back to the shop. There they sat, side by side, sparkling and streaking at us. I lit a cigarette and Charley moodily chomped on a second doughnut. We sat there glaring back at the sets.

"Well," I said, "don't just sit there, do something! I'm going to yank that thing out and look for a carbon track on the PC board around the boost connections."

I yanked the cheater cord from the G-E. Then I went straight up in the air, for there was a loud screech from behind me. Charley was pointing at his Philco. There was the prettiest picture you ever saw!

I plugged the G-E back in, and when it warmed up there they were again: big, fat black bars on the Philco. I ran to the tube shelf and grabbed a new 6JS6 horizontal output tube. After some confusion, the new tube was plugged in, and we watched with fingers crossed. The high voltage sizzled and there we were. No more bars on the Philco. I peeked over the top of the G-E. No more sparkles, either! Just a beautiful, clear picture.

I put the old 6JS6 back and waited. Bars again, and sparkles. Suddenly, I reached over to Charley's set and took the antenna clip off. Hmmm. No bars now! I put the new 6JS6 back, turned it on, and there we were. Two beautiful pix. We headed back for the coffee shop.

Ten minutes and several paper-napkin schematics later, we had puzzled it out. The horizontal output tube in my G-E had been causing a *form* of Barkhausen oscillation, and this had been so strong that it had been *coupled* into the antenna input of Charley's set. Being on the common shop antenna, this had been more than enough.

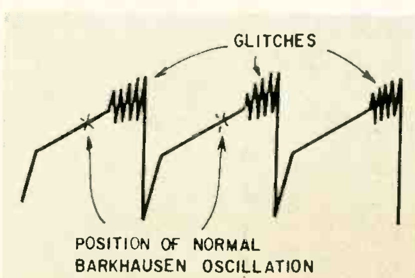


Fig. 1—High-frequency oscillations or "glitches" apparently developed as the horizontal output tube reached a peak.

Ordinary Barkhausen oscillation shows up as black wiggly bars about an inch or two from the right side of the screen. In other words, just a little bit before the horizontal output tube reaches peak conduction. However, *this* thing must have been making an oddball oscillation just as the tube reached the peak, or perhaps even during the first split microsecond of actual "flyback." It must have been similar to what TV transmitter engineers call a "glitch"—a burst of very-high-frequency oscillations at the cycle peak (Fig. 1).

So, you might call what we'd had a very severe case of "Glitch-hausen oscillation!" Back at the shop, we tried it one more time. The G-E had a beautiful picture: no trace of sparkles or bars, etc. Since the set's owner had been complaining about "funny-looking color pictures" for some time, when it went home it had a brand-new 6JS6 in it. **R-E**

For the musically inclined hobbyist—first in an eight-part series

Part 1 of 8 parts

Go-Go Guitar Amplifier

IF YOU'RE AN ELECTRONICS BUFF AND YOU enjoy playing the guitar, here's a unit you can build that will make it possible for you to combine both hobbies. Although the amplifier isn't hi-fi, its gain and response characteristics do make it an excellent choice for both guitar or public address use. The amplifier has dual inputs and can deliver a continuous 10 watts of music power output. And if this isn't enough, a future issue will describe a compatible 50-watt booster amplifier.

A host of other electronic gadgets are also coming and they are all related to this unit. They include an input mixer, tremolo, bongos, reverb amplifier, fuzz box and a 12 Vdc to 115 Vac inverter. For more details about these other units see page 40.

Why the dual input? Because it adds

(text continued on page 40)

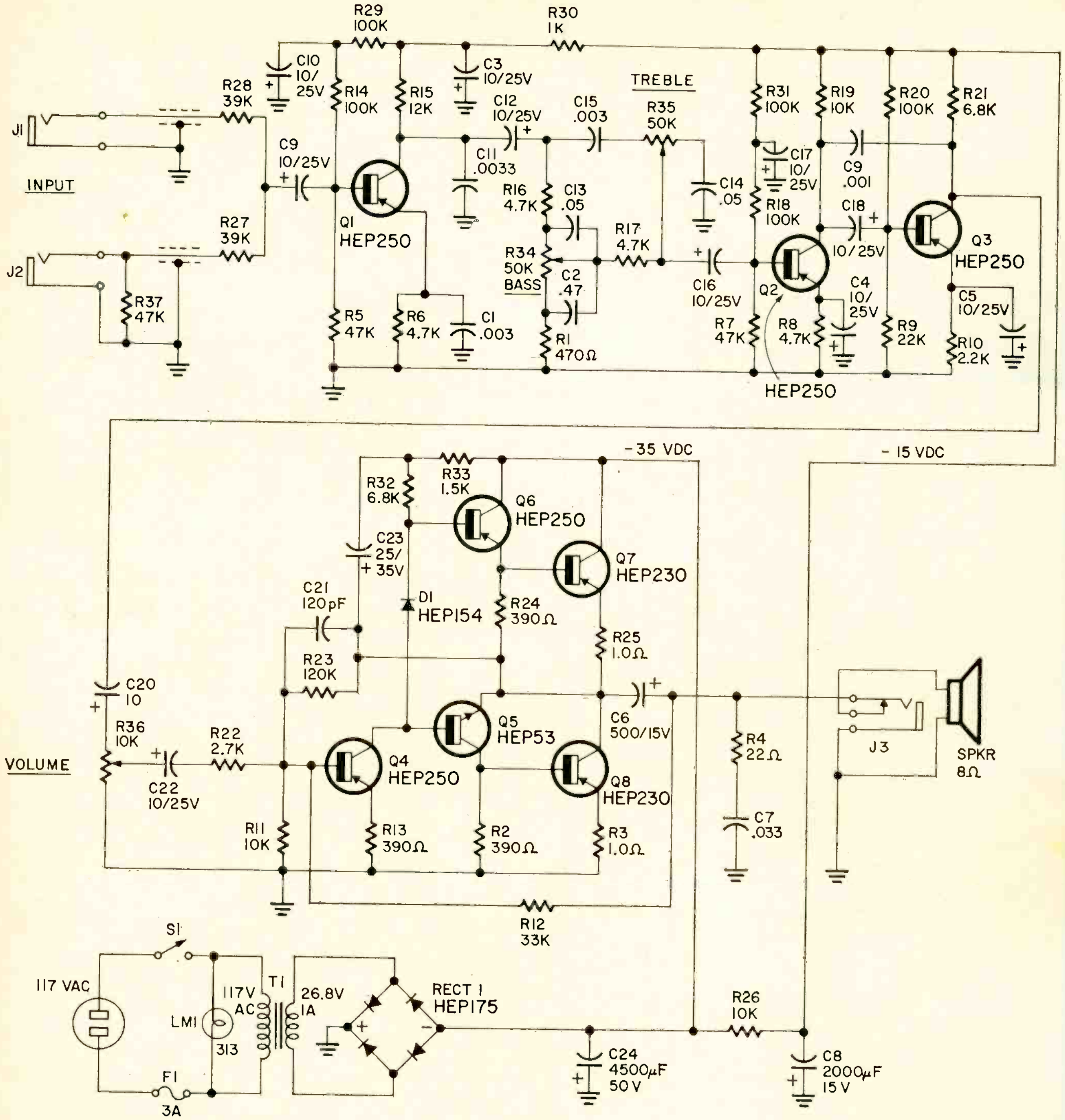


Fig. 1—Dual input to preamplifier section (top) adds versatility. The power amplifier develops up to 10 watts of music power.

ELECTRONICS PARTS LIST

Q1, Q2, Q3, Q4, Q6—HEP 250 (Motorola)
Q7, Q8—HEP 230 (Motorola)
Q7, Q8—HEP-230 (Motorola)
RECT 1—diode bridge assembly HEP 175 (Motorola)
D1—HEP 154 (Motorola)
T1—Filament transformer, Primary 117 Vac. Secondary 26.8 V, 1 A (Triad F40X or equiv.)
C1, C11, C15—0.003 μF, 600 V (Mallory SX230 or equiv.)
C2—0.47 μF, 100 V (Mallory PVC1047 or equiv.)
C6—500 μF, 15 V electrolytic (Mallory TC1505 or equiv.)
C13, C14—0.05 μF, 100 V, disc ceramic
C3, C4, C5, C9, C10, C12, C16, C17, C18, C20, C22—10 μF, 25 V, electrolytic (Mallory TC22 or equiv.)
C7—0.033 μF, 100 V (Mallory PVC1133 or equiv.)
C8—2000 μF, 15 V, electrolytic (Mallory TC-1520 or equiv.)
C19—0.001 uF, 600 V, (Mallory SX210 or equiv.)
C21—120 pF, 600 V (Mallory SX312 or equiv.)
C23—25 μF, 35 V, electrolytic (Mallory MTAA-5E35 or equiv.)
C24—4500 μF, 50 V, electrolytic (Mallory CG-452U50D1 or equiv.)
R1—470 ohms, ½ W
R2, R13, R24—390 ohms, ½ W
R3, R25—1 ohm, 1 W
R4—22 ohms, ½ W
R5, R7, R37—47,000 ohms, ½ W
R6, R8, R16, R17—4,700 ohms, ½ W
R9—22,000 ohms, ½ W
R10—2,200 ohms, ½ W
R11, R19—10,000 ohms, ½ W
R14, R18, R20, R29, R31—100,000 ohms, ½ W
R15—12,000 ohms, ½ W
R21—6,800 ohms, ½ W
R22—2,700 ohms, ½ W
R23—120,000 ohms, ½ W
R26—10,000 ohms, ½ W
R27, R28—39,000 ohms, ½ W
R30—1000 ohms, ½ W
R33—1,500 ohms, ½ W
R34, R35—potentiometer, 50,000 ohms, 2 watts (IRC 11-123 or equiv.)
R36—potentiometer, 10,000 ohms (IRC 13-116)
S1—spst toggle
LM1—pilot lamp, No. 313
F1—¼ A-fuse, type 3AG
J1—phone jack (switchcraft 11) or equiv.)
J2, J3—phone jack, N.C. (Switchcraft 12A or equiv.)
Heat sinks for Q7, Q8—HEP 500
Fuseholder
Pilot lamp holder (Dialco 81410-112-201
Transistor sockets (6) (Elco 05-3304 or equiv.)
Transistor socket rings (6) (Elco 55-47202 or equiv.)
Power transistor sockets (2) (Motorola HEP 450 or equiv.)
AC line cord
SPKR—8-ohms (Utah MI-8JC or equiv.)
Knobs, grommets, 5¼" x 3-13/16" x 18 gage aluminum chassis, 8-7/8" x 4¼" x 18 gage aluminum control panel, terminal strips and misc. hardware.

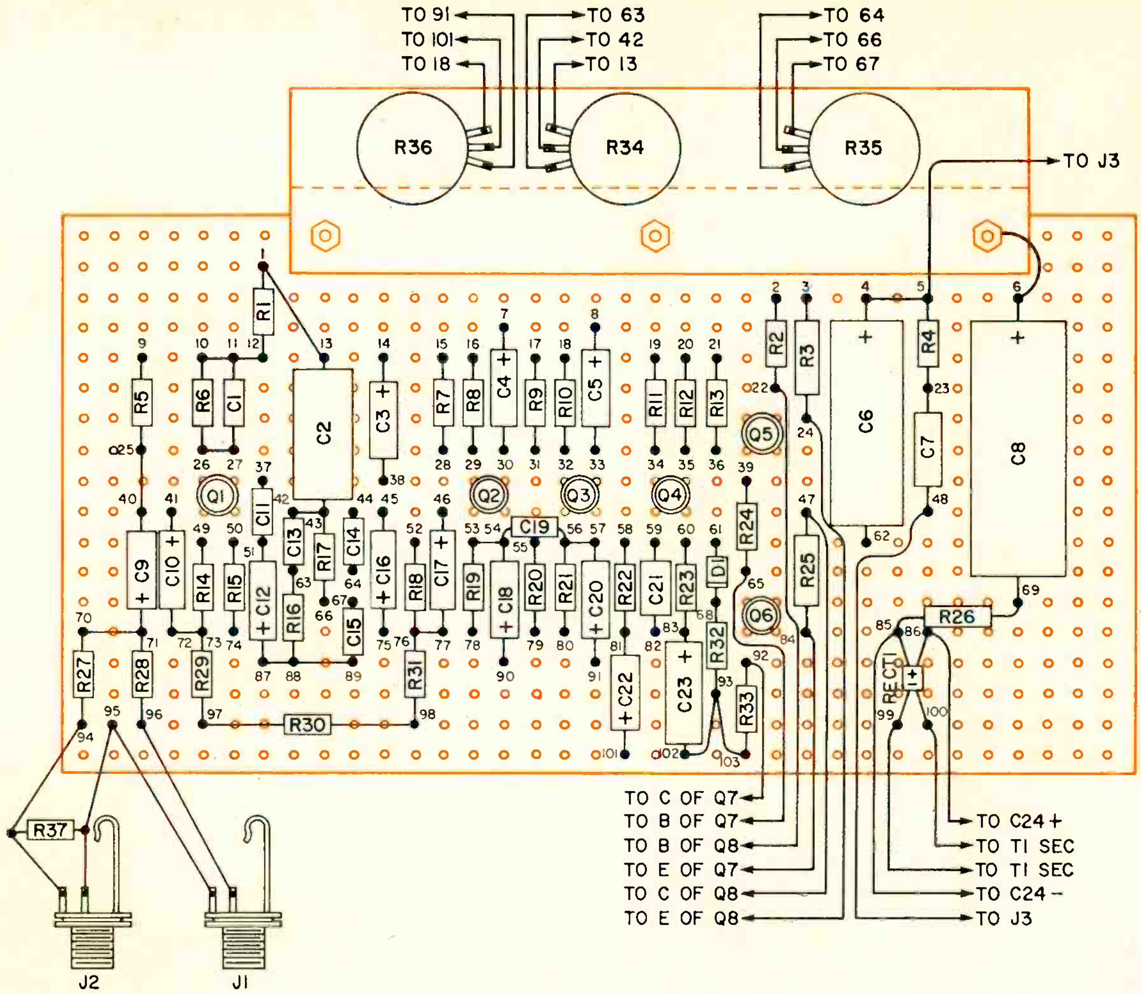
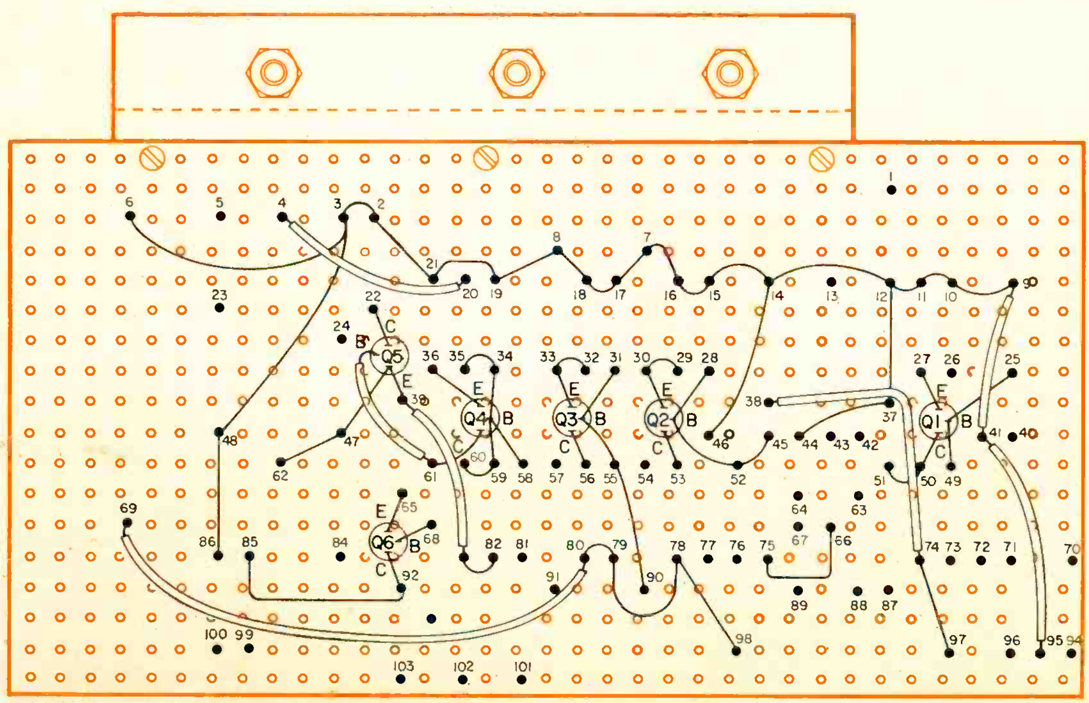
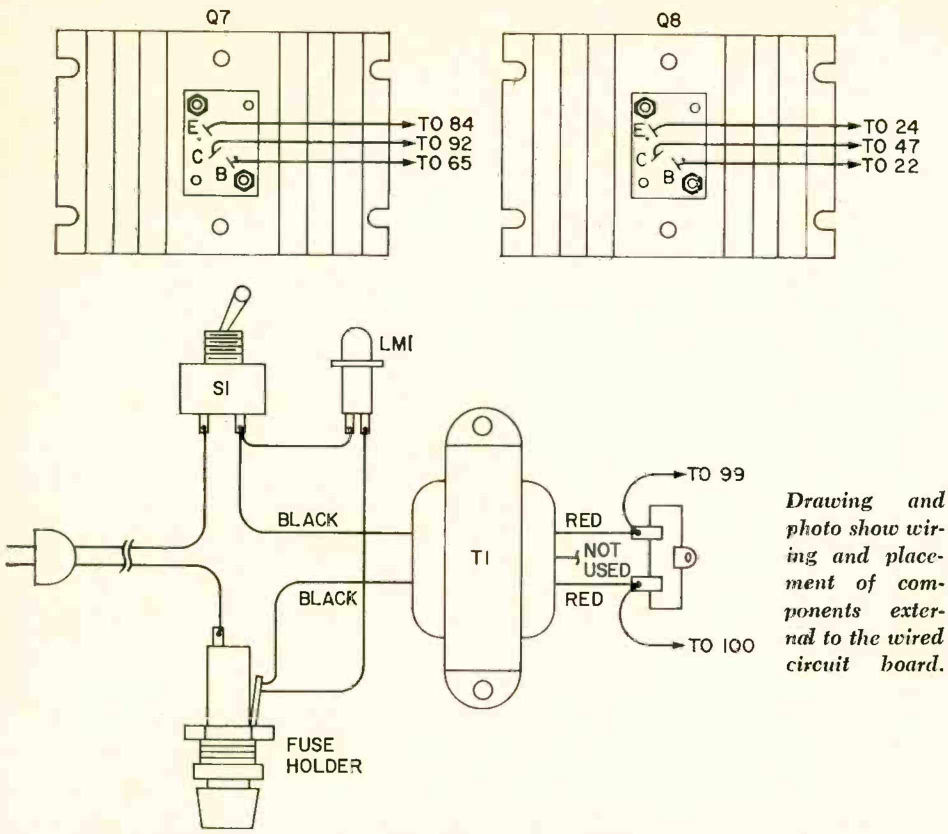


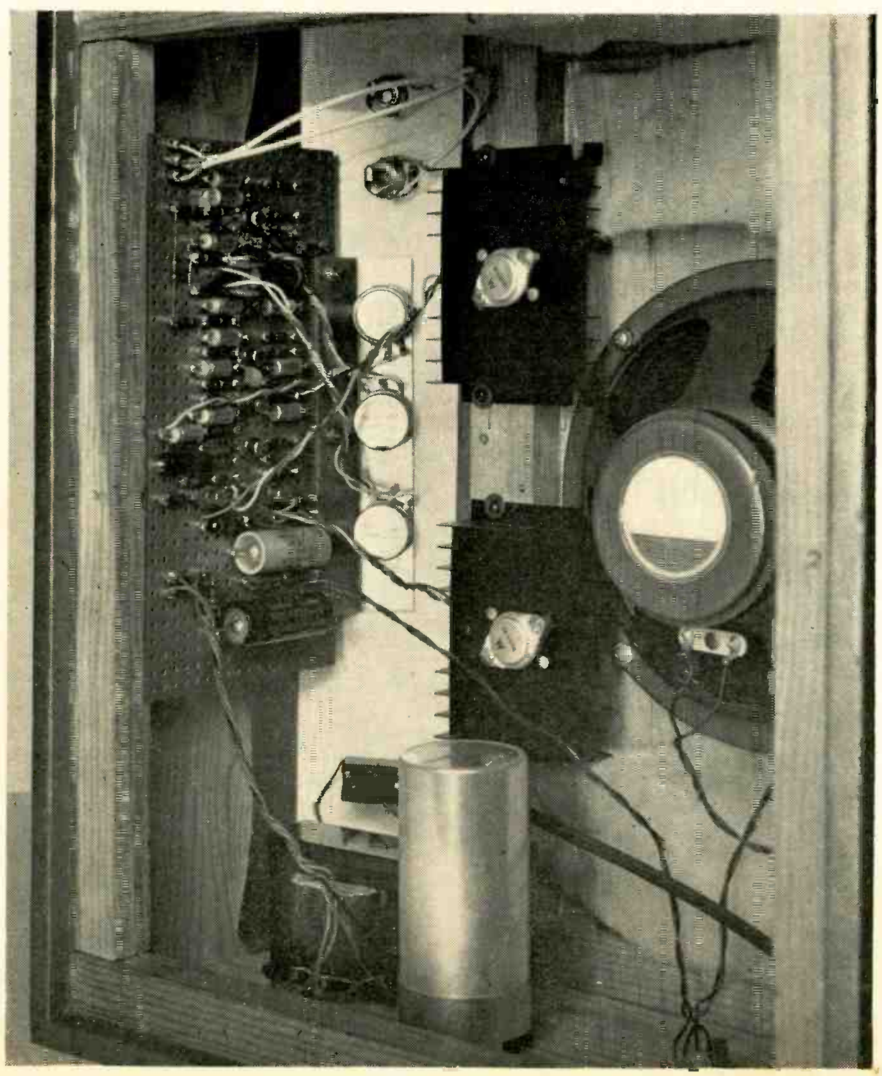
Fig. 2—Top view shows component layout. Where indicated, use hookup-wire leads to external parts.

Fig. 3—Bottom view shows point-to-point wiring. Hole numbers correspond to numbers above.





Drawing and photo show wiring and placement of components external to the wired circuit board.



versatility. It makes it possible to place the guitar in front of a full recorded orchestra or, if you wish, combine your instrument with that of a friend. And the 10-watt output is ample for large group meetings or even a teen-age dance.

Two parts to the circuit

The guitar amplifier actually breaks down into two units—a preamp and a power amplifier. These are both shown in Fig. 1. You will note that the preamp provides both voltage gain and tone control while the power amplifier develops about 10 watts of music power.

In the preamp, audio input signals are combined in a summing network consisting of resistors R27 and R28. This is then coupled to buffer amplifier Q1. The output from this transistor amplifier is applied to a tone compensation network that controls the frequency response of the preamp and in turn the amplifier.

When both the BASS and TREBLE controls are set to midrange, the response curve of the amplifier is "flat". Varying the setting of BASS control R34 changes the amplitude of the low frequencies applied to

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ONLY THE BEGINNING

Here you have the basic guitar amplifier. But there's more to come in this exclusive R-E series.

In December

• **Dc to ac inverter** that makes the guitar amplifier a portable unit.

In Following Months

• **Reverb unit** to give your guitar amplifier that "big" sound.

• **Fuzz box** to produce those "in" fuzz effects used by today's hot recording groups.

• **Vibrato** to add a pulsating rhythm to your music sound.

• **Electronic mixer** to get those "special" hard to duplicate effects.

• **Booster amplifier** delivers 50 watts of audio power to handle even the larger party.

• **Electronic bongos** to round out your electronic music system.

---

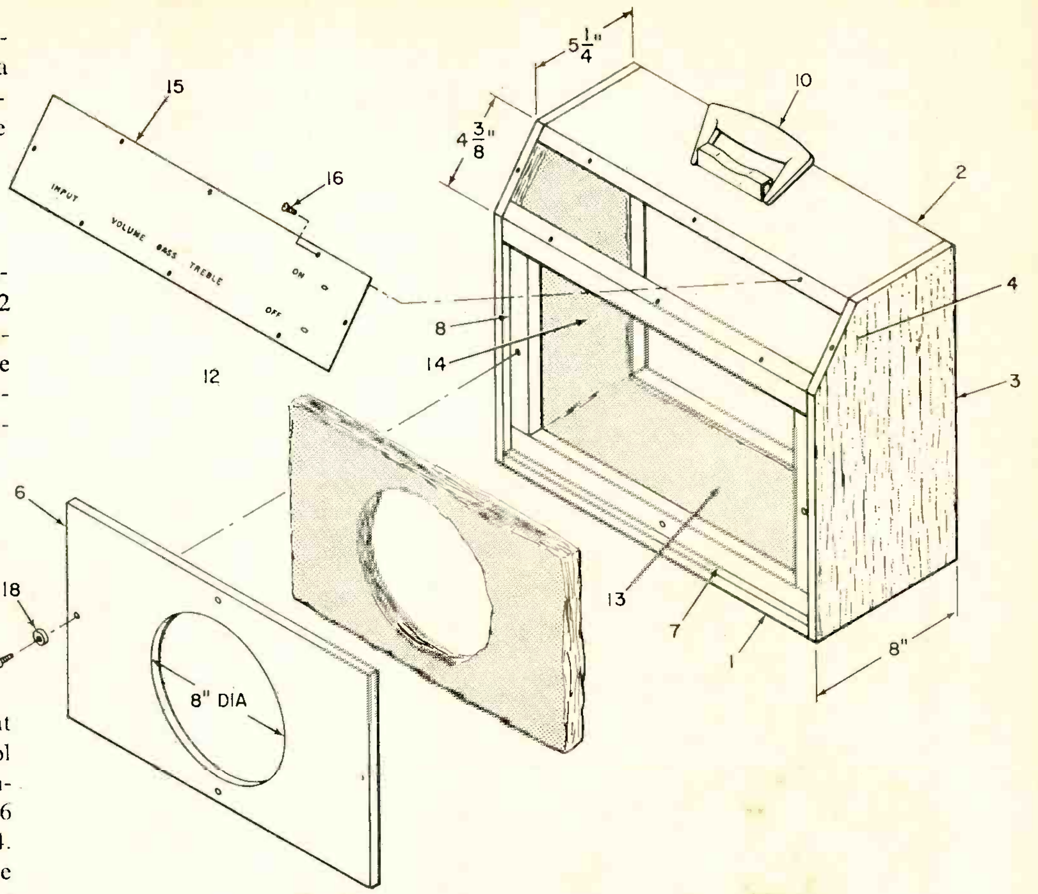
transistor Q2. The high frequencies are controlled in a similar fashion. Rotating TREBLE control R35 affects the high-frequency response.

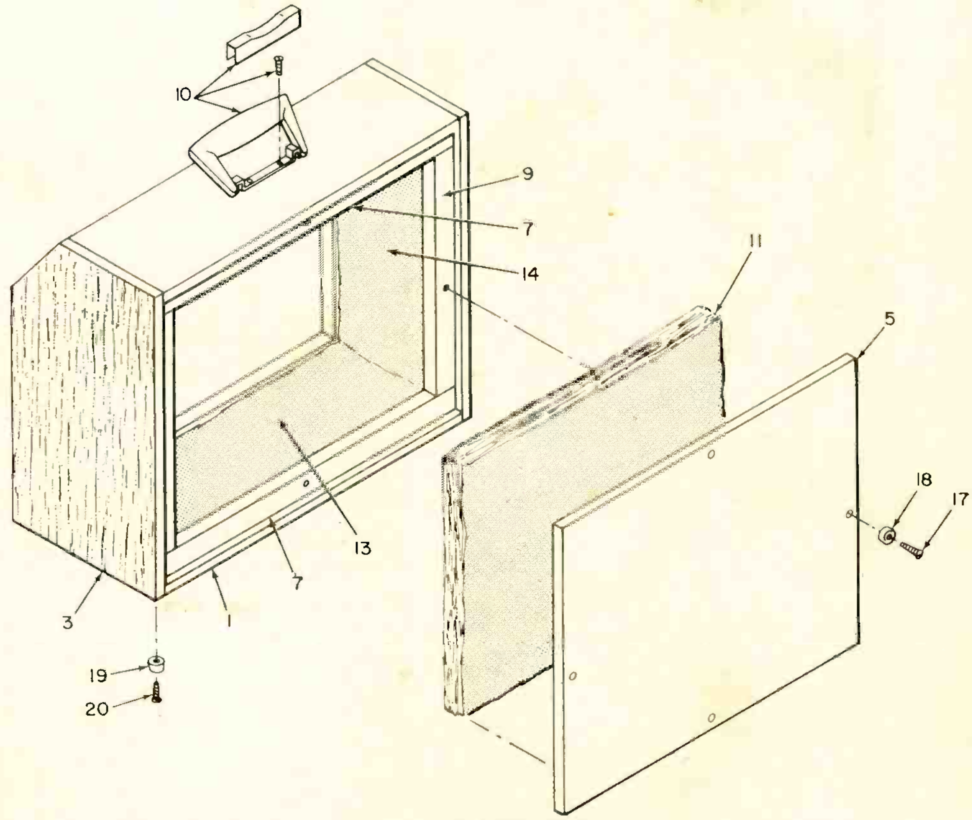
The power amplifier

Two cascade, common-emitter amplifier stages (Q2 and Q3) follow the tone compensation circuit to increase the signal level to that required to drive the power amplifier. The power amplifier itself is a single-ended class-B circuit that has a low output impedance. This makes it possible to drive the speaker directly without any need for an output transformer.

The signal that appears at the wiper of VOLUME control R36 is coupled to complementary transistors Q5 and Q6 through amplifier transistor Q4. Since transistor Q5 inverts the signal and transistor Q6 does not, properly phased outputs are developed to drive power transistors Q7 and Q8. Positive and negative feedback are introduced by resistors R23 and R12, and capacitor C23, to compensate for the unsymmetrical output stages. This allows the positive signal peaks to approach the same amplitude as the negative signal peaks. Capacitor C21 was selected in test to produce optimum output response. Resistor R4 and capacitor C7 are incorporated to prevent phase shift at the upper frequency limits due to the rise in output impedance. Dc power for the power amplifier and preamp is developed by a brute-force bridge rectifier circuit that provides well-filtered −35 volts for the power amplifier and −15 V for the preamp.

The amplifier is fun to build and even more fun to use. The instructions and diagrams are complete and no additional data is needed. All parts are readily available from most large suppliers. Build this one fast so you can be ready for the other seven-add-ons that go with it. **R-E**





CABINET PARTS LIST

1. BOTTOM 8 x 17 x ½" plywood
2. TOP 6 x 17 x ½" plywood
3. END 8 x 15 x ½" plywood (2 required)
4. FRONT 2 x 17 x ½" plywood
5. BACK 14 x 17 x ½" plywood
6. SPEAKER COVER 9-¾ x 17 x ½" plywood
7. CLEAT ¾" x 1 x 17 (4 req.)
8. CLEAT ¾" x 1 x 8-¼ (2 req.)
9. CLEAT ¾" x 1 x 12 (2 req.)
10. HANDLE ASSEMBLY
11. BACK INSULATION 1" x 13 x 16 glass fiber
12. SPEAKER INSULATION 1" x 8-¼ x 16 glass fiber
13. BOTTOM INSULATION 1" x 5-¼ x 17 glass fiber
14. END INSULATION 1" x 5¼ x 12 (2 req.) glass fiber
15. CONTROL PLATE 4⅛" x 18 16-gauge aluminum
16. PLATE MOUNTING WOOD SCREWS ROUND HEAD
17. WOOD SCREWS OVAL HEAD 1" (8 req.)
18. WASHERS (8 req.)
19. RUBBER FEET (4 req.)
20. WOOD SCREWS, ROUND HEAD (4 req.)

FOR YOUR CAR

Aircraft Weather Receiver

Easy AM tuner conversion brings in FAA weather reports

By LAUREN A. COLBY

THROUGHOUT THE UNITED STATES, THE FEDERAL AVIATION Agency maintains a system of low-frequency broadcast stations transmitting recorded weather information in the 200-kHz to 400-kHz band. These stations transmit aviation weather forecasts and regular hourly observations of the actual weather conditions at selected cities within a radius of about 200 miles of the station. While intended for pilots, the information available from these FAA stations can be extremely interesting to anybody who wants to study weather patterns and the flow and movement of weather systems. A list of the stations now in operation and their transmitting frequencies is in the table.

I wanted to install a receiver for aviation weather in my car, so that I could listen to the broadcasts while commuting to work. However, the only available commercial units which would tune the 200–400-kHz band cost $40 or more, were not designed for use with a vehicle-mounted antenna and were not readily adaptable to dash mounting. So I decided to build my own receiver. I modified a transistor AM broadcast tuner to produce a three-stage trf receiver, fixed-tuned to the 332-kHz weather broadcasts in my area.

My unit is sensitive enough to run off a short antenna, such as a regular broadcast-band auto antenna. It is fixed-tuned, so it comes on with a simple throw of a switch. Thus, mounting on my already cluttered dashboard is unnecessary. Instead, the unit is installed in a cigar box and simply rests on the back seat. It is completely independent of the car radio or the car wiring. And the total cost of the entire unit was around $20.

To build your own aviation weather receiver, you need one of those little Japanese AM broadcast tuners, such as the one sold by Lafayette Radio for $7.95, catalog No. 99 H 9040. You also need six 100-pF disc ceramic capacitors and a "universal"-type transistor i.f. transformer (Radio Shack No. 273-515). Finally, you need an audio system of some sort. Mine consists of a modular 3-watt amplifier, Lafayette Radio 99 H 9132, driving a 3-inch, 8-ohm speaker, hung from the coat hook in the car.

Parts for aviation receiver cost about $20. Author used an AM tuner (right) and a modular 3-watt amplifier for his unit.

The circuit of the tuner is in Fig. 1. After gathering all the components, the first step is to "pad down" the 445-kHz i.f. transformers to the approximate frequency you wish to receive. To do so, connect 100-pF disc ceramic capacitors across the tuned windings of all the i.f. transformers (see Fig. 2). Solder the capacitors to the printed wiring on the bottom of the circuit board. If the frequency of the station you are trying to receive is very low, you may need 150-pF capacitors.

Next, disable the tuner's oscillator by disconnecting

Transcribed, Continuous Weather Reports

State and City		Call	Freq (kHz)	State and City		Call	Freq (kHz)	State and City		Call	Freq (kHz)
ALA.:	Birmingham	BH	224	MAINE:	Bangor	BGR	239	OHIO:	Cincinnati	LUK	335
ARIZ.:	Phoenix	PHX	326		Millinocket	MLT	344		Cleveland	CLE	344
	Tucson	TUS	338	MASS.:	Boston	BOS	382	OKLA.:	Oklahoma City	OKC	350
CALIF.:	Blythe	BLH	251	MICH.:	Detroit	DT	388		Tulsa	DW	245
	Fresno	FAT	344		Houghton	CMX	227	OREGON:	Pendleton	PDT	341
	Los Angeles	LAX	332		S. Sainte Marie	SSM	400		Portland	PDX	332
	Oakland	OAK	362		Traverse City	TVC	365		Redmond	RDM	368
	Red Bluff	RL	338	MINN.:	Duluth	DL	379	PA.:	Allentown	AB	400
COLO.:	Englewood	EWD	379		Int'l Falls	INL	356		Pittsburgh	AGC	254
	Grand Junction	GJT	396		Minneapolis	MS	266	S. C.:	Charleston	CA	239
	Trinidad	TAD	329	MISS.:	Jackson	JAN	260		Spartanburg	SPA	248
D.C.:	Washington	DC	332	MO.:	Kansas City	MC	359	S. D.:	Rapid City	RAP	254
FLA.:	Jacksonville	JAX	344		St. Louis	LM	—	TENN.:	Knoxville	TYS	281
	Miami	MF	365		Springfield	SGF	254		Memphis	TS	371
	Pensacola	PNS	326	MONT.:	Billings	BIL	400		Nashville	BN	304
	Tallahassee	TL	379		Bozeman	BZN	329	TEX.:	Amarillo	AM	251
GA.:	Tampa	AMP	388		Great Falls	GT	371		El Paso	EL	242
IDAHO:	Atlanta	ATL	266		Miles City	MLS	320		Fort Worth	FT	365
	Boise	BO	359	NEB.:	Missoula	MSO	308		Galveston	GLS	206
ILL.:	Idaho Falls	IDA	350		North Platte	LBF	224	UTAH:	Delta	DTA	212
IND.:	Chicago	MDW	350	N. M.:	Omaha	OM	320		Ogden	OGD	263
KAN.:	Indianapolis	IN	266		Albuquerque	ABQ	230	VT.:	Burlington	BTV	323
	Garden City	GCK	257	N. Y.:	Roswell	ROW	305	VA.:	Roanoke	ROA	371
LA.:	Wichita	IC	332	NEV.:	Elmira	ELM	375	WASH.:	Seattle	SEA	362
	Grand Isle	GNI	236	N. J.:	Las Vegas	LAS	206		Spokane	GEG	365
	New Orleans	MS	338	N. C.:	Newark	EWR	379		Walla Walla	ALW	356
	Shreveport	SHV	230		Raleigh	RDU	350	WIS.:	Milwaukee	GM	252
								WYO.:	Casper	CPR	269

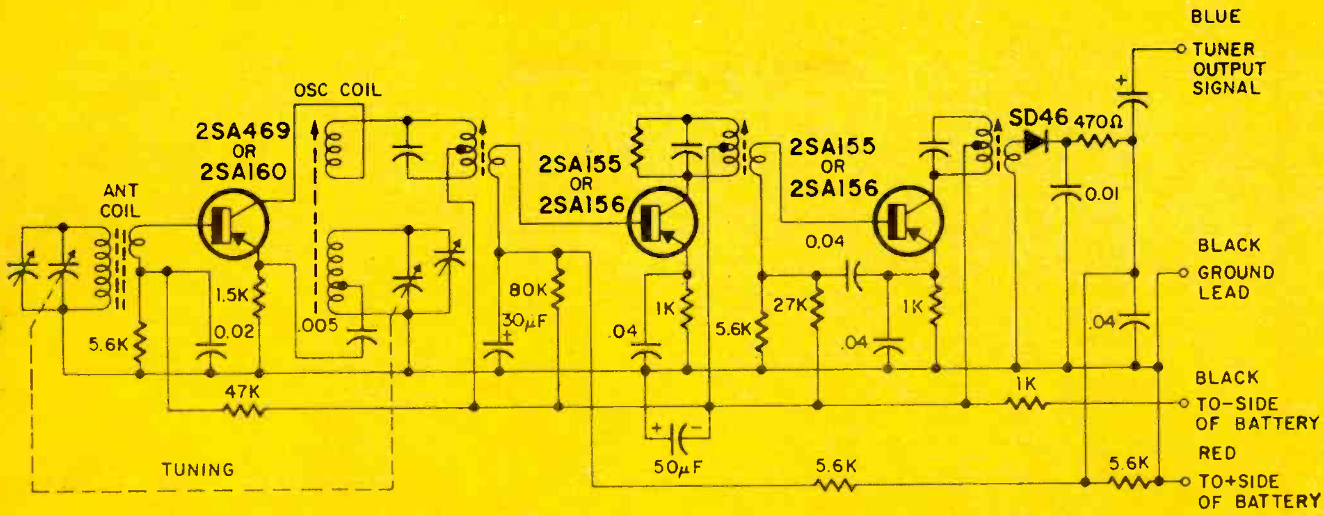


Fig. 1—Modifications to basic tuner circuit include "padding" of i.f. transformers, disabling the oscillator, and a new antenna coil.

and removing the 0.005-μF capacitor which runs from the emitter of the mixer transistor to the tap on the oscillator coil. Then connect the tuner to a 9-volt source and to your audio system.

To prevent motorboating, use a separate battery to power the audio amplifier, and decouple the tuner from the amplifier by installing a 50,000-ohm resistor between the tuner output and the amplifier input.

Now connect a signal generator to the base of the "mixer" transistor. Using a modulated signal, tune the generator from about 300 kHz to 400 kHz, to determine the resonant frequency of the i.f. strip, now that you've padded it down. It should be about 360 kHz. Bring it down or up to the desired frequency by adjusting the slugs in the tops of the i.f. cans.

Remove the ferrite antenna coil and the tuning capacitor assembly. In their place, mount a miniature printed-circuit i.f. transformer. This transformer, which serves as the antenna transformer, is mounted by drilling 1/16" holes in the printed-circuit board, in a pattern corresponding to the lugs on the transformer. To accommodate the transformer, you will have to remove some of the unused printed circuitry on the bottom of the board. Cut the copper with a knife or sharp-pointed tool, and pry it away from the board. If you break any connections which are still to be used when the receiver is completed, bridge the gaps with hookup wire.

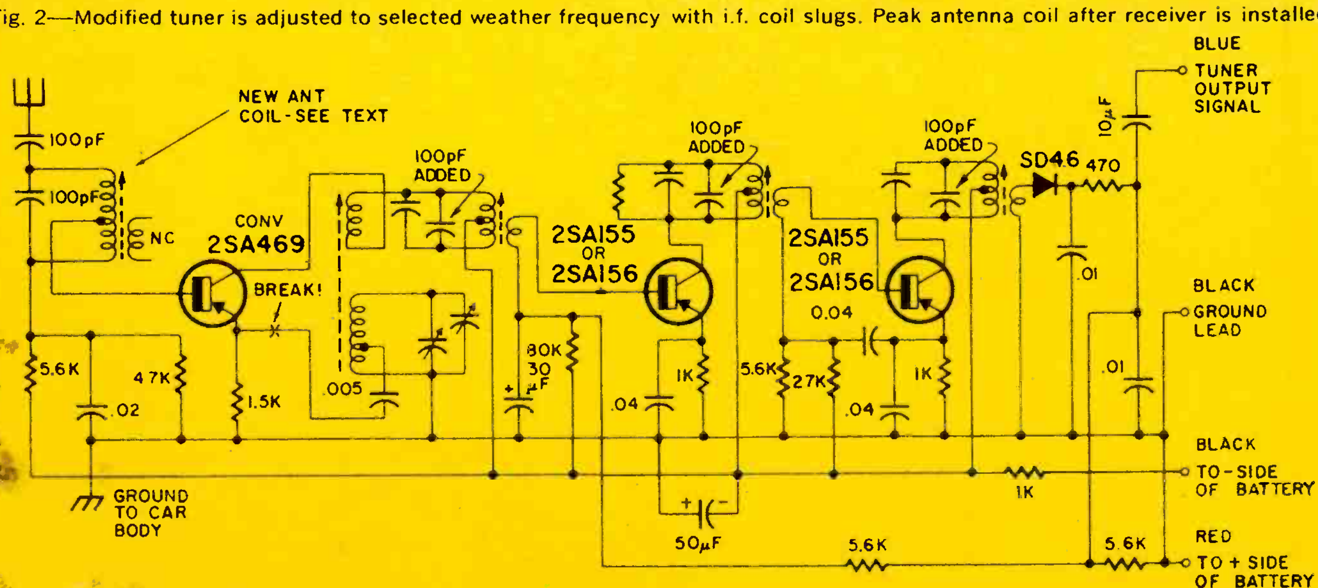
Only the primary or tuned winding of the transformer is used. Pad it down with a 100-pF capacitor and connect it as shown in Fig. 2. Make the connections with lightweight stranded wire. (The lugs on printed-circuit components are very delicate, and the tension from regular No. 20 hookup wire will break them.) I used a short length of twisted-pair phonograph pickup wire to make the connection from the transformer to the transistor, soldering the connections at one end to the transformer lugs and at the other end to the terminals left by the removal of the original ferrite antenna coil.

Be sure to ground the transformer shield, preferably by locating the shield tabs in such a way that one of them passes through a section of grounded circuitry and then soldering it to ground.

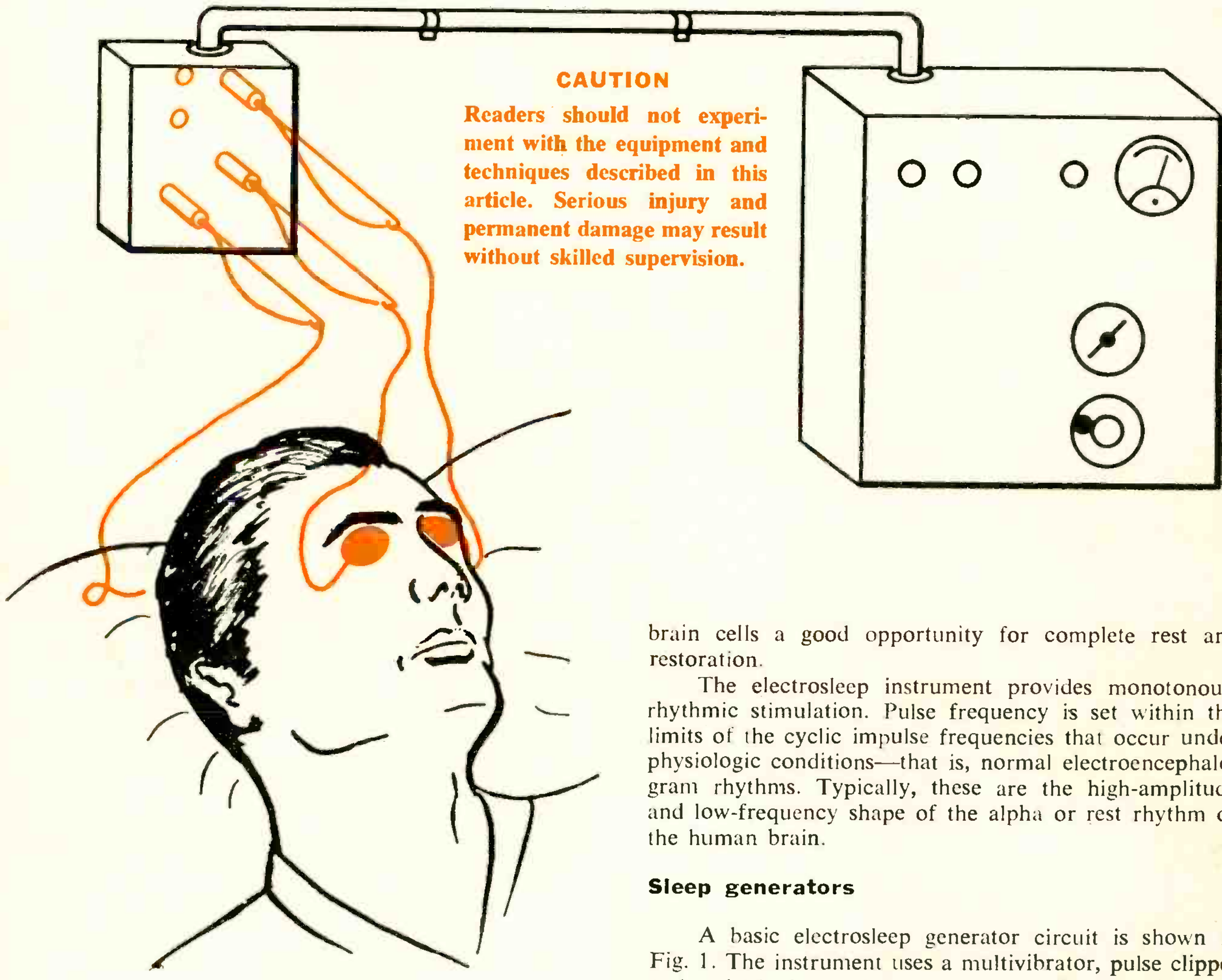
Having installed the new antenna coil and the antenna capacitor, bring the signal generator output lead near the antenna lead and peak the antenna coil. Next connect a

(continued on page 97)

Fig. 2—Modified tuner is adjusted to selected weather frequency with i.f. coil slugs. Peak antenna coil after receiver is installed.



Look What They're



CAUTION

Readers should not experiment with the equipment and techniques described in this article. Serious injury and permanent damage may result without skilled supervision.

By L. GEORGE LAWRENCE

When a low-voltage, pulsating current is passed through certain regions of the human head, sleep is induced. It takes special electronics and wave pulses to make it possible.

"ELECTROSLEEP" IS AN OFFSPRING OF ELECTROANESthesia, first practiced by the French scientist S. Leduc in 1902. Leduc used a direct pulsating current to obtain narcosis first on a dog and later on himself.

Contemporary electrosleep methods and equipment evolved in Russia, and Western buyers purchased early instruments through the trade outlet V/O Sojuzchimexport, Moscow. Advanced versions of the sleep-inducing pulse generators were the Elektrodorm I and Elektrodorm II models used by Russian and European clinics.

Aside from providing restful, healthy sleep, electrosleep has been used with good results in the treatment of schizophrenia, a disease many scientists believe results from overexhaustion of the nervous system. In these and similar situations, sleep therapy apparently affords the brain cells a good opportunity for complete rest and restoration.

The electrosleep instrument provides monotonous, rhythmic stimulation. Pulse frequency is set within the limits of the cyclic impulse frequencies that occur under physiologic conditions—that is, normal electroencephalogram rhythms. Typically, these are the high-amplitude and low-frequency shape of the alpha or rest rhythm of the human brain.

Sleep generators

A basic electrosleep generator circuit is shown in Fig. 1. The instrument uses a multivibrator, pulse clipper and cathode follower, with provisions for metering output. The absence of coupling capacitors enables a *galvanic* or direct-current component to be obtained at the patient electrodes. Switch S1 and potentiometer R1 determine multivibrator frequency. Pulse duration is adjusted with R2.

In these and similar electrosleep generators, a rectangular waveform is produced that is not unlike the pattern of the alpha wave mentioned previously.

Current-induction electrodes are placed near the eyes. Typically, a good working impulse lasts from 0.2 msec to 0.3 msec. The *mean current* might have a magnitude ranging from 6 μA to 12 μA or from 1 mA to as much as 8 mA. Some scientists have used frequencies up to 34 Hz, 16 volts peak-to-peak at 600 μA.

A typical experimental situation is shown in the drawing above. A mechanical timer governs the length of the generator's run. Initial treatments in a clinical situation usually last about 30 minutes. Later, time is increased to as much as 2 to 3 hours. After about 15 to 20 treatments have been given to an individual, the course may not be repeated for 2 or 3 months—this changes from case to case. Once the current has been turned off,

Doing With Electrosleep

a person might "sleep on his own" for 3 to 4 hours or more.

Generally, the ability of the pulsating current to invoke a sleep-like inhibition of the nervous system depends on several factors:

The environment in which the current is applied.

Frequency of treatment repetition and duration of a session.

Characteristics of the current, including direction, frequency, duration, wave envelope, mean pulse strength, electrode placement and so on.

The technique works in the majority of cases, though not with every individual.

Dream modulation?

Efforts to alter dreams and dream content by means of electrosleep-type electronics are being explored. Subliminal techniques applied in the past consisted of little more than a loudspeaker placed beneath the pillow to provide playback of prerecorded programs.

The fact that scientists observe voltage fluctuations in electroencephalograms (EEG) and find actively discharging neural units in the brain, indicates the brain or at least part of it is *not* at rest during sleep. Although many hypotheses have been formulated, biochemical and biophysical studies during sleep have failed (except for a few promising leads) to yield information about the nature and location of those fundamental processes that determine the basic role of sleep and dreaming.

A neon-type square-wave generator with simple provisions for impressing a speech pattern (or music) on patient electrodes is in Fig. 2. The wave trains, as derived from the square-wave system, are of much lower magnitude than those of electrosleep systems. However, since these trains affect the nervous system, it was hoped the subject's susceptibility to "cue" information (speech and music) could be increased! The idea certainly would be a bestseller on the commercial market—if safe and functional. **R-E**

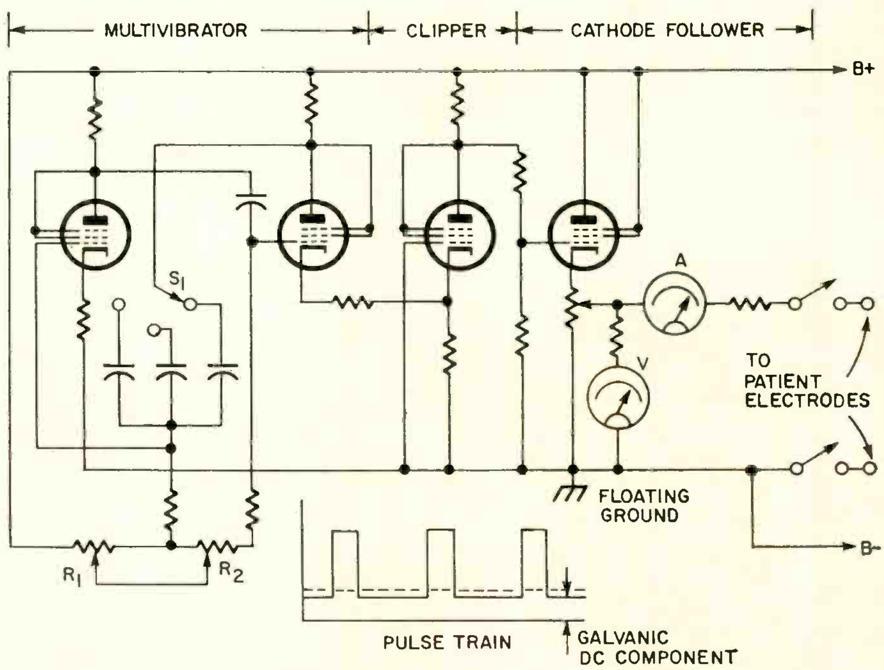
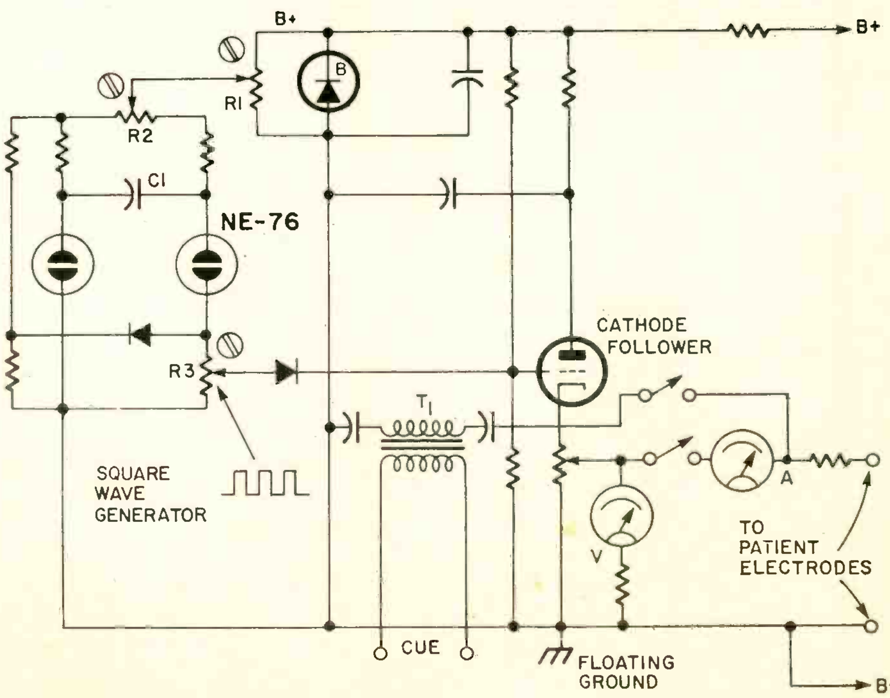


Fig. 1—Output of Russian-developed sleep inducer resembles brain's alpha rhythms.

Fig. 2—Pulse generator for experimental dream modulation has lower output than electrosleep unit. Cued information fed in at T1 may be in speech or music form.



$\Delta F = \Delta B + \Delta C$ (OR F = EC)

NOTE: R1 AND C1 DETERMINE FREQUENCY;
R2 DETERMINES PULSE WIDTH;
R3 DETERMINES HEIGHT OF OUTPUT AMPLITUDE;
T1 TRANSFORMER FOR INSERTION OF PILOT TONE.

PHOTOTACH FOR YOUR SHOP

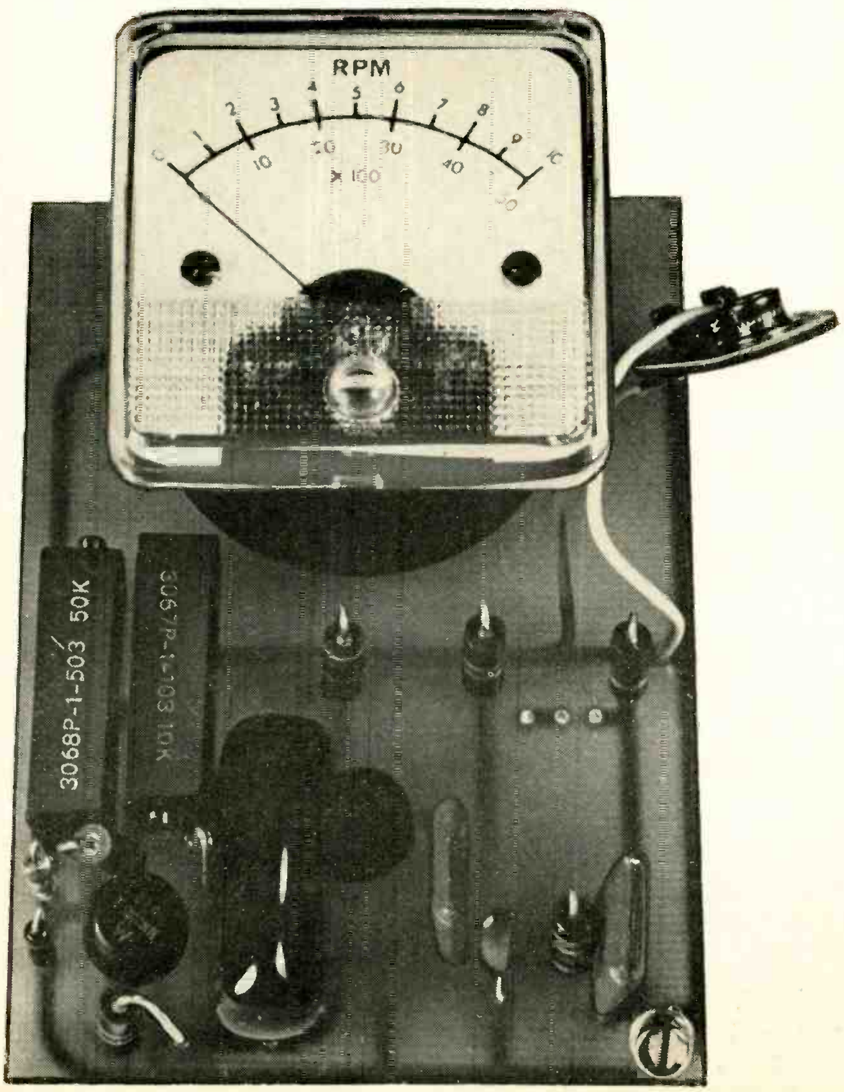
Non-contact device measures operating rpm of any rotating shaft

By BRICE WARD

HOW WOULD YOU LIKE TO READ THE speed in rpm of any rotating shaft without making physical contact with it? Drill motors, lathes, drill presses, slot-car wheels, capstan drives, turntables and dc tape recorder drives are just a few possibilities. Best of all, how would you like to do this without fiddling with dials or knobs?

This little hand-held tachometer measures rpm this way: Place a contrasting mark on the shaft, pulley, capstan or what have you, and make sure a steady illumination falls on it (from an *incandescent* lamp or flashlight). Aim the probe, press a push-button switch and read the rpm directly from the calibrated meter.

Too simple you say? Well, some setups may require your ingenuity and a little juggling. I'd like to hear about any *different* uses of either the complete tachometer or any portion of the circuitry. I would also like to see installation ideas devised by readers for this skeleton system.



Meter for the phototachometer is mounted directly on board.

How it works

The *sensing circuit* uses a cadmium selenide cell designed to respond quickly to changes in light level. Other cells could probably be used, but the Clairex unit (see parts list) will provide excellent response out to the limit of the rpm range and probably beyond this range.

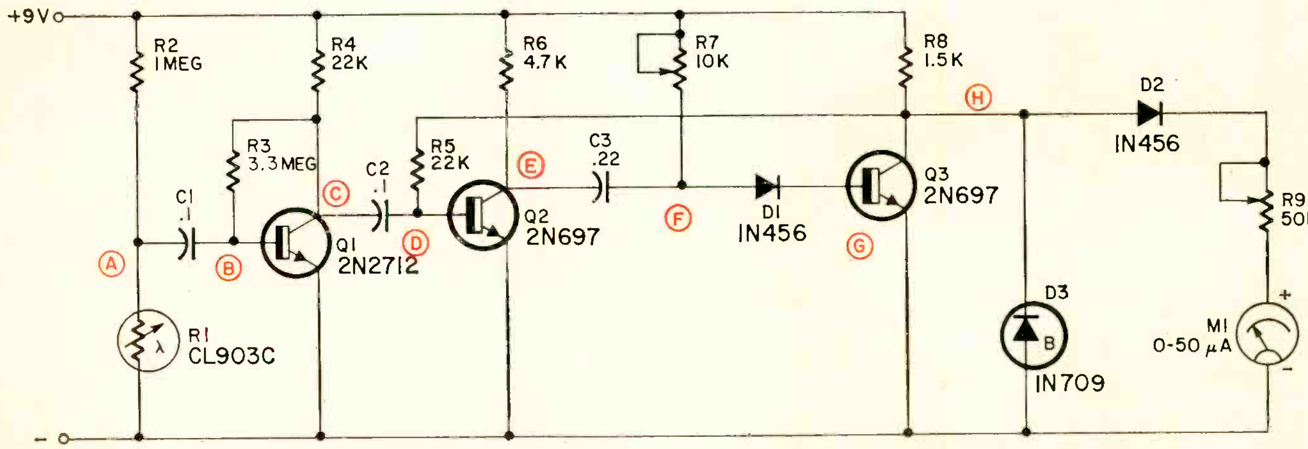
Output from the photocell is coupled through capacitor C1 to Q1, used as an amplifier with a voltage gain of about 50 (Fig. 1). The amplified voltage pulse is coupled through C2 to the multivibrator (Q2–Q3).

Transistor Q1 and the photocell, then, form the sensing element circuit. Any device that can deliver a 1-volt or better, positive-going pulse to the multivibrator could be used to drive the meter circuit.

A *pulse standardizing circuit* utilizes a monostable multivibrator followed by a Zener diode. The monostable multivibrator, variously called a one-shot or univibrator, has only one stable state, determined by the feedback arrangement used. Here, the pulse width is determined by the variable time constant of C3–R7, and the pulse height is clamped to a 5.2-volt level by Zener diode D3.

Pulse counting is achieved with a simple half-wave rectifier. It applies the average power of the pulses to the meter, which smooths the pulses by acting as an integrator. A series of waveforms illustrate what occurs in the circuit. All waveforms are positive-going above and negative below the applied zero reference line.

The voltage at point A in Fig. 1 is negative-going with an amplitude of



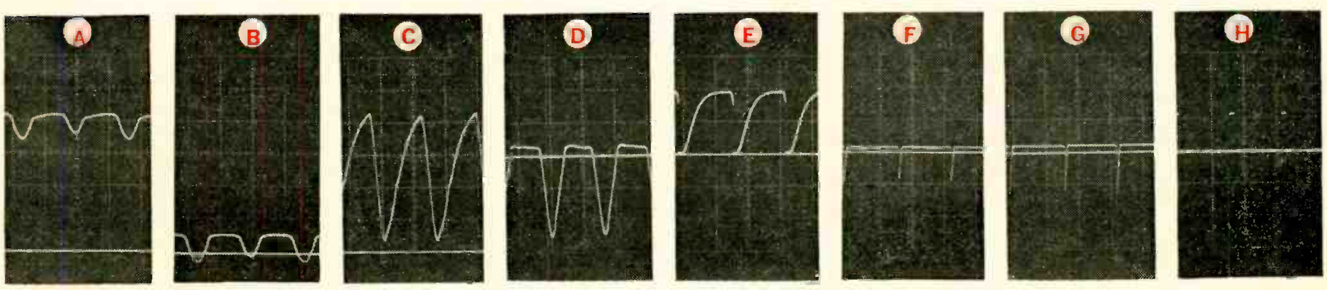


Fig. 1—Using a florescent lamp as a signal source, negative-going, 120-Hz input from R1 (A) is 0.8V (from 4.2 level). At B, dc level shifts; base–emitter drop is 0.6V. Pulse amplification is shown at C (2V/cm). As pulses go positive (above reference line) at D, multivibrator-transistor Q2 conducts. As conduction begins in Q2 (E, top), regeneration drives it into full conduction (5V/cm). Negative pulse width at F is a function of the C3–R7 time constant. Q3's base–emitter current path (G) is through D1. Since D1 is cut off by the signal at F, Q3 is also off. Voltage at H rises to a level that is controlled by Zener diode D3.

about 0.8 volt starting from a 4.2-volt level. This 4.2-volt level will change with the light level on the photocell or the voltage applied to the circuit. (An 18-volt supply should give a 1.6-volt negative-going signal, permitting the probe to be moved back from the pulsing light source.)

Since a fluorescent lamp temporarily extinguishes on each half-cycle of 60-Hz line voltage, pulse frequency is 120 pulses per second, or (multiplying by 60) 7200 rpm. This gives a good source for examining circuit operation, and was used to calibrate the phototachometer.

This voltage pulse output of the cell is coupled by C1 to the base of Q1 (B), overcoming the positive bias on Q1 and cutting it off. The result is decreased current flow through R4 and a consequent reduction in the voltage drop across R4. Since R4 and Q1's collector–emitter resistance represent a voltage divider to ground (from the 9-volt source), if the voltage across R4 decreases, the voltage across Q1's collector–emitter increases and the voltage on the collector of Q1 (C) increases with respect to ground.

Multivibrator operation

In the multivibrator, Q2 is normally cut off and Q3 is conducting. The collector–emitter current of Q3 is then determined by the resistance of R8. With a low Q3 collector voltage, less voltage is returned to the base of Q2 (D) than is required to cause forward base–emitter junction bias.

When the signal on the collector of Q1 swings positive, the voltage rises on the coupling capacitor C2. In trying to charge to this rising voltage, C2 draws current through Q2's base–emitter junction, causing Q2 to conduct and its collector voltage to drop (E).

Capacitor C3, which was charged to about 7.6 volts, begins to discharge through R7, and drives the anode of D1 (F) sharply negative, cutting the diode off. Since Q3's base–emitter current path (G) is through D1, Q3 is cut off and the voltage at point H rises to a level controlled by D3. The 5.2-volt pulse developed serves to drive the metering circuit, and supplies regenerative bias to Q2.

As long as D1's anode remains negative with respect to its cathode, Q3 will remain cut off, and the length of time that the anode remains negative is determined by the time constant of C3–R7.

In short, the multivibrator has developed a pulse of a width determined by the C3–R7 time constant and a height determined by the Zener diode at its output. On completion of the C3 discharge, the voltage on the anode of D1 goes positive with respect to its cathode and begins to draw current through Q3's base–emitter junction. Next, the voltage drops on Q3's collector feed a negative-going voltage back to the base of Q2, causing Q2 to begin cutting off. The positive-going voltage developed on Q2's collector starts to charge C3, reinforcing the switching cycle by positive feedback.

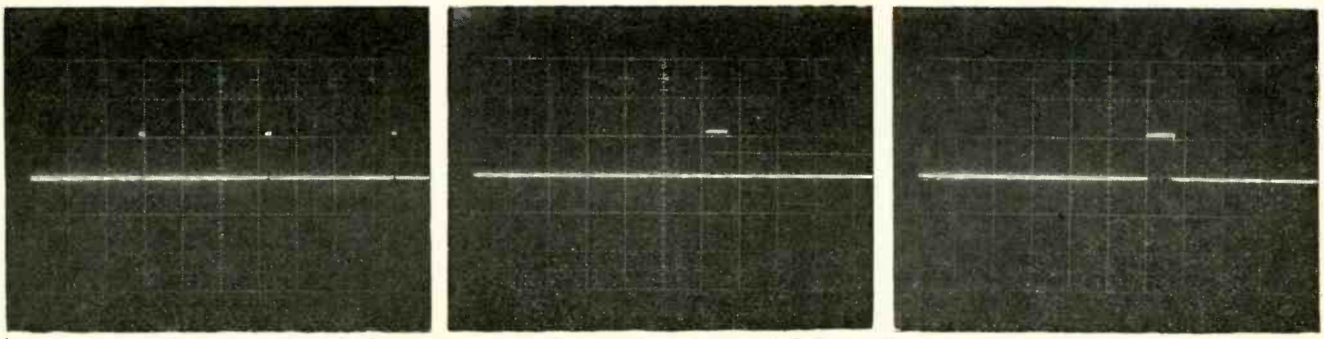


Fig. 2—Scope photo (left) shows pulses at point H with a 3600 rpm (60 Hz) input instead of the 7200 rpm calibrating input (120 Hz) shown in Fig. 1. Pulses appear every 3 cm instead of 1.5 cm, halving the current to the meter. Center photo obtained at point H indicates a pulse width of 0.56 msec. Adjusting R7 increases the pulse width to 0.7 msec (right).

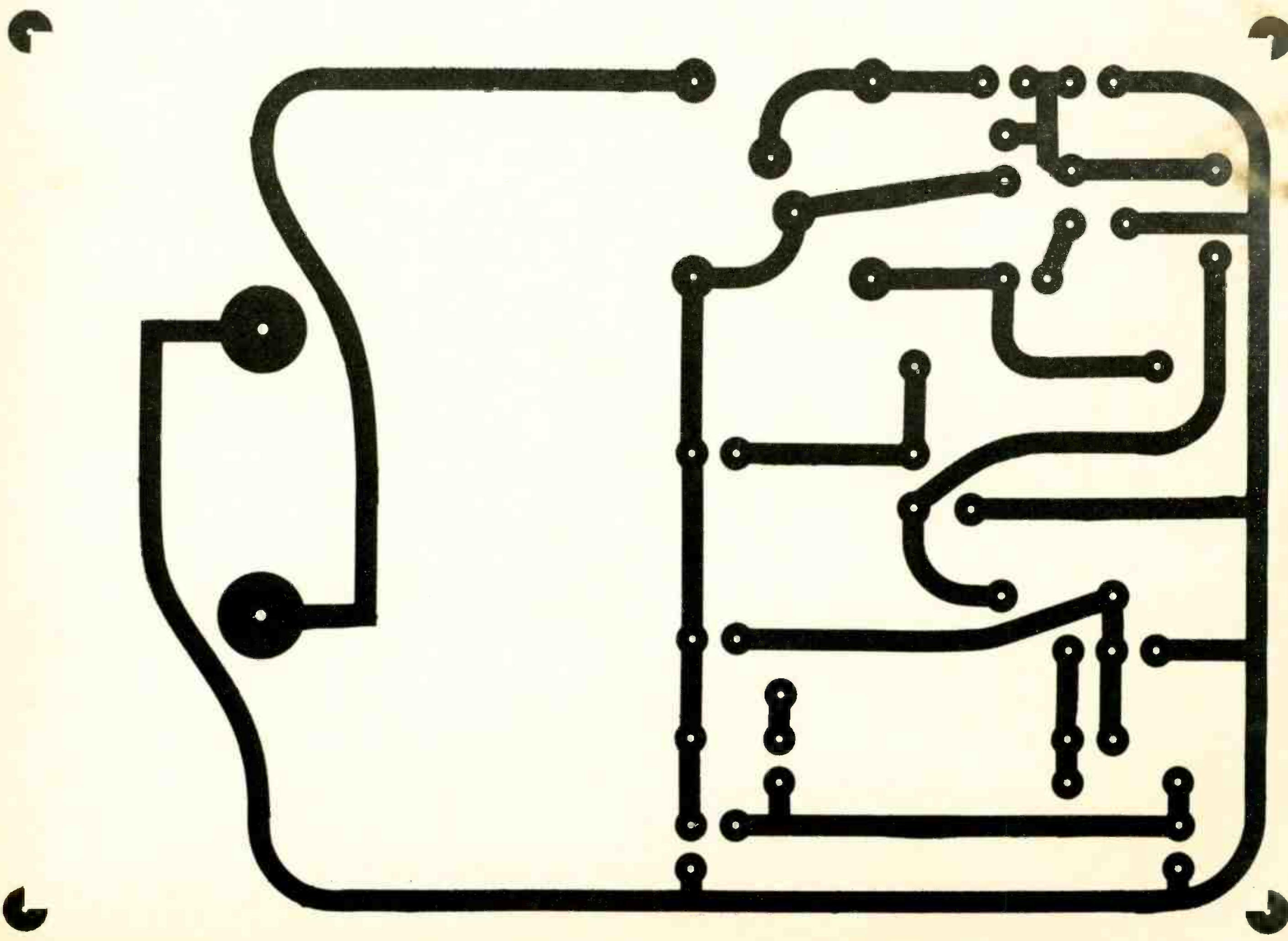
Switching times for Q3 are extremely fast (probably in the nanosecond range), and the entire standard pulse is generated in about 0.56 msec.

Figure 1-h shows pulses generated at 7200 rpm, while Fig. 2 shows them generated at 3600 rpm. The 7200-rpm pulses appear 8.5 milliseconds apart. This means that roughly 14 more pulses could be generated between existing pulses, or a pulse rate equivalent of 100,000 rpm.

At this rate, due to the extra energy generated, the meter range would have to be increased to 500 μA to read the total current.

As the system is set up, 10,000 rpm is the upper limit, and R9 is adjusted to give a full-scale reading on the meter.

Printed circuit board used for the phototachometer is reproduced actual size. You can trace PC board interconnections or transfer the circuit photographically.



Construction

For ease of construction, the unit was built on a circuit board. Before installing R7, adjust it with an ohmmeter to about 3500 ohms or, if you prefer, use a 3600-ohm resistor. The photocell (R1) can either be installed on the board or connected with a two-conductor cable for remote location use. Connect the negative battery lead to point A (Fig. 3) and the positive lead to point B. Points C, D and E can be used to raise the voltage on the photocell.

To do this, remove R2 from its present location and install it from point C to point D. Install a second battery with the negative lead going to the old R2 connection (extension from point B) and the positive lead to point E. With this arrangement a pair of 9-volt batteries will apply 18 volts to the photoresistor (increasing its sensitivity), but the circuit still receives only 9 volts.

With 18 volts on it, the probe can be moved farther from the device being measured. Depending on the amount of light striking the rotating shaft, surrounding ambient light and other circumstances, a 9-volt probe will function about 6″ from the shaft. With the extra battery, this distance could probably be increased to 12″.

The meter is installed with the *plus* (+) terminal to point G and the *minus* (−) or unmarked terminal to point H.

If you're a "scratch" builder or experimenter, the transistors and other circuit components are not critical. For example, any reasonably good npn silicon transistors should work in the circuit. Reversal of all polarity-sensitive elements and the battery should allow operation with pnp types of transistors.

The Zener diode is not critical either. If it's rated at less than the voltage on the collector of Q3, and clamps the pulse amplitude, this can be corrected by adjustment of R9. The metering diode should be germanium, but this diode and D1 would probably work with silicon devices.

The phototachometer can be used without a case, but since the meter movement supports the circuit board it could be mounted in a case. Make a cutout for the meter and allow the meter to support the circuit board inside the case.

A larger meter movement could be used by drilling holes spaced a little farther apart on the printed circuit board and again hanging the circuit board on the meter.

Adjusting your tach

If you use a graduated 50-μA meter, every reading will have to be multiplied by 200. (This is done quickly by adding two zero's and doubling the result.) As mentioned earlier, a fluorescent lamp will provide a 7200-rpm pulse source. Since we want to determine what the meter should read for 7200 rpm, we reverse the procedure: divide 7200 by 2 (3600) and remove two zero's (36) to obtain a setting point for our calibration.

Hold the light cell about 12 inches from the fluorescent light and move it in. The meter should jump to some intermediate value, and then double this value as the probe is moved a little closer. It appears to be characteristic of fluorescent lamps that the light pulse output is higher on one cycle than the other. Therefore, the first meter jump represents a reading of *every other pulse* from the lamp or 60 cycles per second (3600 pulses per minute).

At the point where the meter value doubles, adjust R9 for a reading of 36 on the meter, and the tachometer is calibrated. By proper adjustment of R9, the phototachometer should be capable of reading pulses out to the equivalent of 100,000 rpm. The photocell response time may become a limiting factor at or before this rate is reached.

Trying it out

First, in reading something like the propeller on a model airplane engine, remember that if the prop has two blades the indicated rpm will be twice the true rpm since the light is being chopped at twice the actual rpm. And if a disc has 30 segments the indicated rpm will be 30 times the actual.

This applies for any rotating device. Determine the number of full cycles for each revolution and divide the rpm reading by this figure to obtain true shaft rpm.

If you measure very high-speed devices, such as a model airplane engine, it might be necessary to reduce the overall pulse width by reducing either C3 or R7, and to reset R9 to indicate, say, 50,000 rpm full scale.

Other possibilities? Connect the photocell to the circuit board using a long cable. The very small probe can then be mounted at a remote location to monitor some shaft rpm not otherwise easily read.

The unit could be used as a fail-safe. The univibrator pulses could be applied to a rectifying system used to energize a relay. If monitoring shaft rotation, the relay would de-energize and sound an alarm when rotation stopped.

In short, the potential uses for the circuitry are restricted only by your imagination. **R-E**

PARTS LIST

C1, C2—0.1 μF, 75-V Mylar capacitor
C3—0.22 μF, 100-V ElMenco 1DP-3-224 or equal
R1—Clairex CL903C fast-response photocell
R2—1-megohm, ½-watt resistor
R3—3.3-megohm, ½-watt resistor
R4, R5—22,000-ohm, ½-watt resistor
R6—47,000-ohm, ½-watt resistor
R7—10,000-ohm, Bourns E-Z Trim No. 3067-1-103 potentiometer
R8—1500-ohm, ½-watt resistor
Q1—2N2712 transistor (G-E)
Q2, Q3—2N697 transistor
CR1, CR2—1N456 germanium diode
CR3—1N709 silicon zener diode
M1—50 μA, 1 9/16″ square dc meter (Lafayette Radio 99 H 5049 or equiv)
MISC—Circuit board, battery clip, 9-V battery

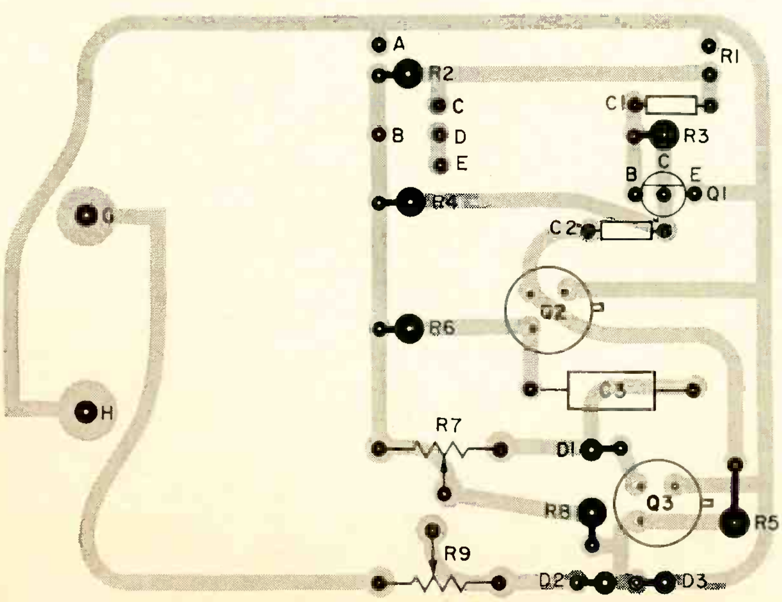
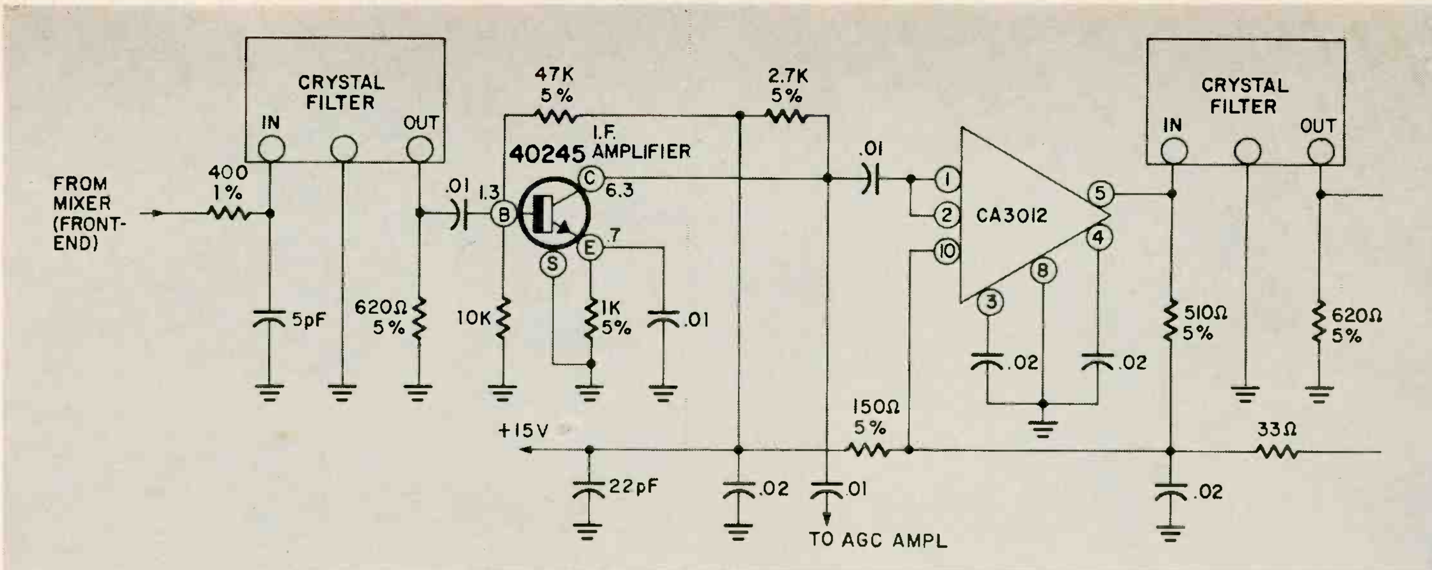


Fig. 3—Component placement on the PC board. Text explains letters A–H.



What's New in FM Tuners

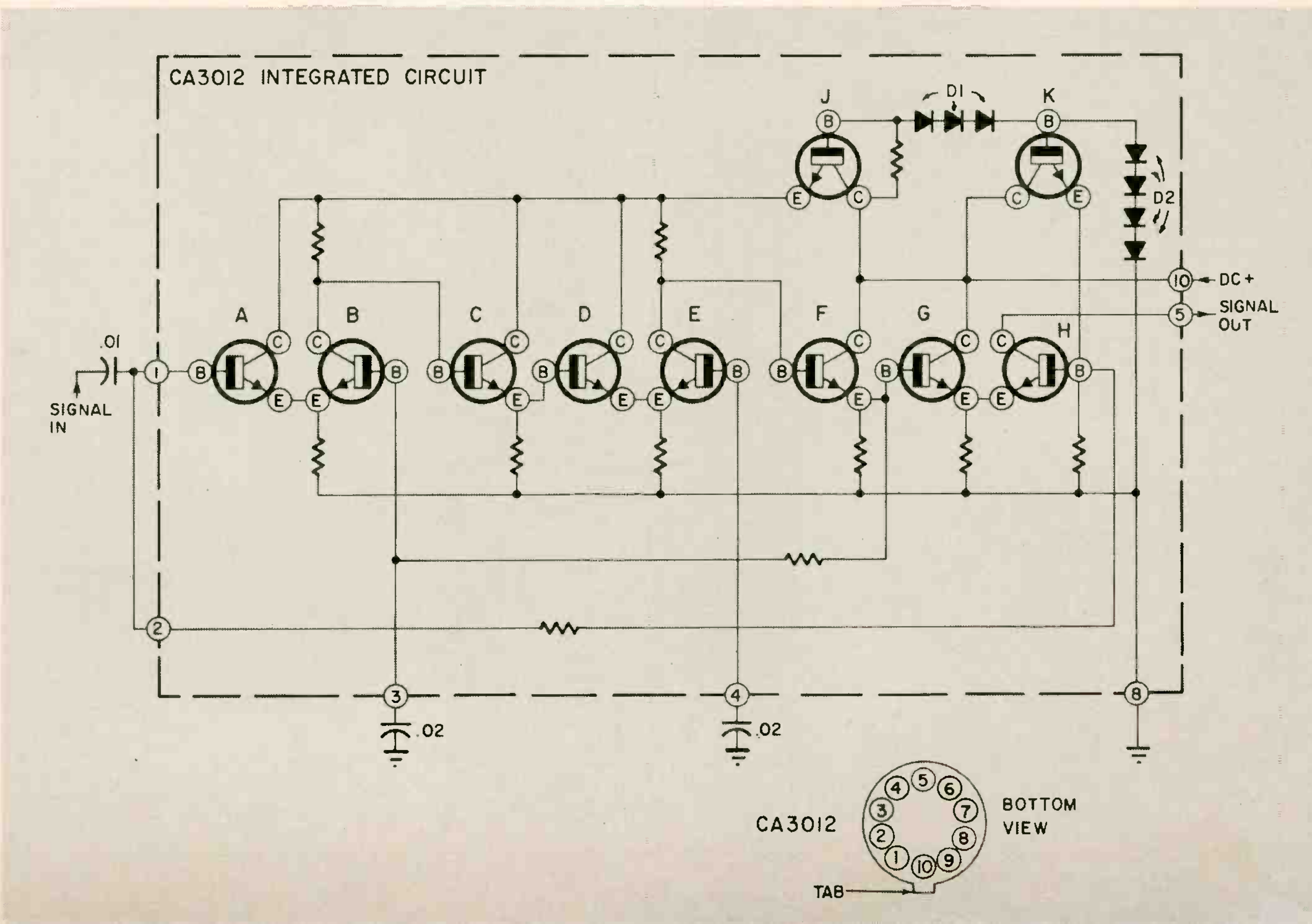
IC's and crystal filters in the Heathkit AR-15 and AJ-15—Zero-gain front end in the Marantz 18

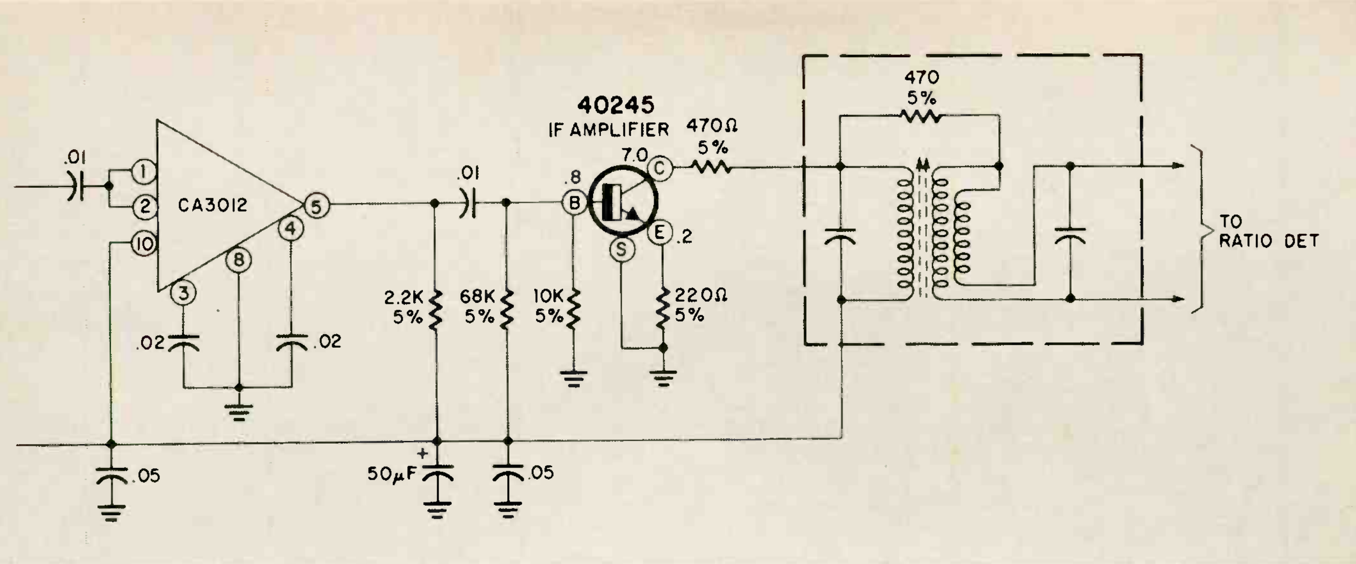
By PETER E. SUTHEIM

RAPID ADVANCES IN SEMICONDUCTOR DEVICES HAVE WORKED THEIR way into the FM tuner. Amplifier circuits were easily conquered by the semiconductor, but FM tuners took longer. The requirements are much more stringent than in an audio amplifier. And the need for extremes in frequency response, sensitivity, and signal-to-noise ratio are still rather demanding. However, as you saw last month, FET front ends and ceramic filters have gone a long way toward making FM tuners a new conquest of the semiconductor. Fact of the matter is that the specs on some of the new semiconductor tuners far exceed those attained with vacuum tubes in top-of-the-line tuners of a few years ago.

But now let's look into some more special features and interesting circuitry. IC's are also starting to appear in modern tuners. A good example of IC use is the Heathkit AJ-15 tuner. (The same circuit is also used as the FM tuner section of the Heathkit AR-15 receiver). Here, conventional transistors are used as input and output stages of the i.f. strip (figure above) to provide linear amplification where it is needed. But all the limiter stages are included in two integrated circuits (IC's) and crystal filters are used in place of conventional i.f. transformers.

Want to see what's inside those two IC's? Take a look at the schematic diagram shown below. It is the diagram of





the CA3012 IC. It contains 10 transistors, 7 diodes and 11 resistors. In effect, each of these IC's contains three cascaded emitter-coupled amplifiers which symmetrically clip the 10.7 MHz i.f. signal to provide hard limiting. Much of the pioneering in the use of IC's in FM tuners was done by the H. H. Scott Company.

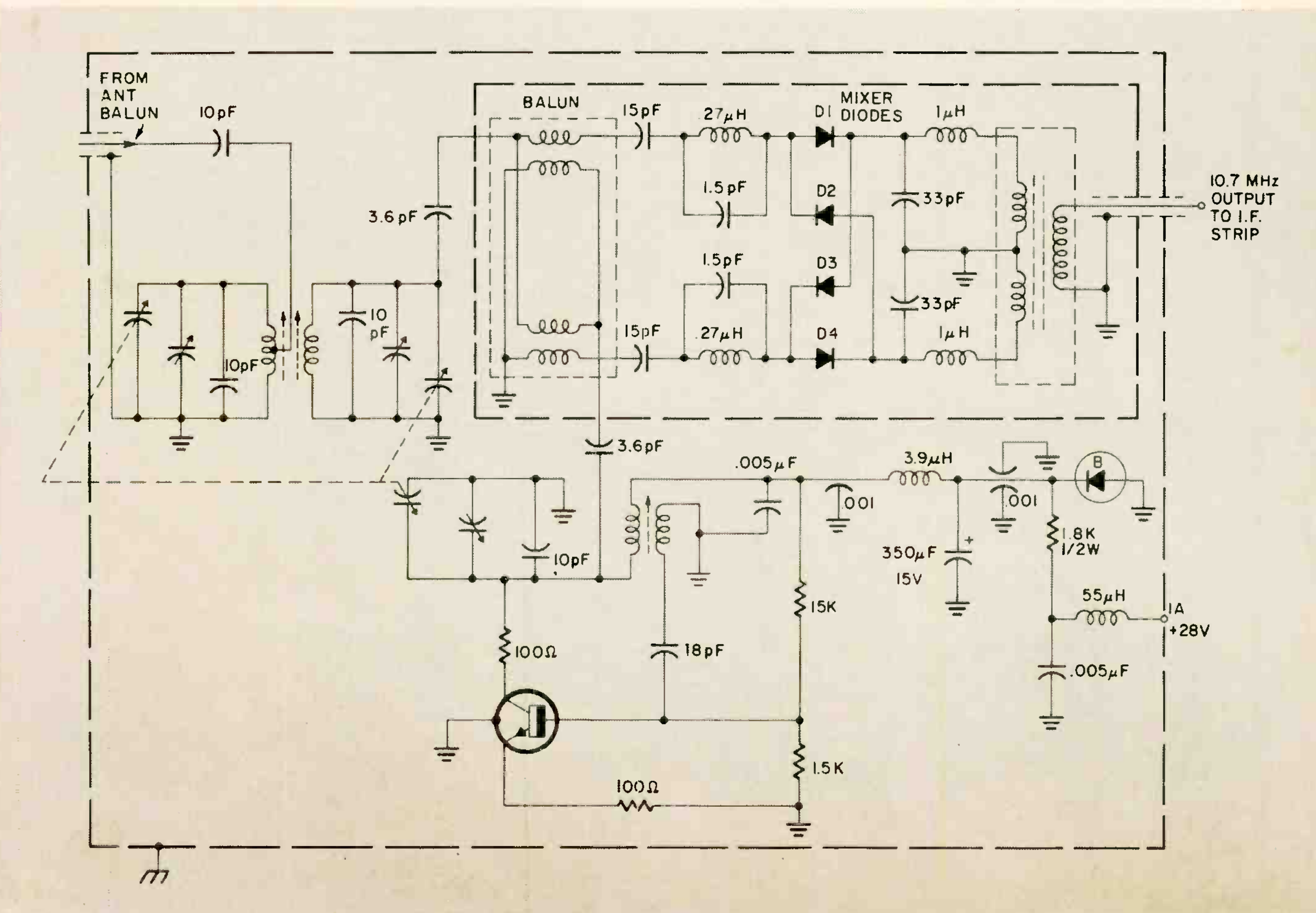
The specially designed quartz crystal filters replace conventional i.f. tuner circuits and eliminate the need for i.f. alignment, excepts of course for the detector coil. These crystal filters provide a steep-skirted, flat-topped bandpass with very linear phase characteristics at all signal levels.

Zero gain front end

Stereo tuner front-ends have seem several interesting circuits. But one of the more remarkable circuits to found in today's FM tuners is in the Marantz 18. Unlike the conventional front-end, their circuit provides absolutely zero gain. In fact, it doesn't have any transistors, tubes, or other active devices except for the transistor in the local oscillator circuit (see figure below). With their special design, Marantz claims a sensitivity of 2.5 μY for 30 dB quieting. This is not spectacular but is still excellent. What is at least as important, the receiver shines at the other end of the dynamic range scale—its spurious response rejection is a remarkable 100 dB. For all practical purposes this means there is no possibility of cross modulation.

A $1050 FM tuner

Another most unusual FM tuner is the CM Laboratories model 804. It introduces digital readout tubes to replace the conventional FM dial. Tuning is said to be positive, to the exact center of the channel. Drift, misalignment and mistuning are eliminated. The new technique pinpoints the frequency since the tuner can be tuned only to the 100 discrete channels designated by the FCC for FM broadcasting. It does this with a crystal frequency synthesizer which produces 100 separate and stable crystal-controlled frequencies. An FET front-end, linear ramp detector and stable L-C, filters instead of i.f. transformers round out the circuits. But at the $1050 price, it's certainly not the tuner for everyone. **R-E**



Solid-State Rectifier Repairs

Expert tips help you pinpoint semiconductor troubles in modern rectifier circuits

By MATTHEW MANDL

CONTRIBUTING EDITOR

SILICON RECTIFIERS OUTLAST TUBE types, are smaller, can handle high currents and need no filament or heater voltages. Consequently they are making the tube rectifier obsolete. A silicon rectifier, mounted in an octal-base housing, is even available for direct replacement of an old standby, the 5U4-G.

Generally, silicon rectifiers have replaced selenium types in power supplies, although some seleniums are still used in new equipment (focus rectifiers in some color sets, auto battery chargers, etc.).

The simplicity of solid-state rectifiers, however, can be misleading. They are not trouble-free, and when defects appear an understanding of their characteristics is necessary to make proper tests and replacement. Common failures include opens, shorts, arcing and intermittent operation.

Rectifier testing

Silicon rectifiers can be checked easily with a vom or vtvm. On the R×1K scale, an ohmmeter should show virtually infinite resistance with reverse polarity, and approximately 500 to 1500 ohms with forward polarity. An infinite resistance reading in both directions shows an open unit, while a low resistance reading in both directions shows a shorted or otherwise defective unit.

Seleniums present more of a problem since they don't have infinitely high resistance in the reverse direction. Even on the R×1-megohm scale, readings are misleading. Also, seleniums may continue to rectify, though their internal resistance builds up. Consequently, a higher voltage drop occurs across the rectifier, and output voltage declines.

Thus, it's best to read the output voltage of selenium rectifiers while they are in the circuit and compare it with the specified value. Also check to see that the power supply load is not excessive, because this would also cause a voltage decline.

If you suspect an open or shorted rectifier, you can test it with the setup shown in Fig. 1. A 12-volt filament transformer is used, plus a resistor of about 500 ohms. If the rectifier is shorted, a sine wave appears on the scope. If the rectifier is all right, a half-wave pattern similar to Fig. 2 will appear.

The polarity of the rectifier terminals applied to the tester will make no difference. In one position the pattern of Fig. 2 will be inverted, but still indicates proper rectification. If the rectifier is open, some capacitance leakage may still produce a pattern on the screen, but it would again be a sine wave, indicating a defective unit. (It is a good idea to check new seleniums in this manner—sometimes "new" ones may have deteriorated if they've been in stock for some time.)

Tips on replacement

Don't replace a silicon or selenium rectifier with one having lower voltage or current ratings. You can, however, use a higher-rated replace-

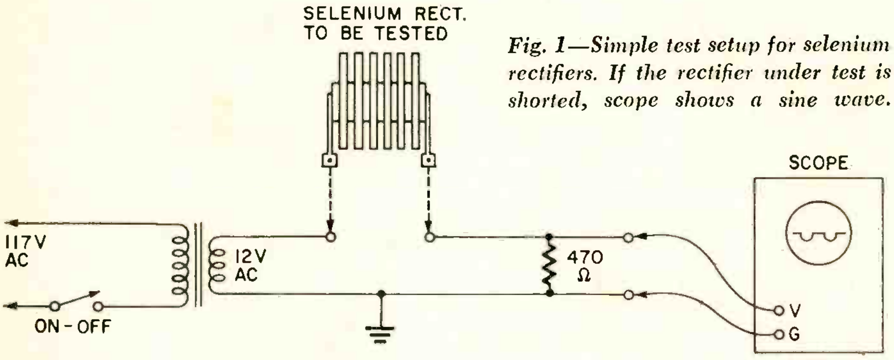


Fig. 1—Simple test setup for selenium rectifiers. If the rectifier under test is shorted, scope shows a sine wave.

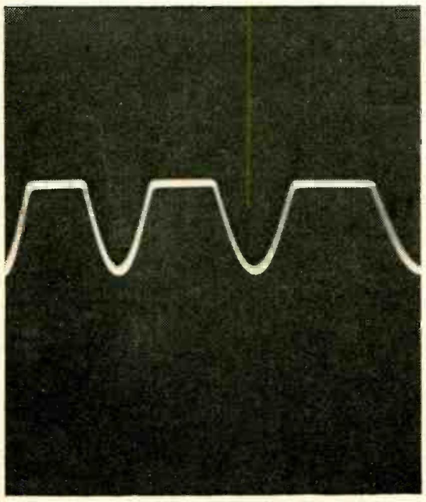


Fig. 2—Half-wave pattern indicates rectification. It may be positive or negative.

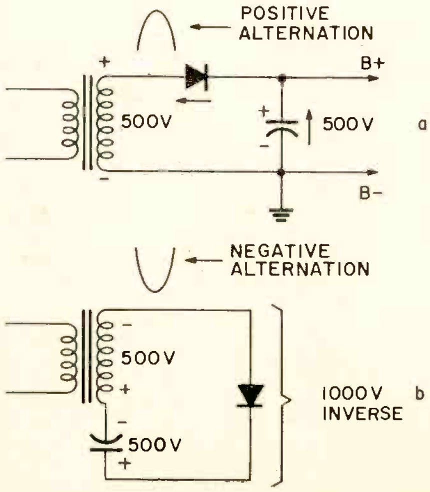


Fig. 3-a—Basic half-wave rectifier circuit b—Development of peak inverse voltage.

ment if the larger unit doesn't take up too much room. Make sure the peak inverse voltage rating is the same (or higher) in the new unit, or the replacement will not last long.

Peak inverse voltage development is shown in Fig. 3. A basic half-wave rectifier circuit is shown at (a). When a positive half-cycle of ac appears across the secondary, electrons flow in the direction shown by the arrows, and the rectifier conducts. The capacitor is then charged to the peak voltage across the secondary. During the negative alternation (b) the charged capacitor can be considered in series with the transformer-secondary voltage source. The rectifier doesn't conduct, but at the peak of the negative alternation the combined voltages (secondary plus charged capacitor) apply 1000 volts to the rectifier (peak inverse or peak reverse voltage). If the rectifier doesn't have a high enough rating, it will be quickly damaged.

If you read 500 volts across an ac source, the meter reads the effective rms value and not the peak. The peak is 1.41 times the rms value. Thus, for Fig. 3, if the 500V represents an rms value, the actual peak voltage across the rectifier will be $500 \times 1.41 \times 2 = 1410$V.

Typical circuitry

Three basic types of power supplies are found in modern TV receivers. One is the half-wave type shown in Fig. 3, where only half cycles are rectified. It requires more filtering for smooth dc output, but needs no transformer center tap.

A second method is full-wave rectification. Two rectifiers are needed with a center-tapped transformer. To avoid the center tap, four rectifiers can be used in the *bridge* arrangement we'll discuss later. A third method is to use a voltage-doubling system for obtaining a higher potential than that available from a given secondary.

Half-wave systems are not always as simple as Fig. 3. A typical example is the low-voltage supply used in the RCA KCS-158 receiver shown in Fig. 4. Here, L1 and L2 do not form a transformer; instead these are separate filter chokes that minimize noise pickup from the line, and reduce interference fed into the line from the receiver. Capacitor C1 is a low-pass shunt, also for noise signals.

The power transformer is an autotransformer and tap 1 is a voltage stepup terminal for supplying the B+ supply system with a potential higher than line voltage. Tap 2 supplies full voltage to the series heaters. Tap 3 supplies the heater string with a lower-than-normal voltage to keep it warm and provide an "instant-on" picture when the set is turned on. (The master switch must be in the on position for this operation.)

The half-wave silicon rectifier feeds a filter network consisting of a series choke and two filter capacitors. The circuit breaker protects the system from power supply shorts, while the fuse opens for higher-current faults contributed by the filament string.

"Instant-on" troubles call for a check of the double-pole switch and connections to transformer tap 3. An open circuit breaker calls for testing for shorted filter capacitors or excessive current drain from the circuitry the power supply feeds.

Capacitor C4 is across the rectifier for protection against current surges and transients caused by on–off switching. In most applications using silicon rectifiers, these capacitors are connected across the input or output of the rectifier.

Because of their small size, silicon rectifiers are easily damaged by voltage surges and heat. Heat is dissipated by using metal mounting flanges (or direct mounting on metal chassis). Because perfect flat-surface contact between the rectifier and the heat sink is difficult to obtain, silicone grease is used to fill the air gaps and help make a good thermal contact.

Thus, when such rectifiers are replaced, coat the heat sink and flange of the rectifier with silicone grease to avoid heat damage. Also, do not replace a rectifier without the accompanying shunting surge capacitor.

A typical voltage-doubler power supply is shown in Fig. 5. When a positive alternation appears across the secondary, rectifier D1 conducts and charges C1 to the peak voltage. With a negative ac alternation across the secondary, D2 conducts and charges C2 to the peak voltage. Because D1 and D2 are in series, a doubled voltage is available across the two. Capacitor C3 shunts both C1 and C2, and hence stores the full double-voltage charge.

If output voltage is low from this supply and the rectifiers check out okay, look for defective charging capacitors. If either C1 or C2 can't hold a full charge, output voltage declines. The rate of discharge from C3 affects output voltage and regulation (ability to hold output voltage with current changes). If a partial short or other excessive current drain exists in the receiver circuitry fed by the power

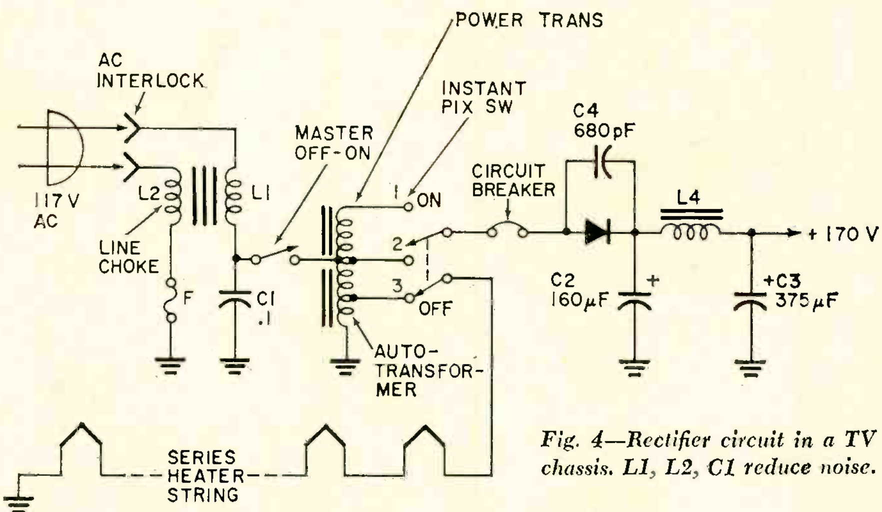


Fig. 4—Rectifier circuit in a TV chassis. L1, L2, C1 reduce noise.

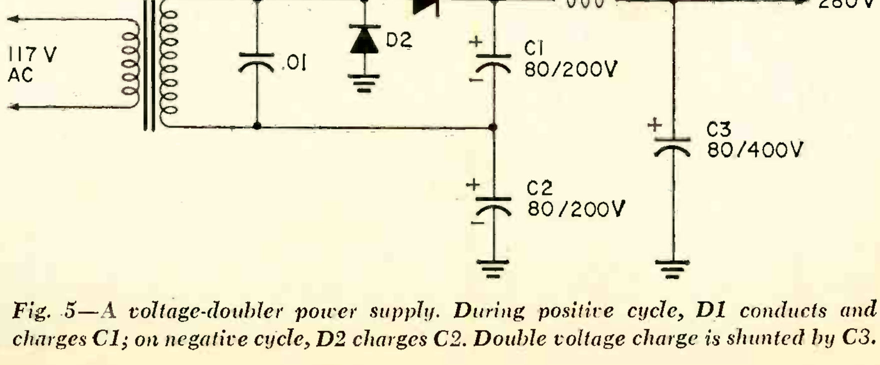
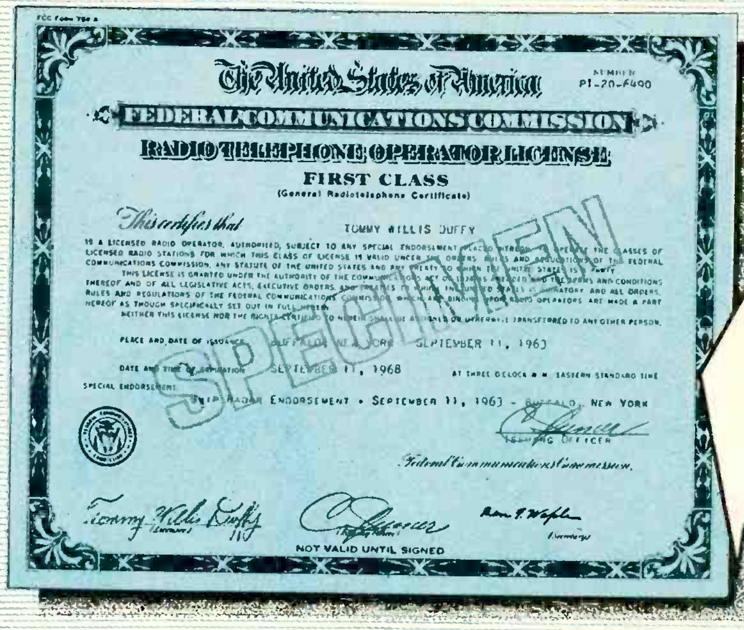


Fig. 5—A voltage-doubler power supply. During positive cycle, D1 conducts and charges C1; on negative cycle, D2 charges C2. Double voltage charge is shunted by C3.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This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

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And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal Government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

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supply, the output voltage will drop. If all parts in the supply check out, look for overloading caused in the receiver portion.

A full-wave supply with center-tapped transformer is shown in Fig. 6. Here, each rectifier conducts alternately and thus each half-cycle is rectified for smoother dc output. Since this supplies a transistorized receiver, high-value filter capacitors are used to obtain minimum ripple voltage.

If one rectifier opens, ripple will increase and output voltage will drop. Open filter capacitors will also contribute to ripple, as will a current-drain overload from the supply. In this receiver the uhf-tuner section has no voltage applied except when the vhf tuner is set to the uhf position.

Thus, if uhf reception is lost, check the switch operation and also look for a shorted capacitor (300 μF) that bypasses the 11.5-volt output. The 0.001-μF noise-filter capacitor shunting the ac line input was omitted from earlier models of this receiver, and should be included when it is found missing during servicing.

Note the switching for battery operation. If trouble occurs during battery operation, check the 12-volt battery under load and also check for proper switch operation.

A typical bridge rectifier system is shown in Fig. 7. Rectifiers D2 and D3 conduct when the upper terminal of the transformer secondary is positive. D1 and D4 conduct when it is negative. Note the high voltage value of the surge (transient) capacitors shunting the secondary. Make sure replacements have as high (or higher) rating to withstand voltage peaks. Similarly, make sure replacement rectifiers are matched to the others and have sufficient peak inverse voltage ratings.

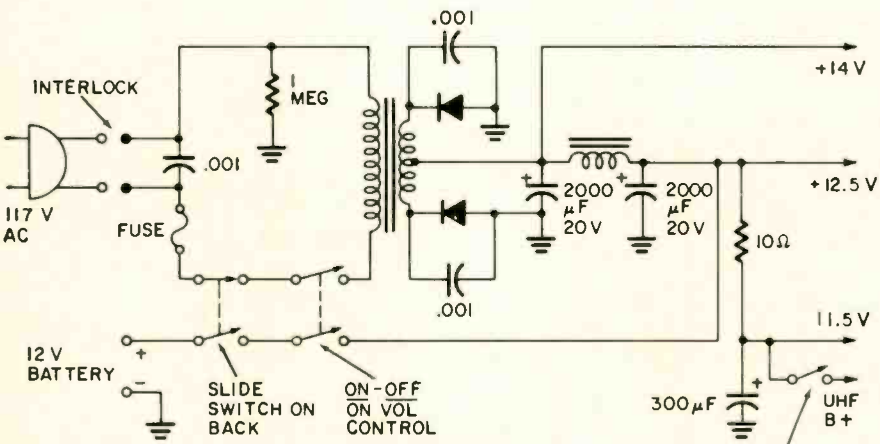


Fig. 6—Full-wave supply, center-tapped transformer. Diodes conduct alternately, rectifying both half cycles. Motorola TS-460 chassis.

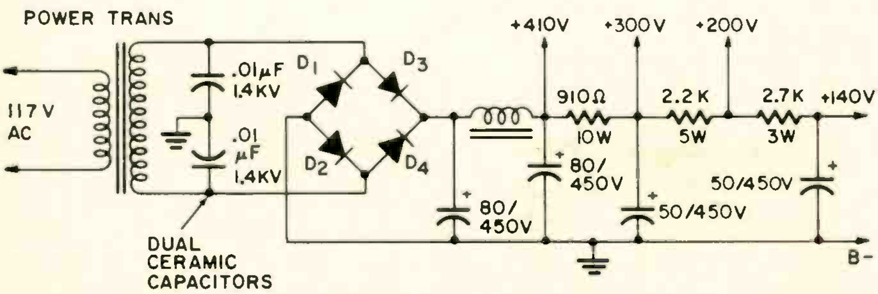


Fig. 7—Typical bridge rectifier circuit. Diodes D2 and D3 conduct when the top of the transformer secondary is positive, D1 and D4 conduct when it has negative polarity.

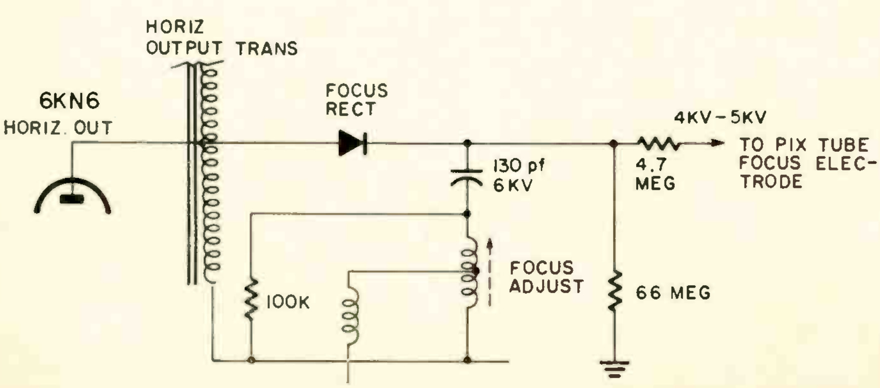


Fig. 8—Focus voltage in color receivers is obtained from a tap on the horizontal output transformer. Rectifier is combined with filter and a voltage-variable component.

Focus rectifiers

In color receivers, the 5-kV focus voltage is taken off a tap on the horizontal output transformer, and rectified by either a tube or a solid-state rectifier. For the latter, selenium sections are stacked in sufficient number to handle the high voltage involved, and the circuit uses a filter-resistor network, plus a voltage-variable component such as a variable resistor or a slug-tuned inductor. A typical circuit is shown in Fig. 8.

Because of the high voltage, the selenium stack may arc and cause intermittent focus as well as streaks across the picture-tube screen. If this occurs, blow or brush out any dust accumulation on the stack, and also measure the voltage to make sure it isn't excessive. If the trouble still persists, replacement of the rectifier will be necessary.

A strong odor indicates the unit is defective and sections are shorting out and overheating. Avoid prolonged breathing of this odor, because selenium can produce poisonous fumes. (Selenium itself is poisonous and for this reason the rectifier plates are painted or coated with a thin protective covering to avoid absorption by the skin during handling.)

If poor focus can't be corrected by the focus adjustment, check for an open filter series capacitor (130 pF, 6 kV, in Fig. 8). Also check for an open series (4.7-megohm) resistor, and check for voltage at the pin of the picture-tube socket. If no open circuits or component defects exist, check the rectifier.

Convergence rectifiers

In addition to power supply and high-voltage rectifiers, rectification is

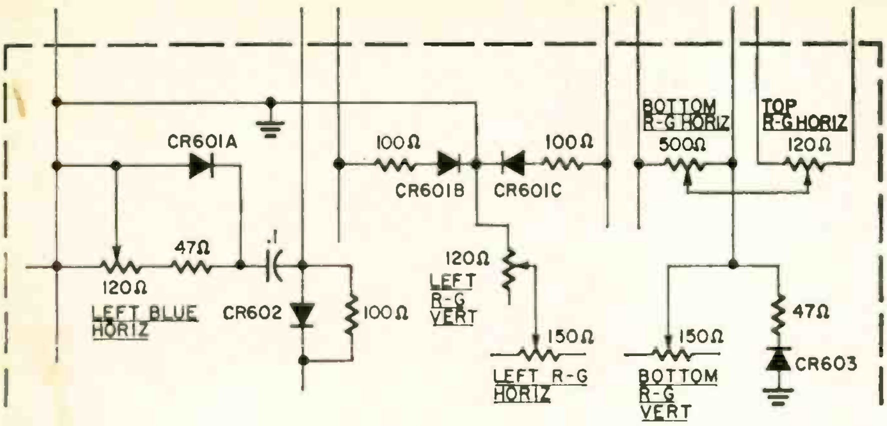


Fig. 9—Convergence circuitry in color receivers also makes use of rectifiers. Defective or intermittent diodes here can cause colors around sharp-contrast scenes.

also used in the convergence circuitry of color receivers. Typical is the circuitry shown in Fig. 9, which is a partial schematic of the Admiral G-13 color convergence board. Note that five solid-state rectifiers are used for the various convergence areas of the screen.

If convergence adjustments fail to produce results, rectifiers should be checked. If one is defective, associated circuit components should also be tested for defects that might have contributed to rectifier failure. Defective or intermittent rectifiers in the convergence circuitry can cause unstable convergence and the appearance of false colors surrounding sharp contrast changes in the televised scenes.

In one receiver an intermittent CR603 (Fig. 9) caused narrow red bands to appear around sharply defined objects in the picture. In another receiver a defective CR601A produced hue distortion on the screen that could not be corrected by adjustment of the convergence controls.

When one or more rectifiers in the convergence board must be replaced, a dot generator should be used to check convergence before closing the back of the set. This will insure convergence hasn't been even slightly affected by a new unit, or that other component troubles aren't contributing to poor convergence.

Don't expect perfect convergence, particularly at extreme tube edges, because new convergence rectifiers can't compensate for the many variables affecting convergence. If most of the screen area is converged, however, an excellent color picture will be obtained. Excellent (though not perfect) convergence is shown in Fig. 10, where only the dots along the borders are slightly off the true circle representation from the generator. **R-E**

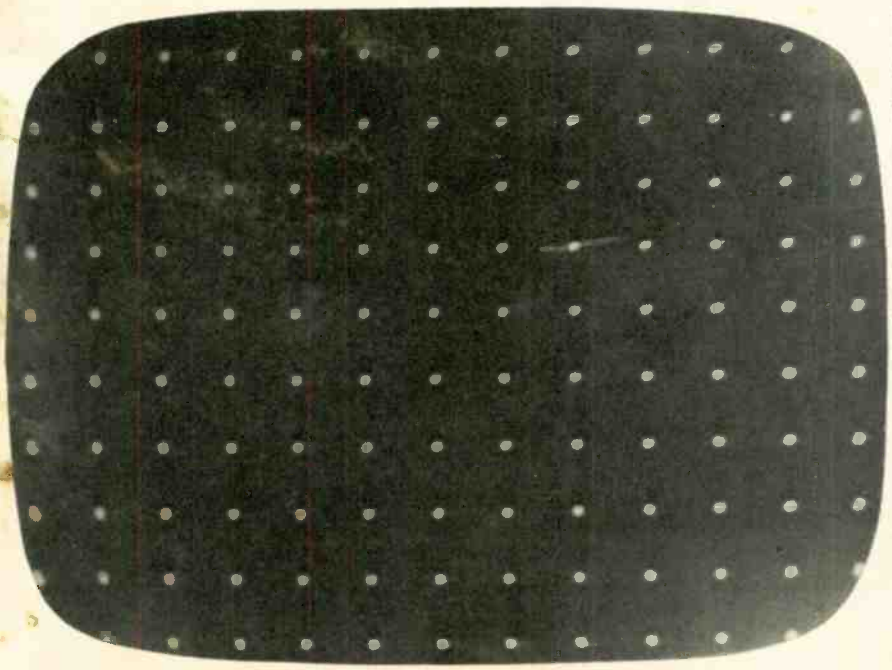
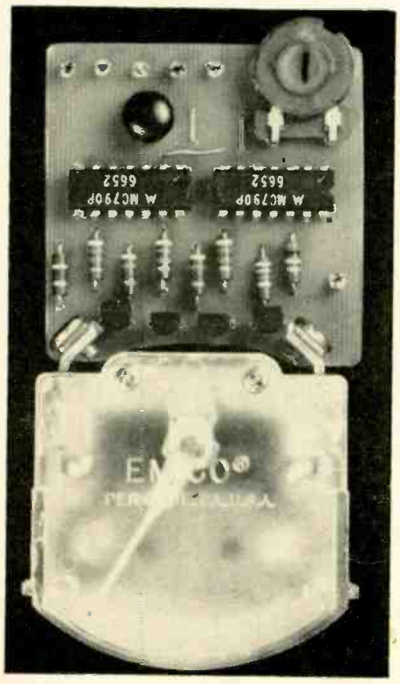
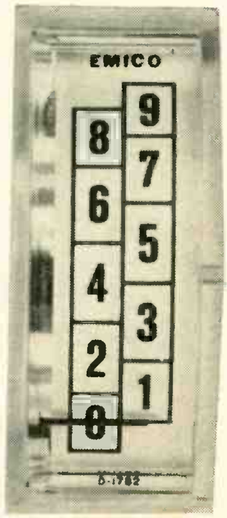


Fig. 10—When convergence diodes are replaced, recheck convergence with dot generator. Photo shows good convergence, even though edge dots are not circular.

Build a $10 Experimenter's IC Decimal Readout Module





PC module is small (1"x2"x4") and mounts all readout components: decade counter, decoder/driver, and modified panel meter.

By RALPH GENTER

THE ASSIGNMENT WAS PLAIN ENOUGH. GET RADIO-ELECTRONICS readers a versatile decimal counting module. Give them a basic block that counts from zero through 9 *and* indicates it. Make it resettable and cascadable, so any number of units can be placed side by side to obtain any desired accuracy.

Now readers would have the modular heart with which they could build their own electronic counters, digital voltmeters, frequency counters, electronic stopwatches, photographic shutter testers, electronic piano tuners, ballistic velocity meters, adding machines, computers, dragstrip speed measurers . . . and heaven knows what else. Besides, there might be quite a bit to be gained simply by studying such a module, as its operating and service principles would be identical with much of the digital industrial electronic equipment in use today.

The trouble began when we started pinning down the specs on such a unit. It had to be small—not over 1" x 2" x 4", and a one-piece unit. It had to be near foolproof. It *had* to use integrated circuits—no neon bulbs, diodes, capacitors or critical pulse circuits allowed. It should be snappy, running anywhere from pushbutton speeds on up to 10 MHz. Less than 0.5 W per module of supply power would be nice. And, of course, it must be legible and easy to read, and must read out in plain numbers. Finally, if anyone was going to build one, it would have to cost less than $10 per decade—experimenter's single-quantity cost.

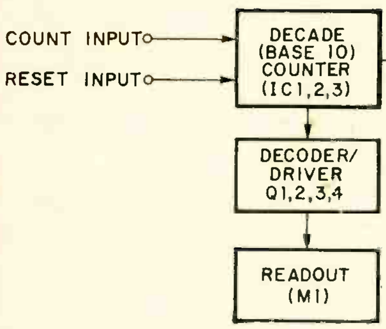


Fig. 1—An input pulse advances the decade (base 10) counter one step. The tenth pulse resets counter to zero and generates a carry pulse. Decoder/driver sums currents for M1.

$10 per decade?

This was the stickler. Off to the catalogs. Let's see—Nixie tubes $8 each . . . DTL integrated decade counters $10 each . . . decoders $16 each. . . . The IC boys are coming along just fine, but that's almost $35 per decade, and we're not through yet. No wonder the cheapest digital instruments start at $300 and work their way up—and up. ($600 is par for a good electronic frequency

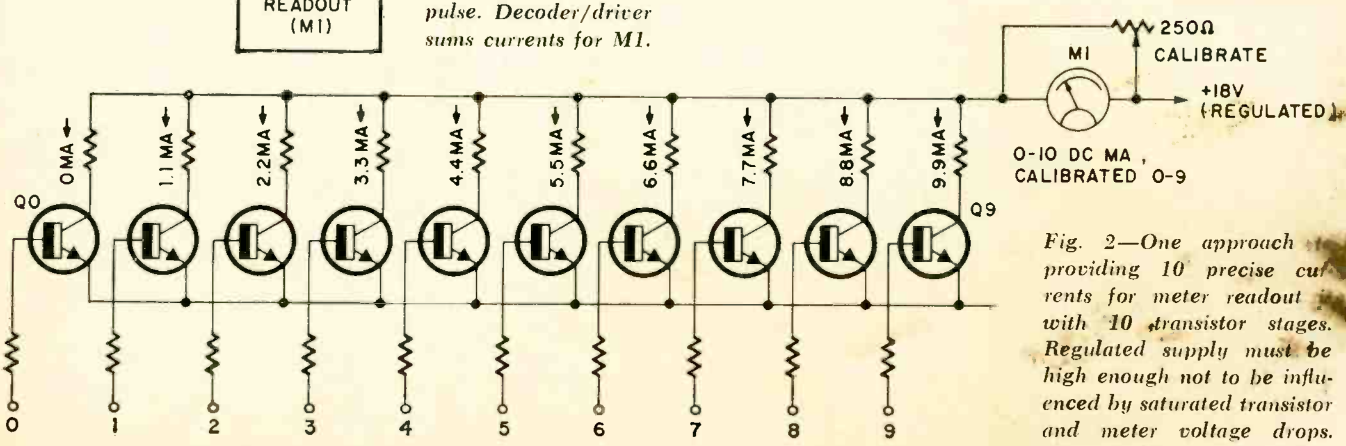


Fig. 2—One approach providing 10 precise currents for meter readout with 10 transistor stages. Regulated supply must be high enough not to be influenced by saturated transistor and meter voltage drops.

meter. But hang on—we're going to show you the same thing for around $60!). No, Nixies are out. So is DTL. Even the old Decatron counters top out above $20, and they can't touch the speed we need. Besides, that bounding orange dot is hard to follow and harder yet to read. So we start from scratch and find a "new" way.

This is easy enough. Let's draw the problem out in Fig. 1. We need three parts: an electronic decade or base-10 counter, a decoder and a readout. The counter has to work like a 10-position resettable stepper, only at a speed anywhere from dc to 10 MHz. Each individual input pulse has to advance the counter one, and only one, count. When the count gets up to 9, the next input pulse has to reset the counter to zero, and produce a CARRY pulse to hit the next decade over. We also have to be able to reset the counter to the zero state anytime we like. This gets our instrument reading 0000 at the start.

We obviously have to have a readout. This is something that brightly and unambiguously indicates the state the counter is in. We suspect that a *binary* counter that is tricked into thinking it is a decimal counter is a good route to follow. Somehow, we must *decode* the counter to find out what state it is really in. The decoded output is an electrical signal that lights up or moves the readout to indicate the proper count. So that's it—we'll need a counter, a decoder and a readout.

The readout

We already voted against Nixie tubes for their price. Ten light bulbs would be nice, but that's at least $4 worth of driver transistors and $2 worth of lamps, jewels and panel work. This leaves little for the counter and nothing for the decoding.

How about a meter? For years, Hewlett Packard used ordinary milliammeters to indicate the least significant states on several of their larger industrial counters. The meters had special scales and the current through the meter was arranged so that the pointer could be only in one of 10 positions—but they were 3", $12 meters.

So, let's update this proved technique. Back to the catalog—Emico's Model 13 horizontal panel meters. All plastic, ¾" wide and less than $3 each, if we do not pick the most sensitive ones. Let's take a 0–10 dc milliammeter and have a special *vertical* 0–9 scale put on it with boxes for each number—no scale markings. Overlap the boxes to gain legibility. Now, put a bright pointer on the whole thing. We have a readout for $2 or so that's as good as any vertical in-line readout going. And, yes, you can get them yourselves in single quantities—see the parts list.

Now, all we have to do is provide 10 discrete currents for the meter to indicate. These currents have to be pretty close—well under 5% if there is to be no question which number the meter is pointing to. We could start with 10 transistor switches, 10 resistors and a regulated power supply, perhaps as in Fig. 2. We'll use an 18-volt supply, high enough that the saturated transistor drops and the drop across the meter will not bother us. Now, we make each resistor provide a suitable current, say 1.1 mA, 2.2 mA, 3.3 mA, and so on.

To go one step better, we provide a little *more* current for each step than we really need and shunt some of the extra current *around* the meter with a calibration pot that [illegible]s get number and pointer positions exactly aligned.

Base current to any transistor provides the proper current to allow the meter to indicate which transistor is receiving current, and our readout is complete. Of course, transistor Q_0 really isn't doing anything, so we can leave it out entirely.

How about some of the other transistors? Can we

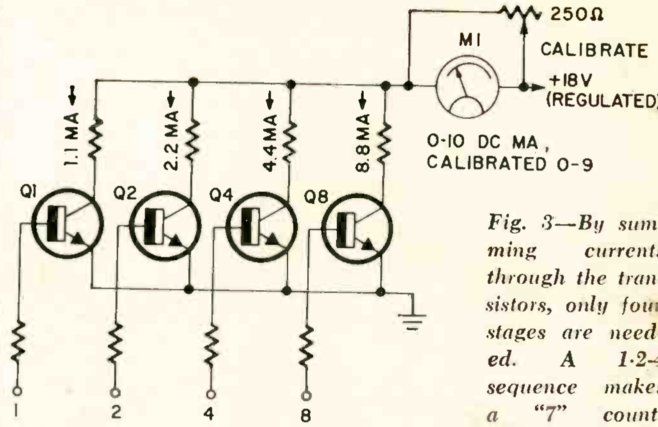


Fig. 3—By summing currents through the transistors, only four stages are needed. A 1-2-4 sequence makes a "7" count.

get rid of a few more? Suppose we *sum* the currents going through the meter, and allow more than one transistor to be on at any one time. If we can get the combinations to line up with the outputs of the base-10 counter, the meter will still give the right answer.

An obvious (but not the best) choice is to use only four transistors and *weight* the currents produced by each transistor in a 1–2–4–8 sequence. To get a 7, we turn on transistors 1, 2 and 4, but *not* 8, giving us 1.1 + 2.2 + 4.4 + 0 = 7.7 mA, or count "7" on our readout. This is detailed in Fig. 3. Note that we save 6 transistors and 12 resistors over the original decoder/driver circuit.

Now we are getting somewhere. Let's refine this decoder/driver slightly, and then we can turn our attention to the counter. The weighting resistors really should be 1% units since most of our positional accuracy is going to be needed for the meter tolerance itself. Also it turns out a 1–2–2′–4 weighting is better than a 1–2–4–8 since it saves us a jumper or two on the circuit board and eliminates an awkward step between counts 7 and 8. We have two transistors weighted "2." Either the 2 or the 2′ transistor can provide 2.2 mA of meter drive. Together they can provide 4.4 mA. We still can get any number on the readout from 0 through 9. Our final decoder/driver circuit is shown in Fig. 4.

Let's turn to the waveforms we'll need at the bases of our driver transistors. One possible combination that is both weighted 1–2–2′–4 and is easy to get out of a counter is in Fig. 5. This is the one we'll use.

Notice that the 2 output comes up on count 2 and stays there for counts 2 through 9, while the 2′ output is used only on counts 4, 5, 8 and 9. The 1 output is used only on the odd counts (1, 3, 5, 7 and 9) and, finally, the 4 output is used only on counts 6 through 9. Taken together, everything adds up to get the right current for the right count.

Our $10 budget still has around $5.80 left after we

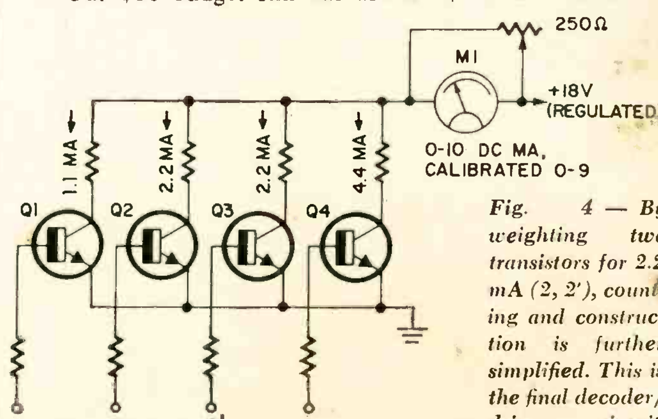


Fig. 4 — By weighting two transistors for 2.2 mA (2, 2′), counting and construction is further simplified. This is the final decoder/driver circuit.

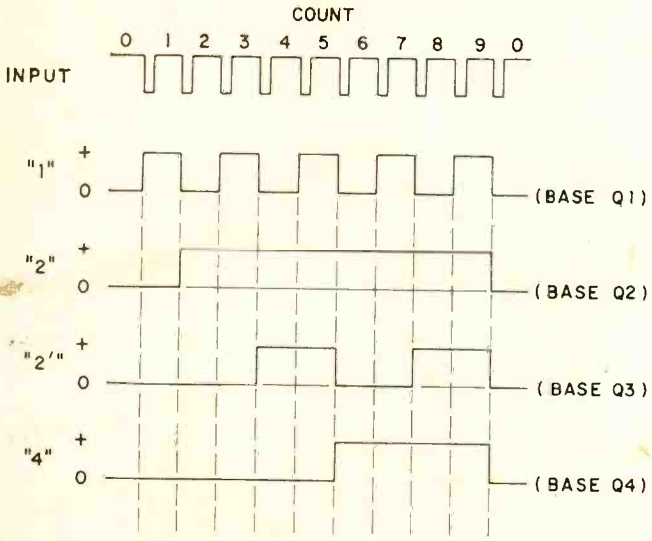


Fig. 5—Waveforms needed on driver bases for correct count.

take out the meter and decoder/driver circuitry. Take out one more dollar for a circuit board, and that leaves $4.80 for a 1–2–2′–4 coded decimal counter. This is easy—we use RTL microcircuits. Two dual flip-flops and a dual gate, and we're home free. Now, all we have to do is figure out how to hook up the counter.

Suppose we take four JK flip-flops and connect them as shown in Fig. 6. This gives us a four-stage binary divider that takes two dual IC's to count to 16. The trick is to somehow convince this type of circuit that it is really a base-10 counter and make it forget the other six states it once knew. We might first note that this connection

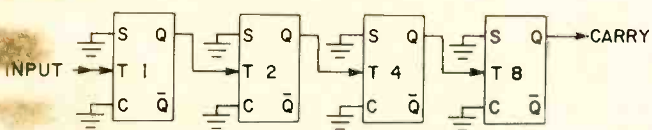


Fig. 6—Four JK flip-flops form a binary divider for a 16 counter.

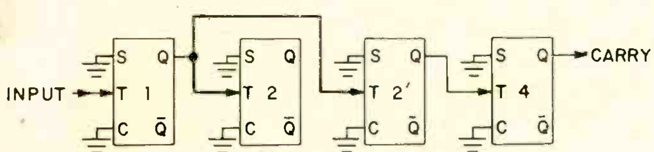


Fig. 7—Connection provides 1-2-2′-4 circuit, but only 8 count.

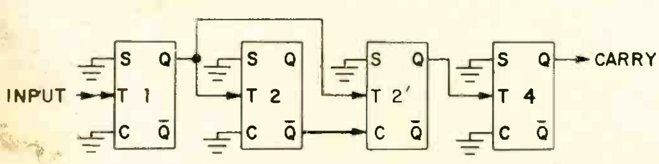


Fig. 8—Hookup inhibits 2′ circuit and corrects 2 and 2′ count.

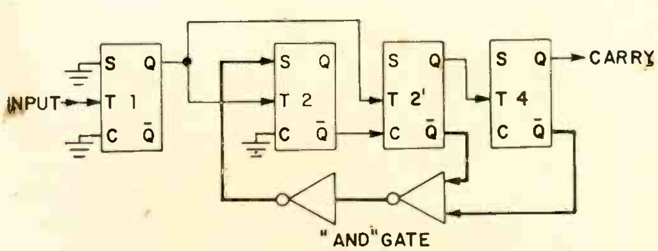


Fig. 9—AND gate inhibits 2 counter for all counts but zero.

Two more examples of how RCA Institutes provides up-to-the-minute Home Training in all phases of electronics:

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&

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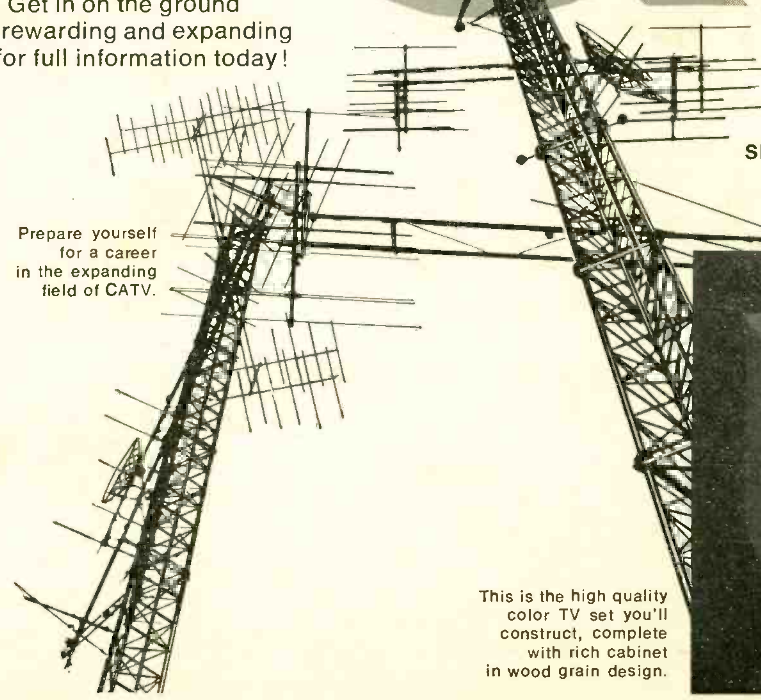
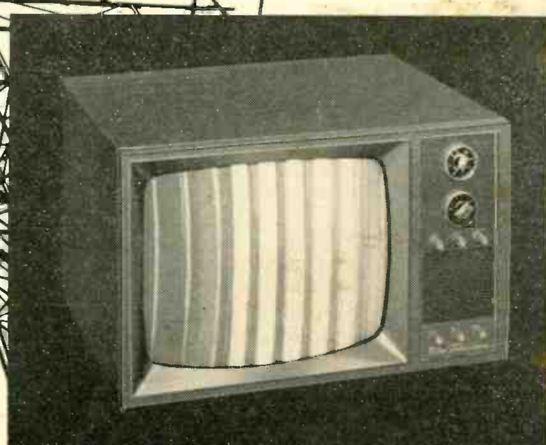


Prepare yourself for a career in the expanding field of CATV.



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Are you just a beginner with an interest in the exciting field of electronics? Or, are you already earning a living in electronics and want to brush-up or expand your knowledge in a more rewarding field of electronics? In either case, AUTOTEXT, RCA Institutes' own method of 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.

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would be a 1–2–4–8 type of deal, so we might rearrange the flip-flops in a 1–2–2′–4 circuit like Fig. 7. Right now, this circuit can count only to 8 and the 2 and 2′ flip-flops are apparently doing the exact same thing.

Now comes the black magic. By lifting some of the grounds on the inputs of the 2 and 2′ flip-flops and by replacing these grounds with signals that change from count to count, we can *inhibit* the operation of these two flip-flops. Look at the timing diagram. We want to inhibit the 2′ flip-flop only when the 2 flip-flop is up, so we add a wire jumper as shown in Fig. 8. That's half the problem. Next, we want to inhibit the 2′ counter *except* for count 0.

We note that *both* the 2′ and 4 flip-flops are up simultaneously on counts 8 and 9 and thus will still be up while awaiting the next count 0. We can add an AND gate to allow this signal to inhibit the 2 counter for every count except count 0, just as shown in Fig. 9. Now, we simply combine both circuits, and out comes our complete 1–2–2′–4 counter in Fig. 10.

You'll find the complete schematic in Fig. 11. IC1 and IC2 are the counter. As these IC's also have a preset

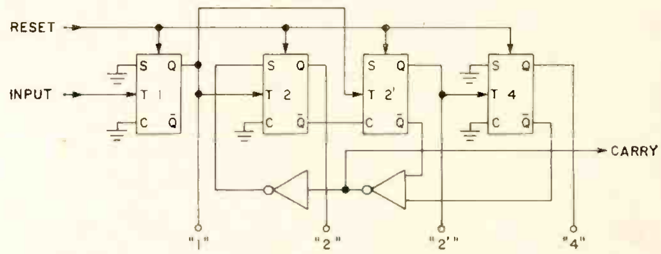
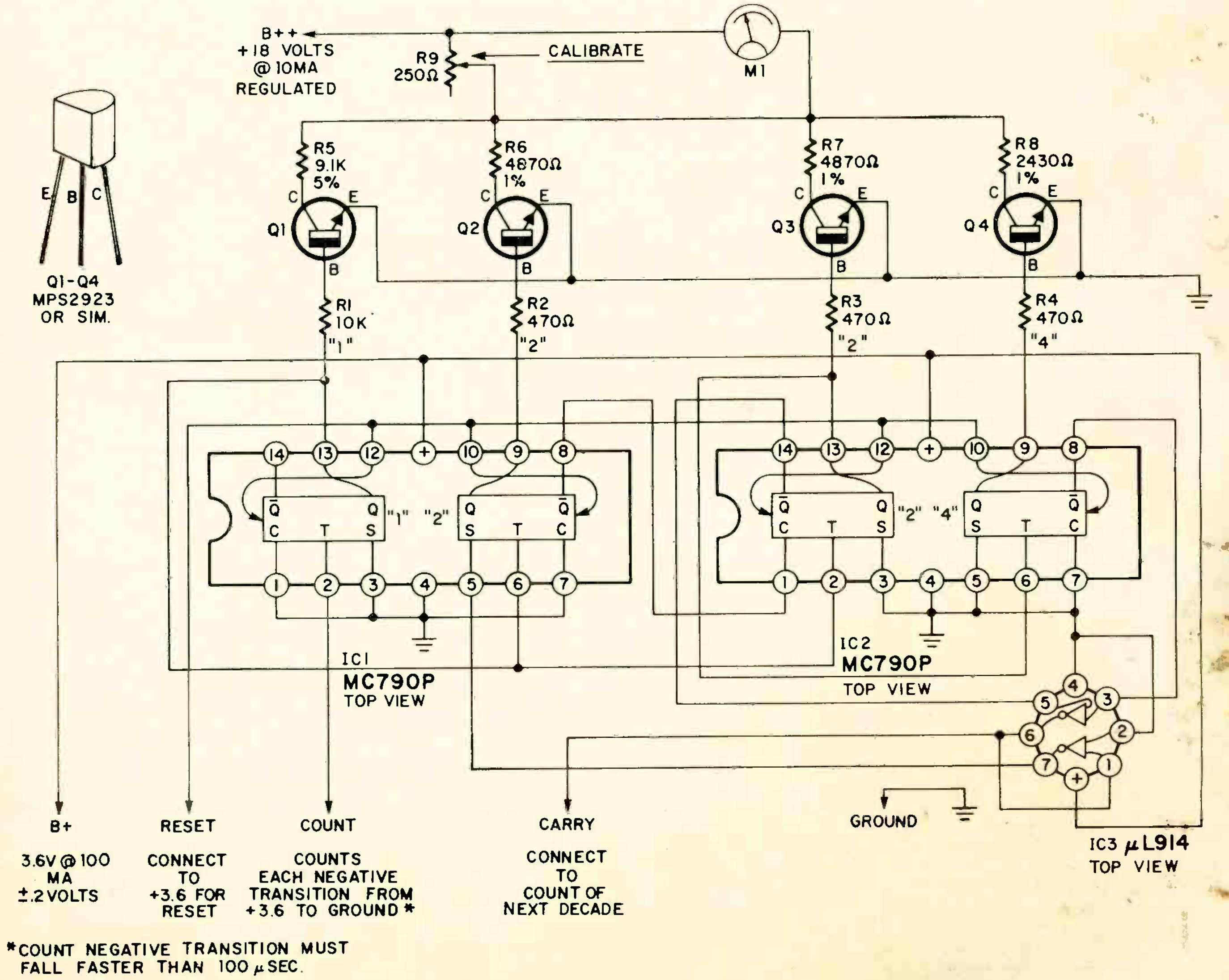


Fig. 10—AND gate and flip flops form complete counter.

PARTS LIST

IC1, IC2—MC790P dual JK flip-flop (Motorola)
IC3—μL914 dual two-input gate (Fairchild)
Q1, Q2, 3, Q4—MPS2923 or similar npn silicon transistor (Motorola)
Note: Data sheets and distributor lists are available from the following respective sources:
Motorola Semiconductor
Box 955
Phoenix, Ariz. 85001
Fairchild Semiconductor
313 Fairchild Drive
Mountain View, Calif. 94041
R1—10,000-ohm, ¼-watt carbon resistor
R2, R3, R4—470-ohm, ¼-watt carbon resistor
R5—9,100-ohm, 5%, ¼-watt carbon resistor
R6, R7—4870-ohm, ¼-watt, 1% resistor
R8—2430-ohm, ¼-watt, 1% resistor
R9—potentiometer, 250 ohms, CTS No. U201-251 or similar
*M1—0–10 dc vertical milliammeter
Circuit board—1-15/16" x 1-15/16" x 1/16" single-sided PC board
MISC: PC terminals (6); wire jumpers (3); No. 6 spade bolts and No. 6 nuts (2); solder.
*Note: The following are available from Southwest Technical Products Inc., 217 West Rhapsody, San Antonio, Tex. 78216. Etched and drilled PC-1 $1.00; meter M1 with special scale $2.25; complete kit of all parts $10.00; postpaid in US.

Fig. 11—Complete schematic of the counter module. IC1 and IC2 are the two dual JK flip-flops and IC3 is the AND gate. Collector resistors on Q1–Q5 determine weighted current to the meter. Count pulses must have falltime less than 100 nsec.



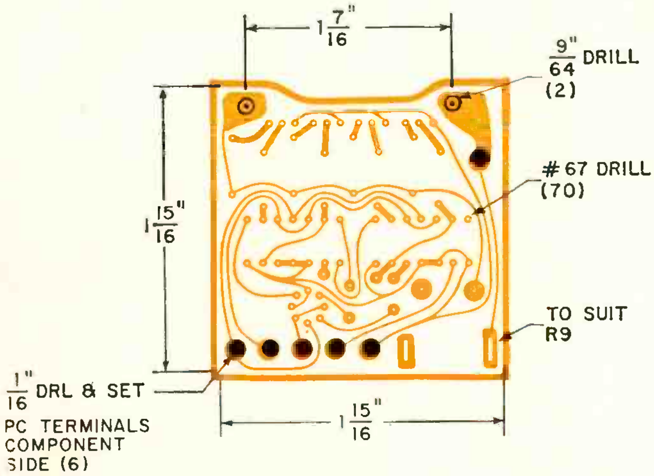


Fig. 12—This 1 15/16"- square PC board will mount on meter.

input, we bring out a common lead that gives you the RESET terminal that automatically resets the counter to 0. IC3 is the AND gate. Transistors Q1 through Q4 drive the meter through weighted precision resistors R5 through R8. R1 had to be a bit bigger than the other base-driving resistors to eliminate a loading problem on IC1.

Two power supplies are required, a regulated 18 volts at 10 mA and a ripple-free +3.6 volts at 100 mA for the IC's. Your COUNT signal should normally be positive, say from +1.5 to +4 volts, and abruptly *drop* to zero whenever a count is desired. *This signal MUST come down only once per count and MUST come down faster than 100-nsec fall time.* If you want to count anything but good square waves, you'll have to "process" your input signals in some simple circuitry we'll talk about later. You'll also find that pushbuttons and mechanical contacts will have to be made bounceless. Once again, this is easily accomplished in a simple circuit.

The CARRY output of any decimal counting module will directly drive the COUNT input of the next module down the line, and you simply cascade as many counting units together as you wish. Four is typical, and allows measurement from 0.1% to 0.01% accuracy.

The RESET input is normally left grounded. To reset the counter, simply apply +1.5 to +4 volts of dc to this input.

The integrated circuits used are guaranteed to operate at an 8-MHz rate, but all the modules we have tested go well beyond 10 MHz. You'll find the meter movement's inertia automatically blanks any high-speed counting, eliminating the need for the strobe or storage circuitry often used in fancier industrial designs.

Construction

Your decimal counting module can be built onto a 1 15/16" square printed-circuit board that mounts directly on the meter terminals. You can buy this circuit board ready to go, but if you prefer, you can lay out, drill and etch your own circuit card, simply by following the layout guide in Fig. 12. Three wire jumpers are needed as shown. The

(continued on page 94)

COMING

Next month, we'll talk about power supplies, input conditioning, time bases and other things that will show you how to build many practical digital readout instruments at a very low cost using these decimal readouts.

69

Electrons and Magnetic Fields

An expert describes an easy-to-follow substitute for the left- and right-hand rules

By James G. Holbrook*

BASIC ELECTRICITY AND MAGNETISM theory often seems dull and dry. We're impatient to hurry on to things more practical and interesting, and consequently we often continue to learn electronics while still uncertain about elementary principles.

I've selected a few short problems which are useful to detect any uncertainty you may have about electronic motions in magnetic fields. Several of these questions have made research engineers and physicists reconsider basic theory.

Fig. 1-a shows the arbitrary but standard definition of the direction of magnetic flux lines as being from the North to the South pole of a magnet. Fig. 1-b thus implies there is a North pole somewhere above the page, with the crosses indicating flux directed into the page.

Stop! Before reading further, examine the two problems in Fig. 2. Part (a) is a Faraday disk generator, showing a conducting disk rotating clockwise on its axis, and with a uniform magnetic field into the page. The disk is of nonmagnetic material, and thus the field is uniform through. as well as around, the disk edges. Brushes touch the center and outer rim of the disk, and motion of the conducting disk in the field causes a voltage to appear at the terminals.

*Research Fellow,
University of Southampton, England

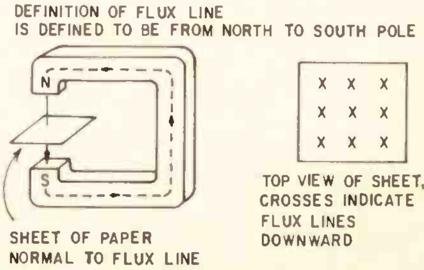


Fig. 1-a—Magnetic flux lines are arbitrarly defined as being from North to South poles of a magnet; (b) crosses represent field directed from above into page.

The problem is which terminal is positive and which is negative. Make a definite choice and don't change; there are of course only two possibilities. Use any method.

Next, look at part (b) which shows the face of a cathode-ray tube with the beam normally striking the exact center of the screen. However, with two magnets around the neck will the beam be deflected to position a, b, c or d? Again make a definite choice.

If you were uncertain about your answers, you will probably find the following new concepts interesting.

First, make a clean break with the traditional left- or right-hand rules. just as many have done with the idea of an external current from positive to negative. Second, consider a new Electron Orbit Rule:

> *When an unrestrained electron moves in a plane normal to a magnetic field, it will circle clockwise when the field is directed away from the observer.*

This new rule is illustrated in Fig. 3. Part (a) shows the field directed away from the observer, and the electron, upon entering normal to the field, begins to circle clockwise. Part (b) shows a symbol which may be used to remember the rule: One flux line into the page, and the orbit or path of one electron. The following applications show how this concept is applied. This

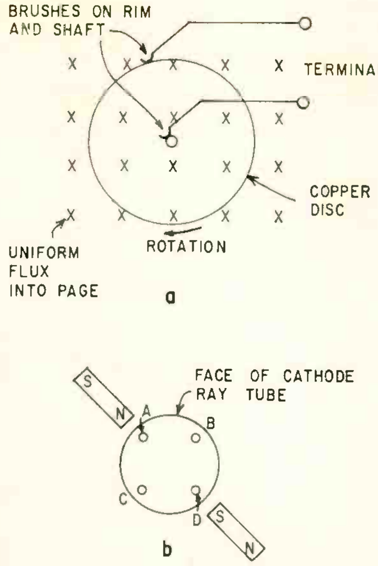


Fig. 2-a—What is polarity of terminals touching rim and shaft of Faraday disk generator rotating in uniform magnetic field? b—With magnets fixed as shown, will light spot deflect to a, b, c or d?

is called the "Electron Orbit Method."

In Fig. 4 an enlarged view of a conductor is shown at rest in a magnetic field. Connecting wires to an external battery will cause a current of electrons to move from the negative terminal into the region of the field. But the Electron Orbit Rule says the electron must circle clockwise, thus it strikes the inside of the wire-to-air boundary (shown by the dotted line), and exerts a force to the right of the wire.

This particular electron is now at rest. It immediately begins to move again, however, because of the attraction from the positive end of the battery. As soon as it gets up speed, it

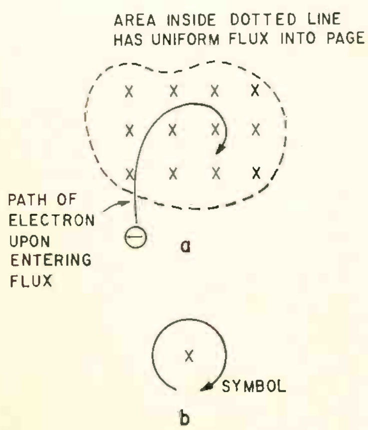


Fig. 3-a—Electron circles clockwise when entering field directed away from observer. b—Electron Orbit Rule symbol.

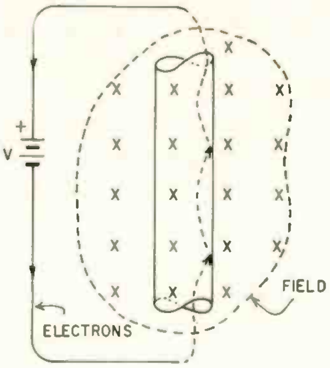


Fig. 4—Motor action is illustrated by electrons striking right hand boundry of conductor, forcing wire toward the right.

again circles clockwise in accordance with the rule, striking the wall. This boundary is very real, as the electron is free to move inside the wire, but strikes a solid wall at the boundary and cannot get through unless the wire is heated to emission temperature, as in a cathode.

You might wonder how a small electron could exert much force upon striking the inside boundary. But remember there are 6.28×10^{18} electrons passing a given point on the wall each second for each ampere of current, and the combined effect is to move the wire.

A wire is shown at rest in Fig. 5-a. No connections are made to the ends. This wire is uncharged, and therefore its free electrons are uniformly distributed up and down the wire. One free electron is shown at the center. We again have a field into the page.

If this wire is physically pulled to the right (not rotated), the electron, being inside the wire, is pulled along with it to the right. But the Electron Orbit Rule says the electron moves clockwise. Hence the electron in the wire follows the clockwise dotted line as the wire moves to position (b). Of course all the free electrons behave in the same way, and the bottom of the wire becomes highly negative. The wire must be kept in motion, or the electrons will merely uniformly redistribute themselves.

The problem in Fig. 2 should now be simple. In part (a) choose any electron at rest in the disk, then start rotating the disk. This first starts the electron in a line normal to the radius. But once moving, it must, by our rule, circle clockwise (toward the axis) and thus the center of the disk, or the lower terminal, is negative.

In part (b), the field is directed downward to the right, and when viewed from alongside the South pole

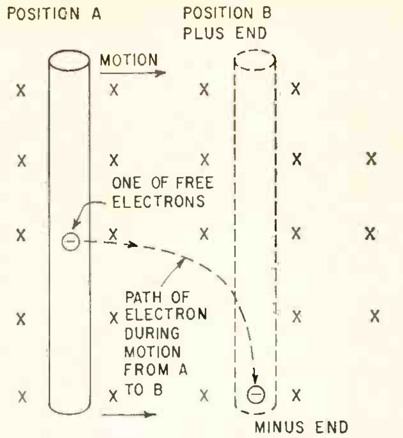


Fig. 5—Generator action is shown as wire is pulled from position (a) to position (b) and electrons move to lower end of wire.

of the upper magnet goes through the glass away from us. The electrons are then rushing into the field from our left and circle clockwise, striking the screen at "c."

With a little practice you can easily re-orient fields and electron orbits to any position. Try applying the new rule to a one-turn loop passing through a field. Remember, it really makes no difference whether the field moves toward the electron or the electron moves toward the field.

The technique will show what sort of potential difference appears on opposite sides of a wire in a field as current passes (the Hall effect in physics), and polarities of voltage induced in transformer secondaries, etc. New applications and even new ideas in electronics will occur as you become familiar with the interaction of electrons and magnetic fields. **R-E**

"After you two have your fun would you do something about this filling that receives radio broadcasts?"

73

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AUDIO LEVEL CONTROLLER, *Model M62,* is a transistorized variable-input-level controlling device especially designed to keep its electrical output constant. Power supplied by a self-contained 9V battery or by an auxiliary dc power

supply. Input impedance: from 100,000 to 500 ohms; output impedance: 500 to 10 ohms. Frequency response: flat 20 to 20 kHz ±2 db; signal-to-noise ratio: with respect to 10-microbar input, 60 db; distortion: any input and distance selector position: 3% maximum. $90 with 1-year guarantee.—**Shure Brothers Inc.**

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TRANSISTOR ANALYZER, *Model 3490-A, Type 2,* portable, solid-state. Continuous instrument monitoring, overload interlocked switching circuits and

test collector current ranges from 100 μA to 30 A. Three independent power supplies and 4½-in. meters. Two test sockets at panel top for in-line type and types where leads are grouped in a circle or square on the bottom. $441.—**The Triplett Electrical Instrument Co.**

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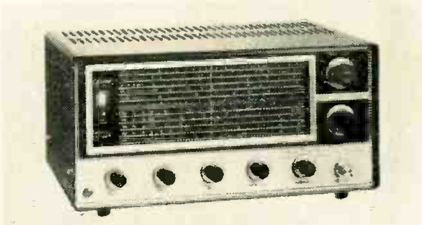

MHz. Push-pull audio stage with thermistor for low distortion and a headphone jack for private listening. Powered by 117 Vac or 12 Vdc. $99.95.—**Allied Radio Corp.**

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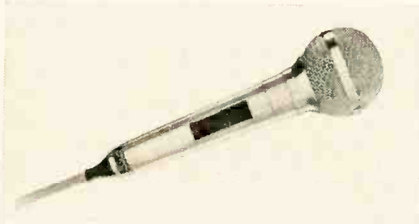
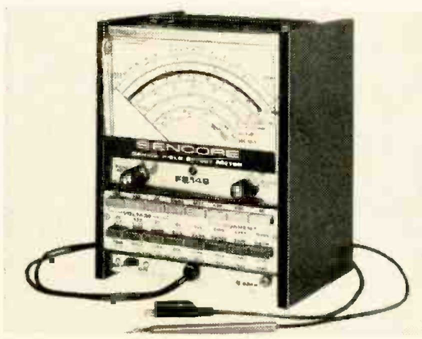


50 to 15,000 Hz. *DM70-250-B*—impedance: 10K; sensitivity: —66 dB re 1 volt per dyne/cm² at 1 Hz; response: 50 to 16,000 Hz. *DM70-550-B*—impedance: 200 ohms; sensitivity: —59 dB re 1μW per 10 dynes/cm²; response: 40 to 18,000 Hz. All made of lightweight, easy-to-handle die-cast metal and finished in nonreflecting brushed chrome. Ball of the mike is designed to control voice popping and wind noise.—**Sonotone Corp.**

Circle 50 on reader's service card

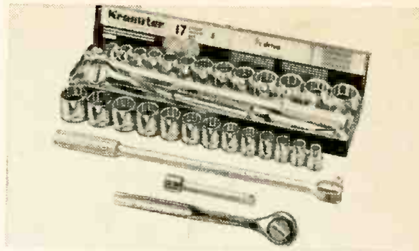
FIELD-EFFECT TVM, *FE149,* provides 8 dc voltage ranges to 1500V. A 0.5V low scale with 0.25V either side assures measurements to less than 0.1V for transistor bias measurements. Eight ac ranges are provided to 1500V rms and 4500V peak to peak. Operates on ac power, on



its self-contained rechargeable batteries or on ac with the batteries plugged in. Pushing one button in the top row to select function and one button in the bottom row for range to make any circuit test. Nonbreakable, scuff-resistant vinyl-clad steel case. $149.00.—**Sencore Inc.**

Circle 51 on reader's service card

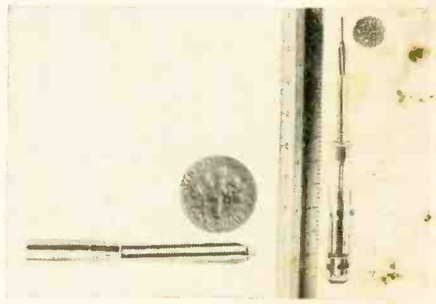
DRIVE SOCKET SET, *No. 30317.* A 17-piece set of ½" drive sockets, handles and accessories plastic-sealed in a 17" long steel case. Also included are 13 thin-wall sockets, 7/16" through 1¼", a 5" extension and a 17" flex handle. All com-



ponents are double-nickel chrome-plated against corrosion, and fully guaranteed. $39.98.—**Kraeuter Tools, Subsidiary of Dresser Industries, Inc.**

Circle 52 on reader's service card

SCREWDRIVER, *Model 1253-B,* made with 3" spring-steel blades hollow ground to 0.012" thickness and a shockproof, unbreakable Tenite II handle. Will hold, start and drive screws as tiny as No. 0-80 and similar sizes. Useful to craftsmen



involved in repair or manufacture of sensitive timekeeping or miniaturized precision electronic equipments and instruments. $1.50. Fourteen other sizes are available, ranging from midget to small, medium and heavy-duty, with blade lengths from 2" to 14".—**Kedman Co.**

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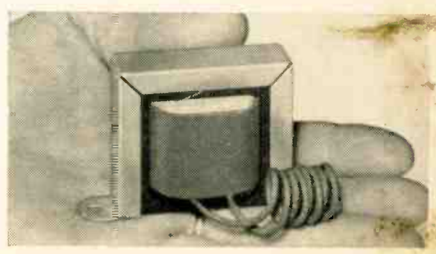
ISOLATION TRANSFORMER, *P-6411.* Reduces shock hazard by isolating equipment from the power line, is rated 117V to 117V at 15VA. Measuring 2" x 3¼" x



1⅞", it is particular useful to equipment manufacturers, experimenters and hobbyists. Less than $6.—**Controls Div. of Essex Wire Corp.**

Circle 54 on reader's service card

CB TRANSCEIVER, *Cobra 98,* has built-in SWR bridge and 3-scale meter. Includes dual transistor power supply for 117 Vac and 12 Vdc. Double-conversion reception and 23 channel 100% modulated transmission. Comes

with a coil-cord ceramic mike. Measures 5¼" x 13⁷⁄₁₆" x 8½" and weighs 16 lbs. $239.95.—**B&K Communications Div.**

Circle 55 on reader's service card

AUTOMATIC TURNTABLE, *SL95.* Two motors. Induction section imparts instant start and driving torque. Synchronous section is governed by 60-cycle electric current. Light-weight, balanced tone arm eliminates vibration. Record platform rises at the push of a

button for auto play and lowers for manual play. Built-in calibrated stylus pressure gauge, adjustable sliding counterweight isolated in rubber, anti-skating control and a snap-in cartridge clip. $129.50.—**Garrard Div. of British Industries Co.**

Circle 56 on reader's service card

CB TRANSCEIVER, *Model CWT-50,* 5-watt, switchable, crystal-controlled 6-channel operation, with crystals supplied for Channel 9, uses three IC's. Antenna with power-boost loading coil; die-cast metal enclosure with separate mike and speaker. Optional ac power supply. Measures 10½" x 2¾" x 2¾" and weighs 2¾ lbs. Comes with earphone, hand and shoulder straps.—**Courier Communications Inc.**

Circle 57 on reader's service card

IN-CIRCUIT TRANSISTOR CHECKER *Model IT-18* measures dc beta in or out of circuit in 2 ranges from 2 to 1000; tests diodes in or out of circuit for forward and reverse current to indicate opens or shorts; measures transistors out of circuit for I_{ceo} and I_{cbo} leakage; provides identification of pnp or npn devices and anode or cathode of unmarked diodes. Also includes a 4½" 200-μA meter and a 10-turn calibrate control. Power is sup-

plied by a D-cell. $24.95 with attached 3' test leads and a polypropylene case with cover.—**Heath Co.**

Circle 58 on reader's service card

ROLLS RADIO, *No. P685,* is made of heavyweight hand cast metal antiqued in silver. Houses standard transistor radio. Ornamental 1933 Rolls replica, unit is battery powered. $29.95.—**Monogram Mail Order Sales.**

Circle 59 on reader's service card

UHER TAPE RECORDER, *Royal Deluxe Model 10,000,* includes 4 speeds; built-in Dia Pilot for sound/slide synchronization; sound-on-sound; sound-with-sound; echo effect. Also, it features 4-track head-assembly modules, interchangeable in minutes; hysteresis-synchronous motor, output power rating of 10 watts per channel rms. Tape slippage is relatively impossible and it is transported at a speed constancy of

0.025% (wow and flutter specification at 7½ ips). Walnut carrying case with plastic lid. Unit operates in any position; frequency response 20–20,000 Hz ±2 dB at 7½ ips.—**Martel Electronics**

Circle 60 on reader's service card

AUDIO-VIDEO TAPE RECORDER, *Model 1000* combines a 4-track stereo and a video tape recorder, utilizing ¼" magnetic recording tape. Maximum reel size 7". Remote-control pushbutton selection for AUDIO or VTR operation. For VTR operation: tape speed, 11¼" ips; recording

time, 37 minutes; video input, 1.4 V p-p (sync negative) 75 ohms. For AUDIO operation: tape speed, 7½ and 3¾ ips; frequency response, 30 to 18,000 Hz ±3 dB at 3¾ ips; distortion, within 1.5% at 1kHz 0 VU; S/N ratio, better than 50 dB. Under $1000. Accessories, TV monitor and camera available.—**Califone-Roberts Div. of Rheem Mfg. Co.**

Circle 61 on reader's service card

ELECTRONIC THERMOTESTER, *Thermy,* measures temperature of any component from −60 to 400°F (−50 to 200°C). Sensitive unit at probe tip reacts instantly upon physical contact, reads out electronically in conjunction with a multitester or ohmmeter. Simple conversion scale translates values from ohms to degrees. Comes with banana pins and phone tip adapters. $12.50.—**Mura Corp.**

Circle 62 on reader's service card

PA AMPLIFIER, *Model UT-35,* has one microphone input, as well as a phono and auxiliary input. Power output is 35 watts on 120 Vac and 32 watts on 14.7

Vdc. Both outputs at less than 10% distortion. Output impedances are 4, 8, 16 ohms, plus 25 and 70 volt line. Measures 7⅞" x 16" x 11" and weighs 25 lbs. $200.00—**Bell P/A Products Corp.**

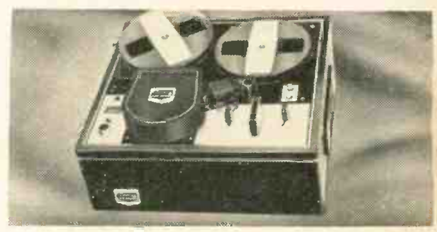
Circle 63 on reader's service card

RADIO KIT LINE consists of two kits; *Model No. 2001 Comancho* transistor radio retails for $19.95 and *Model No. 2002 Scallon* table radio retails for $21.95. Both are designed to teach children and adults important electronic

knowledge and skills and to be built by individuals ages 12 and older. Included with each kit are all necessary parts and fittings and an instructional manual which is very easy to follow.—**Graymark Enterprises Inc.**

Circle 64 on reader's service card

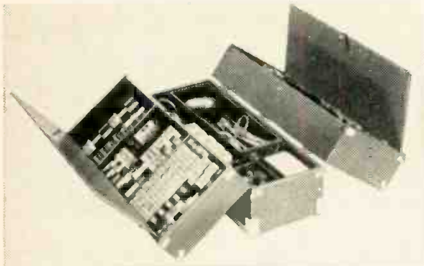
VIDEO TAPE RECORDER, *Model 6402,* with full-field, slant-track, two-head frequency-modulated recording system. Uses ½-in. magnetic tape at 9½



ips tape speed for maximum **50** or 60 minute recording or playback time on either 7 or 8¼-in. reels. Audio re-record is possible without disturbing the video portion. Measures 18½ x 10¼ x 17½-in., weighs 59 lbs. $1200.—**Craig Products Div. of Craig Corp.**

Circle 65 on reader's service card

SUPER 600 TUBE CADDY is a case of over 3300 cubic inches in volume to hold countless tubes, tools, soldering guns, meters and accessories. Heavy 16-gauge steel runners protect the bottom, bottom edges and bottom corners from damage. Special construction allows the upper foldout sections and covers to rest on the



floor when open, giving instant access to all compartments. To go with its rugged construction is a gray vinyl finish.—**Argos Products Co.**

Circle 66 on reader's service card

AUDIO CONNECTOR ADAPTERS, two models; *Part Nos. 389* and *430*. The former accepts two 3-pin audio connectors to interconnect two pieces of equip-

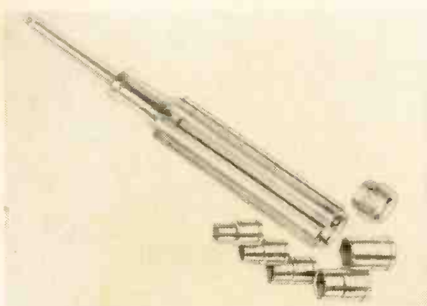
ment or two cables having male output connectors. The latter connects equipment or cables having two 3-pin female audio connector inputs.—**Switchcraft Inc.**

Circle 67 on reader's service card

FIBER OPTIC PENLIGHT, *Speck-O-Lite, Part No. SL-11* consists of one standard penlight with light-guide adapter; two "AA" batteries; and one foot of fiber-optic light guide, which may be cut to desired length. Unit can be carried in the pocket. Useful for hard-to-see product inspection, repairs and troubleshooting. $3.29.—**Kurz-Kasch, Inc.**

Circle 68 on reader's service card

SOCKET NUTDRIVER SET, *Model No. 30999*, has five ¼-in. drive sockets (¼ thru ½-in.) in a hollow spinner han-



dle. Sockets have extra-thin walls, are nickel chrome-plated against rust and corrosion.—**Kraeuter Tools**

Circle 69 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 74 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

1969 ELECTRONICS CATALOG *No. 280*, 536-page illustrated buyer's guide covering the latest range of TV sets and components, 2-way CB radio equipment, hi-fi systems, ham gear, tools, hardware, and electronic kits.—**Allied Radio**

Circle 70 on reader's service card

1969 ELECTRONICS CATALOG, *No. 690*, 512 pages, fully illustrated with 57 pages in 4 color. Features hi-fi equipment, latest citizens band 2-way radios, test equipment, ham gear, optics, tools, books, musical instruments, and complete listings of all major lines of electronic parts.—**Lafayette Radio Electronics**

Circle 71 on reader's service card

MACHINED ALUMINUM KNOBS, *Catalog K-688*, 6 pages. Details six new series of knobs including standard, miniature, skirted, deluxe and various knurled types. Anodizing process for colors of natural aluminum, ebony, or soft gold.—**Alco Electronic Products, Inc.**

Circle 72 on reader's service card

ANTENNAS. Two catalogs: *No. 402-ILL.* 6 pages, describes briefly a series of outdoor antennas. Models included are for uhf/vhf/FM, vhf/FM, uhf and FM. Uhf converters and accessories are also outlined. *No. 404-SL*, 4 pages, features a Monitor series of six indoor antennas for uhf-vhf-FM and vhf-FM plus accessories.—**Gavin Instruments, Inc.**

Circle 73 on reader's service card

ANTENNA EQUIPMENT, *Catalog No. SYS-68*, 16 pages, covers broadband and single channel antennas: broadband and single channel head end amplifiers, active and passive accessories: filters and traps; tapoffs, matching transformers and wallplates; preamplifiers, amplified couplers, connectors and cable.—**JFD Electronics Co.**

Circle 74 on reader's service card

ANTENNA ROTOR. 4-page catalog describes how *Dyna-Rotor* combines solid-state circuitry and a spline drive for greater efficiency. Cutaway diagrams show how unit works.—**Jerrold Electronics Corp.**

Circle 75 on reader's service card

CAPACITOR CATALOG, *68/69 Component Selector* devotes 119 pages to help user select proper stock items designed to meet his requirements. The capacitor reference data provide detailed background regarding capacitor, standardization and rating selection. It also includes application charts, type selector charts and standard-rating selector tables.—**Cornell-Dubilier Electronics**

Circle 76 on reader's service card

ELECTRICAL COMPONENTS. Tabloid type 8-page catalog lists components such as tunnel diodes, integrated circuits, integrated amplifiers and many semiconductors. Fiber-optic devices, meters, switches and other components are also included.—**Poly-Paks Inc.** **R-E**

Circle 77 on reader's service card

There's A "Just Right" Heathkit®

NEW kit AD-27

$169.95

NEW HEATHKIT AD-27 FM Stereo Component-Compact

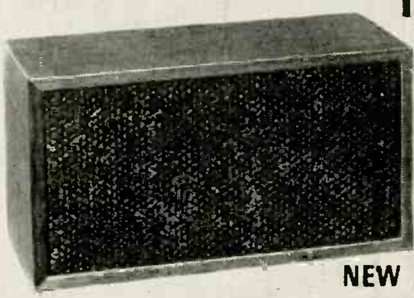
This new Heathkit AD-27 stereo compact has features not found in other units costing twice as much for one very simple reason. It wasn't engineered to meet the usual level of compact performance. Instead, Heath took one of its standard stereo/hi-fi receivers, the AR-14, and re-arranged it physically to fit a compact configuration. The result is performance that is truly high fidelity without compromise. It features 31 transistor, 10 diode circuitry with 15 watts per channel dynamic music power (enough to let you choose most any speaker system you prefer), full-range tone controls, less than 1% distortion, and 12 to 60,000 Hz response. The pre-assembled FM stereo tuner section with 4-stage IF offers 5 uV sensitivity, excellent selectivity, AFC, and the smoothest inertia tuning. The BSR McDonald "500" turntable offers features usually found only in more expensive units . . . like low mass tubular aluminum tone arm, anti-skate control, cueing and pause control, plus a Shure magnetic cartridge with diamond stylus. It's all housed in a smart oiled walnut cabinet with sliding tambour door that disappears inside the cabinet. For value and performance choose the AD-27, the new leader in stereo compacts. Shpg. wt. 41 lbs.

NEW kit AD-17

$109.95

NEW HEATHKIT AD-17 Budget-Priced Component-Compact

Heath engineers took the stereo amplifier from the AD-27 above, matched it with the top rated BSR McDonald 400 Automatic Turntable and put both of these able performers in an attractive walnut cabinet. The result is the high performance, low cost AD-17. The all solid-state circuit delivers 15 watts music power per channel — more than enough to drive any reasonably efficient system. Wide response of 12 Hz to 60 kHz ±1 dB and harmonic & IM distortion both less than 1% at full output are your guarantee of clean, full range sound. Stereo headphone jack, filtered tape outputs and Tuner & Auxiliary inputs too. The BSR McDonald 400 Automatic Turntable features a cueing and pause control, adjustable stylus pressure, variable anti-skate control and manual or automatic operation on all four speeds. Comes complete with a famous Shure magnetic cartridge. The Heathkit manual makes it easy to build . . . the sound makes it a pleasure to own. Order yours now. 27 lbs.

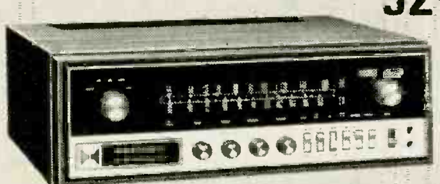


NEW kit AS-18

$32.95

NEW HEATHKIT AS-18 Miniature Acoustic Suspension System

The new AS-18 features famous high quality Electro-Voice® speakers — 6″ woofer and a 2½″ tweeter. The wide frequency response of 60 Hz to 20 kHz and the clear, natural sound of these miniature systems will really amaze you. They're the ideal performance mates to the Component Compacts above and are especially suited for apartments, mobile homes, offices, etc. — anywhere that you need superior stereo sound from a small space. Handles up to 25 watts program material and has a high frequency balance control so you can adjust the sound to your liking. Order 2 for superb stereo now. 16 lbs.



kit AR-15 $339.95*

Wired ARW-15 $525.00*

HEATHKIT AR-15 Deluxe Stereo Receiver

The World's Most Sophisticated, Most Praised Stereo Receiver. And here are just a few of the reasons why leading audio critics and testing organizations, as well as thousands of owners rate the AR-15 as THE stereo receiver. The all solid-state circuit with 69 transistors, 43 diodes and two integrated circuits has many new design concepts to deliver superior performance. The amplifier section has 150 watts of music power . . . 75 watts per channel. Harmonic and IM distortion are both less than 0.5%. The special design FET FM tuner boasts sensitivity of 1.8 uV, selectivity of 70 dB and harmonic & IM distortion both less than 0.5%. The Crystal Filters provide an ideally shaped bandpass and are a Heath first in the high fidelity industry. You'll hear stations you didn't even know existed in your area, and the Noise-Operated Squelch, Adjustable Phase Control, Stereo-Only Switch, Stereo Threshold Control and FM Stereo Noise Filter Switch will let you hear them in the clearest, most natural way. Other features include two front panel stereo headphone jacks, positive circuit protection, loudness switch, speaker switch, front panel input level controls, recessed outputs, two external FM antenna connectors and one for AM, Tone Flat control, electronically filtered power supply and "Black Magic" panel lighting. Seven circuit boards and three wiring harnesses simplify assembly and you can mount your completed AR-15 in a wall, your own cabinet or the Heath assembled walnut cabinet. For the ultimate in a stereo receiver, order your AR-15 now. 34 lbs. *Optional walnut cabinet AE-16, $24.95.

NEW kit AJ-15

$189.95*

HEATHKIT AJ-15 Deluxe Stereo Tuner

For the man who already owns a fine stereo amplifier, Heath now offers the superb FM stereo tuner section of the AR-15 receiver as a separate unit. The new AJ-15 FM Stereo Tuner has the exclusive FET FM tuner for remarkable sensitivity, exclusive Crystal Filters in the IF strip for perfect response curve and no alignment; Integrated Circuits in the IF for high gain, best limiting; Noise-Operated Squelch; Stereo-Threshold Switch; Stereo-Only Switch; Adjustable Multiplex Phase, two Tuning Meters; two Stereo Phone jacks; "Black Magic" panel lighting. 18 lbs. *Walnut cabinet AE-18, $19.95.

NEW kit AA-15

$169.95*

HEATHKIT AA-15 Deluxe Stereo Amplifier

For the man who already owns a fine stereo tuner, Heath now offers the famous amplifier section of the AR-15 receiver separately. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Low Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (±1 dB, 8 to 40,000 Hz at 1 watt); Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; All-Silicon Transistor Circuit; Positive Circuit Protection. 26 lbs. *Walnut cabinet AE-18, $19.95.

Gift For Everyone On Your List

Heathkit MI-18 Solid-State Tachometer

The Professional Tach. That's the new Heathkit MI-18. **In Design**: breaker point, "tach" lead or unique inductive pickup connection; use it with any spark-type engine and any ignition system, 2 cycle 1-6 cyl. engines or 4 cycle, 2-8 cyl. engines . . . all electronics are in the tach itself. **In Performance**: 0-6000 & 0-9000 RPM ranges . . . 250° edge-lighted dial . . . temperature-compensated, ±4% accuracy from 0° —120° . . . adjustable red line pointer . . . 10.5 to 17.5 VDC operation. **In Styling**: stainless steel hardware, splash-proof black & chrome case and scratch-proof glass face for use in rugged conditions. The MI-18-1 mounts in your dash — requires only a 3¼" hole & 2¼" depth. The MI-18-2 comes with mounting case & hardware. Put a Professional Tach in your car, boat, dune-buggy, or bike now — the Heathkit MI-18! Shpg. wt. 3 lbs.

NEW kit MI-18-1
29^{95} Panel Mount

NEW kit MI-18-2
32^{95} With Case

Heathkit GR-17 Solid-State AM-FM Portable Radio

Here's performance the others can't match. The new Heathkit GR-17 portable has a 12 transistor, 7 diode circuit with the same front end as used in Heathkit hi-fi tuners. AM or FM at the flick of a switch and what reception! Big ½" ferrite rod antenna, three tuned transformers and amplified AGC pull in more AM stations. The FM section features a collapsible 34" whip antenna, three IF stages and 5 uV sensitivity for reception over greater distances than you would expect from a portable. The 4" x 6" speaker and an audio output of 350 mW provides clean sound and the GR-17 will keep you entertained for up to 300 hours on a single set of batteries. For the greatest sound everywhere, get your GR-17 today. 5 lbs.

NEW kit GR-17
43^{95}

NEW HEATHKIT HW-100 SSB-CW 5-Band Receiver

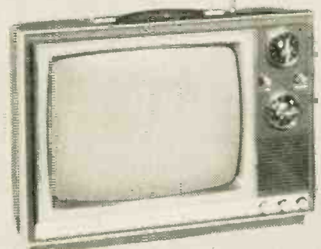
The new Heathkit HW-100 has all the features and performance of the competition at a money saving kit price. And here's what it delivers: the receiver portion has sensitivity of less than 0.5 uV for a 10 dB S+N/N ratio for SSB. Crystal filter selectivity is 2.1 kHz at 6 dB down, 7 kHz at 60 dB down. Image & IF rejection are better than 50 dB. The transmitter has a 180 watt input on either USB or LSB and 170 watts on CW. It operates PTT or VOX on SSB and break-in CW work is provided by operating VOX from a keyed tone, using grid-block keying. Outstanding frequency stability — less than 100 Hz per hour drift after 30 minute warmup . . . less than 100 Hz variation under a 10% line voltage variation. The HW-100 is a really loaded rig — solid-state (FET) VFO . . . 80-10 meter coverage . . . patented Harmonic Drive™ dial mechanism . . . built-in 100 kHz calibrator . . . TALC and much more. Put this hot rig in your shack — order your HW-100 today. 22 lbs.

NEW kit HW-100
240^{00}

HEATHKIT GR-104A Solid-State Portable B&W TV

The perfect portable . . . that's the GR-104. Small and light enough to carry from room to room . . . rugged enough to take it . . . and the picture is the sharpest, most realistic you've ever seen, thanks to Heathkit total engineering. 74 sq. in. viewing area . . . all solid-state circuit for extra reliability and performance . . . covers all VHF and UHF channels, 2-83 . . . 2-speed UHF tuning . . . "memory" VHF fine tuning . . . 3-stage IF for maximum gain with controlled bandwidth . . . gated AGC for steady, jitter-free pictures . . . transformer regulated power supply . . . circuit breaker protection . . . one-piece swing out chassis for easy assembly and servicing . . . runs on house current or battery power with the optional GRA-104-1 rechargeable battery pack. 27 lbs.

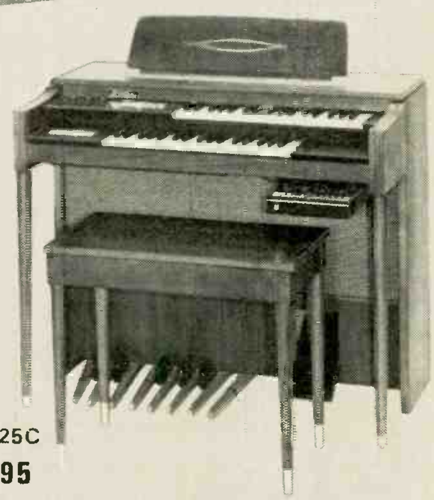
GRA-104-1, 9 lbs. **$39.95**



kit GR-104A
119^{95}

HEATHKIT GD-325C Low Cost Solid-State Organ

This money-saving kit form of the popular Thomas "Artiste" Organ can have you playing songs after just 50 hours of interesting, enjoyable assembly, thanks to the clear, easy-to-follow Heathkit manual and exclusive Thomas Color-Glo teaching method. Features 10 true organ voices . . . variable repeat percussion . . . 13 note heel and toe bass pedals . . . 2 overhanging 37 note keyboards, range C2 thru C5 each . . . 75 watt peak music power amplifier . . . 12" full response speaker . . . Vibrato . . . manual balance control . . . and the solid-state plug-in tone generators — the heart of the organ, are guaranteed for 5 years. Assembled walnut-finish cabinet included. Discover the fun and enjoyment of live music in your home . . . order your Heathkit/Thomas organ today. 172 lbs.



kit GD-325C
439^{95}

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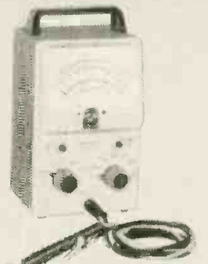
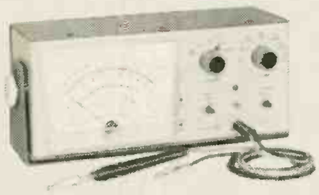
Make This Christmas



Kit IM-18
$28.50
Wired IMW-18
$47.95



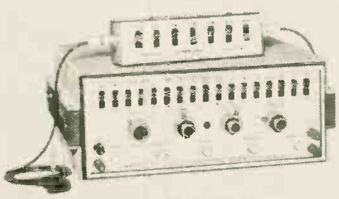
kit IM-28
$36.50
Wired IMW-28
$56.95

Kit IM-38
$39.50
Wired IMW-38
$54.95

kit IM-17
$21.95

kit IT-18
$24.95

kit IP-18
$19.95



kit IG-57
$135.00
wired IGW-57
$199.00

kit IO-18
$84.95
wired IOW-18
$139.95

NEW HEATHKIT IM-18 VTVM

The new IM-18 is a direct decendent of the world's most popular VTVM — the Heathkit IM-11, and continues the features that made the IM-11 famous . . . 7 AC and 7 DC voltage ranges that measure from 0-1500 volts full scale . . . 7 ohms ranges for resistance measurements from 0.1 ohm to 1000 megohms . . . single probe convenience that ends tangled leads & enables you to change from AC to DC/Ohms measurements with a flip of the switch on the probe . . . the light circuit loading of 11 megohm input impedance . . . ±1 dB 25 Hz to 1 MHz response . . . precision 1% resistors . . . DC polarity reversing position on the function switch . . . measurement capability for RMS and Peak-To-Peak AC voltages and dB . . . precision 4½", 200 uA meter for extra sensitivity. In addition, the new IM-18 includes wiring options for 120V. or 240 VAC operation and a three-wire line cord for added safety. 5 lbs.

NEW HEATHKIT IM-28 "Service Bench" VTVM

The new Heathkit IM-28 bears the proud tradition of the IM-13, and it has the same performance specifications as the new IM-18 above — an unbeatable combination! But it also has a number of features that put it in a class by itself, like a large 6" meter with easy-to-read markings . . . extra 1.5 and 5 volt AC ranges for additional accuracy . . . a secure gimbal mounting that allows you to put the IM-28 above, below or in front of your most convenient mounting surface . . . "Set and Forget" calibration — all calibration controls are screwdriver adjustable from the front panel to eliminate disassembly . . . smooth ten-turn vernier control of Zero and Ohms Adjust for greater accuracy and easier setting . . . dual primary transformer for 120/240 VAC operation . . . safe 3-wire line cord as well. The new look of Heathkit instrument styling is evident too — handsome beige & brown color scheme, and new knobs that are easy to turn and fast to read. 7 lbs.

NEW HEATHKIT IM-38 Laboratory AC VTVM

For all around general service work, audio design and trouble-shooting or laboratory analysis, you couldn't find a better value than the new Heathkit IM-38 AC VTVM. Here's why — 10 voltage ranges measure from 0.01 to 300 volts RMS full scale . . . an extended frequency response of 10 Hz to 500 kHz at ±1 dB . . . 10 megohm input on all ranges for higher accuracy and minimal circuit loading . . . wide dB range: —12 to +2 on the meter and ten switch-selected ranges from —40 to +50 in 10 dB steps . . . VU-type ballistic meter damping . . . amplifier filament voltage transformer winding that's balanced to ground for low AC noise . . . 120/240 AC wiring options and new Heathkit styling in sharp beige & brown with an easy-to-grasp, easy-to-read knob. Heathkit engineering has made assembly easy and performance tops. 5 lbs.

HEATHKIT IM-17 Solid-State Volt-Ohm Meter

Another very popular volt-ohmmeter from Heathkit engineering and it's easy to see why — all solid-state circuitry . . . high impedance FET input, 11 megohms on DC, 1 megohm on AC . . . 4 AC voltage ranges . . . 4 DC voltage ranges . . . 4 ohm ranges . . . 4½" 200 uA meter . . . 3 built-in test leads . . . DC polarity reversing switch . . . zero-adjust & ohms-adjust controls . . . continuous 12-position function switch. And that's not all — the IM-17 is battery powered for complete portability and comes in a rugged polypropylene case with built-in handle. Simple circuit board assembly. 4 lbs.

HEATHKIT IT-18 In-Circuit Transistor Tester

In-Circuit transistor testers don't have to be expensive, and the IT-18 is proof of that . . . tests DC Beta 2-1000, in or out-of-circuit . . . leakage Icbo and Iceo current 0-5000 uA out-of-circuit . . . identifies NPN or PNP devices . . . tests diodes in or out-of-circuit for opens & shorts . . . identifies unknown diode leads . . . matches PNP & NPN transistors. The IT-18 is completely portable — runs on just one "D" cell. Easy to use too . . . rugged polypropylene case, attached 3' test leads, big 4½" 200 uA meter, all front panel controls, 10-turn calibrate control. 4 lbs.

HEATHKIT IP-18 1-15 VDC Power Supply

If you work with transistors, this is the power supply for you. All solid-state circuitry provides 1-15 VDC at up to 500 mA continuous. Features adjustable current limiting, voltage regulation, floating output for either + or — ground, AC or DC programming, circuit board construction, and small, compact size. 110 or 220 VAC. 5 lbs.

HEATHKIT IG-57 Solid-State Post Marker/Sweep Generator

The new IG-57 plus a 'scope is all you need . . . no external sweep generator required. Switch selection of any of 15 crystal-controlled marker frequencies (you can view up to six different frequencies on one 'scope trace). Select the sweep range and you are ready to instantly see the results of any changes you make. Four markers for setting color bandpass, one for TV sound, eight at IF frequencies between 39.75 & 47.25 MHz plus picture and sound carrier markers for channels 4 & 10. Three sweep oscillators produce the 5 most-used ranges . . . color bandpass, FM IF, color & B&W IF and VHF channels 4 & 10. Save hundreds of dollars and put full alignment facilities in your shop too — order your IG-57 now. 14 lbs. Kit IG-14, same as IG-57 w/o the sweep, 11 lbs. $99.95.

HEATHKIT IO-18 Wide-Band 5" 'Scope

The New Heathkit IO-18 is destined to be the world's most popular 'scope, just as its predecessor, the IO-12 was. Features 5 MHz bandwidth, the famous Heath patented sweep circuit — 10 Hz to 500 kHz in 5 ranges, two extra sweep positions which can be preset to often-used rates, frequency compensated vertical attenuation, built-in P-P calibration reference, Z-axis input, retrace blanking, wiring options for 120 or 240 VAC operation and new Heathkit styling in beige and brown. 24 lbs.

A Heathkit® Holiday

Wish Your Family Merry Christmas This Year With A New Heathkit Color TV . . . A Better Buy Than Ever With New Lower Prices

NEW Deluxe Color TV With Automatic Fine-Tuning—Model GR-681

kit GR-681
$499.95 (less cabinet)

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

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

now only **$449.95** (less cabinet)

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

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

now only **$399.95** (less cabinet)

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

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

now only **$349.95** (less cabinet)

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

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**

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

kit GR-681

kit GR-295

kit GR-227

kit GR-180

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

New Wireless TV Remote Control
For GR-681
$59.95

Circle 113 on reader's service card

EQUIPMENT REPORT

B&K 465 CRT Tester

For manufacturer's literature, circle No. 116 on Reader Service Card.

THE B&K 465 CRT TESTER IS ANOTHER addition to the long line of popular test instruments from this company. It will test any black-and-white or color picture tube, and is much more "obsolescence-proof" than the older crt testers.

A big factor in this is the use of a five-step heater voltage switch, with a variable resistance in series. This allows setting the heater to any voltage between zero and 13 Vac. Actual voltage on the heater is read on the meter. So, the "full-load" voltage can be read at all times.

The control grid (G1) voltage can be varied from 0 to 100 volts, and the G2 or screen-grid voltage from 0 to 300 volts. This permits checking tubes for proper cutoff with actual operating conditions duplicated as closely as possible. The variable G2 voltage also lets you check low-G2 tubes without danger of damaging them.

A three-step rejuvenator, familiar to B&K users as the Dynamic Intensifier, is used for rejuvenation of weak crt's, including individual guns of color tubes. The voltage applied is controlled and timed to avoid unnecessary "overshooting."

A neon-lamp indicator on the panel shows shorts between heater and cathode, G1 and G2. A REMOVE-SHORTS position on the selector switch, used with the rejuvenator voltage, will burn out most of the "particle" type of shorts in crt's. The heater voltage is not applied to the tube during this operation, lessening the danger of damage.

A three-position slide switch selects each gun of color tubes. Tests may be made for shorts, cutoff and emission. For the important gun-balance test, the reading of each gun can be compared to the rest by flipping this switch back and forth.

If a color tube's guns will read within the "best gun output not more than 1.5 times that of the worst" formula, the tube is good. In weak tubes, the low gun can often be rejuvenated to bring its emission up to that of the good ones.

Color tubes can also be checked for "warmup drift" in screen color. This is done by letting the tube cool off completely, then repeating the mission test, logging the meter reading of each gun after 2 minutes, then after 4 minutes.

The panel meter has a two-positon sensitivity switch. This is used in testing certain special crt's to get adequate meter deflection. Most tubes will read in the "normal" position.

The standard 12-pin socket is used on the cable to the tester. Adapters plug into this to match all presently used crt bases, including round and rectangular color tubes, and even the very small bases used on some miniature crt's.

During the bench testing of this instrument, we successfully blew a short out of an old crt, and rejuvenated several others, including an aged color tube that had a sickly green look due to gun unbalance. All in all, a well-built and useful piece of test equipment.—*Jack Darr* **R-E**

Live Cheaper Electronically

As the cost of living soars, electronic items provide a major exception to the trend. In its latest consumer price index, the Department of Labor found that the average prices of all cost-of-living items in June 1968 had risen 20.9% above the prices prevailing in 1957-59. However, portable and console TV set prices declined 19.8%, and portable and table radio prices dropped 22.8% in the same period.

The cost of repairs has gone up, but not nearly so much as the average of other consumer expenses. **R-E**

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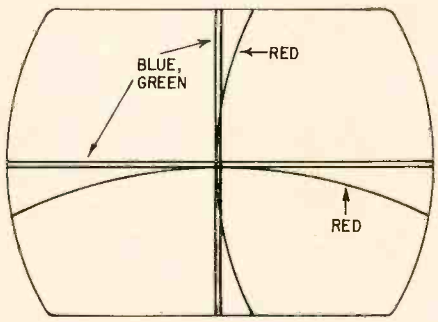
SERVICE CLINIC

(continued from page 27)

could never get convergence until I discovered this!

Here's another thing to check. Be sure that your red adjustments have the proper range, so that the tilt and amplitude controls *will* cause the lines to curve or straighten as they should. Compare the range of the red adjustments with that of the green adjustments, for example. If they don't move the red as far as they ought to, check the tilt and amplitude controls for possible open circuits, broken wiring, etc.



One more: go back and run purity again. Watch out for edge purity: the yoke adjustment. Then, put your dot or crosshatch pattern back on, and move the deflection yoke *very slightly* back and forth, watching your edge convergence. At the same time, check the positioning of your convergence yoke. If this accidentally gets knocked too far *forward*, it'll cause this same symptom. Also, move the convergence yoke very slightly back and forth (watching your convergence at the *edges*), and very slightly *around* the tube neck. It takes only a fraction of an inch of displacement on this yoke to really upset things, and the first sign is usually very poor edge convergence.

Finally, you don't have to pay too much attention to the absolute *straightness* of the lines, as long as they do converge. It's pretty difficult to tell when a line is absolutely straight on the hemispherical faceplate of a color tube, anyhow. (And I'd rather have a slightly curved white line than a straight rainbow!)

Modify kit VTVM?

I'm interested in a kit vtvm. Could I modify it to get a 0.5-volt range?— S. K., Union City, N.J.

Not recommended! The best way would be to *buy* one that has a 0.5-volt range! Modifying kits, especially vtvm's, leads to trouble (calibration, mostly). If you get a kit, build it the way the man says in the book. That way, if it doesn't work, you can get it fixed. **R-E**

SPOT TV X-RAYS
(continued from page 35)

than a few inches away, as when measuring the field external to a television set.

If improper operation is indicated by the source check or a large change in the zero setting, remove the screen on top of the instrument. If the trouble is that a high reading is obtained, the switches should be opened and closed on the GM tube boards successively until the one producing the malfunction is located. Usually the trouble will be dirt or excessive moisture on the GM tube mounting.

If the malfunction is indicated by a down scale reading or the above procedure has not corrected the condition, turn off all but one switch on the GM mounting boards. Set the range switch to ZERO. Set zero with the control below meter face. Turn switch off and another one on. Set zero with the 100K potentiometer (R14) on the mounting board. Turn this switch off and proceed with the next board, setting zero with the 100K potentiometer. When all units have been set to zero, turn all 6 switches on and, if required, set meter zero with the control below the meter face.

During initial adjustments and calibration in the laboratory, the front-panel zero control is adjusted to produce a potential of between 2.6 and 2.8 volts at point C with all sensors switched off.

It is possible that the instrument will respond to light (especially ultraviolet) or strong electromagnetic fields. Light sensitivity is almost invariably caused by a defective light seal at the base of a GM tube. Recoating the glass seal with a light-tight coat of insulating material, such as a black silicone rubber, will eliminate this type of sensitivity.

If operation without the perforated aluminum cover is required, or if an abnormally strong electromagnetic field is expected, connect integrating capacitor C4 between the base of Q4 and ground on each of the GM tube circuit boards, and add a 0.1-μF capacitor between Q7's gate and ground. This does not affect calibration or the time constant.

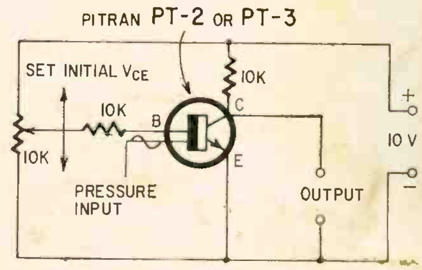
The instrument described in this article was developed and used by the National Center for Radiological Health to measure X-radiation from about 1200 color TV receivers surveyed in the Washington, D. C., area. RADIO-ELECTRONICS *would like to express its appreciation to the NCRH for making this information available so that we could pass it on to our readers.* **R-E**

NEW IC's

PRESSURE-SENSITIVE TRANSISTORS

Pitran PT-2 and PT-3 piezotransistors are silicon npn planar transistors that have their emitter-base junctions mechanically coupled to a diaphragm in the top of a TO-46 can. Pressure applied to the diaphragm causes a reversible change in transistor characteristics and a linear change in output voltage.

Applications include FM oscillators, differential pressure transducers,



accelerometers, flow gauges, blast gauges and weighing scales. A 3½" differential water pressure or ¼-gram point force produces 1 volt output. A circuit for linear dc output is shown. Calibration curves for sensitivity,

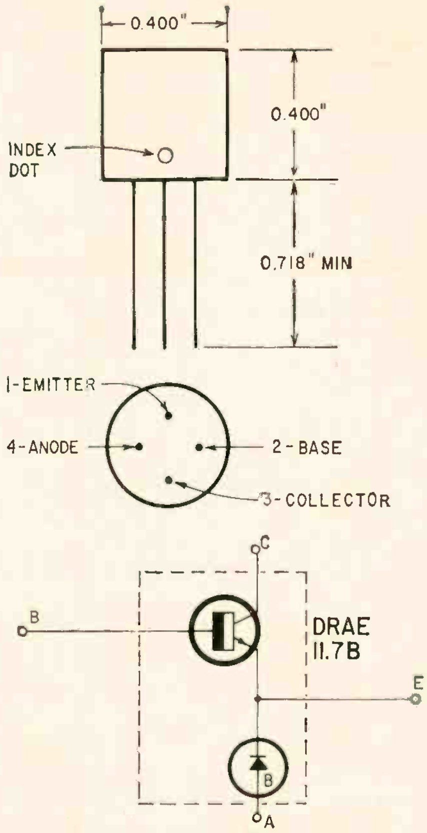
SEMICONDUCTORS

temperature coefficient and over-all performance are supplied with each unit. The PT-2 and PT-3 cost $75 and $125, respectively, in lots of 1 to 99. The units are made by Stow Laboratories, Stow, Mass. 01775.

VOLTAGE-REFERENCE AMPLIFIER

The DRAE 11.7B is a series of composite circuits designed as combination voltage references and error amplifiers for use in regulated power supplies. Each reference amplifier consists of an npn silicon transistor and a silicon voltage regulator diode having equal but opposite temperature coefficients. Temperature differential between elements is held to a minimum to permit reliable operation over a wide range of temperatures.

The basic type number (DRAE 11.7B) of this 11.7-volt reference amplifier is followed by the suffix 10, 25, 50 or 100, indicating the temperature coefficient in parts per million. Case outline, base diagram and schematic of this series are shown. Further information is available from Dickson Electronics Corp., PO Box 1390, Scottsdale, Ariz. 85252. **R-E**



BUILD A $10 READOUT MODULE

(continued from page 69)

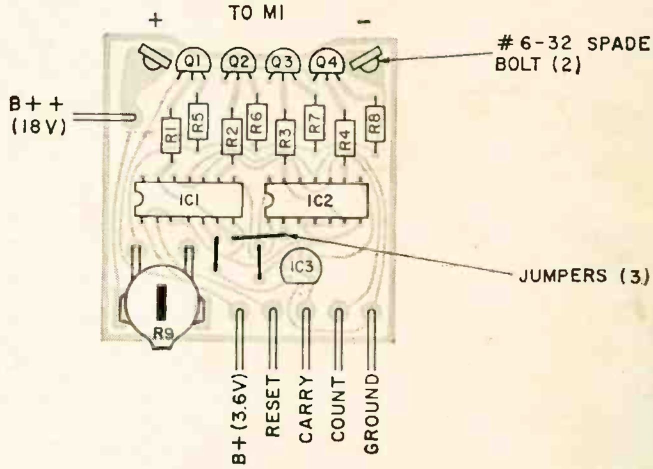


Fig. 13—Component placement and input connections.

component layout is in Fig. 13. IC1 and IC2 go in with their code notch in the direction shown, while the flat side identifies IC3. Two No. 6 spade bolts secure the circuit card to the meter, giving you a rugged, one-piece assembly.

Testing

You can test your unit with two D-cells and a 22½V battery, connected as in Fig. 14. Build up the bounceless pushbutton circuit shown for the input. To calibrate the unit (temporarily, of course, since you'll later be switching to a regulated meter supply), RESET the counter and run the count up to 9. Now adjust R9 to set the pointer precisely to 9. Your counter is complete, and you should be all set to build any of a number of digital instruments at a tiny fraction of their normal cost. R-E

Fig. 14—Test setup for the module uses battery supply for 22.5V and 3.6V. Input (temporary) uses pushbutton circuit.