60¢ ■ FEB. 1970

Radio-Electronics®

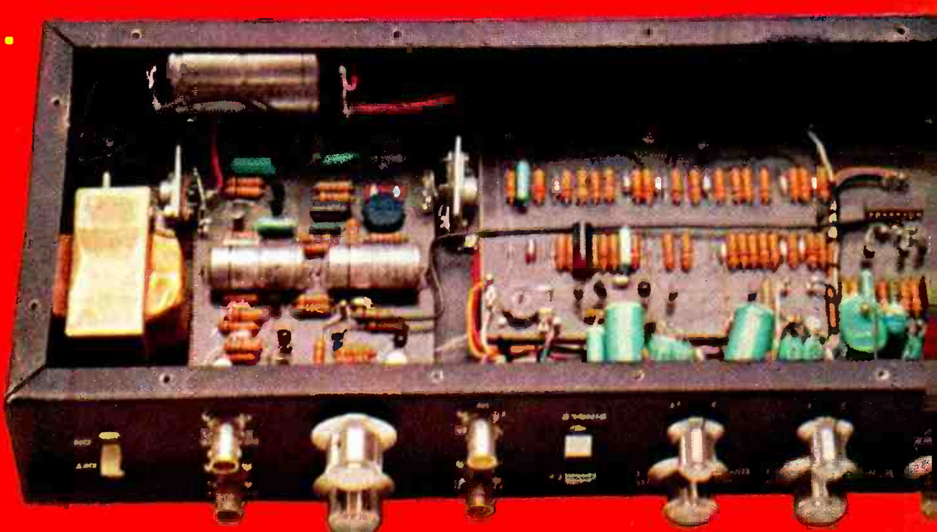
A GERNSBACK PUBLICATION

Photographers ...

Enlarging-time meter for $3.50

Technicians...
Build R-E's

Lab-quality pulse generator

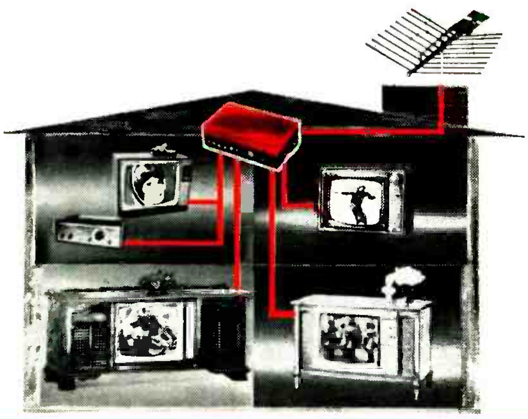


30 IC circuits you can use

CHOOSE-&-USE GUIDE for Capacitors

JFD is ready!...20 million homes are ready!... Get ready...get set...go with new

JFD Home Entertainment Program Center Kits



- ★ Provide up to 4 TV sets with *different* programs — from 1 antenna.
- ★ Beautifully packaged in *full-color carry-home* display carton.
- ★ Distribution amplifier powerful enough to drive up to 12 sets — with additional splitters.

Whether you install it yourself or sell it over-the-counter, the unique JFD Home Entertainment Program Center Kit gets you in on the ground floor of a lucrative new untapped market — 20 million households with two or more sets that can use a distribution system.

Make every home an entertainment center!

Thousands of *old* home owners, *new* home owners, contractors, and builders in *your* area are *ready-to-buy* prospects for (4) JFD Program Center Kits

Easy to sell!
Easy to install!

SEE YOUR DISTRIBUTOR
OR WRITE FOR OUR PROMOTION KIT

JFD ELECTRONICS CORP.
SUBSIDIARY OF RIKER-MAXSON CORP.
15 AVENUE AT 62 STREET, BROOKLYN, NEW YORK 11219
JFD INTERNATIONAL, 2200 SHAMES DRIVE, WESTBURY, N.Y. 11590 / JFD CANADA LTD., ONTARIO, CANADA
JFD DE VENEZUELA, S.A., AVENIDA LOS HATICOS 125-97; MARACAIBO, VENEZUELA

NEW & TIMELY

Volume 41 Number 2 RADIO-ELECTRONICS February 1970

NO GLASSES: 3-D MOVIES & TV

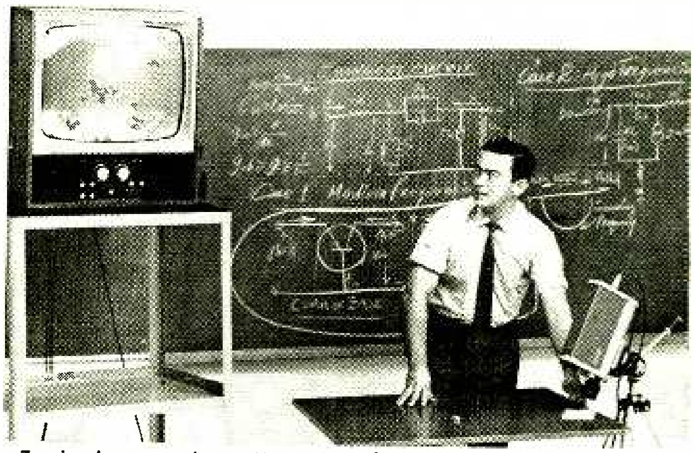
STAMFORD, CONN.—Three-dimensional movies that can be viewed without special glasses are now possible with a newly patented system developed by Dr. Dennis Gabor of CBS Labs. The company is talking with motion picture representatives to introduce the system to theaters.

Two films—color or b-w—of one scene taken at slightly different angles are projected by adjacent projectors onto a curved screen that has been coated with a photosensitive material. The eye creates a stereoscopic image due to the slight displacement of two vertical zones on the screen. A mirror-laser beam arrangement is used for projection.

Meanwhile, Bell Labs announced they have developed a 3-D CCTV system that also requires no special glasses.

At the transmitting camera, one of a pair of flexible Mylar mirrors is made to change from concave to convex shapes like loosely-fitting drum heads. A 3-D scene is reflected by this mirror, and a lens focuses the two "depth planes" on a rear projection screen for pickup and transmission by a TV camera.

At the receiving end, a TV monitor displays the 2-D images, but they are viewed as reflections from a second moving mirror in front of the monitor. The original 3-D scene can then be seen as each image is placed in the correct depth position.



Zeroing in on transistors, Monroe's Prof. Julio Ahumada shows different types to an electronics class. Signal can be fed into college complex.

CCTV STARS AT COMMUNITY COLLEGE

ROCHESTER, N.Y.—One of the most elaborate closed-circuit TV systems for instruction to be installed in a community college is being put into operation here.

Monroe Community College is using 101 classroom-laboratory, receiver-monitor systems to like this one in career programs ranging from electrical technology to police science to X-ray technology. The system, designed and installed by Jerrold Electronics Corp., carries 12 vhf TV frequency channels, although special jacks in the classrooms and labs permit most of the 101 setups to originate programs when cameras are plugged into them.

The college, which had incorporated CCTV into its planning before opening in 1962, uses some 95 miles of coaxial cable and the system will eventually utilize 120 cameras.

DIODES GLOW BRIGHT WITH NEW PHOSPHORS

MURRAY HILL, N.J.—Those three glowing dots on the black box are gallium-arsenide diodes coated with improved rare-earth phosphors developed at Bell Labs. The new phosphors convert the infrared radiation emitted by the diodes into brilliant green, red and blue light, using erbium-, holium- and thulium-bared crystals respectively.

The coating technique, first reported by G.E., may be practical as solid-state light sources for displays, telephone sets and computers. Bell says the phosphors might eventually be used in screen displays excited remotely by infrared radiation—as in TV projection devices.

LOOKING AHEAD

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

4-channel stereo

Will 4-channel sound be the next major advance in home music reproduction?

Variously known as quadrasonics, ambionics and surround stereo, the "4-eared sound" is now under serious consideration by engineers and manufacturers in the tape, disc and equipment fields. Four-channel tapes, and equipment to play them on, are already available; 4-channel FM concerts are being broadcast in Boston and New York. Two 4-channel phonograph record systems have been proposed, both claimed to be compatible with existing 2-channel stereo and monophonic records and playback equipment.

Experimentation with multichannel sound is not new, of course. But for the first time, program sources (tape and radio) and playback equipment have become available to hobbyist experimenters, and demonstrations are being held in various parts of the country.

In most quadrasonic demonstrations and experiments, the two "front" speakers are placed in the normal stereo position, while the "rear" speakers are placed on a line with them either behind or immediately to the left and right of the listeners. A variety of musical effects can be produced from 4-channel systems, and most listeners at the demonstrations appear to have been quite favorably impressed.

Much of the developmental work on 4-channel stereo has been done by Acoustic Research Inc., which has been conducting demonstrations at its Cambridge, Mass., and New York City showrooms. Vanguard Records is already releasing commercial 4-channel open-reel tapes for use with the system, and Columbia Records has produced some

(continued on page 4)

SOLID-STATE TRIPLETS SHIPPED FOR COLOR TV

LINDEN, N.J.—A large shipment of solid-state substitutes for the high-voltage rectifier and shunt regulator tubes in color TV sets was announced by Scientific Components. SC is one of several manufacturers supplying the TV industry with solid-state "triplets"—voltage multipliers. The units are one means being used by manufacturers to cut x-ray radiation from color sets.

(continued on page 4)

Radio-Electronics

February 1970 • Over 60 Years of Electronics Publishing

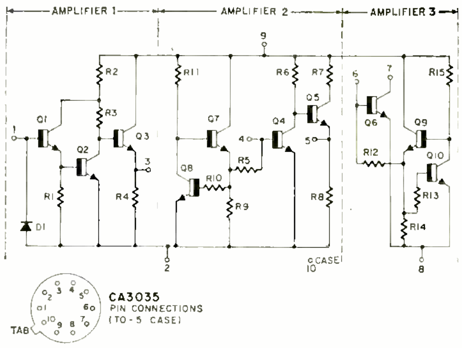
PHOTOGRAPHIC ELECTRONICS

BUILD ONE OF THESE

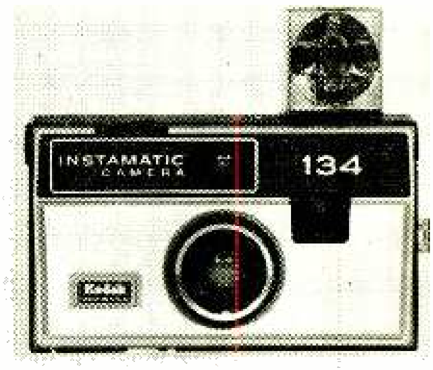
TELEVISION

GENERAL ELECTRONICS

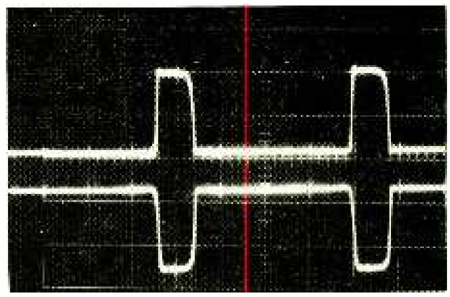
DEPARTMENTS



Inside the CA3035: This high-gain, wide-response linear IC amplifier has hundreds of applications. For 30 of them . . . see page 62



A low-cost camera for amateurs uses a different kind of electronic shutter-control circuit. . . . see page 33



Lab-quality performance from a pulse generator you can build. To put pulses like this on your scope. . . . see page 37

RADIO-ELECTRONICS, FEBRUARY 1970. Vol. 41, No. 2
Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302
Editorial, Advertising, and Executive offices: 200 Park Ave. S., New York, N.Y. 10003. Subscription Service: Boulder, Colo. 80302.
Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U.S. and possessions, Canada, $6. Pan American countries, $7. Other countries, $7.50. Single copies 60¢.

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

Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

PLASTIC HOLOGRAMS MADE IN ½ SEC.

MALIBU, CALIF.—Self-developing, instant holograms (laser-made 3-D photos) are now possible with a technique that uses photopolymers—liquid or gelatin substances that become plastic solids after exposure to light.

According to Hughes Aircraft, who are studying the holography method, a potential use for the technique is in interferometry studies to monitor structural stresses under varying loads.

A problem in such applications has been the precise repositioning required of regular holographic plates after development to compare changes. With photopolymerization, the film develops, is fixed by exposure to ultraviolet projected in ½ sec.

Fewer curves? Introduced at the Los Angeles HiFi Show last year, this LEE (Listening Environment Engineers) Contempo II listening environment chair is "radically different" in appearance to the orginal LEE chair, according to its designers. They also claim the tweeter-woofer systems on each side and sealed baffles create an acoustic chamber that has considerably less distortion, nonlinearity of power response and phase shift than conventional speakers in most room environments. The chair is "plugged in" to conventional stereo gear through a 4-conductor cable. According to the Burbank, Calif. firm, the straight and horizontal lines of this $499 model blend better with most furnishings.

PIONEER BROADCASTER RETIRES FROM AIR

HILVERSUM, HOLLAND—Edward Startz, the pioneer shortwave broadcaster for Radio Nederland, turned his Sunday Happy Station Show over to Tom Meyer last month. Meyer joined the station in 1965.

Startz began international broadcasting in 1928 when the experimental Philips station, PCJ, first went on the air. His programs have gained a wide audience.

The Sunday program is beamed to North America on 11.73 MHz from 9-10:20 PM EST and 11.73 and 9.715 MHz from 9-10:20 PM PST.

(continued on page 6)

NEXT MONTH

Build a hot-carrier diode Linear Dynamic Expander for your hi-fi. This R-E exclusive ends faint background noise.

LOOKING AHEAD

(continued from page 2)

experimental tapes, but has no current plans for commercial release.

In some of the tapes, the two rear channels are used "conservatively"—for example, to provide concert hall realism by reproducing the actual reverberation of the hall. In others, the medium becomes the message as in a recording of "Switched-On Bach," in which the listener is literally surrounded by music.

To play the 4-channel tapes, you need a special 4-head tape player, four channels of preamplification and amplification and, of course, four speakers. Four-channel tape recorder-players are already available—some of them designed for other uses—from such manufacturers as Crown and TEAC, and Telex/Viking is bringing out several versions. Peploe also plans 4-channel tape equipment. Four-channel amplifiers have been announced by H. H. Scott and, tentatively, by Acoustic Research.

The first 4-channel stereo broadcasts are reminiscent of early 2-channel stereocasts in that two receivers (and two stations) are required. In Boston, the weekly concerts of the Boston Symphony have been presented in quadrasonics, and in New York special programs using the Vanguard tapes. In each case, two FM stereo stations are used—one for the front sound, the other for the rear—and the listener must properly deploy the speakers of two FM stereo receivers.

This is conceded to be a stopgap system. Already, preparations are being made for broadcast testing of a compatible single-station 4-channel system, developed by multiplex pioneer William Halstead. By use of extra subcarriers, this system gives specially equipped 4-channel listeners quadrasonic sound, while supplying 2-channel stereo or mono FM listeners with their accustomed signals. Other compatible multiplex systems are also under development.

There are, of course, drawbacks to all of the 4-channel systems which are available now. Not the least is cost—4-headed tape players, 4-channel preamps and amps, four speakers. Integrated circuits, presumably, could bring amplifier costs down sharply in mass production; other cost also could go down somewhat in large quantities. Another drawback has been the lack of a 4-channel phono disc system. And tape recordings presumably would require twice as much tape for a given amount of playing time, because of the two additional tracks.

Two new systems are coming along, however, which could remedy some of these shortcomings. One, which we have already heard in a private demonstration, shows promise of making possible not only a compatible 2- and 4-channel disc but a simplified method of 4-channel broadcasting and quadrasonic tapes in open-reel, cassette or cartridge format which require no more raw material than conventional versions.

This is an "analog multiplex" system developed by engineer-musician Peter Scheiber—former first bassoonist of the Dallas Symphony. Scheiber won't explain the workings of the system (presumably for patent reasons), but it appears to deliver completely compatible and crisp, well-separated sound in both 2- and 4-channel formats.

In the Scheiber system, music is recorded either on tape or a conventional stereo disc, from four separate microphones or other 4-channel source. An "encoder" reduces this output to two channels, multiplexing front and

(continued on page 6)

The sensibly priced tape cassette ...from MALLORY.

Just what you've been waiting for. The new Mallory DURATAPE® Cassette.

You get the quality and performance of expensive tape cassettes at a nice, lots-less price. But not the poor performance or the problems of the special-discount cheapies.

And since they're from Mallory — a company long known for quality electronic products—you can expect high fidelity, smooth operation, and long reliability. And get it . . . every time!

They'll fit any cassette recorder, player, cassette-radio. Even the new cassette changers. And you pick the recording time: 30, 60, 90, 120 minutes.

Our DURATAPE® Cassettes are tough but we put them in unbreakable, easy-to-stack containers just for extra protection. Like in the rain or through the mail.

And we make a head cleaner that's perfect for Cassette Recorders, too.

You'll find this great new thing in sound wherever Mallory products are sold.

MALLORY

MALLORY DISTRIBUTOR PRODUCTS COMPANY
a division of P. R. MALLORY & CO. INC.
Box 1558, Indianapolis, Indiana 46206; Telephone: 317-636-5353

Batteries • Capacitors Cassette Tapes Controls • Resistors • Semiconductors • Sonalert® • Switches • Timers • Vibrators • ICs

Circle 10 on reader service card

ELECTRONICS: WAR ON ROAD NOISE

A dashboard indicator monitors excessive noise levels from vehicles on the spot. The indicator is synchronized with a highly sensitive electronic noise monitor and split-image camera that is triggered by a highway microphone. The device is actuated automatically when a vehicle exceeds noise level limits. A photograph of the vehicle and its noise level chart reading can be used as evidence in court. When a trooper monitors the device also, a description of the noisy vehicle is relayed to another trooper down the highway. The CBS-Lab-built system is now being used in Connecticut.

HAM NET RENAMED

CHEVY CHASE, MD.—The Public Health Service Emergency Radio Network has changed its name to MEDINET (Medical Information Network) and now broadcasts at 14.280 MHz and 7.26 MHz. An alternate emergency frequency is 21.360 MHz.

The ham network is made up of Department of Health, Education and Welfare radio operators who provide rapid communication among health officials during disasters.

(continued on page 12)

LOOKING AHEAD

(continued from page 4)

rear left information into one channel, front and rear right into another. The recording is played back through a conventional stereo phono pickup or stereo tape head and 2-channel preamp, then fed to a decoder, which reconverts the sound to four channels and directs the signals to the proper amplifier-speaker channels.

A 4-channel disc (or tape) recorded by the Scheiber system may be played on standard 2-channel stereo equipment, and both "front" and "rear" sounds for each channel are added together. The discs may also be played monophonically. A conventional stereo or mono disc or tape may be played on Scheiber's 4-channel equipment merely by switching the decoder out of the circuit.

Use of the Scheiber system for 4-channel stereo broadcasting requires no new equipment at the FM stereo broadcasting station. Encoded discs or tapes are merely broadcast in the conventional manner and converted to 4-channel format in the home by use of a decoder inserted between the stereo tuner and 4-channel amplifier. A home listener could, in fact, make a 4-channel tape recording directly from the air using only a 2-channel stereo recorder, since the signal is already encoded. He would, however, need a decoder to play the recording back in quadrasonic mode.

Scheiber estimates that in mass production the decoder would add about $50 to the cost of a stereo component or phonograph system. He says that each of the four channels has equal and full frequency response.

Another compatible 4-channel phonograph system is under development by Jerry Minter, using the basic principles he pioneered in the 1950s as a proposed 2-channel stereo disc system. The Minter system superimposes a 38-kHz carrier frequency on each channel of a standard stereo phonograph disc, with rear-channel signals amplitude-modulated on the carrier. A standard 2-channel stereo phonograph will ignore the carrier, while a specially equipped system will provide full frequency response on four channels, Minter says.

(continued on page 12)

Radio-Electronics

HUGO GERNSBACK (1884-1967) founder

M. HARVEY GERNSBACK, *editor and publisher*

LARRY STECKLER, *managing editor*

Robert F. Scott, *W2PWG senior technical editor*

John R. Free, *associate editor*

Jack Darr, *service editor*

I. Queen, *editorial associate*

Matthew Mandl, *contributing editor*

David Lachenbruch, *contributing editor*

Frances McDowell, *editorial assistant*

Vincent P. Cicenia, *production manager*

Nancy Ochart, *production assistant*

H. Matysko, *circulation*

Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
200 Park Ave. South
New York, N.Y. 10003
(212) 777-6400
President: M. Harvey Gernsback
Secretary: Bertina Baer

ADVERTISING SALES

EAST
John J. Lamson, Eastern Sales Mgr.
N.Y.C. (212) 777-6400

MIDWEST
Ralph Bergen,
6319 N. Central Ave.
Chicago, Ill. 60646
(312) 792-3646

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

SOUTHEAST
E. Lucian Neff Associates
25 Castle Harbor Isle
Fort Lauderdale, Florida 33308
(305) 566-5656

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

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

ATTACH LABEL HERE

name (please print)

address

city state zip code

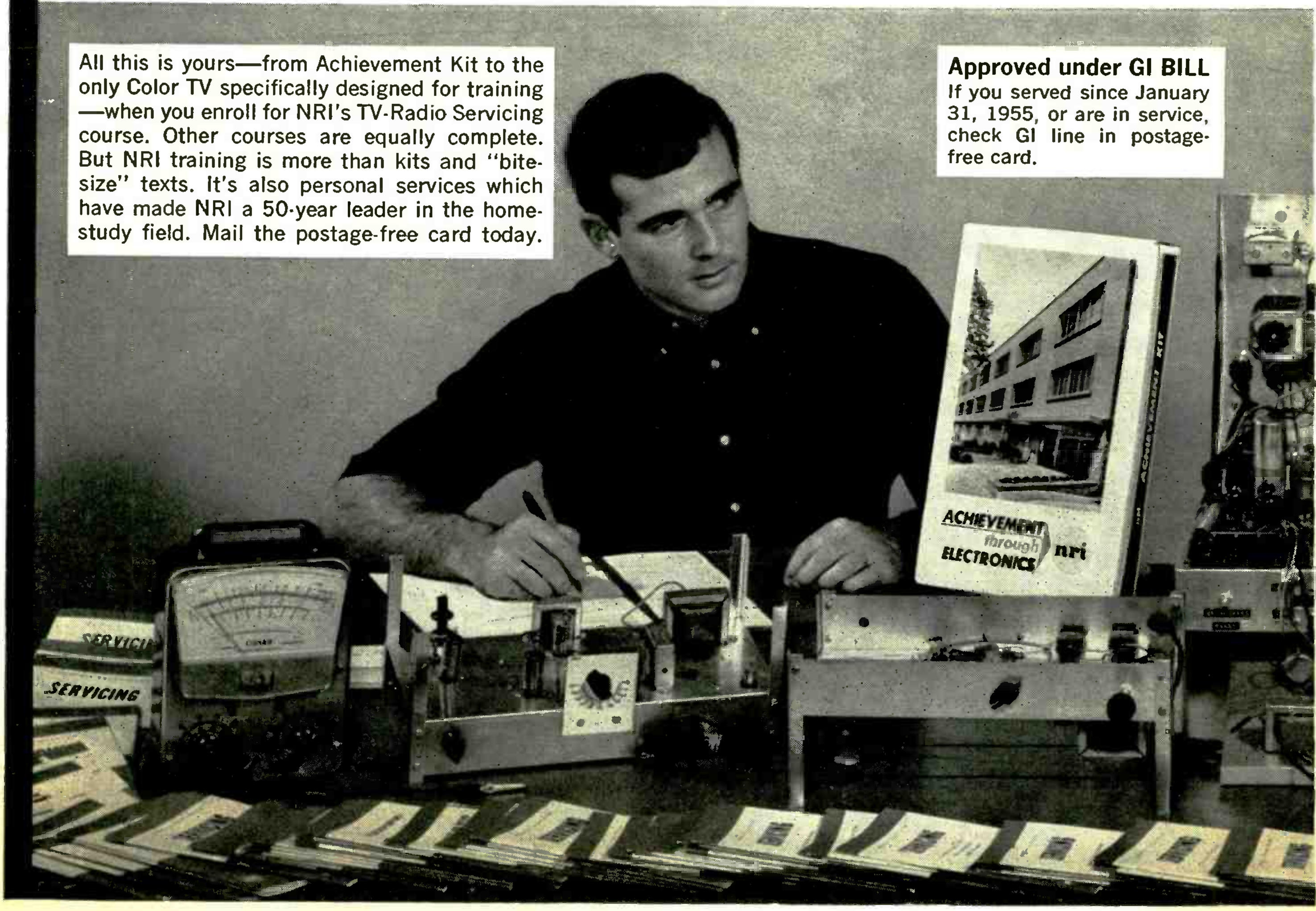
Mail to: RADIO-ELECTRONICS
SUBSCRIPTION DEPT., BOULDER, COLO. 80302

You get more for your money from NRI-

America's oldest and largest Electronic, Radio-TV home-study school

Compare if you like. You'll find—as have so many thousands of others—that NRI training can't be beat. From the delivery of your first lessons in the remarkable, new Achievement Kit we send you, to "bite size," easily-read texts and carefully designed training equipment . . . NRI gives you more value.

Shown below is a dramatic, pictorial example of all of the training materials included in just one NRI Course. *Everything* you see pictured below is included in low-cost NRI training. Other major NRI courses are equally complete. Text for text, kit for kit, dollar for dollar—your best home-study buy is NRI.



GET A FASTER START WITH NRI'S NEW EXCLUSIVE ACHIEVEMENT KIT

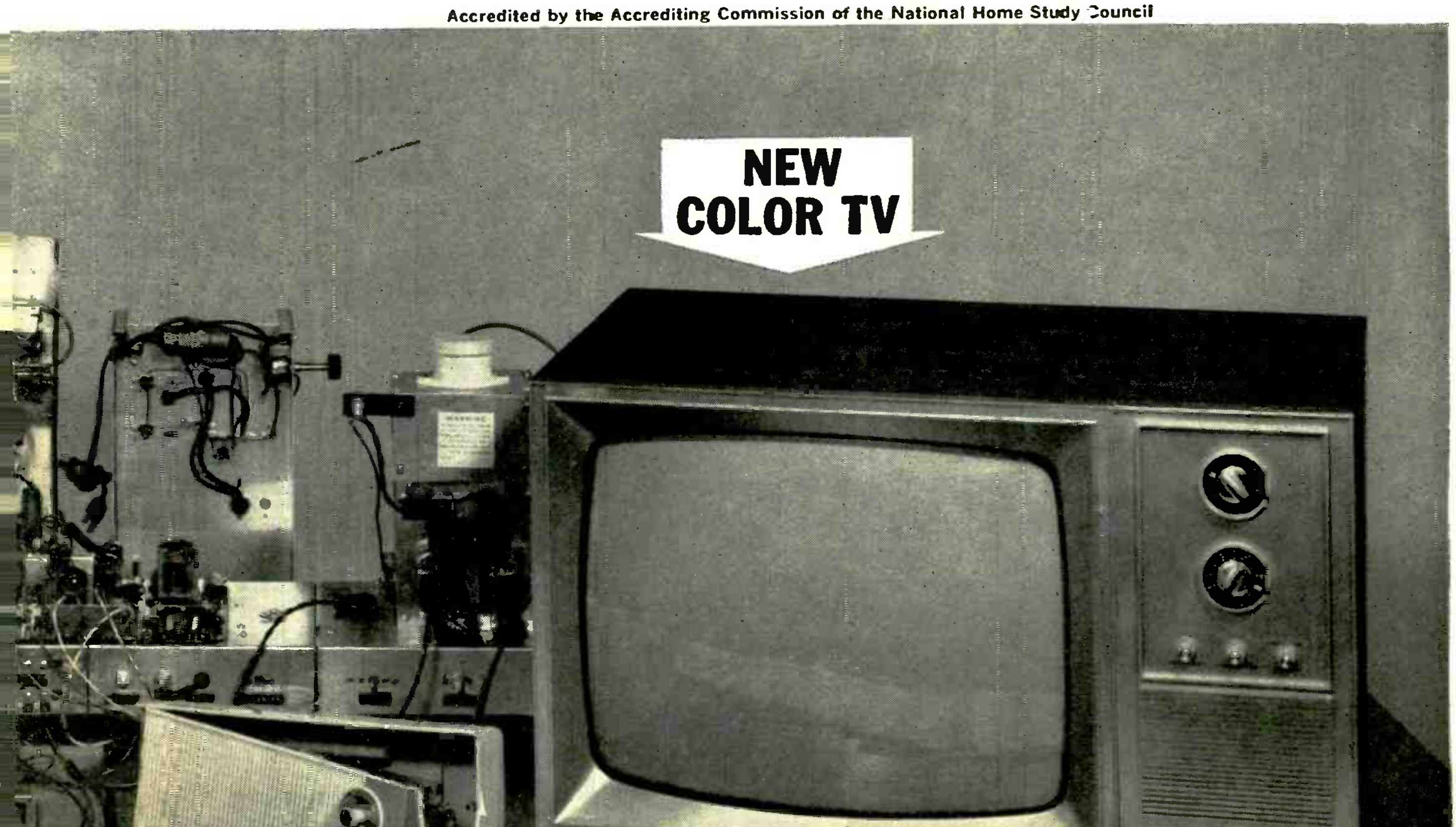
The day we receive your enrollment application we mail out your Achievement Kit. It contains everything you need to make an easy, fast start in the Electronics training of your choice. This attractive, new starter kit is an outstanding, logical way to introduce you to home-study as NRI teaches it . . . an unparalleled example of the value of NRI training . . . training that is backed up by a dedicated staff and the personal attention you should expect of a home-study school. It is your first of a number of special training aids carefully developed by the NRI laboratories to make your adventure into Electronics absorbing, meaningful. What's in the Achievement Kit? Your first group of lesson texts; a rich vinyl desk folder to hold your study material; the industry's most complete Radio-TV Electronics Dictionary; valuable reference texts; lesson answer sheets; pre-addressed envelopes; pencils; pen; engineer's ruler—even postage. No other school has anything like the NRI Achievement Kit.

LEARNING BECOMES AN ABSORBING ADVENTURE WITH NRI TRAINING KITS

Electronics comes alive with NRI training kits. What better way to learn than by doing it? That's why NRI pioneered and perfected the "home lab" technique of learning at home in your spare time. You get your hands on actual parts and use them to build, experiment, explore, discover. NRI invites comparison with training equipment offered by any other school. Begin NOW this exciting program of practical learning. It's the best way to understand the skills of the finest technicians—and make their techniques your own. Whatever your reason for wanting to increase your knowledge of Electronics . . . whatever your field of interest . . . whatever your education . . . there's an NRI instruction plan to fit your needs, at low tuition rates to fit your budget. Get all the facts about NRI training plans, NRI training equipment. Fill in and mail the attached postage-free card today. No salesman will call. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

OVER 50 YEARS OF LEADERSHIP nri IN ELECTRONICS TRAINING

Accredited by the Accrediting Commission of the National Home Study Council

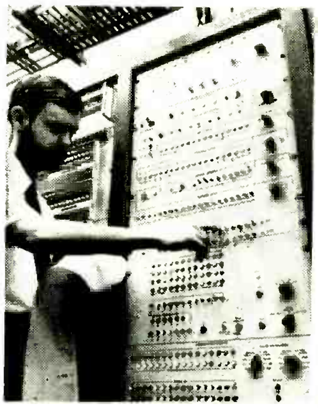


New & Timely

(continued from page 6)

HIGH-SPEED PROCESSOR SPEEDS ANALYSIS OF NOISY SIGNALS

NEEDHAM, MASS.—This advanced digital processor is capable of analyzing radar, sonar, speech, vibration and communication signals up to 100 times faster than present digital units, according to Sylvania, its developer.



The computer can perform a "fast Fourier transform" to detect a signal buried within a mass of undesirable signals on 1000 samples in 12.5msec. Typical digital computers need much more time, depending on the signals being analyzed.

The new processor gets its speed through the extensive use of IC's.

NEW STORAGE TUBE FEATURES DUAL MODE

This new split-screen storage tube from Westinghouse permits stored information to be displyed on part of the screen while data is continuously read out on the remaining part. The dual-mode tube combines the capabilities of a CRT and storage tube in one unit. Applications might include medical instrumentation where a patient's changing response could be constantly compared to stored data. Focus and deflection in the tube is electrostatic. **R-E**

LOOKING AHEAD

(continued from page 2)

Minter, who is president of Components Corporation, says his system has the advantage of simplicity and flexibility. It can be used as either a 3-channel (with one rear speaker) or 4-channel system. Like the Scheiber system, it uses a standard high-quality stereo pickup and a disc which is completely compatible with regular stereo system. Unlike the Scheiber system, which adds the front and rear signals together when played on conventional 2-channel equipment, the Minter disc would play front signals only.

There's still a long way to go before it's really determined whether 4-channel stereo is the sound of the future. It's certainly not ready yet. It needs more research; it needs the establishment of standards. Perhaps the ultimate system will have three channels instead of four. But manufacturers and sound engineers are intrigued. They're studying it carefully. And you'll hear plenty more about it. **R-E**

Circle No. 13 on reader service card →

THE CALECTRO SUPERMARKET

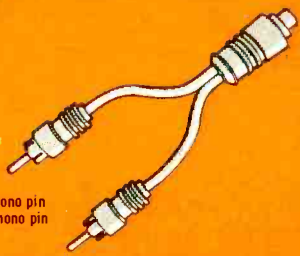
EVERYTHING IN ELECTRONICS!

VARIABLE BALANCE STEREO HEAD PHONE
Unique "Sound Level" control on each earpiece permits adjustment. Frequency range: 20 to 20,000 + cps. 6½' cord with stereo plug. Impedance 4 to 16 ohms.
Cat. No. Q4-132 $17.95 Net

MINIATURE LAMPS

Type PR2 • 2.5 volt • 0.50 amp •
Cat. No. E2-430 • Pkg. of 2 $.29 Net
Type PR3 • 3.6 volt • 0.50 amp •
Cat. No. E2-431 • Pkg. of 2 $.29 Net

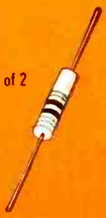
TAPE RECORDER MICROPHONE
Outstanding performance on music and speech for the price. Low impedance matches late model solid state recorders. Removable desk stand; 4½' cord with dual plugs that fit most models. Freq. Response: 100-8k Hz. Output: − 77 dB. Impedance: 200 ohms
Cat. No. Q4-146 $4.95 Net



AUDIO ADAPTORS
"Y" Audio Adaptor has a phono pin jack on one end and dual phono pin plugs on the other.
Cat. No. Q4-288 $.99 Net

RESISTORS
Attractively packaged 2 per pack, showing values, color codes and formulas.

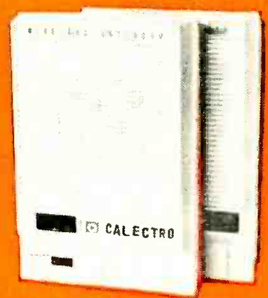
Type	Rating	Sizes Available	Price	Unit
Carbon	½ Watt —10%	10 Ohm-10 Meg	$.19	Pkg. of 2
Carbon	1 Watt —10%	10 Ohm-1 Meg	.19	Ea.
Carbon	2 Watt —10%	10 Ohm-100K	.25	Ea.
Wire Wound	10 Watt —10%	10 Ohm-15K	.36	Ea.



HOBBYIST'S SOLDERING AND TOOL KIT
Diagonals, long nose pliers, soldering iron and solder, solder aid tool, heat-sink, and screwdriver.
An ideal gift item.
Cat. No. H3-378 $7.95 Net.

STANDARD 1000 VOLT CAPACITOR
High quality, compact and reliable. Minimum capacity change with varying temperature. Rating: 1000 volts; tolerance: 20%.

Cat. No.	Description	Net	Unit
A1-060	220pF	$.25	Pkg. of 2
A1-061	330pF	.25	Pkg. of 2
A1-062	470pF	.25	Pkg. of 2
A1-063	680pF	.25	Pkg. of 2
A1-064	0.001uF	.19	Ea.
A1-065	0.005uF	.19	Ea.
A1-066	0.01uF	.19	Ea.



TWO STATION WIRELESS INTERCOM
Just plug into any electrical outlet. Completely portable. Expand system anytime with additional units. Two unit system complete in display pack.
Cat. No. N4-110 $34.95 Net

EXPERIMETER'S CIRCUIT BOARD KIT
Contains a 3⅜" x 4" perforated board, 15 terminals (No. J4-636) and 4 mounting feet w/screws. Build small circuits, hobby and science projects, etc.
Cat. No. J4-660 $.98 Net

The "GC Calectro Hobbyist Handbook" is available at your nearest Calectro Electronic Supermarket. One is located near you. WRITE TODAY and we'll rush you the name and address of your nearest Calectro Supermarket.

CALECTRO
G-C ELECTRONICS
400 SO. WYMAN ST. ROCKFORD, ILLINOIS 61101

GC ELECTRONICS

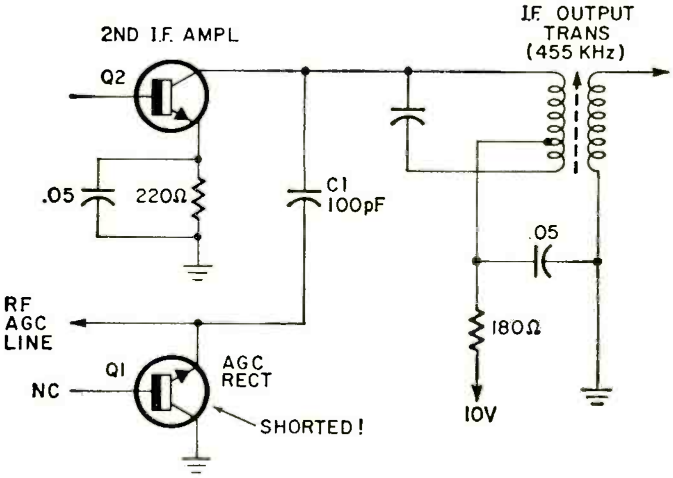
A DIVISION OF HYDROMETALS, INC.

CB Troubleshooter's Casebook

Compiled by
Andrew J. Mueller*

Case 1: No receive but transmit is OK.

Common to: Knight **A-2507**

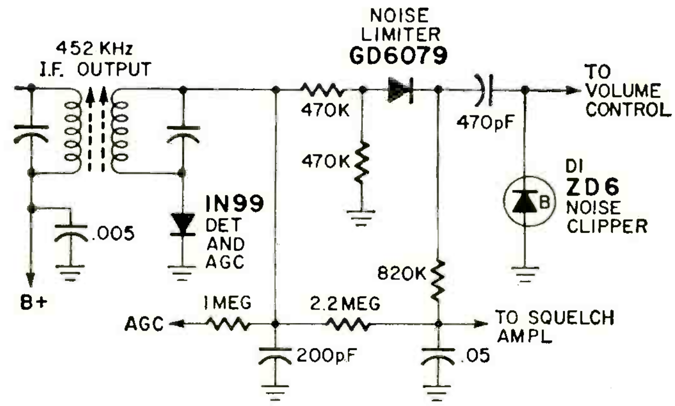


Remedy: Replace agc rectifier.

Reasoning: When Q1 is shorted between collector and emitter it shunts all of the agc voltage to ground. This tends to cutoff the receiver rf amplifier transistor. At the same time most of the rf signal appearing at the collector of Q2 would be shunted to ground via C1. Replacement of Q1 restores the circuit to normal operation.

Case 2: Insufficient noise clipping and distortion on loud signals.

Common to: General **MC-6**



Remedy: Replace D1.

Reasoning: Zener diode D1, the shunt noise limiter, was replaced with a 1N34-A diode by some "technician." It did not clip at all in the reverse direction and too severely in the forward direction. Replacement with the exact type restored the radio to normal operation. **R-E**

*Service Manager, Tel-Air Communications Inc., Pewaukee, Wisc.

Correspondence

WHO'S AN ENGINEER

When I joined the IRE (*now IEEE*) some 10 years ago, this argument was going on in the columns of *Proceedings*. It's still going on in the columns of *Spectrum*, and it isn't settled yet! Actually it's pretty much of a semantic quibble. The secret lies in the qualifier. There are all kinds of "engineers." What Mr. Pritchett (RADIO-ELECTRONICS, November 1969, page 22) is talking about are "design engineers." There are also the kind who run freight trains.

My contention is that the man who is fully qualified as an electronics technician in the field of television maintenance is just as much an engineer *in his field* as the design engineer is in his discipline. He must take a piece of equipment and, from a very complete knowledge of its circuit principles, determine what has failed and why. From actual experience over a long period, I can assure you that this requires a great amount of knowledge.

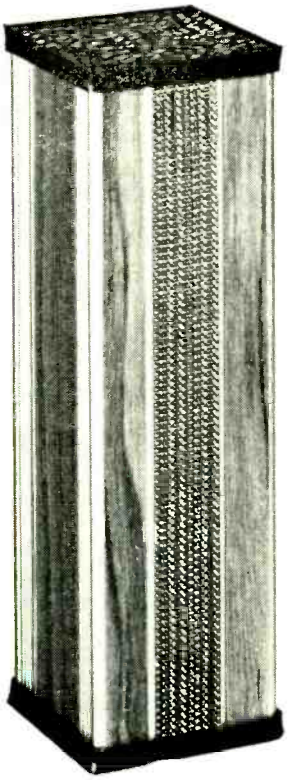
This kind of equipment with the frequent occurrence of "cascaded failures" (trouble in one section causing apparently unrelated troubles in others) demands a high degree of diagnostic skill. He must be capable of using pure engineering logic in its highest form. Unless he can do this, he is not a fully qualified technician. The major difference between the degree engineer and the practicing maintenance technician is entirely in the lack of formal academic qualifications leading to the possession of that favorite British sport, "getting some letters after his name." They, too, by the way, are conducting the same argument with the same lack of results.

Therefore, I maintain that the highly skilled diagnostician who repairs the equipment the design engineer builds must be capable of using the engineering methods and equipment, and, in fact, is equally entitled to the qualified title of "Maintenance Engineer."

JACK DARR
Ouachita Radio-TV Service
Mena, Arkansas

(*continued on page 22*)

TWO NEW BELL RINGERS FROM DELTA



DELTALERT

Ultra Sonic Silent Sentry System

The all new economical-to-use DELTALERT, is more than a total motion detection and intrusion alert system. Use it as a convenience item to turn on lights, ring bells, alarms or monitor any area, indoors or out. Merely plug the system into any wall socket and plug the light, bell or alarm into the back of the unit. DELTALERT's **Extra Feature** variable sensitivity control and adjustable timing features provide you the most advanced sentry system on the market. Unit comes in handsome walnut finish, complete with 110-130V drop cord.

SPECIFICATIONS:

▲ **Ultrasonic Frequency: 35 KHZ**

▲ **Area Coverage: 10-30 feet (depending on environmental conditions such as shape of area)**

▲ **Controls: On-Off Switch; Built in Timer; Variable Sensitivity Control**

▲ **Output: 110-130V at 1 Amp.**

▲ **Power Requirements: 110-130V, 60 HzAC**

ONLY $59^95 ppd.
For Complete Unit, Ready to Use

HIGH VOLT ANALYST

Complete Auto Analyzer

Delta brings you a new concept in automotive tune-up — The High Volt Analyst. A unique and **complete** auto analyzer, it provides all the primary advantages of a scope and yet is **completely portable.**

SPECIFICATIONS:

▲ **Accuracy — Tachometer ± 2% of full scale (all ranges) • Dwell Meter ± 1% (both ranges) • OHMS Scale ± 5% • Low Voltage ± 2% of full scale • High Voltage ± 5% of full scale**

▲ **General — Fully protected meter circuit* • Size: 6½W x 8H x 3½D • Weight: 3¾ lbs.**

▲ **Ranges — DC Volts 0-15V, 15KV and 45KV • OHMS: 0-1 Meg. (10K center scale) • Dwell: 4, 6 and 8 cylinders • Tachometer: 0-1500 RPM, 6000 RPM**

*Batteries (8 Type AA cells) included. Comes complete with standard lead set, a special probe, and high tension lead.

$79^95 ppd. Assembled

$59^95 ppd kit form

DELTA: Please send me literature immediately.
I am enclosing $________ for items checked.

☐ DELTALERT
☐ High Volt Analyst, Assembled
☐ High Volt Analyst, Kit form

Please ship immediately.

Name____________________

Address____________________

City/State______________ Zip______

DELTA

DELTA PRODUCTS, INC.
P.O. BOX 1147 • GRAND JUNCTION, COLORADO 81501

Circle 19 on reader service card

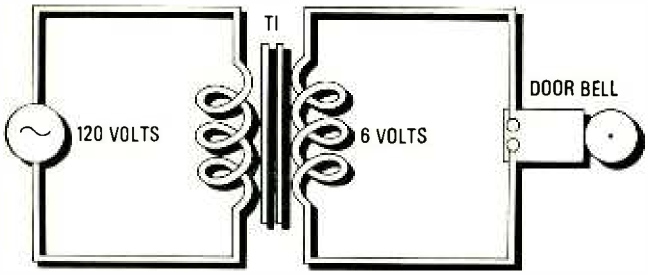
Second in a series...

Can you solve these problems in electronics?

They're a cinch after you've taken RCA Institutes' new communications electronics program.

It includes new preparation for the FCC license plus the assurance of your money back if you fail to get it.

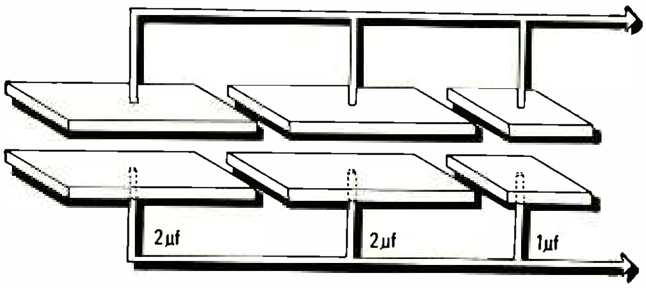
This one is quite elementary.



In this door bell circuit, which kind of transformer is T_1 — step-up or step-down?

Note: if you had completed only the first lesson of *any* of the RCA Institutes Home Study programs, you'd easily solve this problem.

This one is more advanced.



What is the total capacitance in the above circuit?

Note: you'd know the solution to the problem if you'd taken only the first two lessons in RCA's new Communications Electronics Program.

These are the lessons that prepare you step-by-step for an FCC License.

This license is a requirement for servicing all types of transmitting equipment and can help open doors to jobs commanding high income in communications, radio and broadcasting, aerospace, industrial automation and many others.

Answers: Step-down.
5 μf

For a rewarding career with good pay, take that first step now. Send for complete information—mail the attached card.

CORRESPONDENCE
(continued from page 16)

ONE-IC PARTS

I would like to build the one-IC radio that was in the November, 1969 issue of your magazine. Will you please send information about obtaining Amperex parts for this project?

WM. BOVENCHSEN
228 West Spring St.
Bloomfield, Ind. 47424

The Amperex components required for the one-IC radio can be obtained from Amperex Electronic Corp., Hicksville, N. Y. 11802.

MORE ON METER MATE

This letter is in reply to an inquiry sent to R-E concerning the pF Meter Mate (February, 1969):

I am happy that the instrument works well for your needs, but I doubt if it is practical to extend the range to 1000 pF.

The value of the required resistor connected to S2 would be so low as to cause severe loading of Q2, resulting in faulty operation or failure.

One approach might be to connect an emitter follower to Q2, and then determine the value of the differentiating resistor experimentally. (See drawing.)

Actually, I have on occasion used similar circuits to measure larger capacitors by feeding them directly to the voltmeter from the oscillator. Of course, a dc clamp and a calibrating potentiometer must still be used. (See drawing.)

WILLIAM G. MILLER
Newark, N. J.

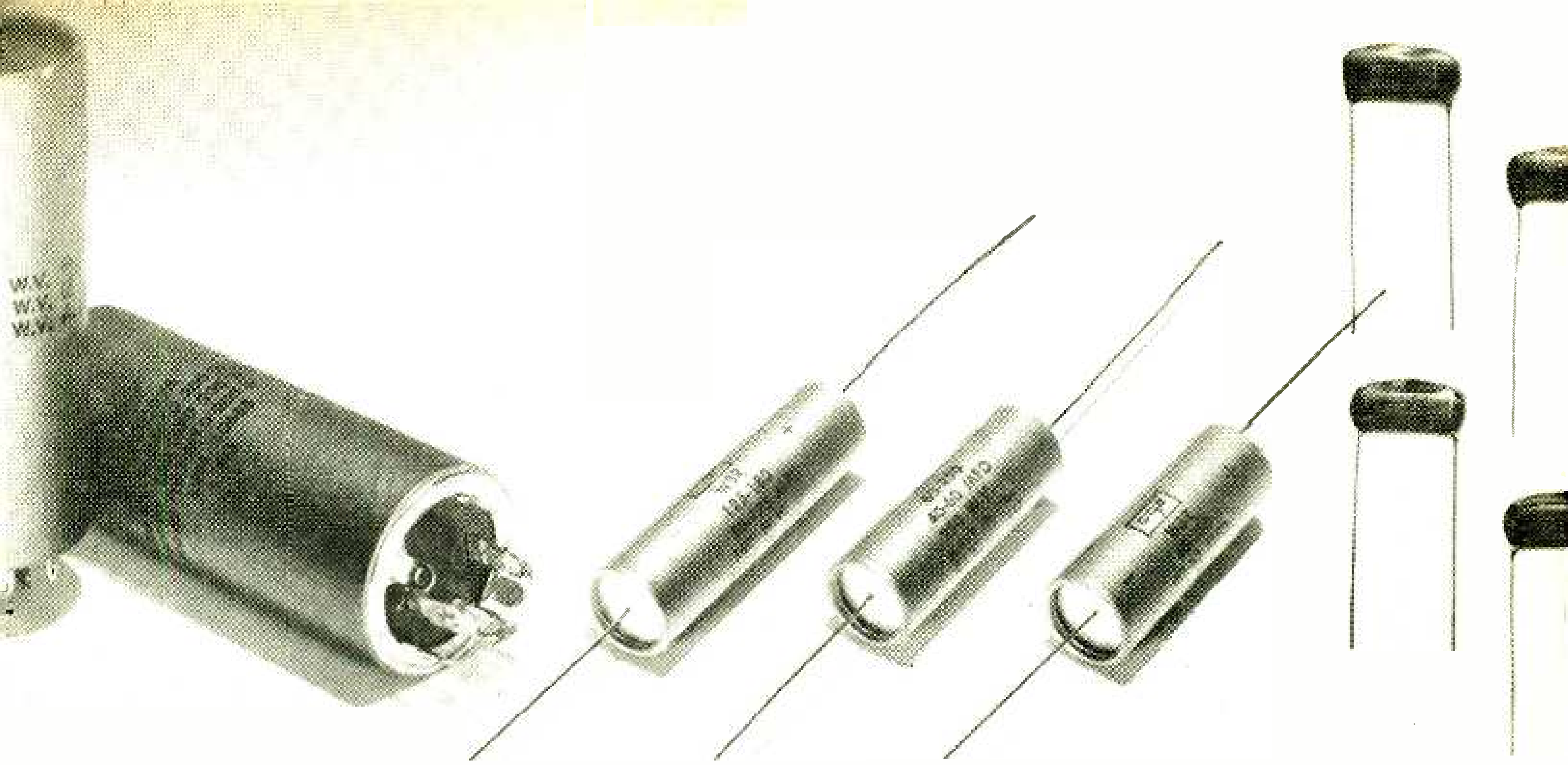
WANTS TRACK LAYOUT

In reference to your article, "For Model RR Electronic Throttle," in the November issue, by Henry J. Mierlak, I would like, if possible, information on a good track layout for HO gauge and the best way to apply the electronic throttle in the set up.

D. McLAUGLHIN
P. O. Box 284
Westminster, Mass. 01473

Being an electronics magazine, we have no data at all on track layouts and suggest you obtain copies of the many railroading magazines available which do have rather comprehensive information in that area. **R-E**

IN THIS ISSUE
Want to build something different? Try the lab quality pulse generator on page 37. Too difficult? Try one of the 30 IC circuits that start on page 62. You'll find them different.



If you've wondered about the differences between different kinds of capacitors you'll find all the answers here

CHOOSE-&-USE Capacitor Guide

by RICHARD R. MARSH*

NO OTHER ELECTRONIC COMPONENT performs many unique and vital functions as the capacitor. It is the only device that causes a 90° phase shift complimentary to the inductor, making tuned circuits possible. It is the only device that actually stores electrons.

The capacitor blocks direct current, necessary for coupling circuits, yet allows alternating current to pass. The capacitor bypasses unwanted signals in electronic circuits. Noise filters are a unique application. Capacitors are used in many timing circuits. Capacitors store energy for use in electronic flash circuits. In power supply filter circuits capacitors smooth ripple after rectification.

Automobile ignition systems can not function without capacitors and noise suppression in vehicles would not be possible without capacitor filters. Power line distribution, requiring power factor correction for high inductive loads, demands large banks of high-voltage capacitors.

As you can see, without the capacitor, electronics and electrical distribution as we know it today would not be possible.

There are two basic families of capacitors—electrostatic and electrolytic.

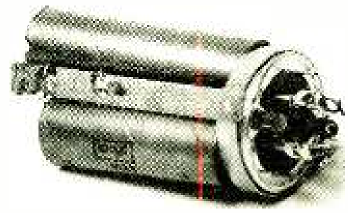
Electrolytic capacitors

In general, electrolytic capacitors are wet or semi-wet units, such as twist-prong can capacitors, all types of aluminum electrolytics, and certain tantalum electrolytics.

The electrolytic capacitor consists of a dielectric of aluminum with a very thin microscopic oxide formed by an electrochemical process. This oxide is so thin and in such close proximity to the two conductors of the capacitor that high capacitance is obtained. By etching the aluminum material, a greater area is exposed and more capacitance is possible.

Electrolytic and electrostatic capacitors are generally *not interchangeable*. They are used in different types of circuits which require special characteristics.

Electrostatic capacitors employing such dielectrics as air, paper, Mylar, mica, etc. are generally used in circuits demanding relatively small amounts of capacitance at rather high voltages and with extremely low leakages. The insulation resistance has to be very high to prevent direct current from passing through the capacitor. Coupling circuits, bypass circuits, tuning circuits, etc. are popular requirements employing electrostatic capacitors.



Multisection electrolytic capacitors are made by placing separate electrolytics into a single case. Leads come out the bottom.

Electrolytic capacitors offer maximum capacitance for its size, but exhibits higher leakage than electrostatic.

Electrolytics generally can not be used in high-impedance coupling circuits, high-frequency tuning circuits, and in some bypass and coupling ap-

*Cornell-Dubilier Electronics

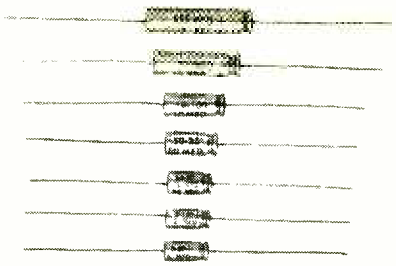
plications. Electrolytics are primarily intended for use in filter circuits and power supplies, bypass circuits where heavy current is used, electronic photoflash, low-impedance couplings and various energy storage devices.

Understanding these two basic families of capacitors and their differences is a must. Most electronic technicians and many engineers believe that the precision of an electrolytic is the same as that of an electrostatic. **This is not true.** The construction of an electrostatic capacitor is usually quite simple; it can be uniformally wound on an automatic machine and held to close tolerance. Electrolytic capacitors, on the other hand, have many variables. The yield of the etch, the aluminum oxide forming process, and the aging process vary widely. It is very difficult to manufacture an electrolytic to close tolerances. Electrolytic capacitors made to close tolerances are sometimes used in highly sophisticated equipment such as computers, space age devices, and critical military equipment.

Electrolytic capacitors in general used throughout the radio and television industry are made to tolerances set by EIA that allow as much as 150% over and 10% under the capacitance indicated on the label. This means that a capacitor rated as 50 μF can be as large as 125 μF and be in tolerance. This works because most circuits do not require close tolerances. In a power supply it makes little difference when a capacitor is over its rated value, as long as there is enough capacitance to perform properly. Increasing the capacitance in a properly designed circuit, will not increase the voltage or change the circuit function. **A larger capacitance can not alter the peak voltage a power supply will deliver.**

Since an electrolytic capacitor has broad tolerance, it is unfortunate that many technicians searching for a replacement unit waste time and money attempting to find a unit with the "exact" rating of the one they replace. For example, if the capacitor originally on the chassis is rated at 60 μF at 400 volts; *this means that the engineer who designed this circuit figured that approximately 60 μF was the minimum capacitance required to make the circuit perform properly.* Often the capacitors installed measure more than 100 μF, and in many cases as much as 200% over the rated value (in spite of the marking on the capacitor itself.)

A TV set manufacturer will not reject these, because he is getting more for his money. This over-spec capacitor generally lasts longer and performs better in the circuit.



Miniature electrolytics with high capacitance values are commonly found in transistor circuits of all kinds.

Several years ago a number of capacitor manufacturers, realizing the broad tolerance in electrolytics, decided it was unfair to the service technician and to distributors throughout the country to pursue a so called "exact" rating of replacement units. Capacitors are now marketed that have wide range ratings: for example: 60 to 100 μF up to 350 volts.

What does this mean? It means that this capacitor was designed and built as a 100 μF 350-volt unit. It could easily be well over that and still be within tolerance. The capacitor can be used in any circuit that requires 60 to 100 μF of capacitance in any voltage up to and including 350.

Years ago electrolytic capacitors had an unfortunate characteristic that resulted in reformation at voltages other than those intended. Many of these old units would have to be reformed when put into a circuit. Shelf life alone would cause voltage rating to drop and capacitance to increase. Taking a 300-volt capacitor and putting it in a 200-volt circuit would cause it to deform to 200 volts and its capacitance would increase proportionately. This has not been true for many years, but many technicians still believe this to be so. Modern capacitors are quite stable and can be used at voltage lower than that specified. A 300-volt capacitor can operate on 10 volts for a year and still operate properly at 300 volts. It makes no difference to the capacitor.

The important thing to remember is that the wide-range electrolytic capacitor is at least what its maximum rating states. In other words the 60 to 100 μF rating guarantes you at least 100 μF at the top voltage.

By using wide-range ratings less than 250 twist-prong capacitors can be used to replace more than 3,000 twist-prong capacitors. This means that a distributor's inventory is smaller, the stocking difficulties are reduced, the required product is easier to find, stock is fresher, and the service technician has what he needs at all times.

The wide range rating is simply a recognition of the physical realities of electrolytic characteristics. But if you select a capacitor that says 60 to 100 μF you can use it in a circuit where you removed a 10-, 15-, or 20-μF capacitor.

The facts are: use a capacitor with *at least* the capacitance and the voltage of that you remove from the circuit, and you satisfy the circuit.

The wide-range application has been added to tubular electrolytic capacitors too. The same principle applies to the tubular aluminum electrolytic capacitor as to the twist-prong.

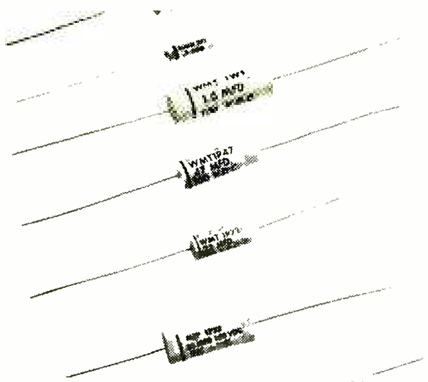
Wide-range tubular electrolytics reflect many recent technological advances in manufacturing. The widespread use of solid state equipment has made re-evaluation of the requirements of the tubular replacement market mandatory. As a result many capacitances and voltages have been introduced that have never been seen before. These new capacitors have been specifically designed for the electronic technician, are well suited for many industrial applications and are found in original equipment too.

Some new voltages (10 volts, 16, 35, 75, 100 and 180 are becoming popular) and very high capacitances have been introduced to meet the requirements of new solid state circuitry. 5000 and 10,000 μF are common in these new tubular constructions. Size has been reduced through new manufacturing techniques and materials. Case sizes have been drastically reduced across the board. These new units operate at 85°C, except for 500-volt units which are rated at 65°C. The 500-volt electrolytic capacitor when operated at 450 volts, or below, becomes a 85°C capacitor.

Eliminating redundent case sizes is important. There is no point in building a capacitor with a given capacitance in a lower voltage if its size can not be reduced. For example, if a 5-μF 150-volt capacitor is in the smallest case size available, there is no point in having a 5-μF unit at any voltage below that, such as 5 μF at 50 volts or 5 μF at 10 volts.

Electrostatic capacitors

Paper dielectrics were one of the earliest types used in low-cost capacitors offering a great size reduction over mica units. However, they have always had a history of failure because of poor moisture resistance. Oil impregnation, wax impregnation and new sealing techniques have improved the life and operation of this type of dielectric but have never completely eliminated the moisture problem.

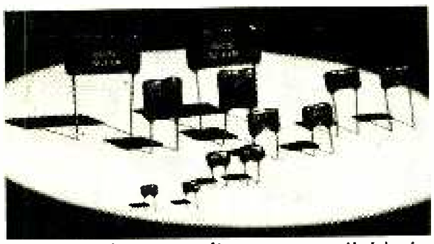


Molded capacitors of polyester film are oval to fit into shallow spaces.

The introduction of Mylar dielectrics eliminated the moisture problem completely. Mylar is uneffected by moisture. Therefore the capacitor seal is less important. Mylar is a good dielectric when used in dc circuits but does not have good characteristics in ac applications. Impregnated paper is a superior dielectric for ac uses or where transient situations might occur.

To get an excellent capacitor for universal replacement a combination of paper and Mylar is used. A layer of Mylar and a layer of impregnated paper are used, one layer upon the other.

The dipped paper Mylar capacitor, very popular today, is the best general purpose universal replacement component for both molded, wrapped, and dipped Mylar type original equipment units.



Dipped mica capacitors are available in a wide range of capacitance values.

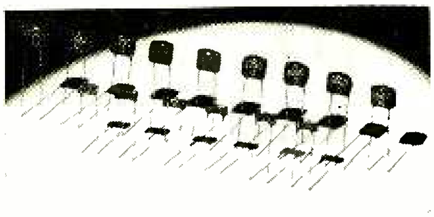
Dipped construction offers the best possible seal, with freedom from humidity and mechanical problems. It is a perfect substitute for all molded and wrap type capacitors as its radial leads can be bent to conform to any mechanical requirement.

In original equipment design there are certain advantages and price considerations that result in using pure Mylar type dielectrics, pure paper dielectrics, and molded type constructions. Where circuit parameters are known, pure Mylar dielectrics and molded constructions are suitable.

The molded type construction is still used because of its uniform size. A great convenience for automated assembly. In the replacement market however, where we never know where a capacitor is going to be used, we highly recommend the service technician to stock *only* dipped paper Mylar type units.

Mica dielectric material is one of the most stable available. Mica has been in existance for many millions of years and is not apt to undergo change. Mica capacitors offer extreme stability, good operation in alternating currents, relative low inductance, and can be manufactured to extremely close tolerances. Mica capacitors are available in tolerances under 1% of rated values. The dipped type construction is becoming the most popular and is found in almost all circuity on the market today.

Many thousands of mica capacitors are available in manufacturers



Miniature dipped mica capacitors are handy where space is at a premium.

catalogs. However, only a very few of these are used in consumer products. For the technician to have an adequate stock of values that are needed some manufacturers have identified specific few well chosen "5%" dipped mica capacitors that will take care of almost all replacement needs.

Ceramic disc type capacitors are extremely popular, offering low inductance, extremely low price, and a variety of temperature compensating characteristics. General-purpose disc ceramics are very inexpensive. However below 100 pF NPO type capacitors are only slightly more expensive and will perform as well or better.

In high voltage requirements it is just as well to use high-frequency (deflection yoke) capacitors for all applications. This eliminates the need to stock separate general-purpose type capacitors and high-frequency units in your inventory.

Electrostatic capacitors can usually be made to close tolerances and many circuits demand precise replacements. Most paper Mylar type units are made within ±10% of their rated capacitance and, as mentioned above, mica capacitors can be made very close and ceramic capacitors can be made relatively close to their rated values. Unlike the electrolytic capacitor which has wide variations in tolerance and is used in the circuits where this tolerance is quite acceptable, many circuits requiring electrostatic capacitors require extremely accurate substitution.

When replacing capacitors good judgment is a must. But a great deal of time and trouble can be saved, resulting in better customer satisfaction and greater profit, if the inherent differences between electrostatic and electrolytic capacitors are kept in mind. **R-E**

SERVICE QUESTIONS FROM R-E READERS

Nonlinearity in old scope

I've just got hold of an old oscilloscope. It works, but it's pretty nonlinear horizontally. Sync doesn't hold too well, and so on. What can I do to this to make it work?—C. B., Rye, N. Y.

The best thing would be to give it what we used to call a "G.I. cleanup!" In other words, start in at one end of the circuit and go all the way through, checking everything along the way. By "everything," I mean all operating voltages, tubes and especially coupling capacitors and plate-load resistors. These are the parts most apt to cause this trouble.

In equipment this old, the coupling capacitors are apt to be just a bit leaky; check them carefully, and replace with exactly the same value, not less than 600-working-volt types. Check all resistors for drift, and electrolytic filters for value. When you get through, you'll be surprised!

'Vertical' hum in sound

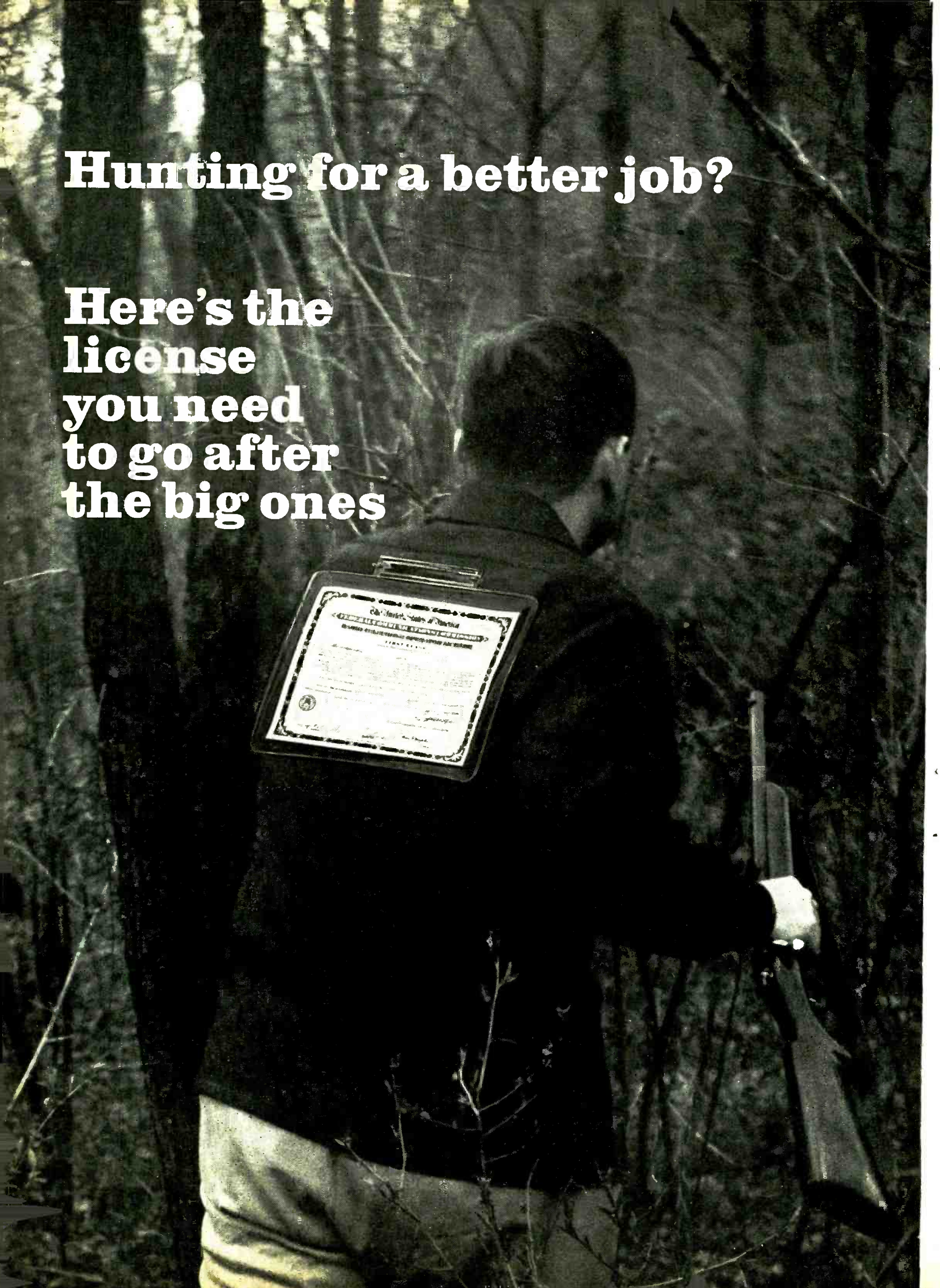
I've got a Zenith 19Z22Q chassis with a crazy hum. It s ounds like a 60-Hz hum but not quite the same! I found out that I could push the audio output tube away from the 12B4 (vertical output) and cure it! What the heck?—S. L., Mobile, Ala.

First and most common hum is power-supply ripple from inadequate dc filtering. This is a "smooth" hum. Second cause is high-amplitude spikes from the vertical output tube. If these get into the dc supply circuits, you'll have a 60-Hz *sound*, but it won't be smooth. It will be more like a "buzz."

Adjust the vertical hold control. If this changes the *pitch* of the hum, there's your source.

The cure is the same in both cases: more filter capacitance, even if you have to add more than the manufacturer's original schematic calls for. **R-E**

This is 30,000 solid state replacement parts.


Hunting for a better job?
Here's the license you need to go after the big ones

A Government FCC License can help you bring home up to $10,000, $12,000, and more a year. Read how you can prepare for the license exam at home in your spare time—with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

Right now there are 80,000 new openings every year for electronics specialists—jobs paying up to $5, $6, even $7 an hour... $200, $225, $250, a week... $10,000, $12,000, and up a year! You don't need a college education to make this kind of money in Electronics, or even a high school diploma.

But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge... the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everyone who wants a good job in Electronics get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can back our courses with this iron-clad Warranty: Upon completing one of our FCC courses, you must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs

The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

Ed Dulaney, Scottsbluff, Nebraska, for example, passed his 1st Class FCC License exam soon after completing his CIE training... and today is the proud owner of his own mobile radio sales and service business. "Now I manufacture my own two-way equipment," he writes, "with dealers who sell it in seven different states, and have seven full-time employees on my payroll."

Daniel J. Smithwick started his CIE training while in the service, and passed his 2nd Class exam soon after his discharge. Four months later, he reports, "I was promoted to manager of Bell Telephone at La Moure, N.D. This was a very fast promotion and a great deal of the credit goes to CIE."

Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and earning his FCC License. Today, he's an inspector of major electronics systems for North American Aviation. "I'm working 8 hours a week less," says Mr. Frost, "and earning $228 a month more."

Send for FREE book

If you'd like to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License ... requirements for getting one... types of licenses available... how the exams are organized and what kinds of questions are asked... where and when the exams are held, and more.

With it you will also receive a second FREE book, "How To Succeed In Electronics," To get both books without cost or obligation, just mail the attached postpaid card. Or, if the card is missing, just mail the coupon below.

ENROLL UNDER NEW G.I. BILL. All CIE courses are available under the new G.I. Bill. If you served on active duty since Jan. 31, 1955, or are in service now, check box on reply card for complete details.

2 NEW CIE CAREER COURSES

1. **BROADCAST (Radio and TV) ENGINEERING**... now includes Video Systems, Monitors, FM Stereo Multiplex, Color Transmitter Operation and CATV.
2. **ELECTRONICS ENGINEERING**... covers steady-state and transient network theory, solid state physics and circuitry, pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

CIE Cleveland Institute of Electronics

1776 E. 17th St., Cleveland, Ohio 44114

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

Cleveland Institute of Electronics
1776 East 17th Street, Cleveland, Ohio 44114

Please send me without cost or obligation:
Your 44-page book "How to Succeed In Electronics" describing job opportunities in Electronics today, and how your courses can prepare me for them.
Your book on "How To Get A Commercial FCC License."

I am especially interested in:

- [ ] Electronics Technology
- [ ] Electronic Communications
- [ ] Broadcast Engineering
- [ ] Industrial Electronics
- [ ] First Class FCC License
- [ ] Electronics Engineering

Name ______________________ (PLEASE PRINT)

Address ______________________

City ______________________

State ____________ Zip ____________ Age ______

- [ ] Check here for G.I. Bill information

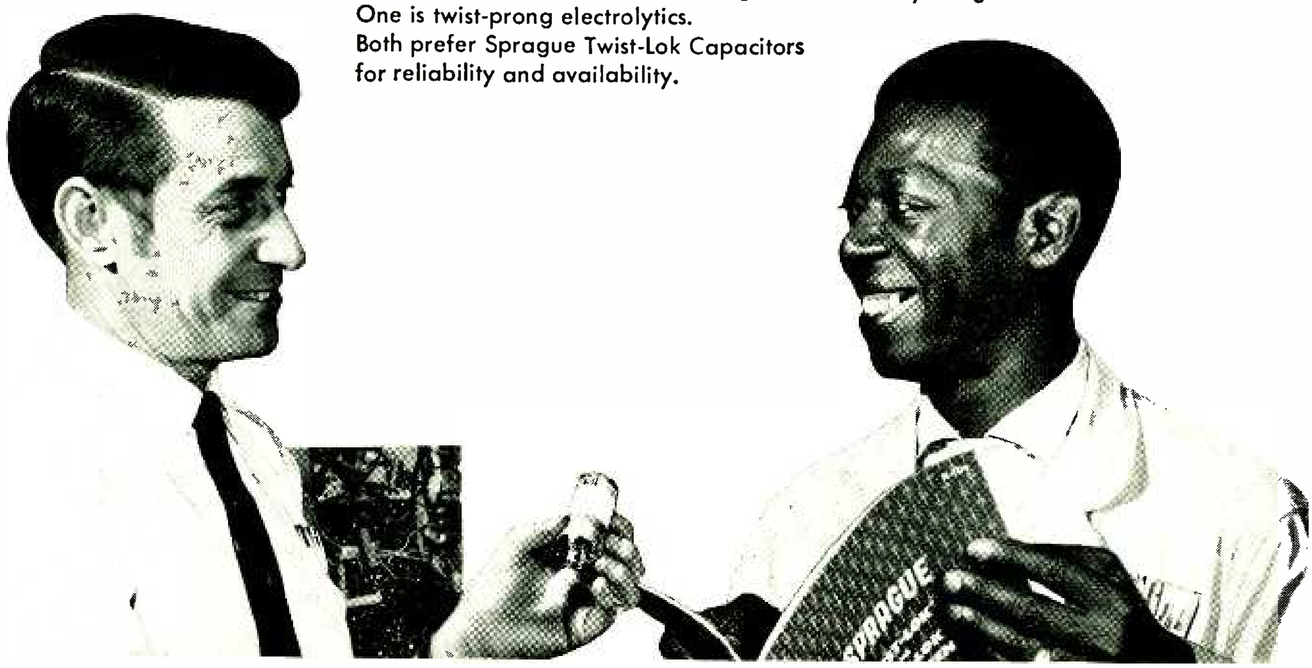
RE-69

Circle 21 on reader service card

Do you choose capacitors the same way Fran French and Lew Russell do?

Then you're sure to pick Sprague Twist-Lok® Capacitors when you need twist-prong electrolytics.

Fran French and Lew Russell keep everything humming smoothly at Delaware Valley TV Service, Philadelphia, Pa. Fran, as Gen. Mgr., and Lew, as Shop Mgr., have had a lot to do with building this 13-man organization's reputation as specialists in color TV. With 20 years' TV servicing experience apiece, Fran and Lew agree about many things. One is twist-prong electrolytics.
Both prefer Sprague Twist-Lok Capacitors for reliability and availability.



Ask your Sprague distributor for a copy of Sprague's Electrolytic Capacitor Replacement Manual K-109 or write to: Sprague Products Company, 509 Marshall St., North Adams, Mass. 01247.

P.S. **You can increase your business 7½% by participating in EIA's "What else needs fixing?" program. Ask your distributor or write to us for details.**

SPRAGUE®
THE MARK OF RELIABILITY

1418-26

Circle 22 on reader service card

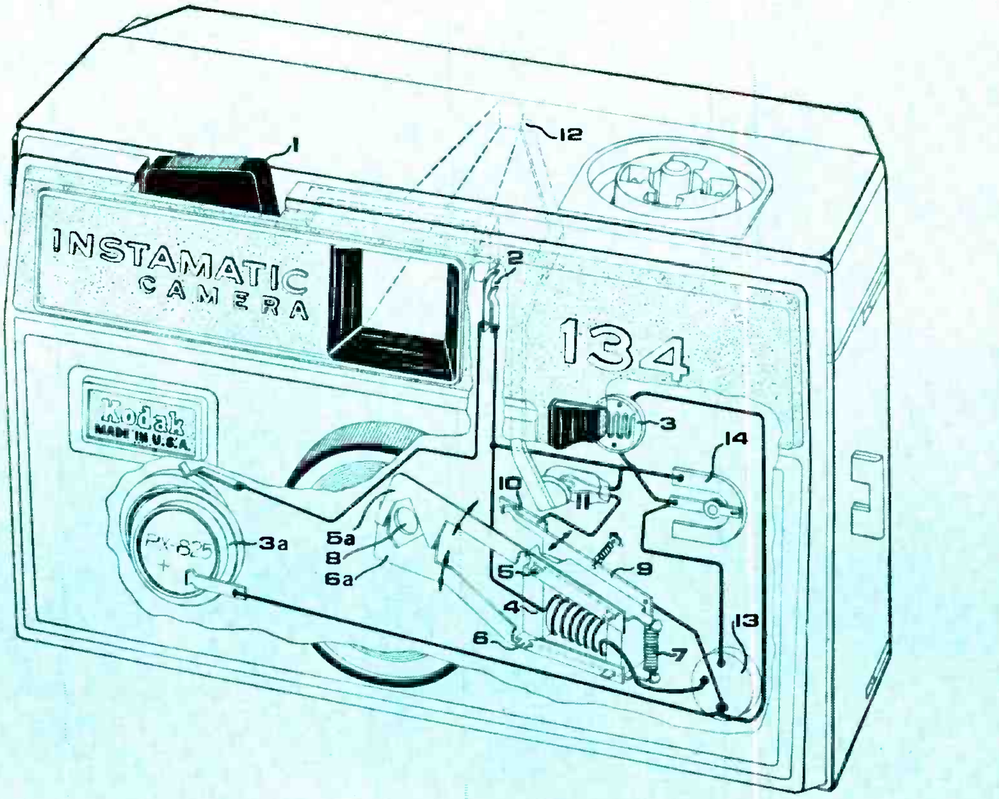
New solid-state circuits: Kodak's 134 shutter control, Valvo's TAA580 IC and Zeiss Ikon's Ikophot T, a meterless 'meter'

ELECTRONICS IN PHOTOGRAPHY

by JOHN R. FREE
ASSOCIATE EDITOR

SOLID-STATE CIRCUITS FOR PHOTOGRAPHY—like other areas of consumer electronics—are being used in easily manufactured, low-cost products as well as sophisticated professional gear.

A recent example of design and manufacturing innovations that put the advantages of electronically controlled shutters in the hands of amateurs is Kodak's Instamatic 134. It sells for under $26. The diagram (right) and Figs. 1 and 2 show how this inexpensive exposure control works. Numbers in parenthesis identify components in the drawing.



Basically, the 134 mechanism combines the circuit of Fig. 1 with a simple mechanical vane arrangement (Fig. 2) to determine how much light reaches the film. The first electronically controlled shutter camera on the market (Polaroid in 1963) also used a CdS-cell circuit and mechanical aperture action. Unlike the Polaroid circuit, though, which use one of several capacitors charged through a photocell circuit to end the exposure, the 134 utilizes variations of flux density in the coil of an electromagnet.

When (1) is partially depressed, switch S1 (2) closes and Q1 (13) conducts to an extent determined by the light falling on CdS cell R2(3). For a bright scene, R2's resistance is lowest and a large current flows through the coil (4) of the relay.

As Kodak engineer Paul Ernisse explains, "This electromagnetic coil has three armatures mounted so as to provide individual control for two vanes (5-a and 6-a) attached to armatures (5 and 6) plus a lamp turn-off switch. All the armatures have a different air gap from armature to relay core; and, hence, a different flux level for operation."

Thus, for a bright scene, current through the coil is sufficient to attract

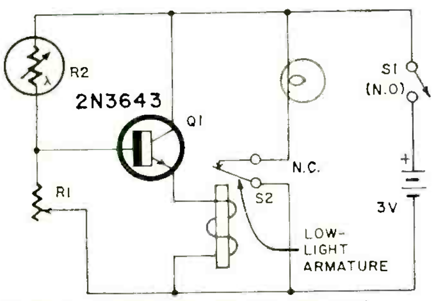


Fig. 1—Basic circuit for the 134.

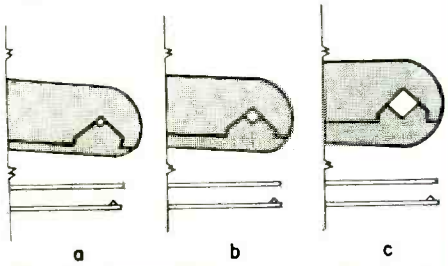
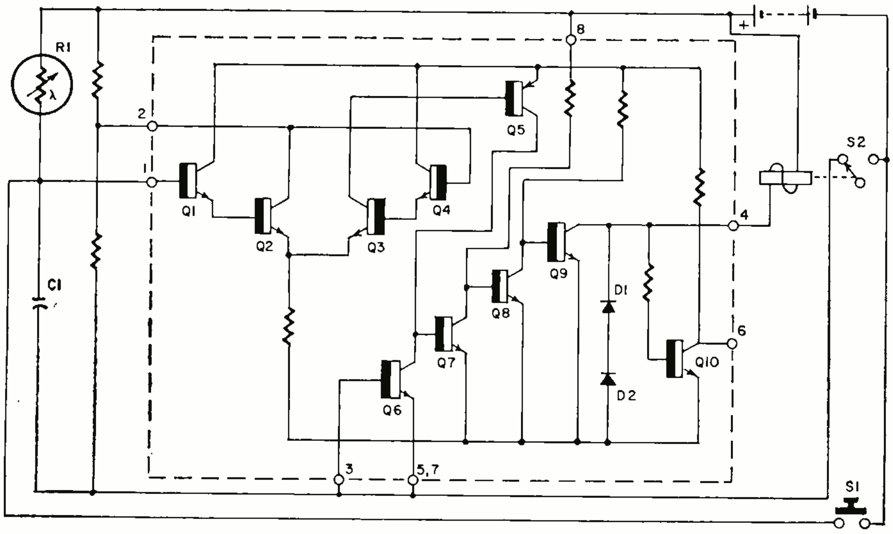


Fig. 2—Increasing aperture size (a-c).



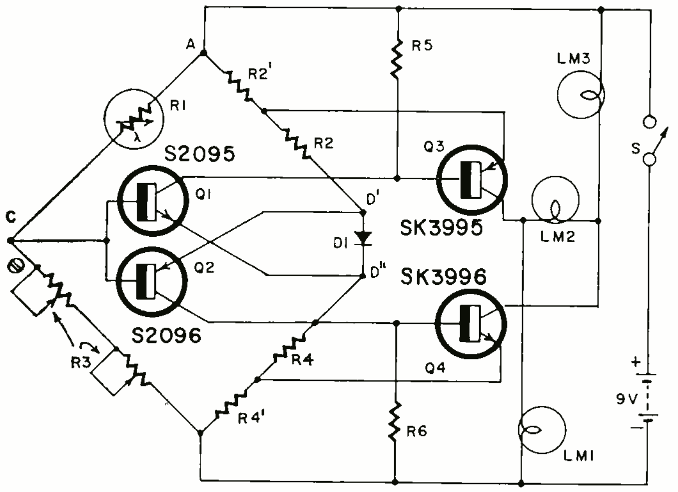


Fig. 3—Shutter-control IC, the TAA580, uses 10 transistors with typical solenoid-CdS-cell circuit.

Fig. 4—Bridge circuit in the Ikophot T becomes unbalanced by light falling on the photocell.

both armatures 5 and 6, and the vanes provide the smallest aperture, f/22 (Fig. 2-a). For intermediate light (f/16), the resistance of photocell R2 increases and current to the coil decreases. As a result, armature 5 is pulled in and vane 5a covers part of the lens (Fig. 2-b).

Under all these lighting conditions, a third armature (9) is pulled in, opening normally closed, low-light switch S2 (10).

When available light is too low to pass enough current to draw in armatures 5 or 6 (overcoming the tension of spring 7), the vanes do not cover the lens, providing an f/11 setting. If lighting is insufficient to draw in armature 9, the low-light switch remains on. A fiber-optic tube (12) lets the user see the lamp, indicating it's time to switch to flash. Calibration pot R1 (14) is set at the factory by selecting a light level that corresponds to proper film exposure at f/16.

Monolithic IC's for cameras

A monolithic IC now being used by West Germany's Prontor in their shutters is the TAA580, made by Valvo, also a German firm. This IC is in an 8-lead flatpack small enough to be mounted inside the lens-mount ring. If two 580's are used, one can provide a time-delay.

A typical application of the 580 is shown in Fig. 3. When the release button S1 is depressed, the solenoid is energized since transistors Q3, Q4, Q5, Q7 and Q9 are conducting, while Q1 and Q2 are off. Light falling on photocell R1 determines the level to which C1 will charge. When a predetermined charge level is reached, Schmitt trigger Q1–Q4, deposited in a Darlington configuration, switches with Q1 and Q2 on. This turns off Q9, which has been keeping the solenoid energized, and the shutter closes. Transistor Q5 is used for level shifting, while current amplifiers Q7–Q8 drive the output transistor, Q9. Diodes D1 and D2 protect the IC from the solenoid's back emf.

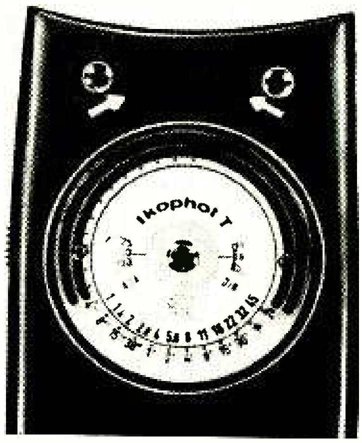
To add time-delay and control the shutter speed, a second 580 can be used with a pot in place of the photocell it would normally use. Pin 6 of the time-delay IC would be tied to pin 3 of the 580 controlling the shutter. Transistor Q10 in the delay IC then prevents Q9 in the shutter-control IC from turning off (through Q6) until the charging capacitor in the delay IC is fully charged.

Meterless exposure readout

The Ikophot T (Zeiss Ikon AG) is an electronically controlled exposure "meter" that uses three lamps, a bridge circuit and indication amplifier in place of a galvanometer (Fig. 4). The bridge consists of photoresistor R1, balancing resistance R3 (actually, 58 separate resistance units), and R2 and R4, two equal fixed resistances. Light on R1 can unbalance the bridge.

The bridge is balanced when lamp LM2 lights. Lamps LM1 and LM3 indicate what direction the balance wheel (R3) must be turned to light LM2.

A four-transistor indication amplifier has two equally complementary



Bulb-readout Ikophot T lightmeter.

channels. The bases of the Q1–Q2 transistor pair are connected at point C and their emitters are tied to point D of the bridge. A voltage-dependent cross current flows through R2–R2′, R4–R4′ and D1. Due to the diode's nonlinear current-voltage characteristics, the voltage on the diode is essentially constant. This biasing potential on the diode compensates the starting voltage for the transistors, since no base current can flow below this voltage. Thus, even minute imbalance currents between C and D′ or D″ produce an increase of collector current in Q1 or Q2.

If C is positive with respect to D, Q3 will conduct. Since the resistance of the emitter–collector path is considerably lower than series-connected lamps LM2 and LM3, lamp LM1 lights. Conversely, LM3 lights if the potential at C is negative.

The cold resistances of LM1 and LM3 are much lower than LM2. Since all three lamps are connected to the emitter–collector paths of final-stage transistors Q3–Q4 across the full battery voltage, LM2 lights with most of this voltage applied to it.

This tells you the bridge is balanced, and exposure times are read beneath stop values from f/1 to f/45 at ASA's from 6 to 3200. **R-E**

build...

$3.50 Enlarging-time meter

by HERBERT ELKIN

Easy contrast-ratio technique lets you measure density ranges on the easel. Eliminates wasted time developing individual test strips

ARE YOU WASTING TIME AND ENlarging paper making test strips in your darkroom? You would like to have one of those fancy commercial darkroom easel meters, but they're too expensive? The circuit shown in Fig. 1 is the answer, and as the title describes, it can be built for $3.50!

The unit determines exposure from the projected image on the enlarger baseboard. It can measure contrast ratios to determine the proper grade of paper or variable contrast filter needed and whether dodging or burning-in is required.

The reduction in darkroom time and the savings in paper will far outweigh the initial cost and effort involved in constructing this device.

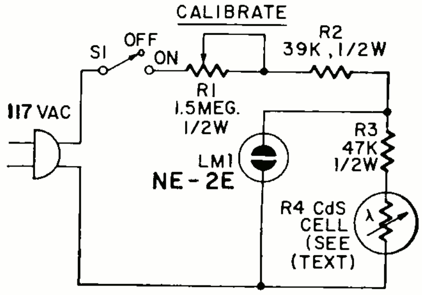
How it works

The unit is an ac-operated variable sensitivity CdS exposure meter. The heart of the meter is a sensitive cadmium sulfide photoconductive cell. The photocell is basically a light sensitive resistor which reduces resistance as the incident light intensity on the cell increases. The photocell used for this unit has a light to dark resistance ratio of over 50 to 1. Therefore, the unit can be calibrated for easel light intensities of 50:1 (minimum discernible illumination to 50 times the intensity). The sensitivity of the enlarging timer is 0.03 foot-candles.

Via switch S1, 117 Vac is applied to R1, R2, and R3, R4 (CdS cell) which form a variable light intensity dependent voltage divider across neon lamp LM1. The voltage across LM1 is:

$$117\text{ Vac} \times \frac{R3 + R4}{R1 + R2 + R3 + R4}$$

Resistor R2 limits the maximum current through LM1 to a safe level and R3 limits the dissipation in the CdS cell. When the voltage across LM1 exceeds 65 Vac (the breakdown voltage for a NE-2E lamp), the lamp glows its characteristic red-orange color. If the resistance of R4 increases (lower illumination) or if R1 is set to a lower resistance, the current through LM1 increases and the lamp grows brighter. After ion breakdown in the neon lamp (at 65 Vac), the voltage across the lamp reduces to its maintaining voltage of approximately 50 Vac (similar to a regulator tube). As the voltage across the neon lamp is further reduced, the lamp will extinguish abruptly at a voltage slightly below the maintaining voltage (the extinguish voltage). Therefore, a voltage hysteresis effect is exhibited



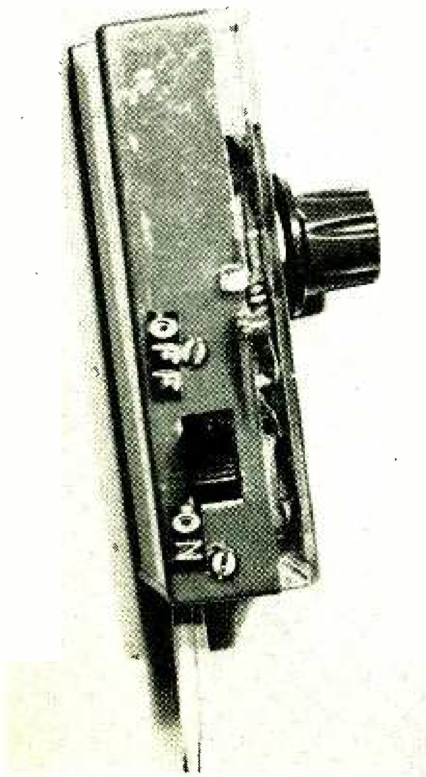
PARTS LIST

R1–1.5MEGOHM, 1/2 WATT POTENTIOMETER, LINEAR TAPER
R2–39K, ±10%, 1/2W COMPOSITION RESISTOR
R3–47K, ±10%, 1/2W COMPOSITION RESISTOR
R4–CdS PHOTO-CELL (SEE TEXT)
LM1–NE-2E, 1/10 WATT NEON LAMP
S1–SPDT SLIDE SWITCH, POINTER KNOB
AC LINE CORD
PLASTIC BOX APPROX– 2-15/16 x 1-1/4 x 3/4

Fig. 1—Potentiometer R1 is calibrated for developer and paper in use.

from turn-on to turn-off. Since the turn-off point is visually and electrically more abrupt, this point is used to sense the required light intensity once *calibrate* potentiometer R1 is set for a particular paper and developer.

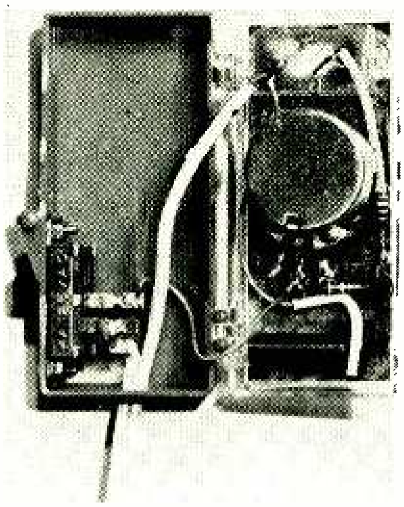
Once the unit is calibrated for a developer-paper combination, the setting of R1 should be recorded along with the proper exposure time for future reference when the same paper and developer are in use. Although the ac supply voltage is not regulated, I found that developer concentration and temperature and developing time variations had a greater effect on the final print than an error in f-stop setting caused by a slight change in ac line voltage.



Switch S1 can be mounted on the side of the box used for the meter.

Now put one together

The unit is built into a plastic box 2-15/16″ x 1-¼″ x ¾″ (see Fig. 2). I cut a hole in the upper front portion of the plastic box for the CdS cell which was mounted with cement. Trim a piece of matte black craft paper to the size of the front of the plastic box. Using a paper hole



Inside the 2-15/16 x 1-¼ x ¾-inch plastic case used by the author.

punch, make a hole at the bottom of the craft paper for the neon lamp. Use white ink to make a scale to reference the position of R1. Cement the craft paper to the plastic box before the CdS cell and potentiometer are mounted. Then use a needle file to remove the craft paper covering the openings for the CdS cell and the potentiometer. Black vinyl tape holds the neon lamp on the inside of the box over the lower opening in the craft paper to the size of the front ing of the neon lamp. Any convenient scale can be used for the potentiometer so long as its setting can be returned to at a later date. The CdS cell shown is not available but the Clairex CL702L will replace it. It has the advantage of being only ¼ inch in diameter (mounted in a transistor TO-5 case) thus smaller areas of the projected negative can be measured. Any CdS cell having a dark resistance of approximately one-megohm and a resistance of approximately 20,000 ohms at 2 foot-candles can be used.

Calibration and use

The meter is calibrated for each type paper and developer used. The proper exposure time and f-stop for a normal "negative" is determined by conventional test strip methods. Then the unit is placed on the easel over a critical area of the negative. Calibration potentiometer R1 is adjusted until the neon lamp just extinguishes. The setting of the potentiometer and exposure time is then recorded for future reference whenever the same paper and developer are in use.

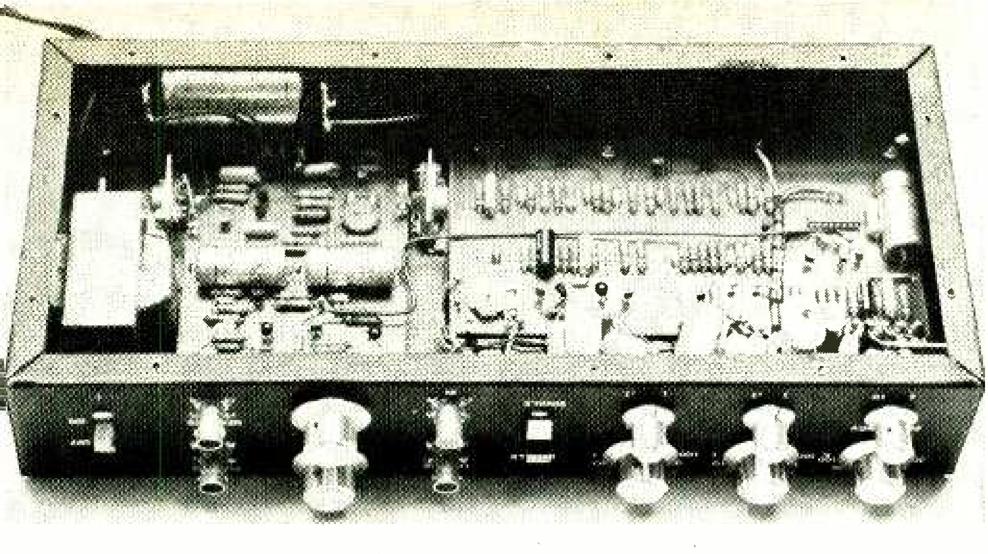
Subsequent negatives can then be analyzed on the easel for density range. The proper f-stop (constant exposure time as determined during calibration) for the negative in question can now be determined by varying the enlarger f-stop until the neon lamp just extinguishes.

If you want to use the f-stop for critical sharpness of your enlarger lens, calibrate the unit using this f-stop. If subsequent negatives call for a different f-stop, the critical f-stop can still be used if you remember that each f-stop deviation from your calibration f-stop means twice (or half) the previous f-stop light intensity. Therefore, if your calibration exposure was 10 seconds at f8 (f-stop for critical sharpness) and another negative requires and f-stop of f11 for the neon lamp to extinguish, you can set the enlarger to f8 and change your exposure time to 5 seconds.

Intensity of light on the easel varies inversely as the square of the distance of the lamp from the easel. So if the calibration negative is raised with the enlarger head to twice the enlarger height at which the enlarging meter was calibrated, the same light intensity on the easel will be obtained by opening the lens up by two f-stops (four times the light through the lens). It's now obvious that the unit should be calibrated at the smallest f-stop if a small enlargement is used to calibrate the unit and you expect to make extreme enlargements using the same paper-developer combination. It may be found convenient to calibrate and record potentiometer R1 settings for a 4 x 5, 5 x 7, 8 x 10, etc. enlargements.

With a little practice. you will be able to turn out perfect prints on the first try without the time consuming operation of making test strips.

Note, the unit shown on the cover is a specially built version and illustrates one possible construction method. The unit the author made is in the photos on these pages. **R-E**



Build Lab-quality pulse generator

Precision unit has 10-Hz to 1-MHz rep rate, variable width and delay, double-pulse mode, 20 nsec rise and fall times—and more

by JAMES BONGIORNO

ARE YOU IN THE MARKET FOR A SOPHISTICATED pulse generator, but can't afford several hundreds of dollars for a commercial unit? Wait no longer because here is a pulse generator that will hold its own with units costing much more.

While it doesn't have all of the sophisticated features of the more expensive units, like variable rise and fall time or programming, it does have most of the features that you or I will ever need. The repetition frequency extends from 10 Hz to 1 MHz, pulse delay and pulse width from 100 msec to 100 nsec, and in addition it has external sync input, external trigger, single shot, trigger output. It also has single or double pulse mode.

The unit can be externally gated to provide any amount of pulses in a single or multiple or continuous burst pattern in any combination of sequences that you can dream up. It also has simultaneous and independently controlled positive and negative outputs at approximately 50 ohms impedance which are short circuit proof and overload proof. Rise and fall times are better than 20 nsec at any output level.

The first step is to get all the parts together. **But make no circuit changes or parts substitutions unless you thoroughly know what you are doing.**

The accuracy of this generator depends solely upon the accuracy of the timing capacitors and the Zener diode D18, which is 8.5V ±1%.

Follow these steps to make your generator. As each stage is built, it can be turned on and checked for proper operation before proceeding further. I suggest you build both boards in steps and check the complete operation of the boards **before** you install them in the chassis.

First, drill out the chassis and mount all controls switches, jacks, OFF-ON switch, pilot light, and fuse. Next, mount the power transformer and wire the *primary* to the OFF-ON switch, pilot and fuse. If you have a well regulated 12-Vdc supply handy, temporarily set the chassis aside. If you don't, you'll have to wire and use the unit's own power supply. Install the four rectifiers RECT-1, 2, 3 and 4 on the output PC board along with C57. Temporarily connect (solder) C55 and C56 to the board observing the correct polarity. **Do not mount anything else on this board at this time.**

Turn the chassis on its side and temporarily solder the three secondary leads from the transformer to the proper points on the board. Connect a dc voltmeter between ground and either supply, carefully observing the polarity of the meter. Turn the power on and note that the voltage should go to about 18 volts. You should have plus and minus 18 volts.

Note, when turning off the supply without a load, be sure to discharge each filter capacitor with a 1000-ohm resistor, otherwise you could get a nasty shock by accidentally touching either supply.

The next steps are the most important ones and there is no room for error. So take your time and do careful clean work. Layout, etch and drill the generator board. The board in the prototype in the photos is slightly different. It does not include all the functions that are in the final unit.

However, the schematic and foil layouts in Figs. 1 and 2 are correct and show all the parts. All of the functions were breadboarded and tried and they all work. However if you feel as I did, you can leave out any functions that you feel you might not need.

First mount all components associated with the oscillator. Q1 and Q2. Temporarily short point **B** to point **D.** Adjust CALIBRATION pot R3 for mid-position. Temporarily connect one of the timing capacitors between points **A** and **D.** Connect a 12-V source to point **N** or connect the unregulated positive 18 volts from the power supply, point **U**, to point **Z** on the generator board. Install Q17 and associated components, and **do not forget to put some kind of temporary heat sink on Q17.**

Turn on the power and check for around +12.5 V at point **N.** Next, connect a scope to point **C.** You should observe a waveform similar to the top trace in scope photo A. Next, install all the components associated with Q9, Q10, Q11, Q12, and Q13. Temporarily short point **C** to point **I.** Connect a scope to point **E.** The trace should appear as in the top trace in photo B.

If you do not have divider action in the second flip-flop, check the first flip-flop to see if it is dividing. If the first flip-flop isn't working, check Q9's collector for a trigger pulse. Also check Q10's emitter for the same pulse; only it should be narrower and of just about 12 volts. amplitude.

Next, install C10, R13, D4, Q5, Q6 and associated components. Check with a scope at point **F.** You should observe a very narrow trigger pulse of about 12 volts amplitude similar to the top trace in photo C.

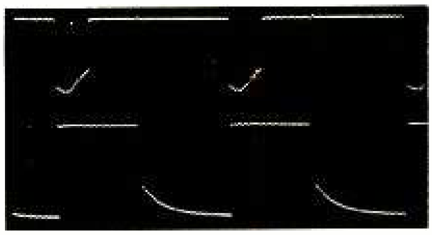


Photo A: Waveforms at C (top) and H. Clock at 10 kHz, delay about 50 μsec.

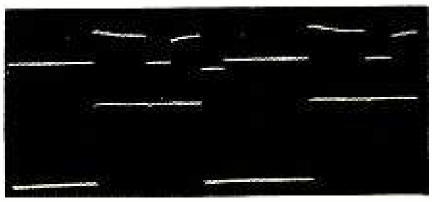


Photo B: Waveforms at G (top) and E. Frequency is 1 kHz, delay 500 μsec.

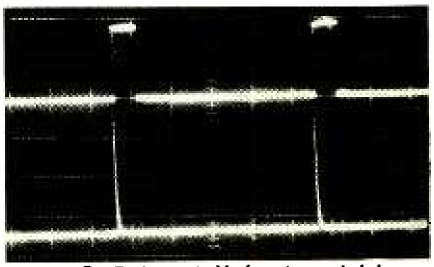


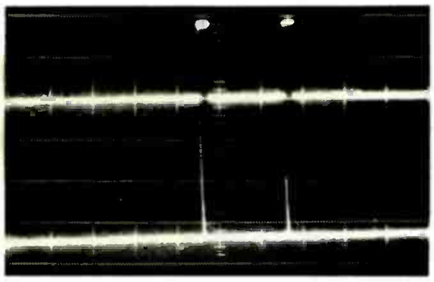
Photo C: Pulse at X (top) and trigger output. Clock frequency is 10 kHz; delay is 100 nsec, width, 10 μsec.

Now install Q3, D3, R15, C12, D17, Q16, R49, R47, D18 and the 342CJ integrated circuit. Use small nose cutters and snip off pins 1, 7, 9, and 15 from the IC as these aren't used. Temporarily short point **O** to point **N**. Temporarily connect a timing capacitor between points **J** and **K**. The value of this capacitor **must** be 1/10 that of the one you have connected to the oscillator. Connect a scope to pin 2 of the IC. The trace should appear as in the top trace of photo C, but not necessarily of the same width. Then, connect a scope to point **H**. The trace should appear as in the bottom trace of photo A. Note: in the top trace of photo A, you will notice a retrace spike. In the first step, when you checked the oscillator, this retrace spike will be absent as you have not yet installed Q3.

Install R14 and C11. Temporarily short point **E** to **Q**. Connect a scope to pin 2 of the IC. You should observe a waveform similar to the top trace in photo D. Connect the scope to point **G**. You should observe a waveform similar to the bottom trace in photo B. Connect the scope to point **H**. You should observe a trace similar to the bottom trace of photo E. At point **C**, trace should look like the top trace in photo E.

Install Q7, Q8, Q15 and associated components. Temporarily short point **P** to point **N**. Remove the timing capacitor connected to points **J** and **K**. Connect this *same* capacitor between points **L** and **M**. Install a 100-pF capacitor between points **J** and **K**. With a scope connected to point **X**, you should observe a trace similar to the top trace in photo C. Reconnect point **E** to **Q**. You should now observe double pulses at point **X**. This completes the operational check of the generator board. If you like, you can install all the remaining components and then temporarily set the board aside. **Do not install it in the chassis yet.**

Install *only* the components associated with the two regulators (power supplies) on the output stage board. Do



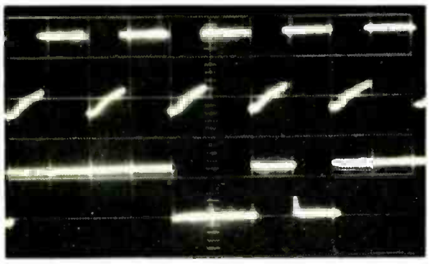
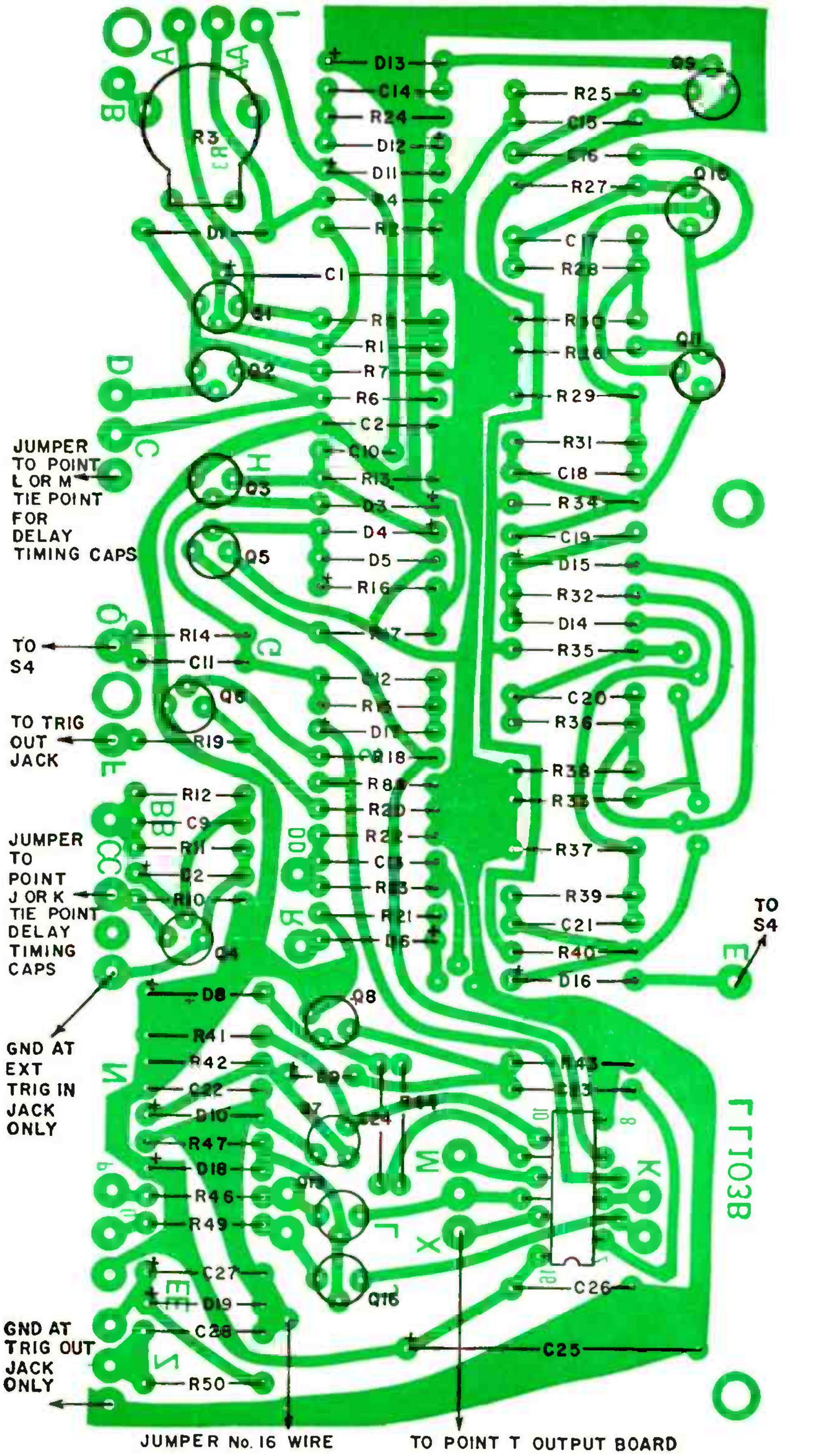


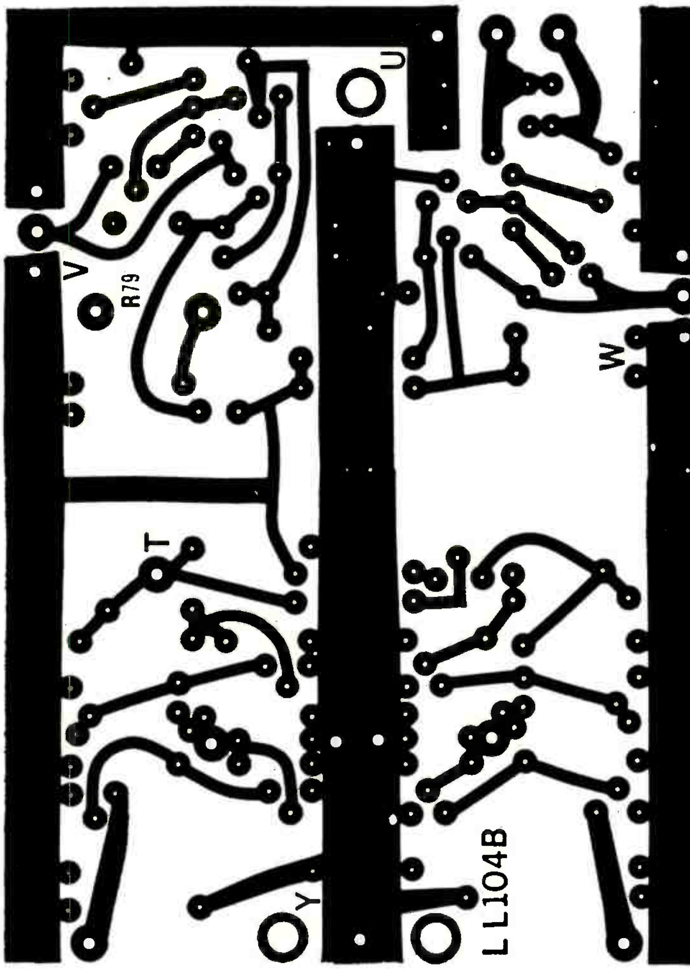
Photo D (top): Double-drive pulse at X (top) and trigger out. Clock at 1 kHz, width, 100 μsec. Photo E: Clock at C (top) and turn-off gate at H. Clock at 1 kHz, delay, 500 μsec. Scope at 500 μsec per div.

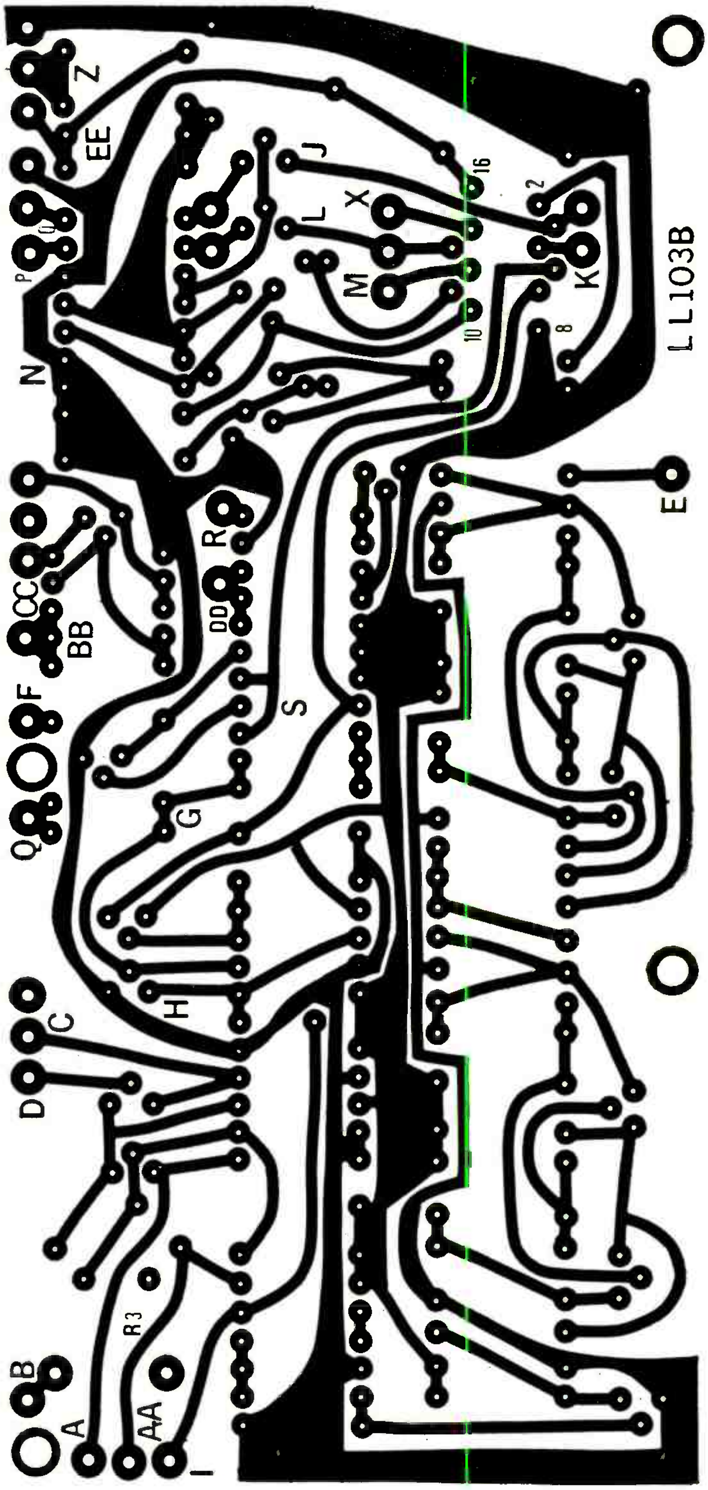


Parts layout for the main generator board.

PARTS LIST

All resistors ½ watt 5% unless noted
†R1—4700 ohms
†R2, R50, R63, R68, R77—1000 ohms
R3—1000 ohms, trimmer, Mallory MTC13L4
R4, R7, R18, R71, R72, R82, R83—100 ohms
R5, R6, R10, R62—510 ohms
R8—7500 ohms, frequency vernier control
R9, R46, R48, R52, R54, R55, R56, R65, R66 selected value—see text
R11, R22, R25—680 ohms
R12, R17, R20, R21, R23, R35, R40, R41—1800 ohms
R13, R43—2400 ohms
R14, R15, R32, R44—120,000 ohms
R16, R42—18,000 ohms
R19, R33—180 ohms
R24, R28, R31, R58, R61, R89—10,000 ohms
R26, R76—200 ohms
R27, R34—1200 ohms
R29, R30—7500 ohms
R36, R39—33,000 ohms
R37, R38—15,000 ohms
R45, R49—2700 ohms
R47—390 ohms 2%
R51, R53—25,000 ohms delay and width verniers
R57—2200 ohms
R59—10 ohms
R60, R78—470 ohms
R64, R67—3600 ohms
R69, R70—270 ohms
R73, R74—1000 ohms, 1%





Actual-size PC patterns for the power supply and main generator boards.

R75—560 ohms
R79—250-ohm trimmer Mallory 251L4
R80—390 ohms
R81—2000 ohms
R84—100,000 Ohms
R85, R87—100 ohms, 2 watts output level control Ohmite type AB CU1011 or equiv.
R86, R88—50 ohms 4 watts (carbon only)

Capacitors

†C1—330 μFF 3V tantalum electrolytic
C2, C15, C22, C26, C28—0.15 μF 50V mylar or ceramic
*C3, C29, C36—3.9 μF 1%
*C4, C30, C37—.39 μF 1%
*C5, C31, C38—.039 μF 1%
*C6, C32, C39—.0039 μF 1%
*C33, C40—390 pF 1%
C7—330 pF polystyrene 5%
C8—11 to 110 pF trimmer
C9, C10, C11, C12, C13, C23, C24—100 pF polystyrene 5%
C14, C19, C20, C21, C34, C41—33 pF polystyrene 5%
C16—120 pF polystyrene 5%
C17, C18—68 pF polystyrene %5
C25, C53, C54—500 μF 15V electrolytic
C27, C59— 10 μF 15V tantalum electrolytic
C35, C42—8 to 40 pF trimmer
C43, C44, C45, C48—10 pF polystyrene 5%
C46, C47—selected value—see text
C49, C50, C57—0.22 μF 50V mylar or ceramic
C51, C52—100 μF 15V tantalum electrolytic
C55, C56—1000 μF 25V electrolytic
C58, C62—.0033 μF 50V mylar or ceramic
C60, C61—27 μF 6V tantalum electrolytic
Q1, Q2, Q4, Q5, Q6, Q7, Q10, Q11, Q12, Q13, Q14, Q26, Q27, Q28—2N4123 (Motorola) or 2N3646 (Fairchild)
Q3, QQ8, Q9, Q18, Q19—2N4258 (Fairchild)
Q15, Q16, Q24, Q25, Q29, Q30—2N4125 (Motorola)
Q17, Q31—2N3054 (RCA) or 2N4921 (Motorola)
Q20—2N4030 or 2N2904 (Fairchild)
Q21, Q22—2N3646 (Fairchild)
Q23—2N3300 or 2N3299 (Fairchild)
Q32—2N4918 (Motorola)
D1 thru D17 and D20 thru D25 1N914 (Fairchild)
D18—8.5 V Zener 1-W ±1% (Schauer)
D19—13-V Zener 1-W ±2% (Schauer)
D26—4.7-V Zener 250 mW 5%
D27-D30—1N4001 (Motorola)
IC1—342CJ (Amelco)
T1—Stancor P8180 or equiv.
J1 thru J6—BNC panel jack
S1—2-pole 5-position selector switch
S2—spdt slide switch
S3—normally open, momentary contact pushbutton
S4—dpdt slide switch
S5, S6—2-pole 6-position selector switch

†**Note:** Readers may wish to modify the clock circuit with the following changes, reported in a last-minute change, by the author to yield better performance. Change R1 to 1K, C1 to a 27-μF, 6V tantalum electrolytic and replace R2 with a 2.4V, 1W, 1% Zener diode (Shauer), its cathode to Q1's base.

Miscellaneous Parts

6" x 14" x 3" steel chassis and bottom plate knobs, screws, nuts, washers, heat sink brakets, 2 post terminal strips (2), pc boards, lettering, bumper feet, stand offs, board terminals (Keystone), off-on switch, pilot light, fuse, line cord and plug, etc.

*A kit consisting of the 14 ±1% tol capacitors is available from Lambert Laboratories, 48 Washington Street, Westfield, New York 14787. Price—$32.50 postpaid

A kit of all semiconductors including all diodes, all rectifiers, all Zeners, all transistors, and one IC is available from the same source. Price—$43.75 postpaid

Both glass epoxy etched circuit boards are also available. Generator board: Price—$9.50 postpaid. Output stage board: Price—$7.50 postpaid

A kit of parts including the following is available.
1. All semiconductors used in the generator.
2. All 14 ±1% timing capacitors
3. Both glass epoxy circuit boards.
total $88.50

A complete kit with all parts is available for $150 from the above source.

not install any of the output stage components yet. C55 and C56 should be left temporarily connected. Make sure you have some form of temporary heat sinks on Q31 and Q32 as they run pretty warm. Make sure all components are in the right places and are also in the right polarity.

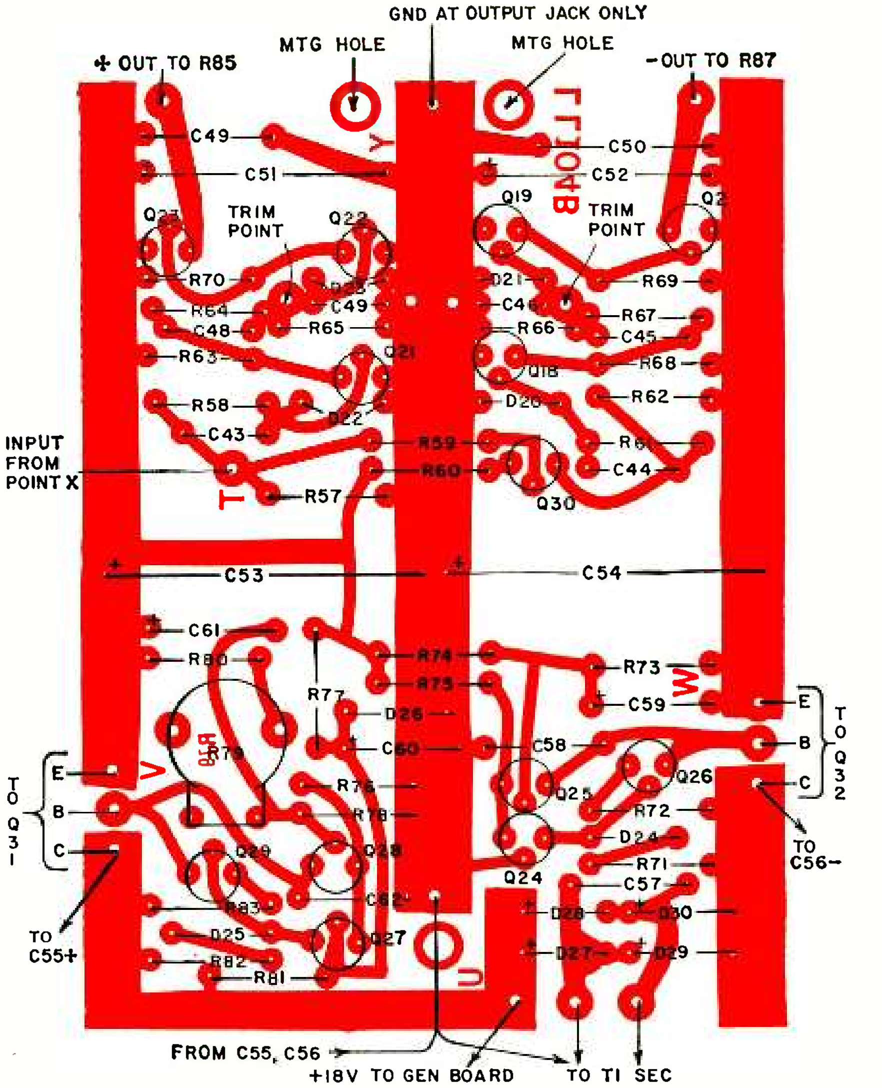
Connect a dc meter to the positive output, point **V**, and turn the unit on. The output should go to some positive level depending upon the setting of R79. Adjust R79 for exactly +10.3 V. Remove the meter leads and connect them to point **W**, the negative output. It should be exactly −10.3 V ±2%.

Connect the 50-ohm 4-watt resistor directly across the negative output. The output should drop less than 0.5 V, which indicates regulation better than 0.5%. Do the same for the positive output. It should also fall within 0.5% regulation. Connect an ac meter across either output and load that output with the 50-ohm resistor. The total ripple of either output should be lower than 2 mV rms, indicating a factor of .02%. Capacitors C59, C60, and C61 must be tantalum types for high frequency regulator stability.

Transistors Q31 and Q32 can be almost any silicon types as long as they can dissipate 5 watts or more and have good heat sinks. I used what I had on hand, but remember, under full load conditions either or both pass transistors might have to dissipate 2.5 watts continuously.

Now mount only the components associated with the positive output stage. C51 and C52 *must* also be tantalum types. Connect a 50-ohm 4-watt resistor from the emitter of Q23 to ground point

(*continued on page 71*)



Above is the parts layout for the power supply board.

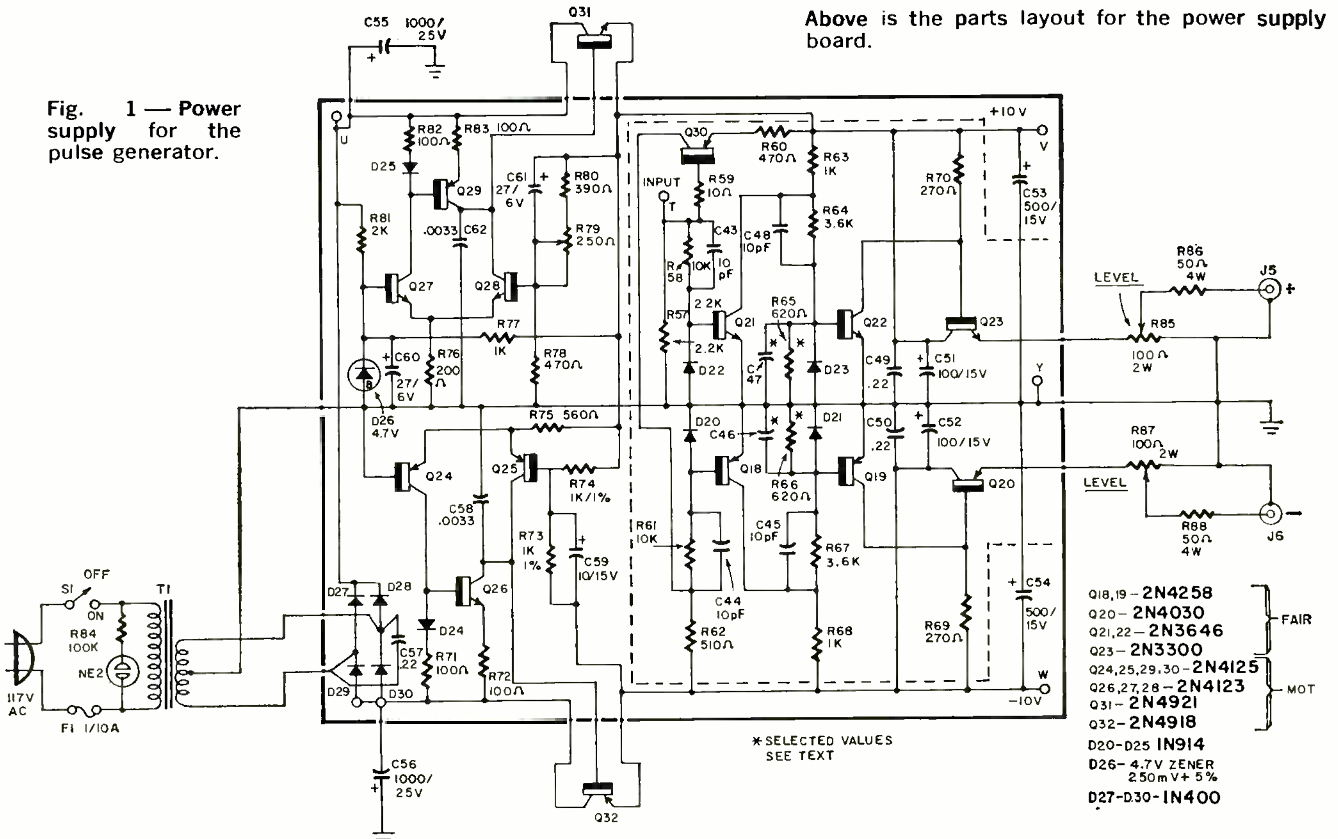


Fig. 1 — Power supply for the pulse generator.

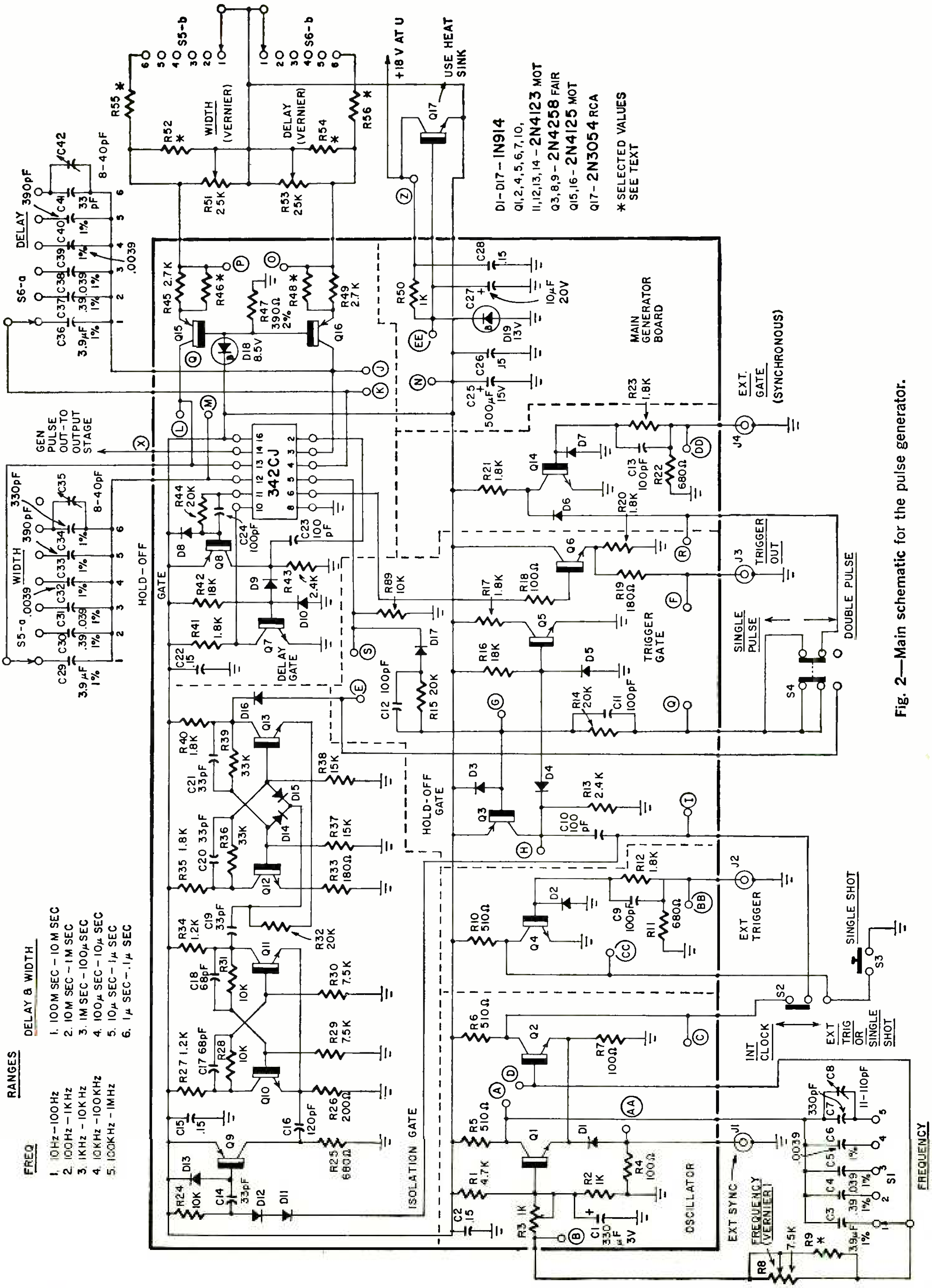


Fig. 2—Main schematic for the pulse generator.

TECHNICAL TOPICS

Oil-change circuit . . . cold solder locator . . . IC probe . . . safe hot-chassis

by ROBERT F. SCOTT
SENIOR TECHNICAL EDITOR

NOW THAT THIS COLUMN HAS SETTLED down to a regular routine, let me fill you in on a little of its background and let you in on a good thing.

In the April, 1958 issue of *R.S.G.B. Bulletin* (now *Radio Communication*), the official publication of the Radio Society of Great Britain (the British counterpart of our ARRL), Pat Hawker, G3VA, introduced "Technical Topics" as a regular column. It was to be—and still is—devoted to a survey of amateur radio developments and developments in electronics of particular interest to the radio amateur. It consists mainly of abstracts of articles and circuits from publications from all over the world supplemented by material contributed by readers.

I have been a constant reader of Pat's "Technical Topics" and many of its items have been clipped and filed in my "engineering notebook." When we decided that there was a place in RADIO-ELECTRONICS for a similar column to augment, and possibly replace, "Northworthy Circuits," we decided that it, too, should be called "Technical Topics." First, because there is hardly a more fitting title, and secondly, perhaps as a tribute to Pat Hawker and the RSGB for their continuing contributions to amateur radio and communications.

If you find this column useful or interesting, you will surely value a copy of RSGB's *Amateur Radio Techniques*. It is 154 pages of the best selections from Pat's Technical Topics from 1958 to 1968. You can order a copy from Comtec, Box 592, Amherst, New Hampshire 03031. It'll cost $2.50 postpaid.

Change your oil, Mister?

You have probably heard this question many times on trips to a local service station for a minor repair. If the oil in the car hasn't been changed in the last few weeks, you can't answer right away. You'll check the lube sticker on the door jamb, glance at the odometer and then try to recall whether Detroit recommends oil changes every 3,000 or 5,000 miles. If you are like most of us, you'll figure on X quarts of oil at Y cents per quart and decide to let it go until the next time the car needs servicing.

Bissett-Berman Corp., Los Angeles, California makes a line of electrochemical timers, called E-cells and has developed a number of interesting applications for them. One is an oil-change indicator sold commercially as the Sentry-7. In developing the circuit, they took into consideration the fact that oil pollution and depletion depends, not only on the mileage but also on the time the oil is actually in the engine—running or not—and the number of times the engine is started.

The E-cell is about the size of a 1-watt resistor and can be obtained with delays ranging from tenths of a second to around 1500 hours. They are designed with microampere-hour ratings ranging from 4 to 1500 with current ratings ranging from 0.1 μA to 2.0 mA.

The basic operation of the E-cell is similar to electrolysis or electroplating. The anode has a predetermined amount of silver that is gradually eroded away and deposited on the cathode. The rate of silver transfer from anode to cathode is proportional to the instantaneous current through the cell. As long as silver remains on the anode, the cell resistance is low and the drop across is around 10 mV. When the silver has all transfered to the cathode (at the end of the time period) the cell resistance increases abruptly and the voltage across it rises to around 1 volt (Fig. 1). When used in the basic timing circuit (Fig. 2), the abrupt change in voltage can be used to bias a transistor on or off or trigger the gate of an SCR. Series resistor R1 is selected for the specified current at supply voltage E_s.

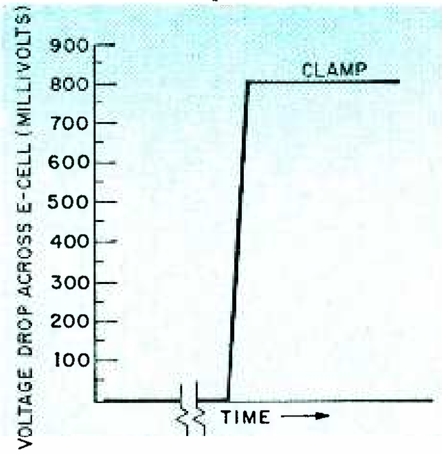


Fig. 1—Sharp voltage increase occurs when silver transfers to cell's cathode.

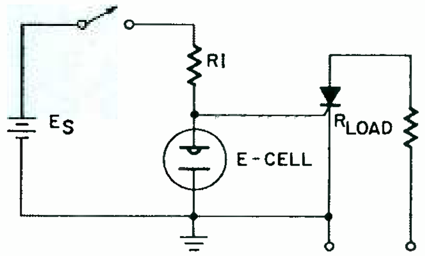


Fig. 2—Timing circuit uses sharp voltage change to trigger SCR gate.

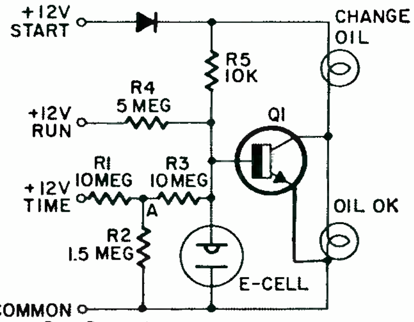


Fig. 3—Oil change circuit measures time oil is in engine, lighting lamp.

The oil-change indicator circuit is shown in Fig. 3. Note that the current flow through the E-cell comes from three sources: the START, RUN and TIME terminals. The TIME terminal is permanently connected across the car's battery to account for the total time the oil is in the engine. The drop across R2 is about 1.5 volt and only a small current flows through R3 and the E-cell. The START terminal is connected to the "hot" terminal on the starter motor or the corresponding terminal on the ignition switch. The RUN terminal connects to the "hot" lead to the ignition coil.

When the ignition switch is turned to start the engine, a relatively heavy current—about 1 mA—flows through R5 and the cell. Returning the ignition switch to the normal run position connects the battery to the cell through a 5-megohm resistor (R4) that limits current to about 2 μA.

The indicator lamps are both 12-volt types but the one used as the CHANGE OIL indicator should have a much higher current rating than the other. If the oil has not been used long enough to be changed, the OIL OK light comes on when the starter motor is running. The CHANGE OIL indicator does not light because its resistance is much lower (because of its higher current rating).

At the end of the time period, the resistance of the cell rises sharply and biases the transistor base to about 1 volt positive. The next time the car is started, the transistor conducts and draws current through the CHANGE

OIL lamp. The OIL OK lamp does not light because it is short-circuited by the conducting transistor.

Reverse the connections to the E-cell after each oil change so the silver-plate element becomes the anode for the next timing cycle.

Locator for cold-solder joints

Cold-solder connections seem to be more common now that printed circuits are almost universal in commercial equipment and are widely used in kits and home-built projects. If you suspect that a trouble in a complex piece of gear is due to a defective connection, you can spend hours probing, pushing and pulling each component, trying to locate the defective joint. If this fails, you spend more time touching-up or resoldering each connection. And, if you are not careful, you may inadvertently break a component lead or loosen another joint.

Mr. D. Goodman, of Tel-Aviv, decided what was needed for detecting cold-solder joints was a low-range ohmmeter delivering a low voltage to the test prods—to protect transistors—and a high current to simulate possible operating conditions. His simple and inexpensive cold-solder-joint locator was described in the "Letters" column of *Wireless World* (London, England).

The circuit of the locator is shown in Fig. 4. It consists of a simple transistor/Zener diode voltage regulator, a resistive bridge and a 200-μA zero-center meter. The bridge balances with about 1 ohm across the test leads. Resistor R1 (about 0.5 ohm) is selected for fullscale deflection to the right when the test leads are shorted. The value of R1 and R2 will depend on the transistor and diode used. The circuit draws about 250 mA from the 1.5-volt cell. The voltage across the test leads is about 200 mV at 100 mA.

Safe "hot-chassis" operation

Transformerless and ac-dc equipment always presents a serious shock hazard to the owner and to the service technician. Safety precautions urge that you ground the chassis; either to a waterpipe ground or through a grounded duplex receptacle. But, sometimes these precautions are not enough. There is always the possibility that the neutral and hot sides of the power line may be transposed at the receptable or elsewhere in the wiring installation.

If you ground the chassis and then plug in the equipment so the hot side of the line is connected to the chassis, you'll see fireworks and blown fuses. Remove the ground and touch the chassis and you may get a severe shock.

Writing in the New Zealand ham magazine *Break-In*, ZL2BEV described what appears to be a foolproof method of connecting transformerless gear to the power line. It automatically switches the ground (neutral) side of the power line to the B-minus bus or chassis and prevents current from flowing from the hot line until the chassis has been grounded.

This circuit (Fig. 5) is particularly useful if space or other limitations make it necessary to use a transformerless power supply in equipment you are building. You might want to add it to your ac/dc set or other equipment.

Assume that line A is normally hot and B is the neutral. Diode D1 senses line polarity. If the equipment is plugged in incorrectly or line polarity has been reversed, full line voltage appears across relay RY1 and D1. The diode conducts, energizing the relay and reversing the polarity of the line feeding the equipment. At the same time, RY2 is energized to connect the line to the transformerless power supply with the neutral going to the B-minus bus or chassis.

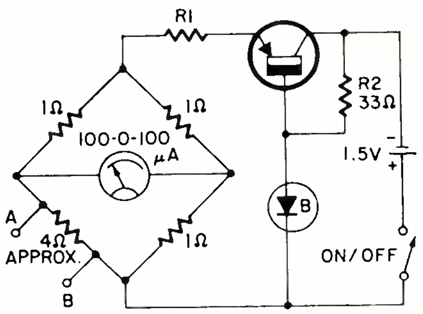


Fig. 4—Cold-solder-joint spotter delivers high current across joint; meter deflects right for good joints.

Only RY2 is energized when the line cord is plugged in correctly.

Electrical wiring codes limit the permissible current through the grounding line. Therefore, you must use the most sensitive relays (dpdt for RY1 and dpst for RY2) that you can find. Select values for R1 and R2 to limit relay current to the lowest level that provides reliable operation.

Test probe for digital IC's

When checking IC logic circuits such as in the digital frequency meter digital clock (in the August and September 1969 issues, respectively) we need to know the dc level at the various gates and outputs. We are not so much interested in the precise voltage as we are in whether the voltage is high or low (logic "1" or logic "0").

Several manufacturers have developed IC test probes with a tiny lamp in the tip (for high visability) to indicate the state of the test point. The diagram in Fig. 6 shows a probe of this type developed by Britain's National Physical Laboratory and described in *Electronic Engineering* (London, England). The components are mounted in a probe 6 inches long, and 3/8 inch I.D. The lamp is located about 1 inch from the tip and is visible through a small window.

The circuit has a high input impedance to minimize circuit loading. The threshold voltage level depends on the supply voltage and on the ratio of R1 to R2. When they are equal, the threshold voltage is half the supply voltage. The Zener diode protects the indicator lamp against excessive voltage by limiting the lamp-driver base voltage. The probe operates from 4–15-volt supplies. **R-E**

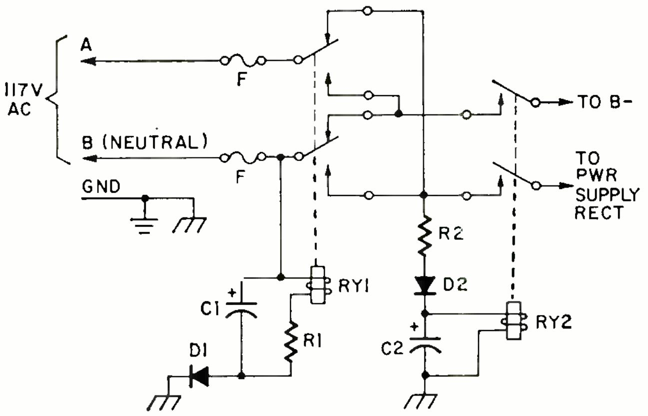


Fig. 5—Polarity reversal occurs when D1 senses incorrect line polarity, energizing relay RY1.

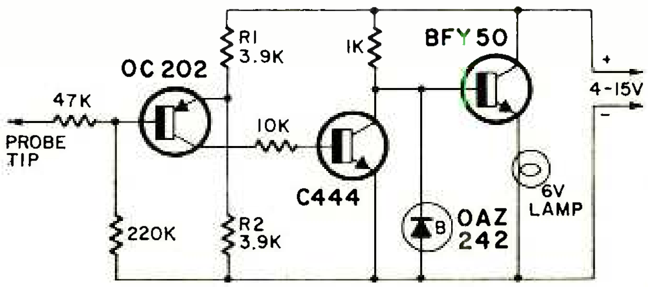


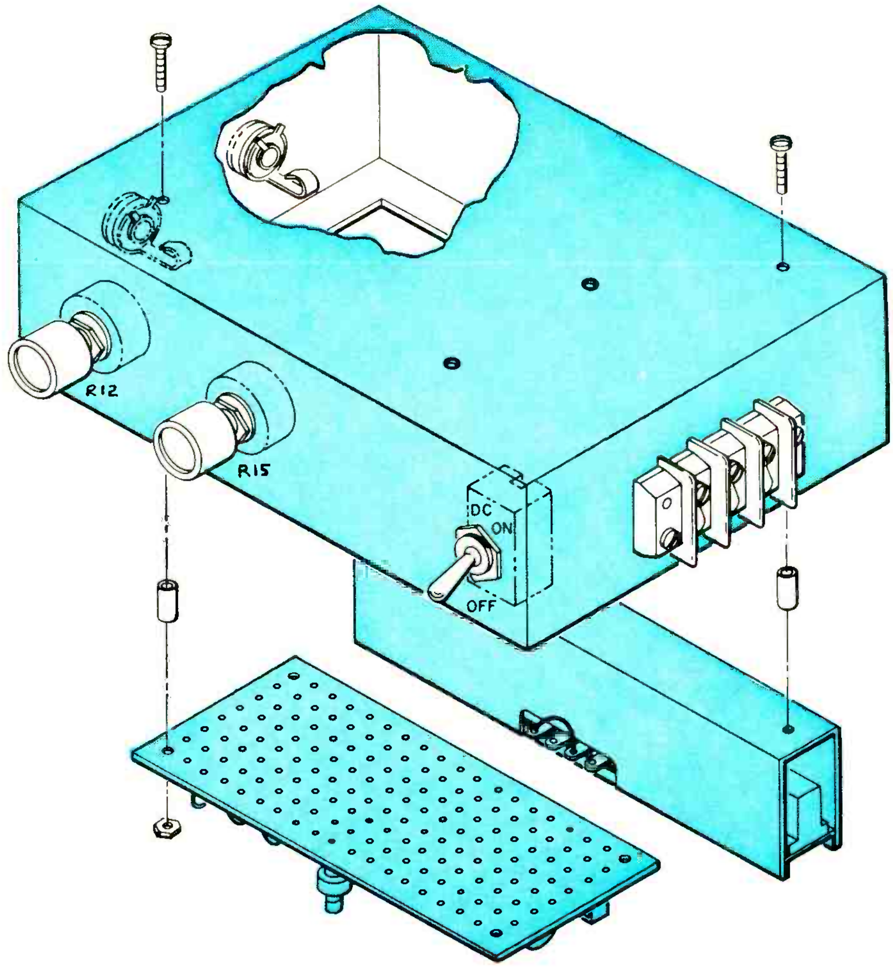
Fig. 6—High-impedance, IC test probe indicates high or low voltage for digital IC's through indicator lamp.

A REVERBERATION UNIT CAN ADD SOME very effective liveliness to a guitar's sound. Through the use of an echo and a slight delay, the reverberation unit can give to a guitar's sound the effect of playing in a cavern.

The HEP Reverb has several advantages. By mixing the guitar's output and its "echo" electronically, no extra power amplifier or speaker system is required. The system has also been designed to be compatible with an electronic guitar system. The nominal input to the reverb is 50 to 100 mV, while the output is continuously adjustable from 0 to approximately 100 mV. The unit can also be made very portable by using two 6-volt batteries for power. This eliminates the problem of transformer hum pickup by the reverb spring unit and the need for a special power supply.

Here's how it works

Power is applied to the barrier strip, observing correct polarities, and the unit is turned on. The guitar's output is applied directly to the reverb input. The guitar's output is then adjusted to bring it within the 50 to 100-mV range of the reverb unit. Then, with the DEPTH control at minimum, the output LEVEL is adjusted to be compatible with the guitar power amplifier input. The output of the reverb is connected by a shielded cable to the guitar power amplifier input. The DEPTH control is set to give the desired reverberation. The DEPTH control can give more than enough reverberation and, therefore, should not be turned to maximum unless a special effect rather than a live sound is desired.



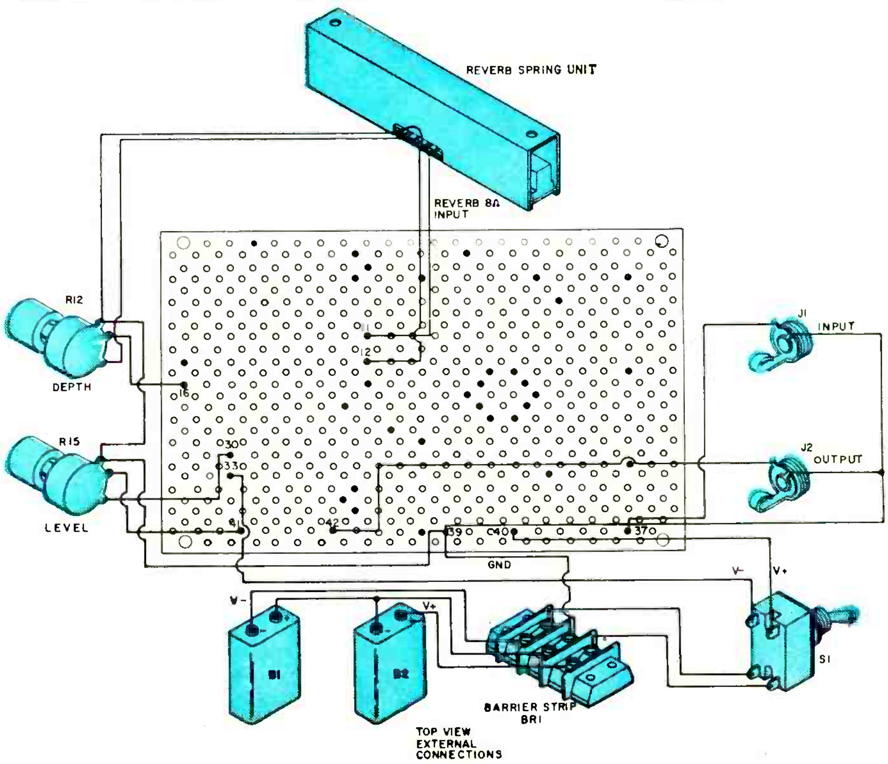
Build IC Guitar Reverb

by JACK JAQUES

The HEP reverb can be broken into five parts: the preamplifier, the power amplifier, the reverb spring unit, the mixer and the output stage.

A preamplifier boosts the low-level guitar output to a level for the power amplifier. Feedback enables the preamp to compensate for coupling inefficiencies in transformer T1, thus giving better low frequency response.

The power amplifier is biased in class A for a very linear output. Transformer T1 couples the power amplifier's output into the 8-ohm input of the reverb spring unit. If the Argonne transformer is used, only half of the primary winding should be connected. The connections are be made from the starting winding to the center tap winding. If the Stancor

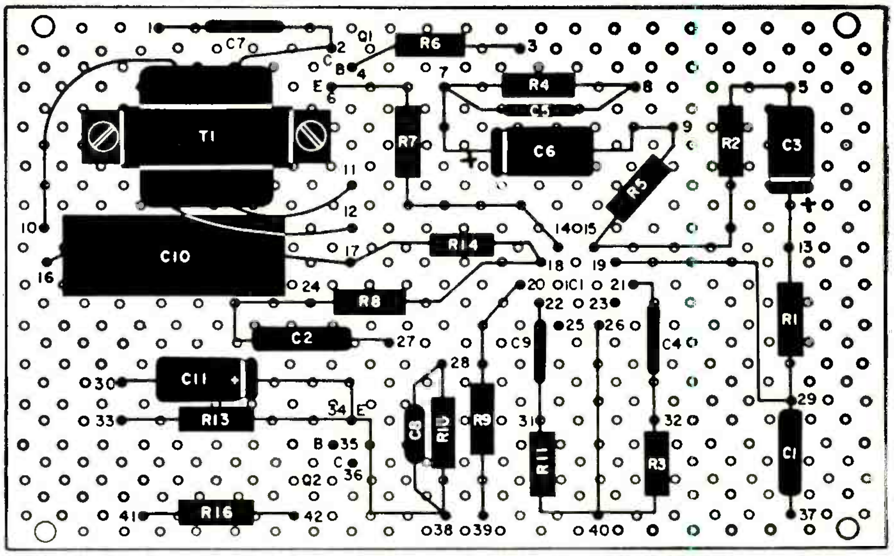


transformer is used, the whole Primary is used and the 8-ohm secondary tap is used. Transistor Q1 requires a small heat sink. Use HEP 502 or an equivalent unit.

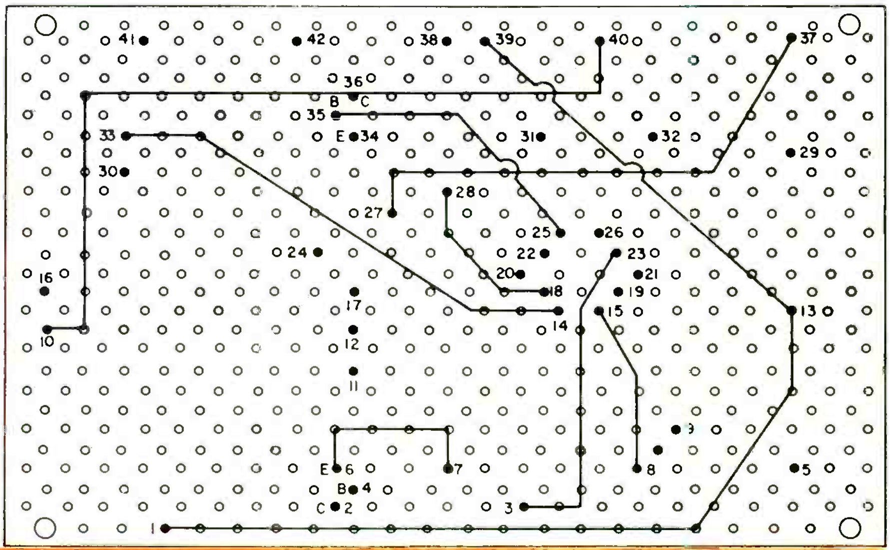
The reverb spring unit is merely a spring attached between two transducers. The input signal is converted into mechanical spring motion by the transducer. This motion travels the length of the spring in a few milliseconds to another transducer that converts the motion back into an electrical signal. The time it takes the motion to travel down the spring imparts the delay characteristic and the reflection of the motion at the transducers produces the echo effect.

The spring unit has a 20 to 40 dB loss which must be made up if the reverb output is to drive the guitar amplifier power input. The other half of the IC preamp provides this gain. It is also used to mix the original signal with the reverb spring unit output. The gain and mixing is done by R8, R10 and R14. The spring unit that the reverb unit is designed for is the Midland number 14-630; however, a Gibbs spring unit may also be used. The Gibbs unit will give a longer delay and better echo, but it is larger. If you use it you'll need a larger chassis box. The Gibbs spring unit needs an 8-ohm input and R14 should be changed to 2,700 ohms.

The output stage consists of Q2 in an emitter follower circuit. This circuit provides a lower output impedance to avoid loading down the IC. Resistor R16 is used to isolate the IC from capacitive loads. R-E



Numbered connections show placement of parts on top and wiring on the bottom.

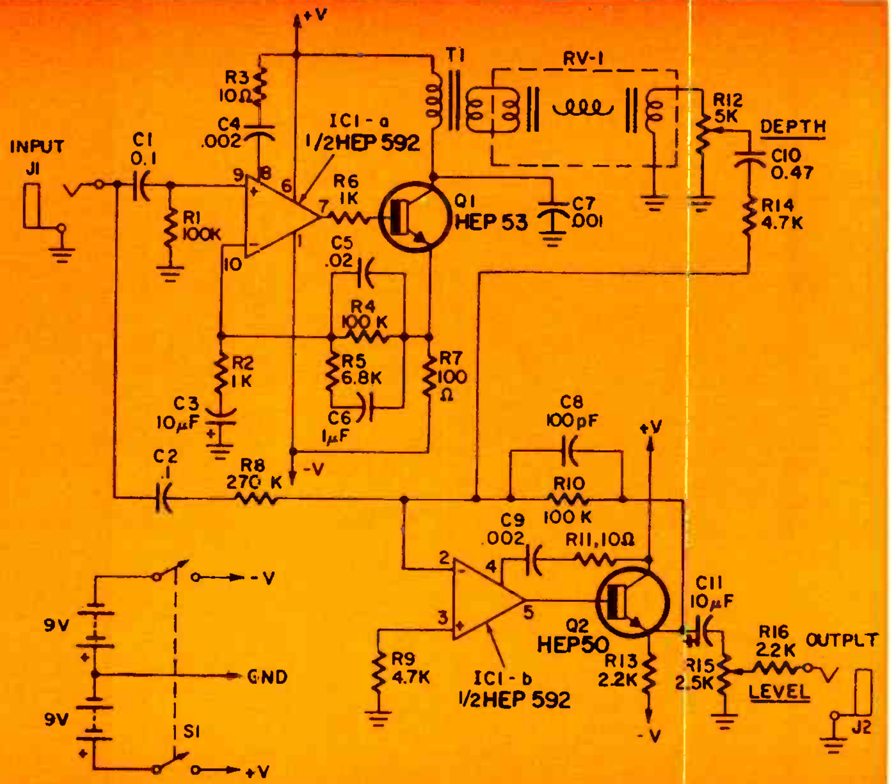


PARTS LIST

All capacitors 15 V or higher unless noted
C1, C2—0.1 µF, 12V
C3, C11—10µF, 15V, electrolytic
C4, C9—0.002µF
C5—0.02µF
C6—1µF, 15V, electrolytic
C7—0.001 µF
C8—100 µF
C10—0.47 µF, 3V

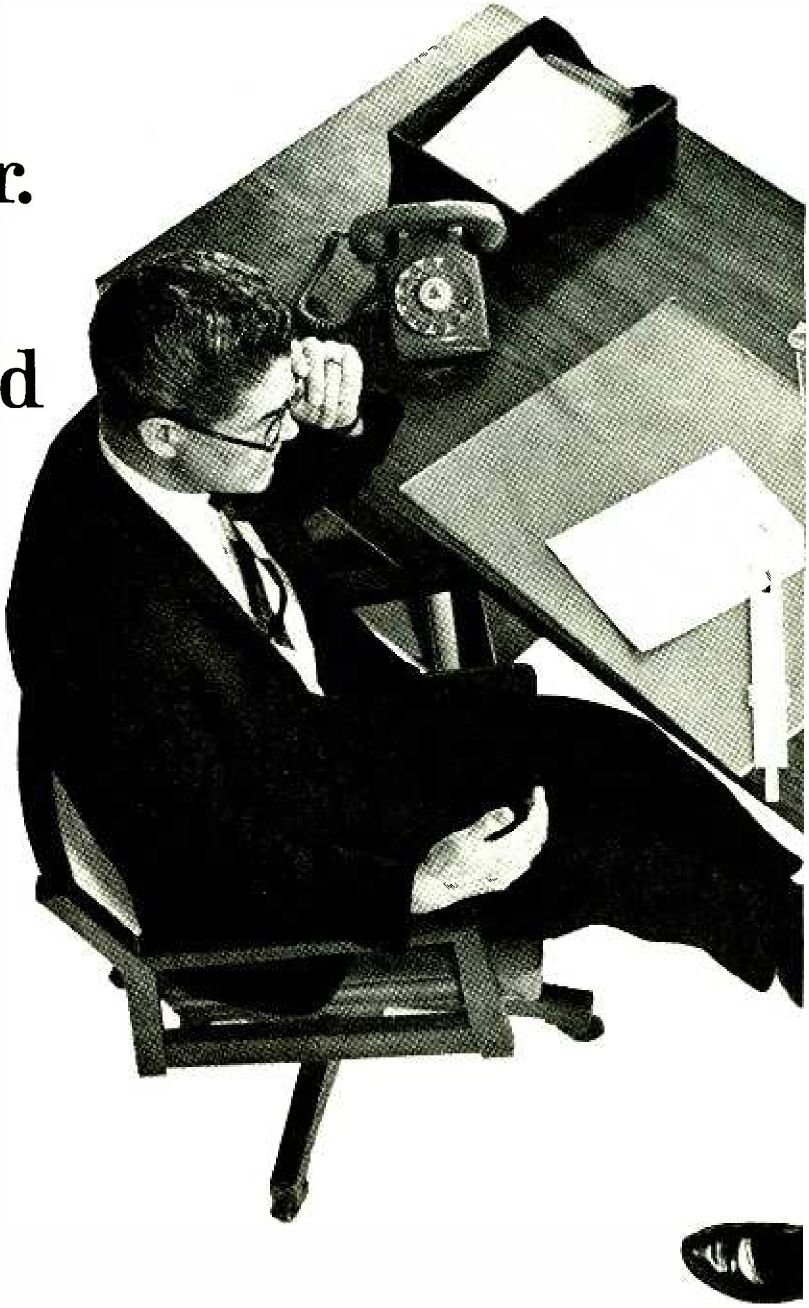
All resistors ½-watt 10%
R1, R4, R10—100,000 ohms
R2, R6—1,000 ohms
R3, R11—10 ohms
R5—6,800 ohms
R7—100 ohms
R8—270,000 ohms
R9, R14—4,700 ohms
R12—potentiometer, 5,000 ohms
R13, R16—2,200 ohms
R15—potentiometer, 2,500 ohms
IC1—HEP-592
Q1—HEP-53 (npn)
Q2—HEP-50 (npn)
T1—Audio output transformer Argonne AR-137 (or) Stancor TA-21
RV1—Reverb spring unit (Olson Electronics X-82 or McGee Radio 14-630)
J1, J2—2-conductor phone jack
S1—dpst toggle switch

Miscellaneous
3-terminal barrier strip
Chassis box 5 x 7 x 2 inches
perforated phenolic board
Connecting terminals
TO-5 heat sink



IC halves boost input from guitar and compensate for loss in the reverb spring.

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule. You study with the assurance that what you learn can be applied to the job immediately.

CREI Programs cover all important areas of electronics including communications, radar and sonar, even missile and spacecraft guidance. You're sure to find a program that fits your career objectives.

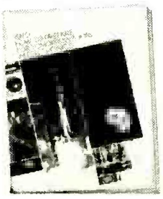
IN-DEPTH COVERAGE OF SOLID STATE ELECTRONICS ...including integrated circuits!

You're eligible for a CREI Program if you work in electronics and have a high school education. Our FREE book gives complete information. Mail postpaid card for your copy. If card is detached, use coupon at right or write: CREI, Dept. 1402A, 3224 16th St., N.W., Washington, D.C. 20010.

Founded 1927

CREI

Accredited Member of the National Home Study Council



CREI, Home Study Division
McGraw-Hill Book Company
Dept. 1402A 3224 Sixteenth Street, N.W.
Washington, D.C. 20010

Please mail me FREE book describing CREI Programs. I am employed in electronics and have a high school education.

NAME__________ AGE_____

ADDRESS__________

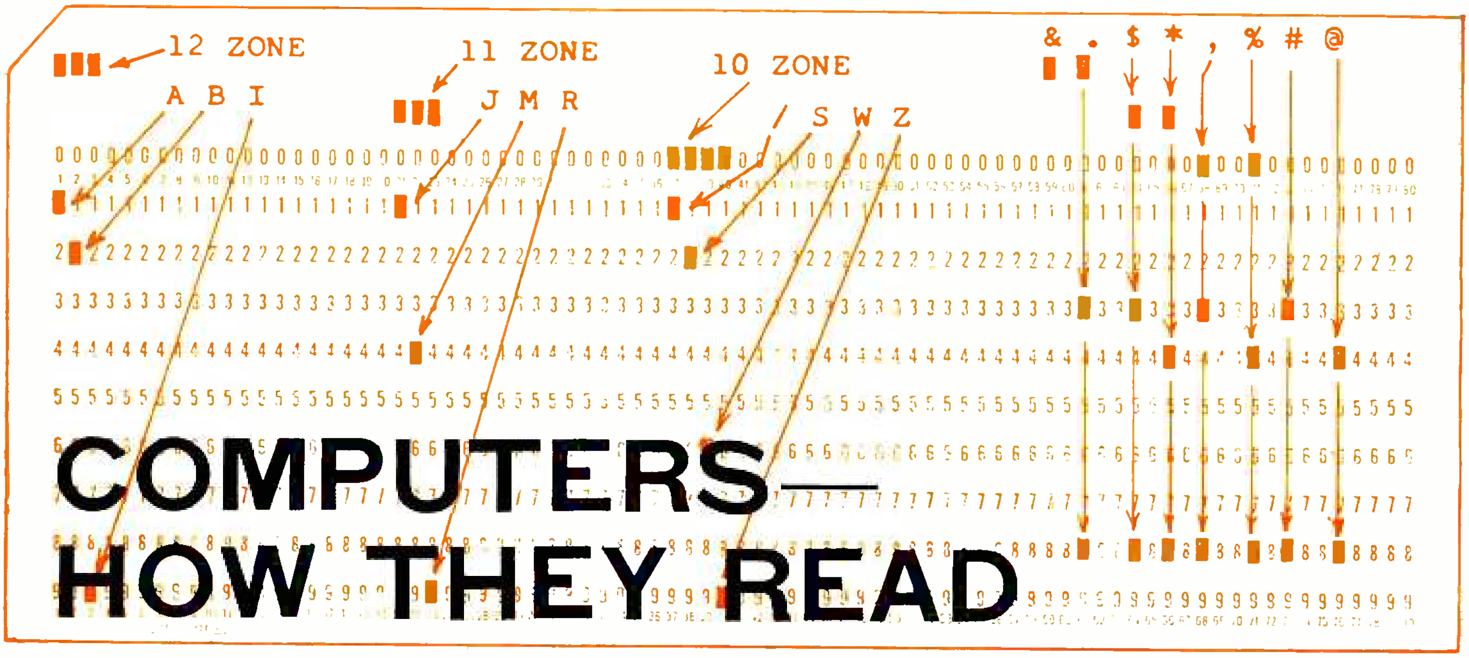
CITY______ STATE_____ ZIP CODE_____

EMPLOYED BY__________

TYPE OF PRESENT WORK________ ☐ G.I. BILL

I am interested in
☐ Electronic Engineering Technology ☐ Computers
☐ Space Electronics ☐ Nuclear Engineering Technology
☐ Industrial Automation ☐ NEW! Electronics Systems Engineering

APPROVED FOR TRAINING UNDER NEW G.I. BILL



COMPUTERS— HOW THEY READ

Magnetic ink . . . punched cards and paper tapes . . . light pens: Supplying input information to modern digital computers

by **MATTHEW MANDL**
CONTRIBUTING EDITOR

FOR A DIGITAL COMPUTER TO PROCESS business data or perform arithmetical operations, input information must be supplied to it. Thus the computer is told what the problem is and the manner in which it is to be solved (called a *program*). It is also given the data it needs to complete the computing operations.

Electronically, this is not as easy as it sounds. The computer's primary circuit function is basically switching. Thus, only *two* states are used: ON and OFF (corresponding to 1 and 0). It is a *binary* machine, where 2 is represented by 10, 3 by 11, 4 by 100, etc. It doesn't recognize internally our letters or base-ten numbers.

In programming, however, we want the convenience of using *our* alphabet and decimal numbering system. So when we punch a card or tape using a key-punch machine or an electric typewriter, we use special circuitry to convert a single key depression of, for instance, 6 to its binary equivalent of 110, etc. Similarly, letters are converted to a specific binary-number representation so they can be stored and read out of the computer as required.

Switching and routing

Electrical wire feelers can sense a hole in a card or tape and generate a sensing signal or pulse. A single pulse (or several simultaneous ones) can be routed to matrix converting circuits to produce a given binary number. A typical encoder of this type is shown in Fig. 1. Here, a single pulse entering any one of the horizontal lines results in an output binary number representative of the input number. If a pulse is applied to the "5" line, as shown, the two diodes in this line connect to the proper vertical wires to produce an output of 0101, the binary equivalent of the numeral 5.

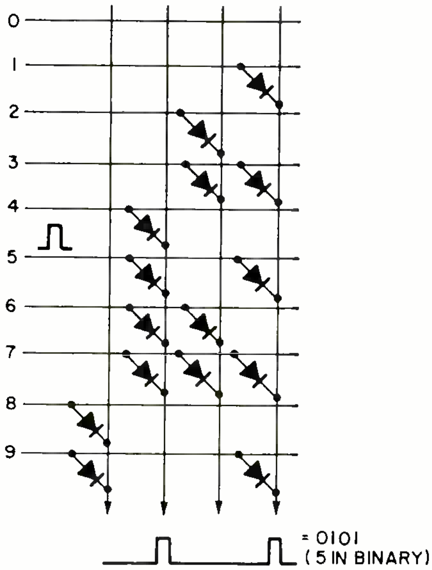


Fig. 1—Input to diode matrix encoder generates proper binary output.

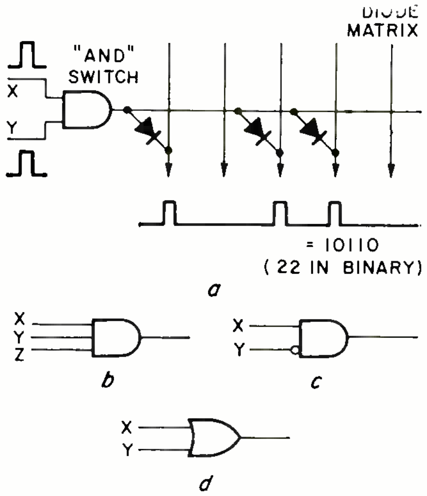


Fig. 2-*a*—Simultaneous x-y inputs generate a 22 output. *b*—3-input, gate. *c*, *d*—x-input and OR gates.

Note the symmetrical arrangement of the diodes in the encoder. At the right, the diodes connecting to the vertical wire are from alternate horizontal lines. Next, diodes connect to two adjacent horizontal lines, skip two horizontal lines, etc. In the third vertical column from the right four horizontal lines have no diodes, and four adjacent horizontal lines do. This follows the structure of the binary system and the diodes correspond to the 1's in the table shown below. Vertical

← etc.	32	16	8	4	2	1	Value
	0	0	0	0	0	0	0
	0	0	0	0	0	1	1
	0	0	0	0	1	0	2
	0	0	0	0	1	1	3
	0	0	0	1	0	0	4
	0	0	0	1	0	1	5
	0	0	0	1	1	0	6
	0	0	0	1	1	1	7
	0	0	1	0	0	0	8
	0	0	1	0	0	1	9
	0	0	1	0	1	0	10
	0	0	1	0	1	1	11
	0	0	1	1	0	0	12
	0	0	1	1	0	1	13
	0	0	1	1	1	0	14
	0	0	1	1	1	1	15
	0	1	0	0	0	0	16

and horizontal rows can be increased for obtaining any binary magnitude desired.

Logic switches can be used to obtain a specific binary number if, and only if, two pulses are applied to the circuitry simultaneously. This is shown in Fig. 2-a. If pulses x and y are present to the logic "*and*" switch an output is produced and a binary 10110 is obtained from the diode matrix circuitry. The *and* switch is also known as a *coincidence* circuit or gate, because no output is produced unless coinciding signals are applied to the inputs. Three inputs could also be used, as shown for the symbol at Fig. 2-b, where x, y, and z must be present before an output is obtained. The logic gate at Fig. 2-c produces an output only for an x input. If y is present it *inhibits* the output and hence the logic is x *but not* y. At Fig. 2-d an OR circuit is shown, where either x *or* y *or both* inputs produce an output.

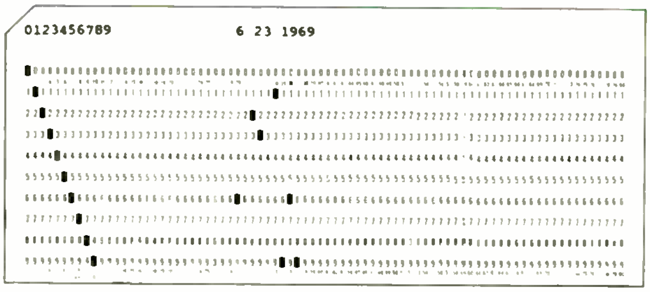


Fig. 3—Standard IBM card with 80 vertical number columns. Single punch identifies numerals.

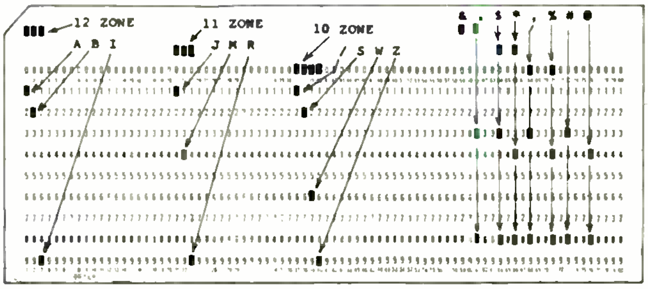


Fig. 4—Two or more punches in column, along with a zone punch, identify letters and characters.

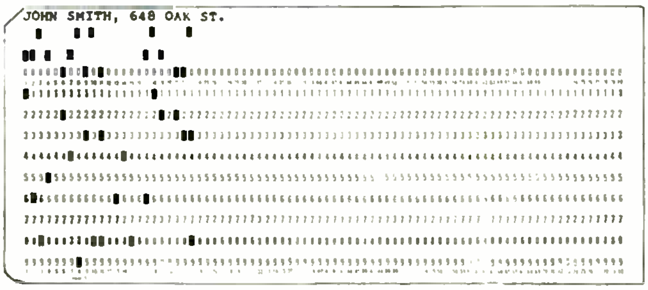
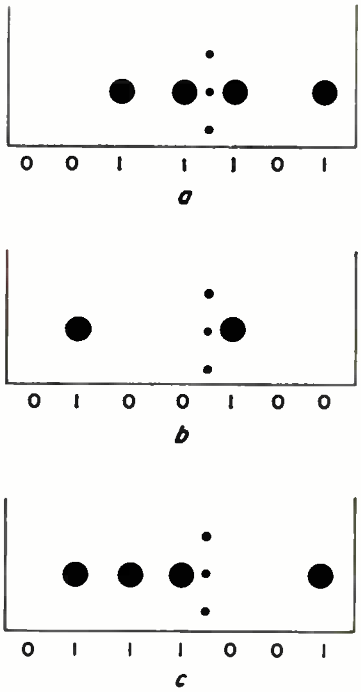
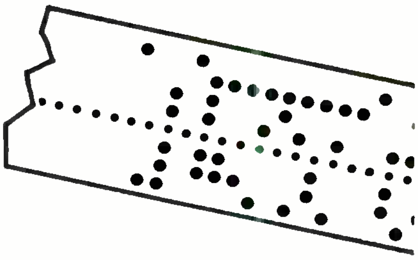
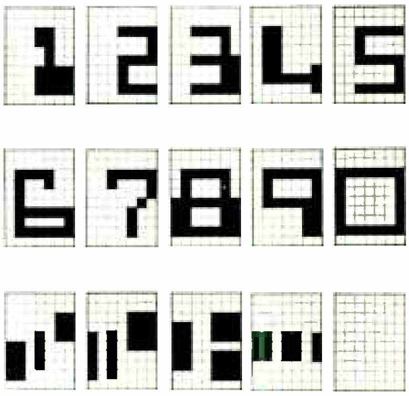


Fig. 5 — Typical name and address punch card. Remaining space can be used for city and state.

Fig. 6 (below)—Binary number 00-11101 and others on punched paper. 7-channel punching (right, Fig. 7), and magnetic ink characters (Fig. 8).







Card input

The 3¼ x 7⅜-inch IBM card and its coding have become a virtual standard in the computer field. As shown in Fig. 3, there are 80 vertical columns of numbers (0 to 9). A single punch in any vertical column identifies a specific numeral. Numbers can be punched in any sequence and spaces left between.

For the letters of the alphabet and other characters, two or more punches in a vertical column are used. As shown in Fig. 4, for representing A through I, an extra hole is punched near the top of the card (identified as 12 *zone*). This punch, in addition to a punch in the vertical number column, identifies the particular letter. Thus, a 12 zone punch plus a 1 punch represents A, while a 12 zone punch and 3 indicates a C, etc.

For letters from J through R an 11-zone punch is used in addition to the numeral punches. The 11-zone area lies between the horizontal 0's and the 12 zone. (The 0's are considered the 10 zone.) To represent K, an 11 zone punch is accompanied by punching a 2 in the same vertical column. The 10 zone is used for S through Z, starting with a punch in the 2 numeral for S. A 10 zone punch plus a 1 punch produces a "/" representation (called a *slash* or *solidus*). Other characters are available, some using three punches in the vertical plane, as shown at the right in all three parts of Fig. 4.

A representative example is shown in Fig. 5, where a name and address are punched. Note that this only takes up the left portion of the card, leaving room for city and state, and other related data on a single card.

If the information on such a card is stored in the internal memory of a computer, letters as well as numbers are replaced by their binary representation. Thus, there is no identifiable difference in numeric or alphabetic storage. If, for instance, the binary number 10010 represents S, an alphabetic print-out is necessary. If a numeric print-out is specified, the base-ten value 18 will be printed.

Paper tapes are prepared by a punch mechanism linked to an electric typewriter. Tape width is approximately 1 inch, and 7 or 8 bit limits are usually used for any horizontal hole punching. The binary number representative of the typewriter key depressed is punched on the tape directly. A punched hole represents 1 and the absence of a hole is 0. This is shown in Fig. 6 where the binary number 0011101 is shown at A, 0100100 at B, and 0111001 at C. A typical tape using seven-channel punching is shown in Fig. 7. Sprocket holes run lengthwise through the tape between the third and fourth-bit channels from the right.

Magnetic-ink reading

In computer data-processing practices, automatic character-reading devices are widely used for automatic bookkeeping and accounting procedures. As shown in Fig. 8, the characters have a peculiar shape which allows for better identification by the computer, while at the same time being readable to us. You've probably noticed these on your bank checks. They are printed with an ink containing ferro-magnetic substances so they can be read by the magnetic-ink character recognition (MICR) process. The magnetic materials are of the iron-oxide types used in magnetic tapes.

The character reading method is shown in Fig. 9-a. The check is inserted into the reader which slides it past a permanent magnet. Thus the materials in the printed characters become magnetically energized. Next the check passes over a read head which senses the magnetic densities of the numeral and produces an output signal. Matrix decoding is used to interpret the signal and identify the character.

As shown in Fig. 9-b the signals developed depend on the width and position of the vertical and horizontal lines making up the character. For the numeral 9 shown, signals of opposite polarity are produced as the right vertical segment of the 9 approaches and leaves the read head. During the time the horizontal sections pass the head, no magnetic *change* occurs, hence the output signals drop to the zero level. As the left vertical member of the 9 is reached, a negative and positive voltage change again occurs.

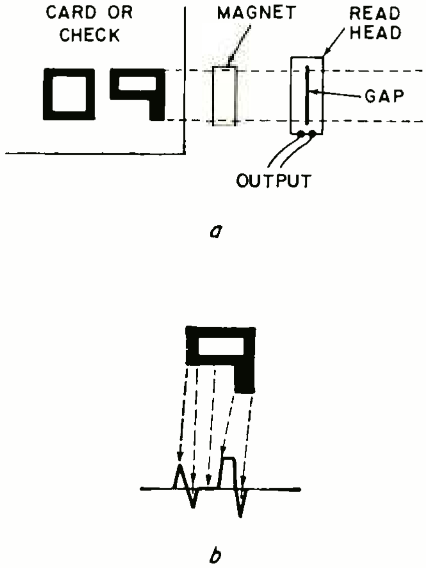


Fig. 9-*a*—Magnetizing and read heads. *b*—Output signal for the numeral 9.

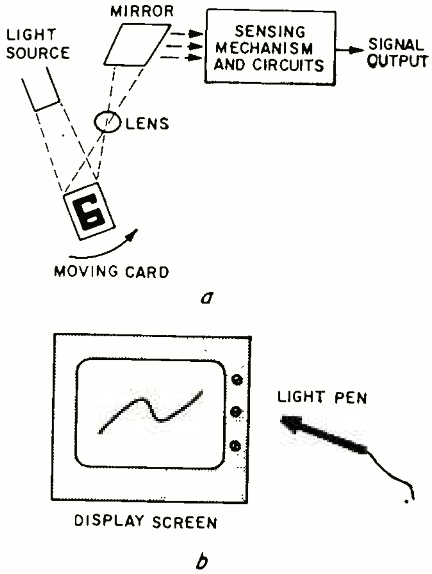


Fig. 10-*a*—Optical scanning method. *b*—Data display screen and light pen.

(The over-all polarity of the resultant signal can be changed by transposition of the output lines of the read head.)

Each character produces its own individual-type signal waveform. The decoding circuits are designed to recognize the particular make-up of a given signal and establish its numerical value or significance.

Other methods

Optical methods are also in use for reading data into a computer. In one procedure the check or card is stationary and a moving pinpoint of light scans the characters to be read. As shown in Fig. 10-a, however, the light source can be fixed and the card or check moved pass the source. A lens system and reflecting mirror channel the light variations to a sensing device which produces an output signal for identifying the character which is read.

Data display screens have become popular for giving a visual indication of program results or graphs of the problem results. Some of these units have been specifically designed to permit changing the displayed information by use of a light pen as shown in Fig. 10-b.

Such display screens function in similar fashion to a television receiver tube. Under direction of the computer, electron-beam scanning within the tube displays the data or graph required. It is rescanned and recirculated to keep the image visible. When the light pen is brought to a particular portion of the screen, the represented data can be changed or added to as required. The internal electron beam, as it rescans the displayed information, senses the changes made by the light pen and sends the new information to the computer. In turn, the latter now modifies the computational results to conform to the changes indicated and again displays the results.

Not only can the contours of graphs be changed, but alphabetical or numerical (alphanumeric) displays can also be changed as needed. In addition, the screen can be used for entering a new graph or sketch into the computer for processing. Rough schematics, for instance, can be sketched by the light pen and, with proper programming of the computer, reshaped into a professional-appearing end result. **R-E**

TOOLS FOR ELECTRONICS

by TOM HASKETT

This issue, starting on the facing page, is the sixth part of our new series of articles on tools for electronics. It ends our description of wrenches. Next month we will continue the series with the next section of the article on soldering tools. We believe you will find all of this material a handy, practical addition to your R-E Reference Manual.

If you wish you can purchase a special hardcover binder to keep your Reference Manual pages together. It has a dark blue fabric cover and is gold stamped Radio-Electronics Reference Manual. The cost is $1.00, postpaid. Order from N. Estrada, 17 Slate Lane, Central Islip, L.I., N.Y. 11722.

The **crossbar** (Fig. 18) is used for extra leverage with several handles or sockets having a hole in the end. A unique handle is ETM's Eccen-Drive 1300 which works something like a crank.

Fig. 18—The crossbar delivers extra leverage. Unit shown is the Williams model B-30.

Attachments and adaptors

If you have to work a nut or bolthead in a well or recess, you'll need a **shaft extension** (Fig. 19). One end is male, the other female; it snaps onto the handle, and the socket snaps onto it. (Some extensions are male-to-male.) You can get extensions from 3″ to 36″ long. Some have flexible, coiled-steel shafts.

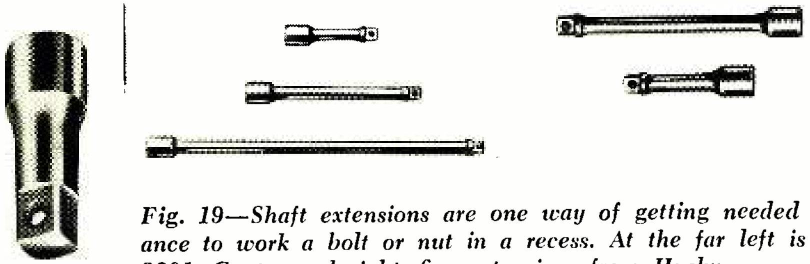


Fig. 19—Shaft extensions are one way of getting needed clearance to work a bolt or nut in a recess. At the far left is P&C 3201. Center and right, five extensions from Husky.

It's sometimes useful to use a handle having one size of drive shaft to drive another size socket. The size and sex adaptors shown in Fig. 20 are made to do just such jobs. Most common are the **male-to-female** size adaptors, but occasionally useful are the **male-to-male** and **female-to-female** versions. The **plug adaptor** is male-to-male, both ends same size.

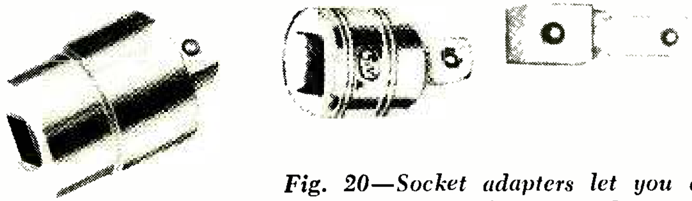


Fig. 20—Socket adapters let you drive ⅜-inch sockets with ¼-inch drive, or vice-versa. At left is Husky CB-80. Center is Stevens Walden male/female. Right is Stevens Walden male/male.

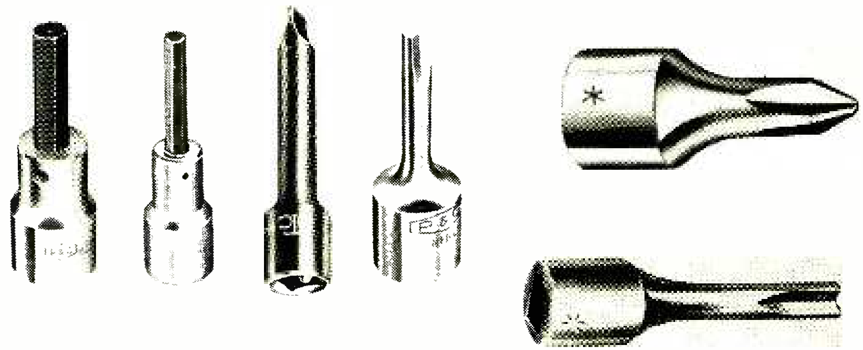


Fig. 24—Assorted screwdriver type tips. From left to right are P&C 3290 Allen head, Owatonna A-5 Allen head, Owatonna standard screwdriver, P&C Clutch type. At right are Phillips driver and clutch head types.

In Fig. 25 you see an unusual but useful tool. It has 8 sockets, double heads, and swivel ends. It handles nuts from 7/16″ to ⅞″.

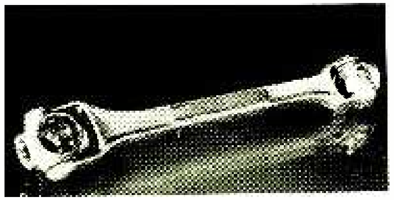


Fig. 25—Eight-socket, double-head, swivel end wrenches are a toolbox in a single tool. Illustrated is Sears Craftsman model 9AT4407.

Several other attachments and devices are made for use with socket wrenches. And there are **power** or **impact** wrenches. But such devices are used chiefly in automotive, construction, plumbing, and similar trades, and seldom in electronics.

What you've seen so far are individual socket wrenches, handles, and accessories. It is often more convenient to buy a set including several of each. A representative set is shown in Fig. 26. You can get sets with from 8 to over 50 pieces.

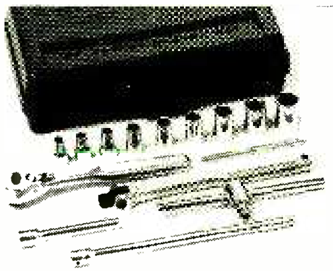


Fig. 26—Complete sockets are also available. One small set is shown here. It is made by Sears Craftsman. It's a ¼-inch drive.

Another way of working nuts at an angle is to use **a universal joint adaptor** (Fig. 21) which fits between a straight handle and any socket.

Fig. 21—Universal joints reach around corners. Left is Husky universal socket. Center is Husky universal joint. Right is Stevens Walden universal socket. Note that the sockets operate direct. The joint is used with a socket.

If you have a standard handle and would like to convert it to ratcheting action, the **ratchet adaptor** (Fig. 22) is an easy solution. It fits between the handle and socket.

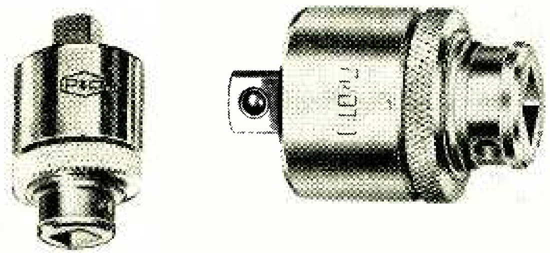


Fig. 22—Reversible ratchet drive adapters add ratchet action to non-ratchet socket sets. At left is P&C 3247. At right is Proto model 5247.

The **crowfoot adaptor** (Fig. 23) is shaped like an open-end wrench. It's useful where you cannot slip a socket over the end of a bolt or nut, but must work from the side.

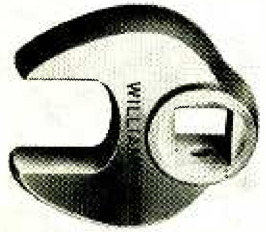


Fig. 23—Crowfoot adapter works like an open-end wrench. Extremely useful where you can't slip a socket over a bolt or nut. Unit shown is Williams model BC-1700.

You can get several types of screwdriver-bit adaptors which mate with socket handles. Many are shown in Fig. 24. There is the **standard slotted type**, the **Phillips**, the **Allen** or **hex**, and the **clutch**.

The adjustable wrench

The **common single-head, open-end adjustable wrench** shown in Fig. 27 is similar in shape to the fixed-jaw, open-end wrench. The head is set at about a 22° angle to the handle. But this wrench has one adjustable jaw and one stationary jaw. A knurled thumbscrew is rotated to bring the movable jaw toward the fixed jaw and fit the nut or bolthead. A single such wrench can therefore fit a range of nut and bolthead sizes. As before, the handle length is determined by the jaw size. These wrenches are available from about 4″ to 24″ long, with jaw capacities as follows:

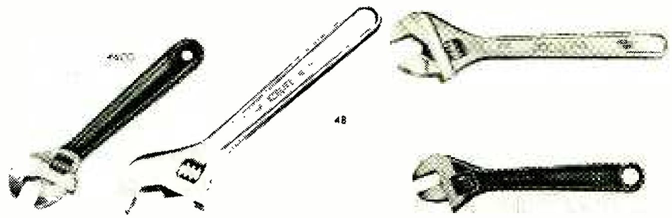


Fig. 27—Single-head open-end adjustable wrenches. Far left are Xcelite 46GC and 48. Left top is Channellock 812. Left bottom is Utica U-21060.

Length	Jaw capacity
4″	½″
6″	¾″
8″	15/16″
10″	1⅛″
12″	1 5/16″
15″	1 11/16″
18″	2 1/16″
24″	2½″

To cover a wide range of nut sizes with fixed-jaw wrenches, you have to buy a lot of wrenches, which can be expensive. But two or three sizes of adjustable wrenches will cover pretty much the same range at less cost. The two lengths most useful in electronics are probably 6″ and 10″.

Some adjustable wrenches are available with plastic handles.

There are two disadvantages to the adjustable wrench: Since there are only two parallel surfaces which contact the nut, you don't get as much purchase as with a socket or box wrench. And the jaws sometimes become loose and slip when you're turning a nut. This can deface the nut or injure you. The second disadvantage is overcome on some adjustable wrenches, as shown in Fig. 28. When you press the **jaw-locking**

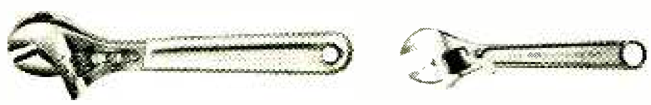


Fig. 28—Jaw locking wrenches are helpful. Two types are shown here. At left is Mathias Klein model D500-8L. Jaw opening sizes are scribed on side of wrench. At right is Utica Select-O-Lock model U-21063.

button, the adjustable jaw is locked in place. Thus you can set the jaws on a nut, and lock them in that position. Some models have indexing marks on the jaws so you can preset them for specific nut sizes.

Most adjustable wrenches have only one head, but a few manufacturers make the **double-head** version shown in Fig. 29. It's useful for a portable tool box because it takes up less room than two single-head wrenches. One set of jaws has a larger capacity than the other.

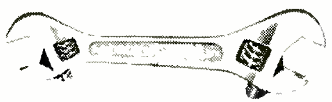


Fig. 29—Double-ended adjustable wrench presents two sets of adjustable jaws in different sizes. Tool shown is Diamond model DB78.

An unusual tool is Witherby's Flare wrench. It combines the best features of pliers, vise, and adjustable wrench. One jaw is adjustable, and the handles are movable.

The pipe wrench

Also called a **Stillson,** this wrench has serrated jaws which are not parallel (Fig. 30). The outer jaw, which is adjustable, is made with a small amount of play which provides a tight grip on the pipe (or antenna mast) when the wrench is turned in the direction of the movable jaw. This is the only wrench which will take a bite on round objects. The jaw always leaves marks on the work and should never be used on bolts or nuts unless the corners have been rounded so that you cannot turn it with another type of wrench. Pipe wrenches are made in lengths from

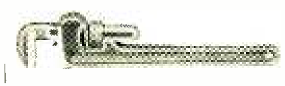


Fig. 30—Common pipe wrench, commonly called Stillson is great for turning antenna masts. Armstrong model 8M is shown here.

range of nut sizes as your nutdrivers. Then you'll never be stymied by hard-to-reach nuts in those sizes. Miniature box ratchets are nice and convenient, but most useful only if you work lots of nuts and bolts.

The least expensive way of being equipped for nuts larger than ¾" is to get two adjustable wrenches—a 6" and a 10". If you regularly work a lot of large nuts and bolts, it's worth your while to get a set of socket wrenches, since they speed up the work. Get 12-point sockets where possible, since they're faster to work than 6-point types. And you don't need 4- or 8-point sockets, for square nuts are rarely used in electronics.

All good wrenches are plated with chrome or nickel, or black-finished, so they can't rust. And reputable manufacturers guarantee nearly all their wrenches. The best wrenches are drop-forged from tool steel and tempered. Cheap wrenches are stamped, and have irregular ridges along their edges. Since they aren't tempered, their nut-mating surfaces deface easily and they rapidly become unsafe and useless.

Tips on wrench use

Always use the correct size wrench and seat it firmly on the nut or bolt before applying pressure. If you don't, the wrench may slip, possibly injuring you and almost certainly defacing both the nut and the wrench jaws. This is particularly important with box and socket wrenches, because if you deface the internal points very much, you have ruined the tool beyond repair.

There's a right way and a wrong way to use each type of wrench. An offset open-end wrench is useful to turn a recessed bolt, and in limited quarters where there is little space to swing a wrench. In such a case, turn the wrench over after each swing so that the opposite face is down, and the angle of the wrench opening is reversed. Since most such wrench heads are set at a 15° angle, you get complete rotation of a hex nut in only 30° by flopping the wrench. Pull on the wrench to turn the nut. In general, never push on a wrench; if it slips or the bolt breaks loose suddenly, you may skin your knuckles and be thrown off balance. Sometimes, however, the only way you can move the wrench is by pushing it. In such a case, don't wrap your fingers around it. Push it with the palm of your hand and hold your hand open.

A box wrench won't slip off the nut, and is best used before an open-end wrench. Swinging a box wrench through an arc of 15° is

6″ to 48″, with jaw capacities from 1/8″ to 6″.

Auto or monkey wrench

These two styles are similar in design. The **auto wrench** (Fig. 31) is made for turning odd-sized nuts or bolts which other wrenches won't fit. The wrench is sturdy and built for rugged duty. It has parallel, smooth jaws, one of which is adjustable.

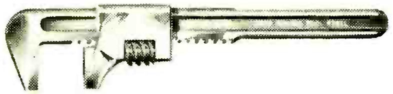


Fig. 31—Original monkey wrench (and there are left-handed versions). Diamond C79 shown.

Miscellaneous wrenches

The odd-shaped wrench shown in Fig. 32 ratchets, and adjusts automatically to several sizes. It has serrated jaws, and therefore marks the work. But it can handle nuts and boltheads no other wrench will.

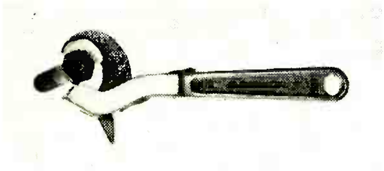


Fig. 32—Unusual adjustable ratchet wrench is made by Weil. Works when other wrenches don't.

A unique tool is Hunter's Adjust-A-Box wrench shown in Fig. 33. It's available in lengths of 8″, 10″, and 12″, with jaw capacities from 1/4″ to 1 7/16″. The tool is basically an adjustable wrench which is narrower than an ordinary adjustable. Thus it will work in smaller quarters. It is also useful for holding and placing nuts and bolts in tight spaces.

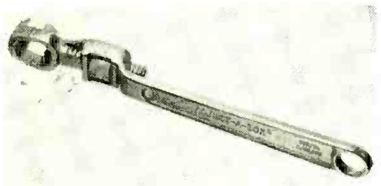


Fig. 33—Adjustable box wrench made by Hunter is great for working in tight corners.

How to buy wrenches

Your first acquisition should probably be a set of miniature combination wrenches (one end open, the other box) to cover the same

usually sufficient to loosen or tighten a nut. Unless you have room enough to swing a box wrench in a full circle, lift it completely off the nut when it comes to the limit of its swing. Then place it in a new position to start another swing. Since a box wrench can't slip off a nut, it's ideal for loosening tight nuts or setting them up (giving them their final tightening). After you loosen a nut with a box wrench, it's usually faster to run it off the bolt with an open-end wrench. (The reverse is true, of course, if you're putting a nut on a bolt.)

All adjustable wrenches should be turned in one direction only. You want to apply force to the stationary jaw; if you turn the wrench the wrong way you force the adjustable jaw. The wrench may slip or you may ruin the mechanism. When you place an adjustable wrench on a bolt, work the thumbscrew until the jaws fit the bolthead as snugly as possible. If the wrench doesn't fit snugly, it may slip and injure you.

Don't use a pipe or other device to increase the leverage of a wrench. You will probably succeed in breaking the wrench handle or defacing the jaws, and the manufacturer's guarantee doesn't apply when you use a cheater.

Likewise, don't strike a wrench with a hammer to tighten or loosen a nut. (The exception to this rule is the striking-face wrench, which hasn't been covered here, as it's seldom used in electronics.) Use penetrating oil on a frozen nut or bolt, and give it time to work in. And never use a wrench as a hammer or pry bar.

Wrench care and repair

In general, don't oil open-end wrenches. If the jaws are oily, they may slip off a nut and injure you. The exception to this rule is that you should brush-clean and sparingly oil the moving mechanism of an adjustable or ratchet wrench. But keep the jaws and handle clean.

If you damage the jaws of open-end wrenches, you can sometimes repair them by grinding or filing.

To renew the serrations in auto, monkey, and pipe wrenches, use a fine triangular or flat, tapered file. Carefully deepen the low points between the serrations. Don't remove any more material than is absolutely necessary.

Most manufacturers supply repair parts and kits for ratchet, socket, and adjustable wrenches. Thus if you damage the ratchet mechanism, you don't have to replace the entire wrench. R-E

PROGRAMMED

AUTOMATIC FINE TUNING

by LARRY ALLEN, cet

Just read each easily digested frame of information. Then test your grasp of it by answering a multiple-choice question. If you choose correctly, you're guided automatically to the next program capsule. If you miss, don't worry; programed extra information helps you to a correct answer.

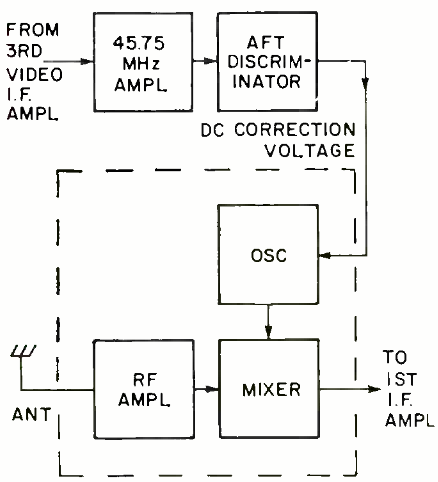
1

Automatic fine tuning, or just simply aft, is common in color sets built since late 1967. Lately, even lower-priced chassis have it. Magnavox was first, with a tube type. All brands and models since use transistors or integrated circuits.

Aft was introduced because some people can't tune color sets properly. It's hard to explain to viewers how important fine tuning is to getting color. The solution is to make the set fine-tune itself. The aft stage tunes the vhf or uhf tuner to the exact position on the tuner and i.f. bandpass curve.

You know that the frequency difference between the picture carrier from the station and the oscillator signal in the tuner is what makes the i.f. picture carrier. The station carrier is rigidly controlled. If the frequency of the oscillator can be held at exactly 45.75 MHz above the station signal, the tuner will remain precisely tuned. All you need is a way to sense when the i.f. picture carrier strays from 45.75 MHz and to bring it back.

A system that does this is in Fig. 1. Signal for the aft sensing section is taken from the third video i.f. in the receiver. A stage of tuned amplification gives a powerful resonant boost to the 45.75-MHz signal, rejecting signals above or below that frequency. A discriminator stage determines whether the picture carrier i.f. is exactly 45.75 MHz. If not, the stage develops a dc voltage with value and polarity proportional to how far and in what direction the i.f. has shifted. This dc output is called *correction voltage*.



The correction voltage is applied to the tuner, where it controls oscillator frequency. An incorrect picture i.f. means the oscillator has drifted. The discriminator detects the drift and develops a correction voltage. That in turn brings the oscillator back so the i.f. is exactly 45.75 MHz.

Question: What signal does the automatic fine tuning system sense?

- ☐ Oscillator signal from the tuner. **Go to Frame 6.**
- ☐ Picture carrier of the i-f. **Try Frame 11.**
- ☐ The complete i.f. signal. **See what Frame 5 says.**

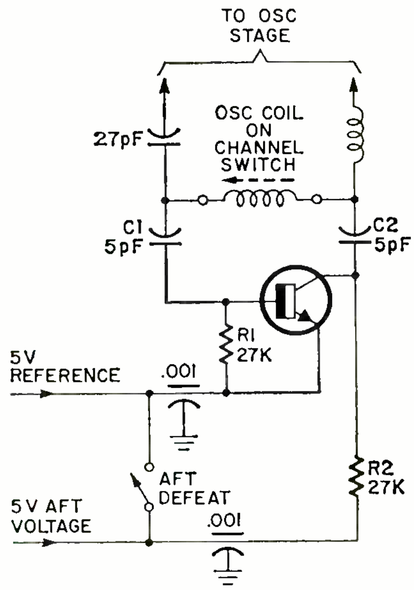
2

Sometimes the controlling system isn't all that simple. For example, some of the first RCA sets to use the control setup shown in Fig. 6.

The base–collector junction in any transistor is always reverse-biased. The control circuit in Fig. 6 takes advantage of the capacitance developed at that junction to tune the channel oscillator coil. The amount of voltage applied between base and collector is determined by the correction system.

A 5-volt reference is applied to the emitter, and to the base through R1. The correction voltage is developed by a dc amplifier that follows the discriminator circuit in the aft section. The normal output of the dc amplifier, whenever the oscillator is on frequency and is producing the proper 45.75-MHz picture carrier i.f., is 5 volts dc. That is applied to the collector of the oscillator control transistor through resistor R2.

The bias across the junction is therefore zero, and the transistor has little effect on the circuit. The only capacitance being applied to the circuit across the active oscillator coil is the effect of 5-pF capacitors C1 and C2. Their effect is slight because of the high resistance between base and collector.



In the positive direction, the correction voltage forward-biases the junction and lowers its resistance, putting C1 and C2 across the oscillator coil.

If the correction voltage goes down from its nominal 5 volts, the junction becomes backward-biased and its own capacitance becomes less and less. It is in series with C1 and C2, and thus reduces the total capacitance across the coil. The result is a rise in the frequency of the oscillator.

Question: What characteristic of a transistor is usable as the tuning control element in an aft system?

- ☐ Emitter–collector resistance. **See Frame 9.**
- ☐ Base–emitter cohesivity. **Look at Frame 18.**
- ☐ Base–collector reverse-bias capacitance. **Go to Frame 22.**

3

No, the amplifier stage in Fig. 3 has nothing to do with bias on the discriminator diodes. In fact, it doesn't affect those diodes at all. The opposite is true—the diodes affect the amplifier. Go back and **reread Frame 17** and pick out the right answer.

4 **No, that isn't right.** Even though you may look upon the second transformer as a discriminator transformer, its primary is nevertheless a tuned circuit for the 45.75-MHz signal. With that in mind, go back and **reread Frame 16** and then try a different answer.

5 **No,** not the entire i.f. signal. The aft system senses only the 45.75-MHz picture carrier. Your answer is pretty close, but it would be a good idea to go back and read Frame 1 again before proceeding to Frame 16.

6 **No, that's wrong.** The oscillator frequency is the one controlled, but it isn't used for sensing. If the aft were to operate directly from the oscillator signal, you'd need a stage for every channel. Fortunately, there is a better way. **Go back to Frame 1,** study the diagram, and try a different answer.

7 **No, it is not the discriminator.** It is possible to put discriminator diodes inside an integrated circuit, and such IC's are available. However, the IC's used so far in aft systems do not combine these functions. **Go back to Frame 14** and try a different answer.

8 **Yes, you're right.** The integrated circuit in an automatic fine tuning system merely takes the place of the transistor used as a 45.75-MHz amplifier.

You may be wondering what is done with the dc correction voltage in the tuner, to make the oscillator shift its frequency. The answer is a fairly recent development—the *Varicap diode voltage-variable capacitor* or *varactor*. It is a special diode which, when backward-biased, takes on the characteristics of a capacitor. Varying the amount of reverse bias varies the capacitance of the diode.

The variable-capacitance diode is made part of the tuning capacitance in the vhf and uhf oscillators. Then, with the correction voltage controlling the capacitance, it is possible to fine-tune the oscillator automatically. (There is usually a fine-tuning knob, too, which is used to bring the oscillator close to frequency with the aft disabled. The aft correction system then holds the frequency.)

The diagrams in Fig. 5 show the oscillator sections of a vhf and a uhf tuner. The aft diode is part of the circuit that tunes them.

The oscillator in Fig. 5-a is a tunable Pierce. Feedback is via the tuned circuit from plate to grid. The variable-capacitance diode is connected across the tuned circuit by capacitor C2. The anode end is grounded by C3.

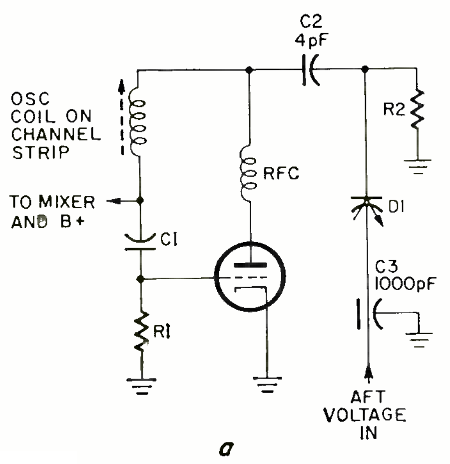
A dc return for the cathode of the variable capacitance diode is resistor R2. Since a varactor must be backward-biased, the anode of this diode must be more negative than its cathode. Some self-bias is developed by R2, which keeps the cathode from going negative.

As long as the oscillator is at a frequency which converts the station picture carrier to exactly 45.75 MHz, a certain aft voltage is applied as shown. If the oscillator drifts slightly, the discriminator in the aft sensing section initiates a correction voltage which changes the voltage applied to the anode of the aft diode in the tuner. That alters its capacitance slightly and thus shifts the oscillator frequency —in a direction that brings the picture carrier i.f. back to 45.75 MHz.

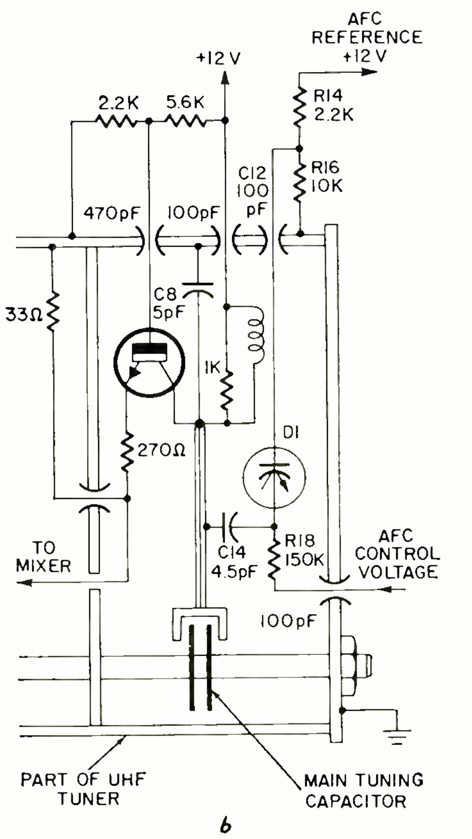
In Fig. 5-b, the aft diode D1 is backward-biased by a 12-volt reference. Voltage divider R14–R16 develops about 10 volts positive for the cathode of the diode.

With this kind of setup, the aft control voltage does not have to be negative. All it has to be is less positive than the reference bias. Then any variation in the anode voltage reflects into the oscillator tuned circuit as a variation in capacitance.

Capacitor C14 and the aft diode are connected in series with each other. They are across a portion of the tuning line that forms the inductance in this uhf tuner. Capacitor C12 decouples the cathode end of the variable-capacitance diode, holding it at rf ground for uhf. The tuned line and capacitor C8 are the other portion of the fine-tuning circuit. The variable main tuning capacitor is shown along the bottom of the sketch. The heavy black lines represent the rotors. R18 and C16 are a decoupling network to prevent the tuning elements of the oscillator circuit from having any effect on the control stages, and vice versa.



a



b

Question: Describe the kind of bias that's applied to the variable-capacitance diode for aft purposes.

☐ A reference-voltage bias. **Move on to Frame 23.**

☐ Backward bias. **Try Frame 21.**

☐ Forward bias to drive the oscillator. **See Frame 20.**

9 **No, that isn't the right answer.** In the system that was described in Frame 2, you may remember that capacitance is involved in the transistor under certain conditions. Go back and **reread Frame 2,** and see if you can't figure out a better answer.

10 **Not so!** If you do get a broad response, it means that you've either connected the meter incorrectly or are turning the wrong slug, or someone has seriously mistuned the secondary before you got to it. If you really don't know what to expect, go back and **reread Frame 15.** Then pick another answer.

11 **Certainly!** It's the 45.75-MHz i.f. picture carrier that is fed to the aft sensing section. The i.f. signal is the same for every channel, and is an excellent signal to check for frequency. If the oscillator drifts or is mistuned, the 45.75-MHz signal cannot be correct. The aft circuits shifts the oscillator back to normal. Since you understand so well, **go on to Frame 16.**

12 **Yes.** If the vtvm is connected properly, and the slug hasn't previously been turned so far away from the zero crossover that it is clear off the curve, the secondary slug will show a very sensitive change in the voltmeter reading as you turn it back and forth. It's a good idea to use a zero-center voltmeter when you do this adjustment—that is, unless the output voltage of the discriminator is not zero. **R-E**

Congratulations, you just completed the course!

13 **No, that's wrong.** It isn't impossible that the correction voltage is positive dc. However, that has nothing to do with how or why you tune the secondary. Something in **Frame 15** has mixed you up, so go back and read it again carefully.

14 **Yes,** this is essentially what the dc amplifier does. It takes a tiny correction voltage developed by the discriminator and makes it into a larger voltage swing. The oscillator control in the tuner is usually a variable-capacitance diode and needs a little more voltage swing than the discriminator alone provides. You'll learn more about this, shortly.

Some television sets use integrated circuits in the aft section. The arrangement is about as shown in Fig. 4.

The integrated circuit is nothing more than a highly efficient amplifier for the 45.75-MHz signals. As you can see in the inset schematic, the IC consists of five transistors and a supply resistor. The input from the third video i.f. in the TV chassis is tuned by L1. The greatly amplified output is applied to a transformer that feeds a capacitance-type discriminator. If you compare Fig. 4 with Fig. 2 (Frame 16), you'll see a strong resemblance.

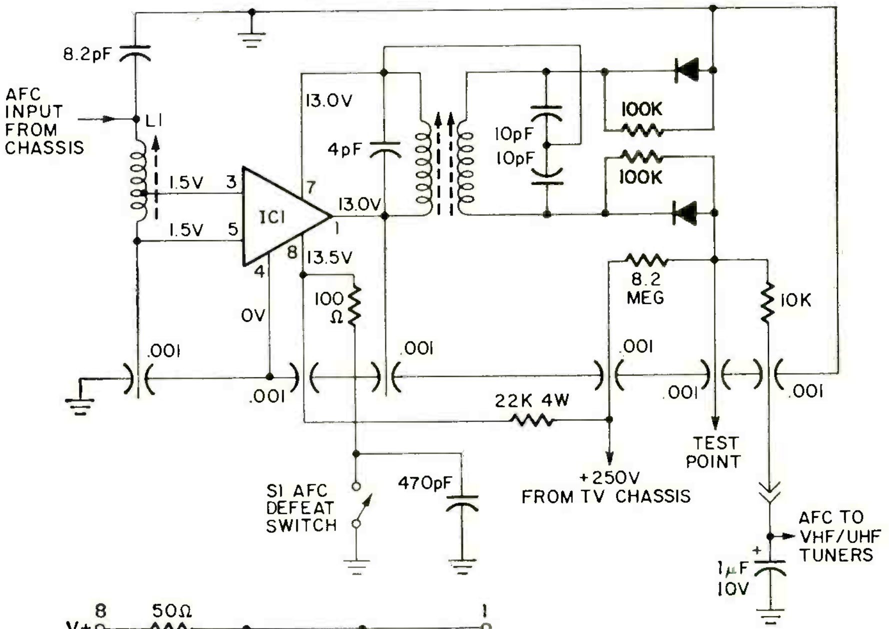
Testing the integrated circuit starts with measuring the dc input voltage at pin 8; it should be about 13.5 volts. Note whatever it is.

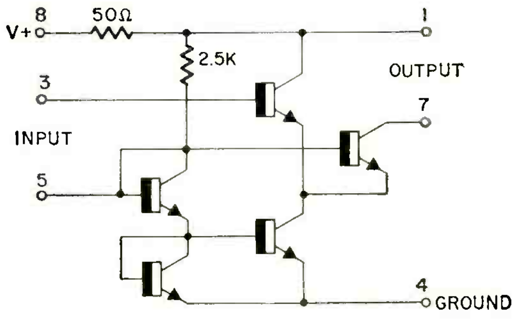
Then measure the voltages at the other pins of the IC. The voltages at pins 1 and 7 should be approximately 0.5 volt lower than the input voltage. Dc at pins 3 and 5 should be about 1.5 volts. If any of the voltages (except at pin 8) is much too low or too high, the integrated circuit is bad. It doesn't really matter what's wrong inside the IC; if you know it's bad, replace it.

If there is voltage at pin 4, rather than the zero volts shown, it isn't a sign the IC is bad; the ground connection for that pin is open.

Question: What is the function of the integrated circuit when it is used in an aft section?

- ☐ Amplifier for the dc output of the discriminator. **Read Frame 24.**
- ☐ As a discriminator. **Go on to Frame 7.**
- ☐ As a 45.75-MHz amplifier. **Try Frame 8.**





EQUIVALENT CIRCUIT OF IC1

15

A good way to troubleshoot any stage or section that involves tuned circuits is first to try aligning it. This is certainly true of an aft system.

Basically, alignment is fairly simple. The only place you can get into trouble is at the discriminator. It's always a good idea to read the manufacturer's suggestions before you start turning the screws. However, if you don't have them, the following principles will help you do a good job.

Start with a 45.75-MHz generator. Be sure it is accurate—crystal control is preferable. A TV marker generator has this signal available.

Feed it into the grid (or base) of the final i.f. stage, the one that supplies the aft sensing signal. Connect a vtvm, set to measure dc, to the signal-strength test point in the discriminator. In a capacitance discriminator, this point is likely to be at the "center" junction of the resistors. If the correction voltage is taken from a "center" point, connect the vtvm at an ungrounded end of the resistive network.

Tune the takeoff coil or the input coil of the aft sensing system for maximum dc reading on the voltmeter. Then do the same for the primary slug in the discriminator coil.

Be sure you get the right discriminator slug. You can sometimes tell by the arrows on the schematic whether the primary slug is the top one or bottom one. However, just to be sure, read the manufacturer's instructions. If that doesn't tell you, turn the slug a tiny bit each way. If there is no change in dc reading, you are probably turning the secondary slug.

Now change the connection of the voltmeter to the correction voltage output point in the discriminator. The schematic will usually tell you if the voltage is supposed to be other than zero.

Turn the secondary slug of the discriminator transformer back and forth for precisely the prescribed output voltage or exactly zero. This should be a very sensitive adjustment. If you find it is very broad or doesn't tune, it has been turned way off by someone or you are turning the wrong slug.

To check the diodes, the easiest way is to disconnect one end of each and measure them with an ohmmeter. They should read high in one direction and low in the other, and the low-direction readings should be about equal. This is known as *matching* the diodes.

The adjustments are a clue to trouble. Dc readings on the transistor amplifier (or tube amplifier, if that is used) are your best clues to whether it or associated supply components are faulty.

Question: How can you be sure, during alignment, that you are turning the secondary slug of the discriminator transformer and not the primary?

- ☐ The secondary shows very sensitive changes in meter readings on each side of "center." **Look at Frame 12.**
- ☐ Look for a broad response. **Go to Frame 10.**
- ☐ Secondary gives a positive dc voltage reading. **See Frame 13.**

16

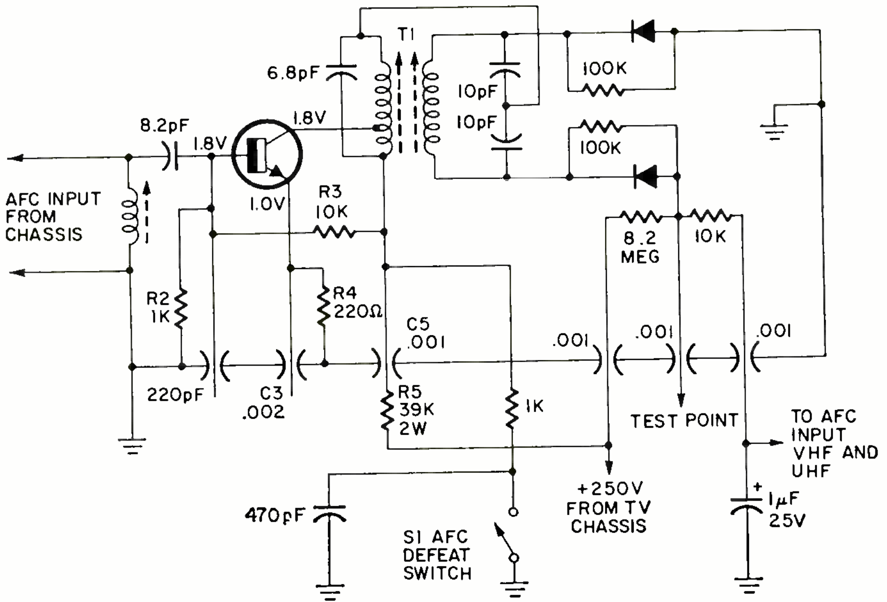
The usual aft system has two stages. One is a tuned stage to amplify the 45.75-MHz picture carrier i.f.

As you can see from Fig. 2, the first tuned circuit is part of the takeoff system. Sometimes the takeoff coil is part of the third i.f. transformer. More often, takeoff is capacitive, with the coil an input circuit in the aft section.

In Fig. 2, a capacitor couples the resonance-peaked 45.75-MHz signal to the transistor base. (A tube is used in older Magnovox chassis.) The amplifier has a tuned collector load, too—the primary of the transformer that couples energy to the discriminator.

The npn transistor is in a standard common-emitter circuit. Collector voltage is of course positive. The voltage comes from regular 250-volt B+ in the TV chassis, applied through R5 and the primary of T1. Bias for the base comes from the same source, applied through divider R3–R2. Resistor R4 in the emitter circuit counters bias by developing 1 volt at the emitter element, and prevents thermal runaway in the transistor.

The whole system can be disabled, in this particular version, by switch S1. It connects a 1K resistor to ground from R5. That reduces collector voltage so drastically nothing can operate.



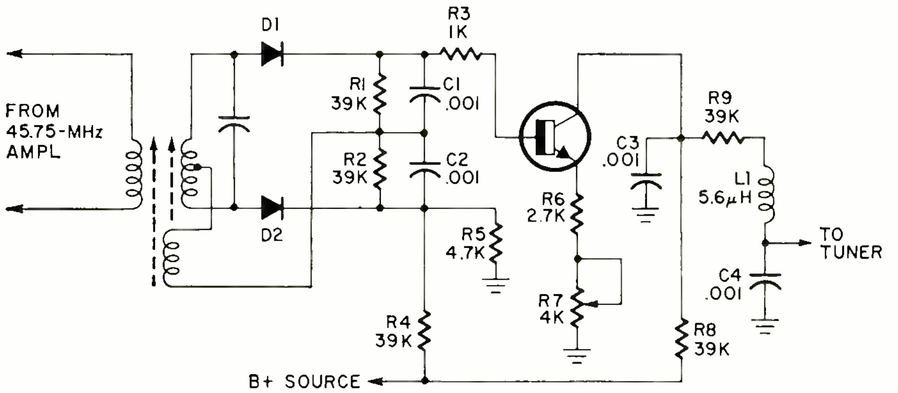
Capacitor C5 decouples the collector load, and C3 bypasses R4 in the emitter circuit.

Question: How much tuning does the aft sense signal get?

- ☐ It is usually tuned at least twice, at the input of the amplifier and at the output. **Check Frame 17.**
- ☐ At the input of the section only. **See Frame 4.**
- ☐ In the TV i.f. section and at the aft input. **Go to Frame 21.**

17

Yes, it is amplified twice—once either at the takeoff point or at the input of the aft section, and again at the output of the aft amplifier. The primary of the discriminator transformer is the collector load, and it's tuned. Therefore, you have to count it when you figure how many times the signal gets resonant stepup in the aft section.



However, the collector load is the only 45.75-MHz tuned circuit in Fig. 3. Fig. 2 showed a capacitance-type discriminator; a capacitive divider across the secondary of the discriminator transformer supplies the phase shift that lets the discriminator sense when the input signal varies from the frequency tuned by the primary. In Fig. 3, a tertiary winding supplies the phase shift.

The discriminator output is taken, in both cases, from the cathode of one of the discriminator diodes. In Fig. 3, it is at the junction of D1 and R1. Certain Motorola, RCA and Sylvania aft systems use a stage of dc amplification for the correction voltage. This is included in Fig. 3.

The dc correction voltage is applied to the base by R3. The collector gets about 4 volts of dc, but is grounded for rf by C3. The emitter goes to ground through R6 and R7. The latter is a potentiometer for adjusting the aft system.

A small change in the output (correction) voltage of the discriminator, which rests at zero when the i.f. is on frequency, causes a change at the base. That alters conduction of the transistor and changes the voltage at the collector. That change is fed by R9, inductance L1, and decoupling capacitor C4, to the tuner.

This output dc is always positive. It varies above and below the nominal 4 volts an amount determined by the discriminator correction voltage. The output of some aft systems swings positive and negative from zero. Question: What is the purpose of the amplifier that follows the discriminator in Fig. 3?

- ☐ It is a followup amplifier for the 45.75-MHz signal to the discriminator. **See Frame 19.**
- ☐ It is a dc amplifier that matches the correction voltage to the characteristics of the correction device used in the tuner. **See Frame 14.**
- ☐ It is there to back-bias one of the diodes of the discriminator, providing more linear action. **See Frame 3.**

18

Nope. There's no such thing as base–emitter "cohesivity." You're guessing. Go back to Frame 2 and reread it thoroughly.

19

If you chose this answer, you really didn't pay proper attention to the explanations in Frames 16 and 17. It might not be a bad idea to go all the way back and read Frame 16 before you even bother reading Frame 17 again. Any amplifier that affects the 45.75-MHz signal would have to precede the discriminator, because that signal is eliminated there. Go back, at least, to Frame 17 and try again after you reread it.

20

Not even close. The way a variable-capacitance diode works is by creating a depletion "insulation" around the junction. To do that, the diode cannot conduct. Consequently, forward bias certainly won't work, because it makes a diode pass current—a condition you don't want. If you have already read Frame 21, proceed to Frame 2. If not, go to 21 and read it first.

21

That's right. The diode must have backward bias. It is not necessarily put there by a reference voltage, although it is in some cases. If you haven't already, read in Frame 22 the explanation of what the backward bias does to create capacitance. If you have, jump to Frame 1.

22

Yes, that's the right answer. So far you've done a good job of mastering the idea of automatic fine tuning. If you hadn't you wouldn't have gotten this far. Now, go on to Frame 15 and see how to troubleshoot an aft system.

23

You didn't read Frame 8 carefully enough. This answer applies to one type of circuit only, and even then it's only partially right. But there are other ways of handling the bias on the diode to assure it is always in the direction it should be. Why don't you read Frame 8 again and give the answers another try?

24

No. Even though you can tell by Fig. 4 that the integrated circuit is completely dc-connected internally, it is not a dc amplifier for the correction voltage from the discriminator. Go back and read Frame 14 again and see if you can't come up with the right answer.

25

It is true the 45.75-MHz signal is amplified in the i.f. section, but it is amplified along with a lot of other frequencies in the television i.f. signal. Therefore, it doesn't count as amplification of the aft sense signal. So, your answer to the question is wrong. Even though the signal is amplified at the aft input, it is also amplified somewhere else. The clue is in Frame 16.

Experimenters... 30 IC circuits you can use

Useful projects with a wide-band, 10-transistor, IC amplifier

by R. M. MARSTON

ONE OF THE MOST USEFUL INTEGRATED circuits yet devised is the RCA CA3035. This modestly priced little unit, which is housed in a 10-lead TO-5 sized case, is described as an "Ultra-High-Gain Wide-Band Amplifier Array." In actual fact, the device houses three separate wide-band amplifiers in a single package, and contains a total of 10 transistors, one diode and 15 resistors.

All amplifiers in the package are single ended, and can be operated from a single power supply; they can be used either singly, or in cascade. When used in cascade, they give a total voltage gain of 129 dB, i.e., 2,800,000 times! Each individual amplifier has built-in temperature compensation, and can operate over the temperature range −55°C to +125°C. The gain and bandwidth of each amplifier can be adjusted, to suit specific applications with suitable external circuitry.

The CA3035 is, clearly, a very high performance little unit, with a vast range of potential applications of interest to the electronics enthusiast. In this series we present 30 practical projects that you can build around it, plus enough information to enable you to design extra projects of your own, if you wish.

The CA3035

The internal circuit and pin connections of the CA3035 are shown in Fig. 1. Amplifier 1 is built around Q1, Q2 and Q3, with input applied to pin 1 and output taken from pin 3. Basically, Q1 and Q2 are connected as a super-alpha pair (to give a high input impedance at pin 1) and are wired in the common-emitter mode, with split collector load R2–R3. Q3 is an emitter follower, with its base direct coupled to Q2's collector, thus making the Q2 collector signal available at a low impedance level at output pin 3. Q1 is biased (in the negative feedback mode) by wiring an external resistor between pins 1 and 3. D1 protects the amplifier from damage by excessively large input signals. Pin 2 forms the ground or negative supply terminal of the amplifier, and pin 9 the positive terminal; the amplifier can be used with virtually any supply voltage in the range 4.5 to 18 volts.

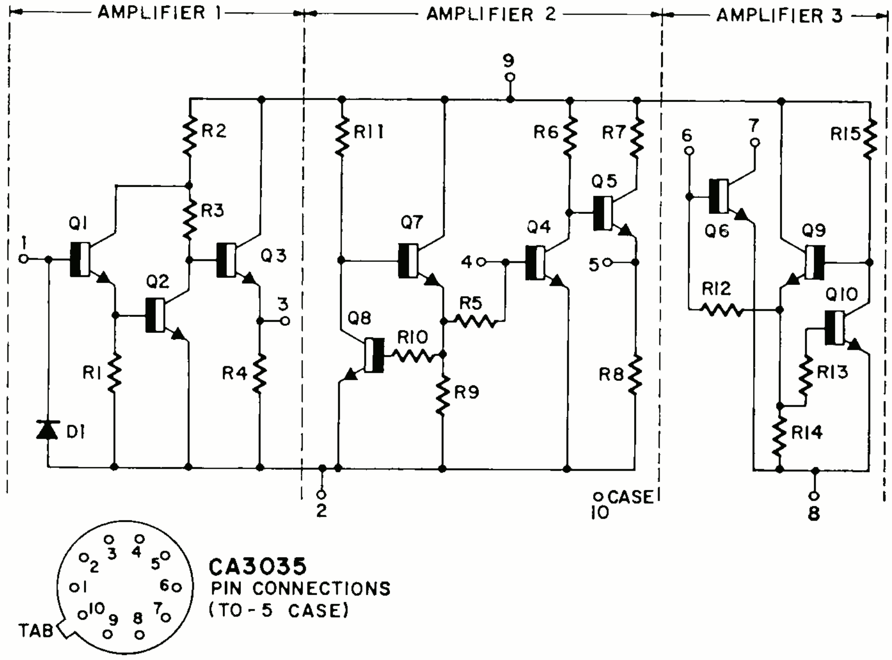
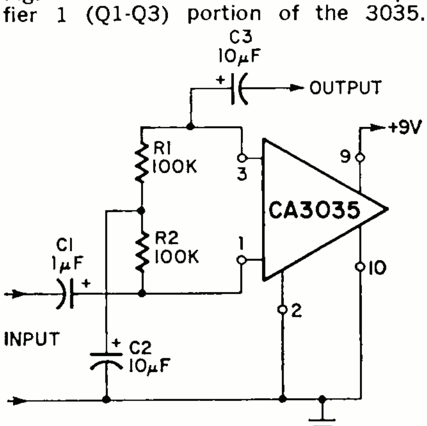


Fig. 1—Internal circuit and pin connections of CA3035 integrated circuit.
Fig. 2—Basic connections for amplifier 1 (Q1-Q3) portion of the 3035.



Amplifier 2 is made up of Q4 and Q5, with thermally compensated base bias applied to Q4 via Q7–Q8 and R5. Q4 is a common-emitter amplifier, and Q5 is an emitter follower. Input signals are applied to the amplifier via pin 4, and low-impedance output signals are available at pin 5. The supply leads (pins 2 and 9) of the amplifier are common with those of amplifier 1.

Amplifier 3 consists simply of Q6, which has thermally compensated base bias applied via Q9–Q10 and R12. Q6 is a common emitter amplifier to be used with an external collector load wired between pin 7 and a positive supply line. The input to the amplifier is applied to pin 6, and the output is taken from pin 7. Pin 8 forms the ground or negative terminal of the amplifier, and pin 9 the positive bias terminal; the external collector load of Q6 can be connected from pin 7 to either pin 9 or to an independent positive voltage source.

Basic connections

Each individual amplifier in the CA3035 package gives a high-quality performance, and can be used (in basic form) with a minimum of external circuitry. Each amplifier offers different characteristics.

Amplifier 1 is a low-noise, low-level, wide-band amplifier with a low noise figure (typically 6 dB), and with a high input resistance. Figure 2 shows the basic method of connecting the amplifier, together with typical performance details when operated from a 9-volt supply.

The amplifier is biased by wiring R1 and R2 in series as a dc negative feedback loop between pins 1 and 3, and the loop is decoupled to ac by C2; the typical pin 3 potential in this mode is 2 volts. Input signals are fed to pin 1 via C1, and output signals are taken from pin 3 via C3.

The amplifier gives a typical voltage gain of 44 dB (× 160), and has a minimum gain of 40 dB (× 100). It has an input resistance of 50,000 ohms, and an output resistance of 270 ohms. Its frequency response is within 3 dB up to 500 kHz. Beyond 500 kHz, the gain falls at a rate of 6 dB per octave, i.e., gain halves as frequency doubles; thus, the amplifier still gives a gain of 20 dB (× 10) at 6 MHz. The amplifier can handle output signal swings of 2 volts peak-to-peak. If it is to be used to give a low distortion output, however, the output signals should be restricted to about 1 volt p-p, or 300 mV rms.

Amplifier 2 is a low-level wide-band amplifier with a medium input resistance. Fig. 3 shows the basic connections. Here, no external bias components are

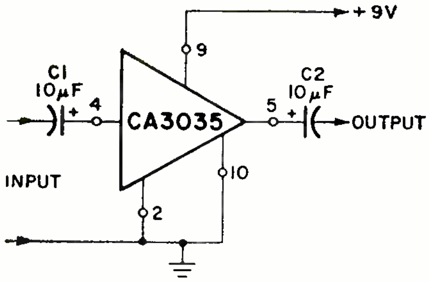


Fig. 3—Circuit connections for amplifier 2 (Q4, Q5, Q7, Q8) in the IC.

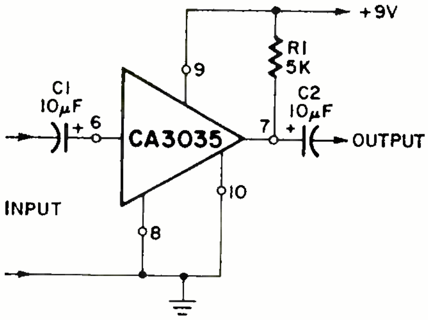


Fig. 4—Connections for amplifier 3.

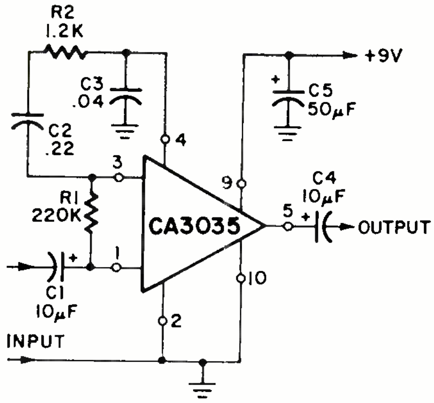


Fig. 5 (upper right)—Cascading amplifiers 1 and 2 like this offers a gain of 7000 (77 dB). Gain holds within 3 dB from 200—6000 Hz.

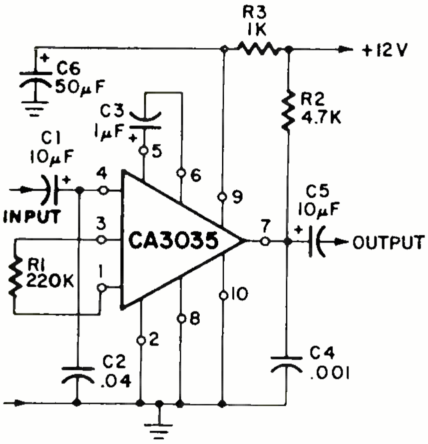


Fig. 6—Gain of 10,000 is obtained by cascading amplifiers 2 and 3.

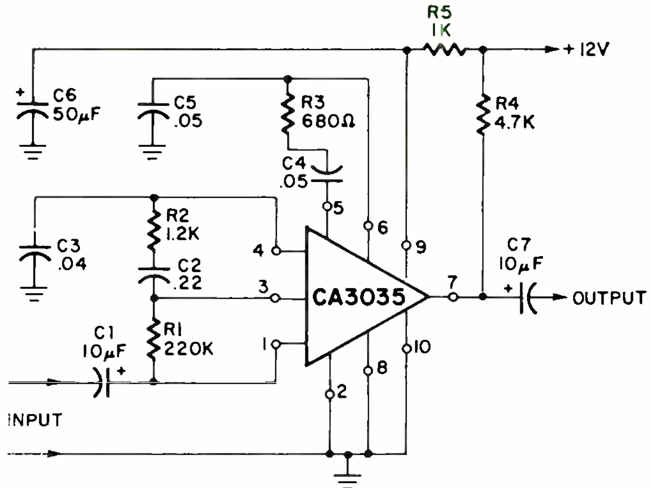


Fig. 7—With all three amplifiers cascaded, gain is 200,000 (106 dB), and bandwidth within 3 dB from 500 to 5000 Hz.

needed, and the input signal is simply connected to pin 4 via C1, and the output is taken from pin 5 via C2. This amplifier gives a typical voltage gain of 46 dB (× 200), and has an input resistance of 2000 ohms and an output resistance of 170 ohms. Its frequency response is within 3 dB up to 2.5 MHz. Beyond 2.5 MHz, the gain falls at 6 dB per octave, so the amplifier still gives 20 dB of gain at 30 MHz. The amplifier can handle maximum output signals of 2.6 V p-p. For low-distortion output, however, limit the output signals to about 1 volt p-p, or 300 mV rms.

Amplifier 3 is a low-level linear, or medium-level non-linear, wide-band amplifier with a low input resistance. Figure 4 shows the basic connections. Here, a load resistor is wired between pins 7 and 9, and the input signal is applied to pin 6 via C1 and the output is taken from pin 7 via C2. This amplifier gives a typical voltage gain of 42 dB (× 126), and has an input resistance of 670 ohms and an output resistance of 5000 ohms (the value of R1). Its frequency response is within 3 dB up to 2.5 MHz. The amplifier can handle maximum outputs up to 8 volts p-p, but the signals are severely distorted at these high levels. If the amplifier is to be used to give a low-distortion output, restrict the output signals to about 1 volt p-p.

The three amplifiers in the CA3035 package operate independently of one another, and can all be operated at the same time, if required. When all three amplifiers are in use using the connections shown in Figs. 2 to 4, the total current consumption of the package rests between 3.5 and 7.5 mA, and is typically about 5 mA.

Cascading amplifier stages

The individual amplifier stages of the IC can be cascaded, to give very high voltage gains. Cascading does, however, present a number of practical problems. Due to the wide bandwidths of the individual stages, stray internal and external positive feedback can easily cause the cascaded stages to oscillate violently at high frequencies, unless considerable care is used in component layout. In addition, the very high available stage gains, combined with wide bandwidths, can cause semiconductor noise to be excessively high at the final output stage.

In most practical applications, very high overall gains are only required over fairly limited frequency bands, and for non-hi-fi purposes, as in speech amplifiers, sound-operated switches, etc. The most satisfactory approach when cascading the CA3035 stages, therefore, is to use external components to deliberately restrict the overall bandwidth of the unit. Restricting the bandwidth increases circuit stability and reduces unwanted output noise.

One way of cascading amplifiers 1 and 2 is shown in Fig. 5. Here, C2, R2 and C3 are wired between the output of amplifier 1 (pin 3) and the input of amplifier 2 (pin 4), and give the necessary frequency restriction. The amplifier 1 bias resistor, R1, is not decoupled to ac, so the input resistance to pin 1 is only about 1.2K. The overall gain of the amplifier, when fed from a 1000-ohm source, is 77 dB (× 7000) at 1 kHz, and the gain is within 3 dB from 200 Hz to 6 kHz.

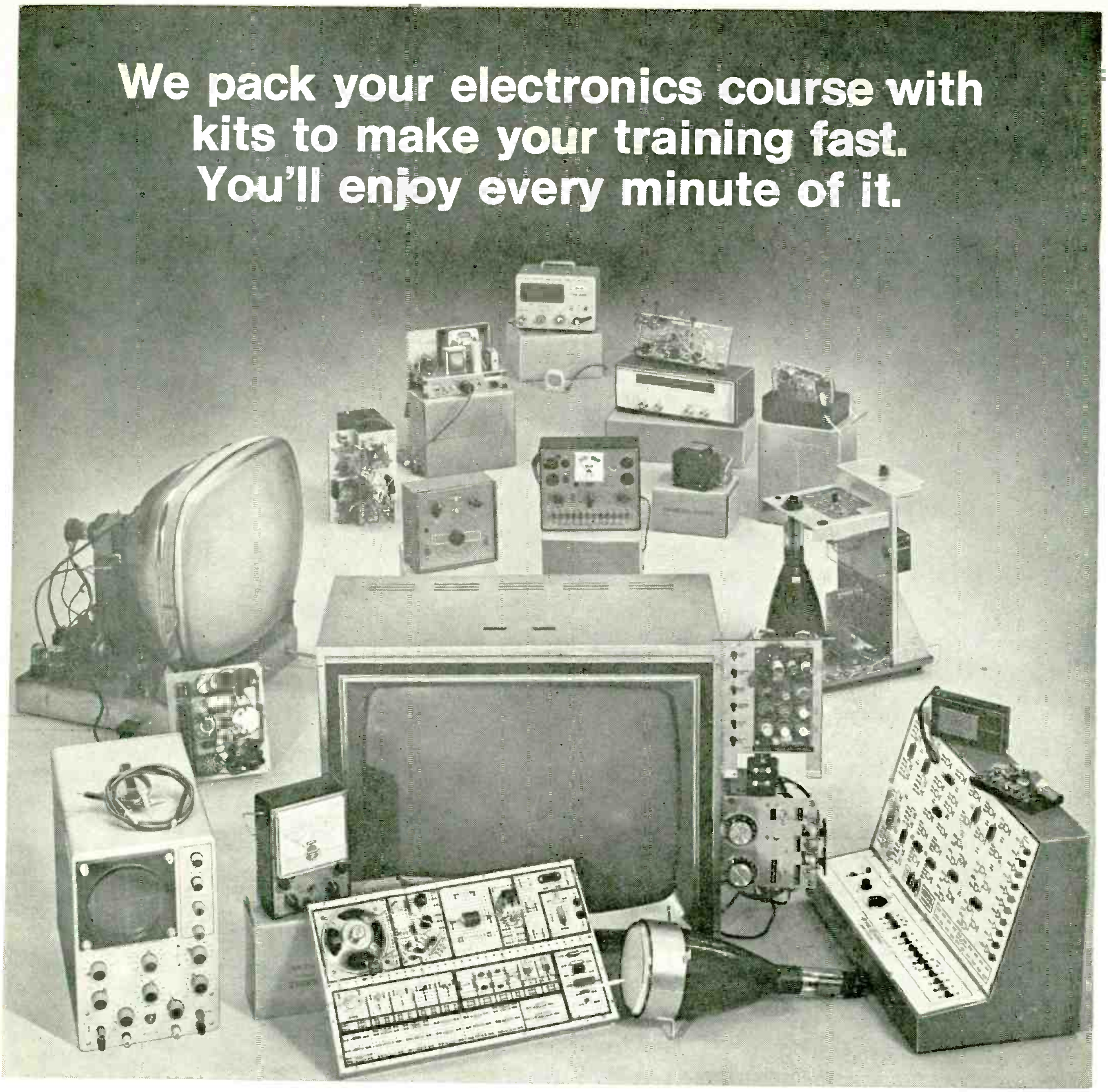
The maximum undistorted output of the amplifier is about 1 volt p-p. The noise output, with the input shorted, is about 20 mV p-p, i.e., the effective noise input of the amplifier is roughly 1 μV rms. Note that the low-frequency end of the response of this amplifier is deliberately restricted by C2, so that the IC does not amplify stray signals picked up from ac power lines. The low-frequency end of the spectrum can be extended, if required, by increasing the value of C2.

Amplifiers 2 and 3 may be cascaded, see Fig. 6, to give an overall gain of 80 dB (× 10,000) from a 1K source, and a frequency response that is within 3 dB from 200 Hz to 5.5 kHz. The low-frequency end of the spectrum is restricted by C3. This amplifier gives a maximum output of about 7.5 volts p-p, but the output is badly distorted at levels greatly above 1 volt p-p.

Fig. 7 shows how to cascade all three amplifiers, to give an overall gain, from a 1K source, of 106 dB (× 200,000) at 1 kHz. Bandwidth is within 3 dB from 500 Hz to 5 kHz. The low-frequency end of the spectrum is restricted by C2 and C4. The noise output, with the input shorted, is about 200 mV p-p, so the effective noise input of the amplifier is roughly 0.3 μV rms. The maximum output is 7.5 volts p-p.

The circuit in Fig. 7 can be adapted as an ultra-sensitive sound-operated switch, driving relay RY1 (see Fig. 8). Here, a pick-up microphone or speaker, with an impedance in the range

(continued on page 68)



Your NTS success package

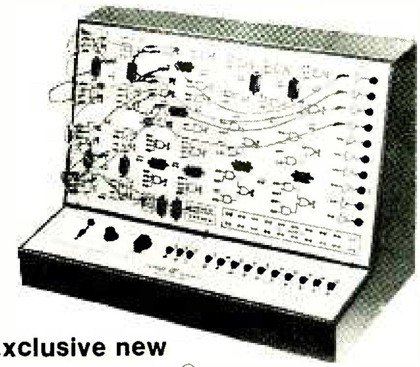
Choose a career in electronics: Computers. Color TV Servicing. Automation. Communications. Whatever the field, NTS has a complete home-study package to get you to the top *faster.* 10 thorough training courses. Each includes *everything* to give you the *working* knowledge required of successful technicians.

NTS Project-Method Training is the practical way to learn electronics. It's a proven combination of lessons and the best professional kit equipment available. NTS provides the *biggest selection of kits ever offered in home-study . . . all at no extra cost.* You'll construct these exciting kits to fully understand electronic circuits, components, and concepts. Our Project-Method lets you build skills by putting theory into practice . . . by working with your hands, as well as your head.

The NTS "learn and practice" approach makes training at home really easy. All it takes is a few hours a week . . . whether you're starting from scratch or in advanced courses. This is the all-inclusive success package that put thousands of men into the best paying jobs . . . or into their own business. If "just a living" isn't good enough for you, now is the time to get something better going for you!

NTS COMPUTER ELECTRONICS

This is the future. And it's happening now. The number of computers will *increase many times* in the next few years.

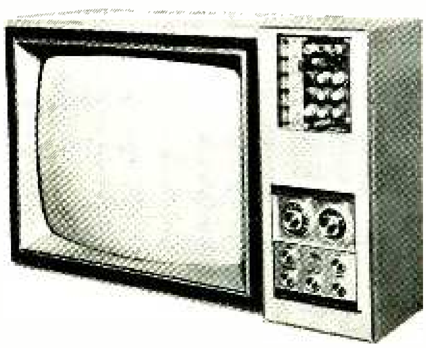


Exclusive new Compu-Trainer®

NTS offers a solid grounding in computer operation, wiring, data processing and programming. One of the 10 important kits included is our exclusive Compu-Trainer®. It's a fully operational computer logic trainer — loaded with integrated circuits — the first ever offered in home study. It introduces you quickly to how, what, when and why of computers . . . from theory to practical servicing techniques. This unit is capable of performing 50,000 operations per second. And it's sent at no extra cost.

NTS COLOR TV SERVICING

This is a broad, easily understood



COLOR TV
295 SQ. IN. PICTURE

program designed to make you a complete home-entertainment service technician. Included, at no extra cost, is a color TV that has more features than any set on the market. You also learn all about stereo, hi-fi, multiplex systems, and become a specialist in Color TV Servicing. Kits also include AM-SW radio, solid-state radio, field-effect transistor volt-ohmmeter, electronic tube tester.

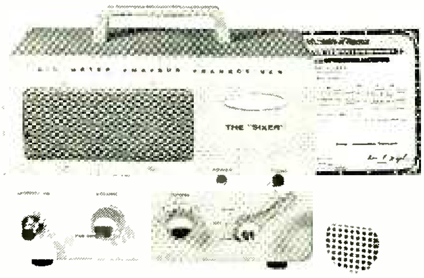
NTS AUTOMATION/ INDUSTRIAL ELECTRONICS

You're trained in the "push-button" electronics that keep industry going and growing . . . from relay type controls to highly advanced systems essential to production. You receive 16 kits including a 5" wide band oscilloscope, and the new NTS electronics lab: a fascinating NTS exclusive experimental laboratory. A complete workshop which makes you familiar with solid-state, miniature, and integrated circuits.

5" Oscilloscope

NTS ELECTRONIC COMMUNICATIONS

The use of 2-way radio systems in private and commercial applications is skyrocketing. NTS prepares you for the big-money opportunities in the field of transmitting and receiving equipment. *Your tuition will be refunded in full if you cannot pass the FCC exam for a 1st Class Commercial Radio-Telephone License within six months after successfully completing this course.* You build valuable kits including Amateur-Phone 6 Meter VHF Transceiver, solid—state Radio, and a field-effect transistor volt-ohmmeter.



5 Watt AM Transmitter & Receiver

CLASSROOM TRAINING AT LOS ANGELES

You can take classroom training at Los Angeles in sunny Southern California. NTS occupies a city block with over a million dollars in facilities devoted exclusively to technical training. Check box in coupon.

NATIONAL TECHNICAL SCHOOLS

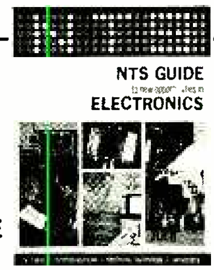
World-Wide Training Since 1905

4000 South Figueroa Street
Los Angeles, Calif. 90037, U.S.A.

APPROVED FOR VETERANS

Accredited Member: National Association of Trade and Technical Schools, National Home Study Council.

TODAY, MAIL COUPON FOR FREE COLOR CATALOG AND SAMPLE LESSON.



NATIONAL TECHNICAL SCHOOLS
4000 S. Figueroa St., Los Angeles, Calif. 90037

Please rush Free Color Catalog and Sample Lesson, plus information on field checked below. No obligation. No salesman will call.

- ☐ MASTER COURSE IN COLOR TV SERVICING
- ☐ COLOR TV SERVICING
- ☐ MASTER COURSE IN TV & RADIO SERVICING
- ☐ PRACTICAL TV & RADIO SERVICING
- ☐ MASTER COURSE IN ELECTRONIC COMMUNICATIONS
- ☐ FCC LICENSE COURSE
- ☐ MASTER COURSE IN ELECTRONICS TECHNOLOGY
- ☐ INDUSTRIAL AND AUTOMATION ELECTRONICS
- ☐ COMPUTER ELECTRONICS
- ☐ BASIC ELECTRONICS

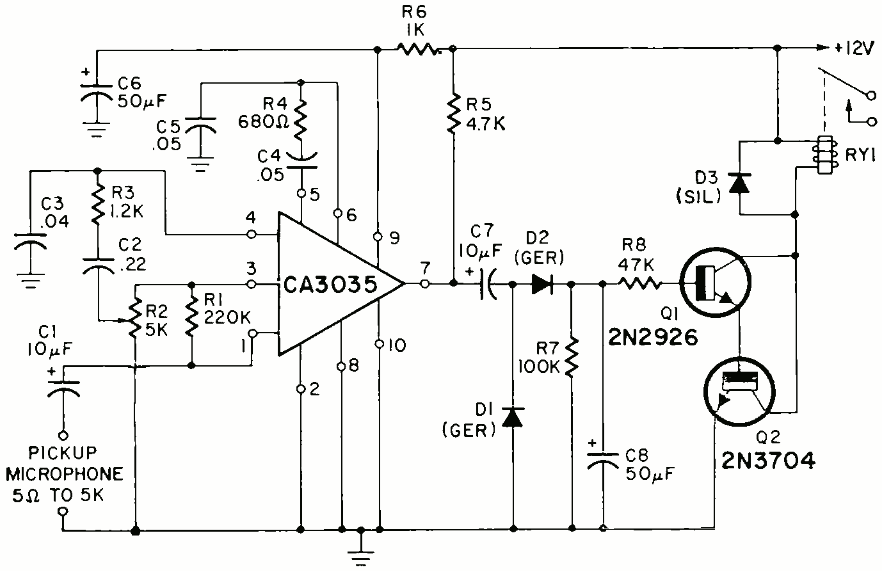
Name ____ Age ____

Address ____

City ____ State ____ Zip ____

☐ Check if interested in Veteran Training under new G.I. Bill.

☐ Check if interested ONLY in Classroom Training at Los Angeles. Dept. 206-020



D1 – D2 = GENERAL PURPOSE GERMANIUM DIODES
D3 = GENERAL PURPOSE SILICON DIODE
RELAY = ANY 6 TO 12 VOLT TYPE WITH A COIL RESISTANCE GREATER THAN 120Ω

Fig. 8—Ultrasensitive, sound-operated switch is variation of Fig. 7.

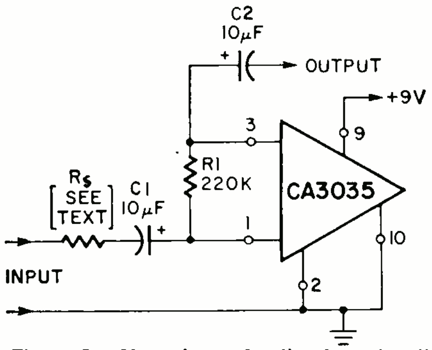


Fig. 9—Negative feedback circuit varies input resistance of amplifier.

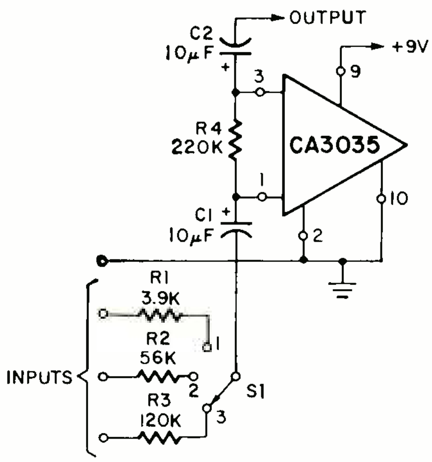


Fig. 10—Switching arrangement lets you change preamp's input sensitivity.

5–5,000 ohms is connected at pin 1 of the IC, and the greatly amplified pick-up signal is taken from pin 7 and is rectified and smoothed via D1, D2, R7, C8 and R8: the resulting dc signal drives the relay on through Q1 and Q2, which are wired as a Darlington-connected common-emitter amplifier. When the dc voltage across C8 is less than 1.2 volts (low sound input), Q1–Q2 and the relay are off. When the C8 voltage exceeds 1.2 volts, Q1-Q2 and the relay are driven on. R2 is used as a variable sensitivity control in the circuit.

The circuit is sufficiently sensitive to give positive operation of the relay at normal speech levels at a range of several yards. The action of the circuit is such that the relay turns on as soon as a reasonable sound is picked up at the microphone, but the relay does not turn off again until several seconds after the sound has ceased. This action, which is controlled by C8, ensures that the relay does not turn off during brief pauses in speech.

When building this circuit, it should be noted that the sensitivity is so high that the switch can be triggered by the sound of the relay turning off, so that an audible positive feedback path is set up and the unit oscillates at a very low frequency. To avoid this phenomena, the relay must either be placed in a sound-damping box, or must be placed some distance from the pick-up microphone.

Varying amplifier gain and input resistance

The gain and input resistance of each amplifier in the CA3035 package can be varied, to suit specific needs, with the aid of external circuitry. The general procedure is pretty simple, and in this section we present some practical projects that utilize the techniques involved. These projects are all based on amplifier 1, but the techniques can be readily adapted to amplifiers 2 and 3 if required.

The basic method of changing the input resistance of an amplifier is illustrated in Fig. 9. Here, R1 is wired as a negative feedback path between the amplifier's output and input. The negative feedback effectively reduces the R1 value to $\frac{R1}{A_v}$, where A_v is the amplifier open-loop voltage gain; this modified resistance is effectively in parallel with the open-loop input resistance of the amplifier. Thus, if we assume that the amplifier of Fig. 9 has an open loop gain of 185 and an input resistance of 50K, the final input resistance of the amplifier, R_{in}, works out at about 1.2 K.

When used in amplifier 1, R1 can be direct coupled between output and input, as shown, and can be used as the amplifier's bias resistor. It can be given any value in the range 33K to 470K. When used in amplifiers 2 and 3, R1 (the feedback resistor) should be ac coupled between output and input by wiring a blocking capacitor in series with the resistor.

Although R1 changes the input resistance of the amplifier, it has no effect on the voltage gain of the actual amplifier between pins 1 and 3. The gain of the circuit (as opposed to the gain of the amplifier) can, however, be varied by wiring a second resistor, R_s, in series between the circuit's input terminal and the amplifier input pin, as shown. In this case, R_s and R_{in} act effectively as a potential divider, which causes only a fixed fraction of the input signal to be applied to the input of the actual amplifier, so reduced gain is obtained from the overall circuit. The actual voltage gain, A, of the circuit works out at $\frac{R1}{R_s + \frac{R1}{A_v}}$ in this case. If $\frac{R1}{R_s}$ is less than about 15, this formula simplifies to $A = \frac{R1}{R_s}$.

R_s modifies the input resistance, R_{in}, of the circuit to $R_{in} = R_s + \frac{R1}{A_v}$. If $\frac{R1}{R_s}$ is less than about 15, this formula simplifies to $R_{in} = R_s$. Thus, by suitable choice of the R1 and R_s values, the voltage gain and input resistance of the Fig. 9 circuit can be varied to suit individual needs.

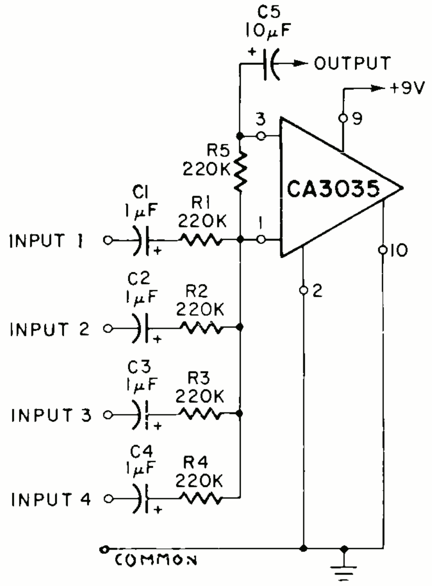


Fig. 11—High-quality 4-channel audio mixer is wired for a gain of unity. Fader controls can be added to inputs.

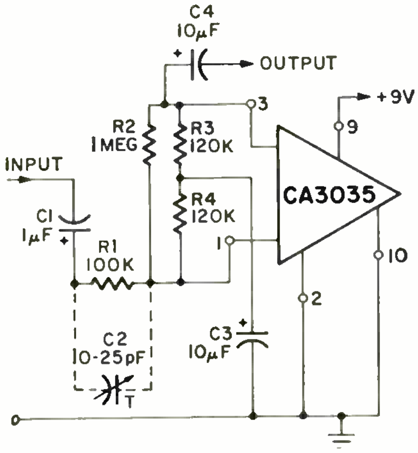


Fig. 12—Simple 10× scope preamp has 100K impedance and response within 3 dB to 150 kHz; C2 can extend response.

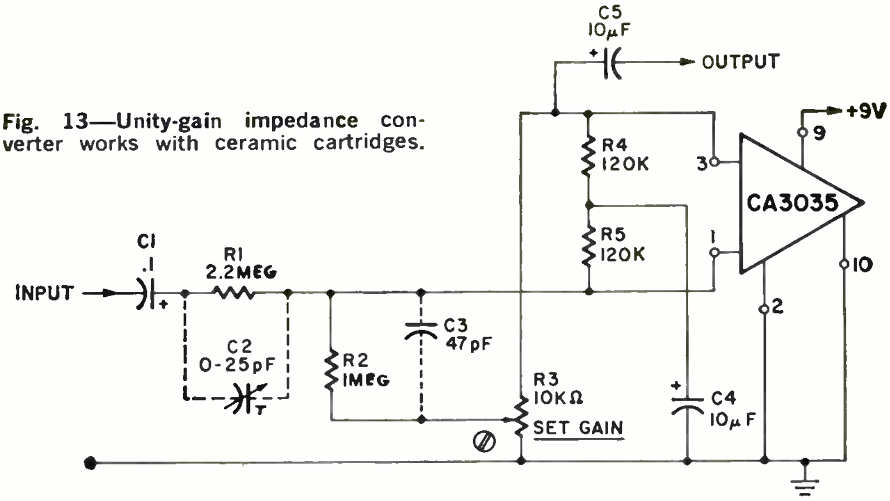


Fig. 13—Unity-gain impedance converter works with ceramic cartridges.

Fig. 10 shows how this technique can be used to make a general-purpose preamplifier with switched sensitivity. In position 1 of S1, the circuit has an input resistance of about 5K and a sensitivity of 2.5 mV for 100 mV output. In position 2, R_{in} is about 56K and the sensitivity is 25 mV, and in position 3 the input resistance is 120K and the sensitivity is 60 mV.

The same technique can be used to make a high quality 4-channel audio mixer (Fig. 11), with an input resistance of 220K to each channel and an overall gain of unity. Each channel can be given a fade control, if required, by wiring a 1-megohm pot between each input and ground, and taking the pot slider to the 1-μF capacitor in the selected channel.

High-impedance amplifier

To use the technique to make a high-impedance (100K) amplifier that gives a gain of 20 dB, and which can be used as a simple scope preamplifier, see Fig. 12. In this case the value of negative feedback resistor R2 is too high to provide correct biasing of the amplifier 1 in the CA3035 package. Therefore R3 and R4 are used to give the necessary bias and are decoupled to ac by C3. In its basic form, this circuit gives a frequency response that is within 3 dB up to about 150 kHz. The response can be extended to about 900 kHz, if required, by wiring trimmer capacitor C2 (shown dashed) across R1, as indicated.

Fig. 13 shows the circuit of a very high impedance (2.2 megohms) unity-gain impedance converter. In this case a 10K preset pot, R3, is wired between the output of the amplifier and ground, and negative feedback resistor R2 is wired between the pot slider and pin 1 of the amplifier. Adjust R3 to give precisely unity gain from the circuit.

In its basic form, this circuit gives a frequency response that is within 3 dB up to 45 kHz. It can be used as a high-quality impedance converter for use with crystal or ceramic pickup cartridges or microphones. The frequency response can be extended to several MHz by adding trimmer capacitor C2 and fixed capacitor C3, as shown. In this case, the circuit can be used as a high-performance input stage for scopes or ac millivoltmeters, etc.

Finally, Fig. 14 hows how the circuit can be connected as an amplifier with light-controlled gain. Here, LDR1 is a cadmium-sulphide photocell, or light-dependent resistor. It acts as a very high resistance (typically several megohms) under dark conditions, and as a low resistance (typically 100 ohms) under bright conditions. Thus, under dark conditions, the LDR value is so high that negligible signal loss occurs across R1, and virtually the full 44 dB of possible circuit gain is available. Under very bright conditions, on the other hand, the LDR value is so low that pin 1 appears as a virtual short circuit, and virtually the full applied input signal is lost across R1 and negligible circuit gain is available.

On the prototype circuit, using a typical LDR, the circuit gives a signal attenuation of −60 dB under very bright light, or −20 dB under normal room lighting. Gain is 44 dB under dark conditions. The maximum attenuation of the circuit can be restricted by wiring a limiting resistor or potentiometer in series with the LDR.

The light-controlled amplifier has a number of practical applications in electronic organs and gadgets. By mounting the LDR in a tube together with a variable-brilliance lamp, the circuit can be used as a wide-range amplifier with noiseless volume control: By modulating the lamp brightness, the circuit can be used to impose tremelo or amplitude modulation on input signals. This system can also be used for PA avc.

Varying the frequency response

The frequency response of each amplifier can be readily tailored to suit individual needs, using techniques similar to those described already for varying gain and input resistance.

Fig. 15-a shows the circuit of an amplifier designed to give a roll-off of 6 dB per octave (i.e., gain halves as frequency doubles), with unity gain at roughly 1 kHz. Here, C2 is wired in a negative feedback path between output and input of amplifier 1. Circuit gain is proportional to the reactance of C2,

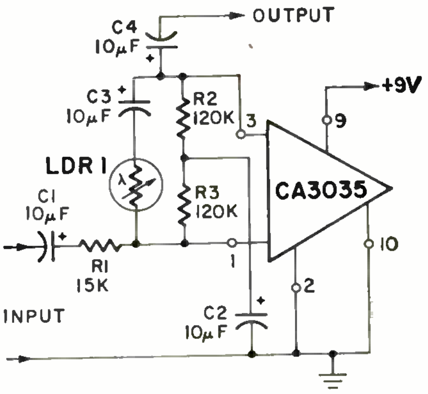


Fig. 14—Light-controlled-gain circuit has several audio applications.

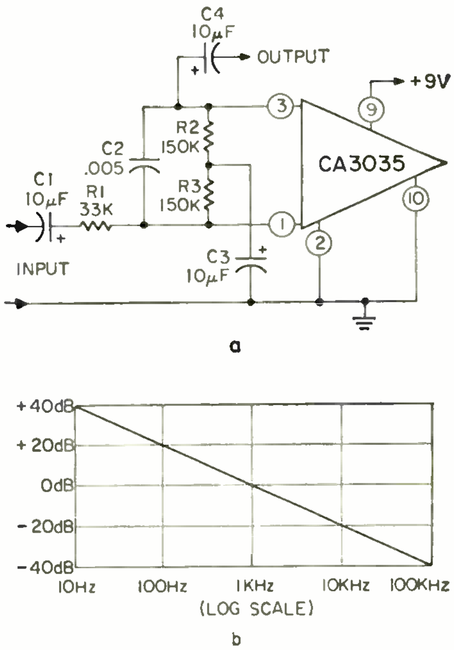
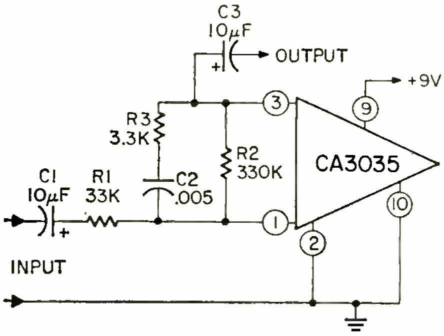


Fig. 15—Circuit for 6-dB/octave roll-off (a) and the response curve (b).

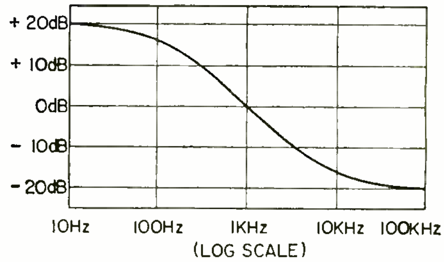
and equals unity when this reactance is equal to that of R1. Since the reactance of C2 halves when frequency doubles, the circuit gives a frequency roll-off of 6 dB per octave (Fig. 15-b). (*turn page*)

30 IC CIRCUITS
(continued from page 69)

The circuit in Fig. 16-a shows how the circuit can be modified to give a 6 dB per octave roll-off, but with controlled



a

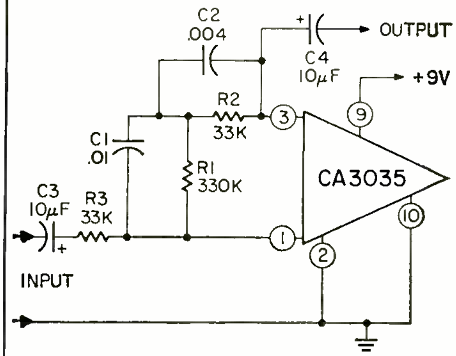


b

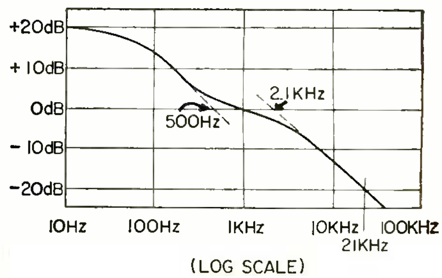
Fig. 16-a—Controlled-gain amplifier with 6 dB/octave as shown in graph at b.

maximum and minimum gain. The minimum gain is restricted, to R3/R1, by wiring R3 in series with C2, and the maximum gain is restricted, to R2/R1, by wiring R2 across the C2—R3 combination. Fig. 16-b shows the performance of the circuit.

Figure 17-a shows how amplifier 1 can be connected as an RIAA equalizer.



a



b

Fig. 17-a—Amplifier 1 as RIAA equalizer with performance as indicated at b.

(continued on page 72)

(*continued from page 40*)

Y. Using a test lead with alligator clips, short input point **T** to ground. Connect a dc meter to the positive output (emitter of Q23) and turn the unit on. The output should remain at ground potential. Upon removing the jumper between point **T** and ground, the output should immediately rise to +10 volts. Install all the rest of the components on the board and repeat the same proceedure for the negative output stage. You are now finished with the chore of making the unit operational and all that is left now is calibration.

Calibration techniques

If you do not have some accurate time reference, such as a calibrated scope or a time interval meter, you will not be able to accurately adjust the unit. Also, you will need at least a 30-MHz scope to adjust rise and fall times of the output stage.

If you don't have one, I suggest you borrow one from somebody as you will reap the rewards of an accurately calibrated generator. It would be preferable to use a time interval meter for calibrating the oscillator rather than a frequency meter. Of course you can use a calibrated scope, preferably with a delaying sweep time base. You must use a scope with a sweep rate of at least 0.1 μsec cm.

It would be best to adjust the output stages first as the board can then be permanently installed in the chassis. Connect a wire from point **Z** on the generator board to point **U** on the output stage board. Also connect a ground lead from the ground terminal on the generator board to the ground terminal **at the transformer end of the output stage board.** Temporarily connect the following points: **B** to **D, C** to **I, P** to **N,** and **O** to **N.** Connect a wire from point **X** on the generator board to point **T** on the output stage board. Connect a .0039-μF capacitor between points **A** and **D**, and adjust R3 for *maximum* resistance. Connect a 100 to 200 pF capacitor between points **J** and **K.** Connect a 390-pF 1% capacitor between points **L** and **M.** Before turning the unit on, make sure that the 50-ohm resistor and 100-ohm pot are temporarily connected to the output you are adjusting.

Connect a scope, using a very low-capacitance probe, to either the + or — output, whichever one you are going to adjust. After turning the unit on, you should notice a pulse approximately 1-μsec wide. For all the calibration procedures it is highly preferable to use the trigger output from the generator rather than relying on the scope's internal trigger.

Continuing, you should notice about 10 to 15% overshoot on the **falling** edge of the pulse. Either R65 and C47 or R66 and C46 should be trimmed to compensate for this. The location of these two components was selected so as not to affect the storage time, which is very low. The value of the resistor will lie somewhere between 500 and 1500 ohms and the capacitor will be somewhere between 10 and 40 pF.

Use as little capacitance and as much resistance as possible—just enough to reduce the overshoot and no more. Do the same for both positive and negative outputs. This completes the output stage board and it can be permanently installed in the chassis now if you like.

Connect a scope to point C on the generator board and without making any changes from the previous adjustments, adjust **R**3 for exactly 10 cycles on the scope, which should be set at 10-μsec per division. If using a time interval meter, the indication should be exactly 10 μsec. Remove the short between **B** and **D** and connect the 7500-ohm vernier control. Turn the control to maximum resistance and switch the scope to 100 μsec/div.

Parallel the control with larger value resistors until exactly 10 cycles appear on the scope or a period of 100 μsec on the TIM (time interval meter). C7, C8, C34, C35, C41 and C42 will be installed and adjusted when you install the board in the chassis. Points **P** and **O** should still be shorted to point **N.** Connect the scope to pin 2 of the **IC**. Temporarily connect a 390-pF, 1% capacitor, between points **J** and **K.** The width of the pulse should be slightly greater than 1 μsec. Parallel R49 with a larger value resistor to bring the width to exactly 1 μsec.

The scope should be set at 0.1-μsec /div to use the full width of the graticle for minimum error. Remove the short between points **O** and **N** and temporarily connect the 25,000-ohm vernier, and adjust it for maximum resistance. Set the scope for 1-μsec/div. Parallel the control with a larger value resistor until the width of the pulse is exactly 10 μsec, the width of the entire graticle. Disconnect the pot and the 390-pF capacitor. Short point **O** to point **N** again and install a 100- to 200-pF capacitor between points **J** and **K.** Connect the scope to point **X** and using the other 25,000-ohm pot and the other 390-pF capacitor, proceed to calibrate the width section in identically the same steps as you just did for the delay section.

Install the generator board in the chassis. Install all of the timing capacitors except C7, C8, C34, C35, C41, and C42. Use the tie points provided on the board and make sure to use the right switch contacts. The next steps are the final calibration steps in this procedure and are critical, so take your time and do it right.

At this stage you should have everything mounted in the chassis with the exception of C7, C8, C34, C35, C41, and C42. Make sure that the ground for the generator board is *not* grounded at the same point as the output stage ground. The best place to ground the generator is at the trigged output jack. Mount C55 and C56 with two terminal strips on the back panel and run the ground lead to the output board.

Mount C7 and C8 in the last position terminals of S1. Turn the generator on and turn the oscillator vernier R8 for minimum resistance (clockwise for highest freq.) Connect the scope to point **C** and adjust the time base for 1-μsec/div. Adjust trimmer C8 fofr exactly 10 cycles on the scope graticle. This is the calibration for a frequency of 1 MHz and completes the oscillator calibration.

Calibration of the delay section can be done in one of two ways. The easiest way is to connect a scope to pin 2 of the IC. Set the time base for 0.1-μsec/div and install C41 and C42. Adjust R53, the delay vernier, for minimum resistance (clockwise for minimum delay). Adjust trimmer C42 so that the width of one pulse is exactly one division wide.

If you are fortunate enough to have a time base that will sweep down to 10 nsec/div, then adjust the trimmer so the pulse is the entire width of the graticle. Note that the pulse does *not* look rectangular at this very narrow width, but this is of no consequence as the falling edge of this pulse should still be fairly fast, and the following stage triggers on the negative edge anyway, so the rise time isn't important.

Next, turn vernier R53 full counterclockwise to maximum resistance. The width of the pulse should be quite a bit wider than 1 μsec. With the scope set to 0.1 μsec/div, parallel the pot with a larger resistance to bring the pulse width to exactly 1 μsec, or the entire width of the graticle. Next, solder this selected resistor in the last position of the *B* section of S6 as shown in the schematic. This completes the calibration of the delay section.

The width section is calibrated in identically the same way as the delay, except that the scope is connected to point **X.** The second way to calibrate the delay section is to use the trigger output to trigger the scope and note how much the output pulse moves across the scope graticle when the delay vernier potentiometer is rotated.

If you look in the photograph, you might not see trimmers C8, C35, or C42 in the prototype. This is because I selected the values and soldered them in, but I should have made it easier on myself by installing the trimmers. This completes the construction and calibration of the generator. However, I would check the calibration of the oscillator after about 20 minutes of operation just to make sure that it hasn't drifted significantly. With proper care in construction and layout, you should have a pulse generator that will perform consistently, maintain calibration accuracy for years, and give many years of dependable service.

For more information

As we are most concerned here with presenting complete construction details of the pulse generator, we are not including a complete description of circuit operation. However, if you would like more data on how this circuit operates send a self-addressed stamped envelope to PULSE-GENERATOR OPERATION Radio-Electronics, 200 Park Avenue South, New York, N. Y. 10003. You will get the complete details by return mail.—*Editors* **R-E**

30 IC CIRCUITS
(continued from page 70)

One set of components gives a 6 dB per octave roll-off towards unity gain at 500 Hz, and the other gives a 6 dB roll-off on a slope that passes through unity gain at 2.1 kHz. To design the equalizer on an empirical basis, proceed as follows:

First, select R1 to set the bias of the amplifier, and then give R3 a value of R1/10 to set maximum low-frequency gain of the circuit at 20 dB. Next, work out the value of C1 that gives a reactance equal to R3 at 500 kHz, and then adjust R2 on test so that the amplifier gain equals unity (0 dB) at 1 kHz. Finally, increase the frequency of the input signal to 21 kHz, and adjust the value of C2 so that the circuit gain falls to –20 dB.

The three circuits that we have looked at so far all give a gain roll-off with increasing frequency. Figure 18-a, on the other hand, shows how an amplifier can be connected to give a gain boost of 6 dB per octave with rising frequency (Fig. 18-b). Here, gain is controlled by low-value capacitor (C1) connected between the input and amplifier pin 1.

At very low frequencies, the reactance of C1 is very high, so most of the applied input signal is lost across C1, and circuit gain is low. At high frequencies, the reactance of C1 is low, so very little of the applied signal is lost across C1, and gain is high.. Circuit gain equals unity at the frequency where the reactance of C1 is equal to R1. Since the reactance of C1 halves when frequency is doubled, the circuit gives a gain boost of 6 dB per octave.

The maximum gain of this type of amplifier can be restricted, if required, by

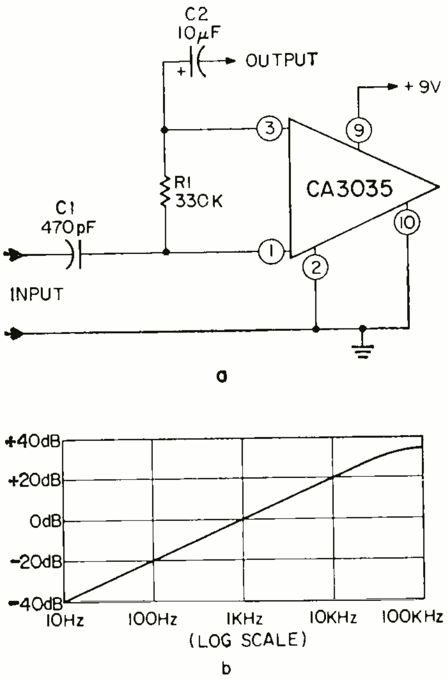


Fig. 18-a, b—Circuit and performance curve of amplifier 1 with 6 dB/octave boost.

wiring a limiting resistor in series with C1, and the minimum gain can be restricted by wiring a resistor across C1.

The techniques of frequency-controlled gain boost and gain cut can be combined to form a variable treble-control amplifier (Fig. 19-a) that gives unity gain up to 1 kHz, with treble response fully variable between ± 6 dB per octave (Fig. 19-b). Figure 19-c shows the states of the frequency-selective networks at different settings of the treble control pot, R3.

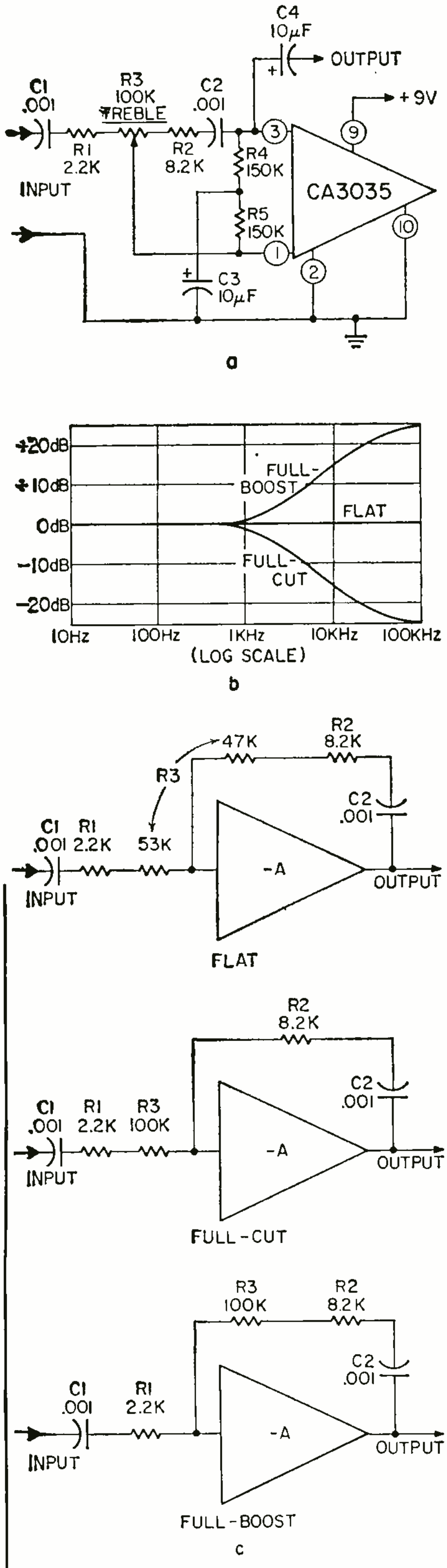


Fig. 19-a—Treble tone-control circuit with performance as shown in graph *b*. Circuits (c) show the effective selective control networks as R3 is varied.

In the FLAT position of the treble control, the network in series with the input of the amplifier is identical to that in the amplifiers output-to-input negative feedback loop, and corresponds to a .001μF capacitor and a 55.2K resistor in series. The impedances of both sets of components are thus equal under all conditions, so the amplifier gives unity gain over the entire frequency band.

In the FULL-CUT position of the treble control, on the other hand, the network in series with the amplifier input is equal to .001μF in series with 102.2K, and that in the negative feedback path equals .001μF in series with 8.2K. At frequencies appreciably below 1 kHz, the reactances of C1 and C2 are equal and are large relative to the largest resistive components in either network, so both networks give equal impedances, and the circuit gives unity gain. At frequencies of 1 kHz and above, however, the reactances of C1 and C2 become low relative to the largest resistive component in the amplifiers input network, so the input network becomes primarily resistive and the negative feedback network becomes primarily capacitive; the circuit therefore gives a gain fall-off with rising frequency.

In the FULL-BOOST position of the control pot, the network in series with the amplifier input is equal to .001μF in series with 2.2K, and that in the negative feedback loop is equal to .001μF in series with 108.2K. Therefore, at high frequencies, the input network is primarily capacitive and the negative feedback loop is primarily resistive, so circuit gain rises with increasing frequency.

Figure 20-a shows how a similar technique can be used to form a variable bass-control amplifier, with bass slope fully variable between $\pm$ 6 dB per octave, and with unity gain above 1 kHz (see Fig. 20-b). Figs. 20-b, -c and -d show the states of the frequency selective networks at different settings of BASS control, R3, so that circuit action can be readily understood. The circuit action is similar to that described for treble control, except that frequency selective component C2 is used as a shunt, rather than a series, element.

Finally, Figure 21-a shows how the basic circuits of Figs. 19 and 20 can be combined to form an amplifier giving fully variable bass and treble control, with unity gain at 1 kHz. Resistors R1 and R2 are used to minimize interaction of the two controls, and make it necessary to change the treble circuitry slightly relative to that of Figure 19. Figure 21-b shows the measured performance of the circuit, which is suitable for use in hi-fi installations, so long as the maximum output of the IC is kept to less than 300 mV rms.

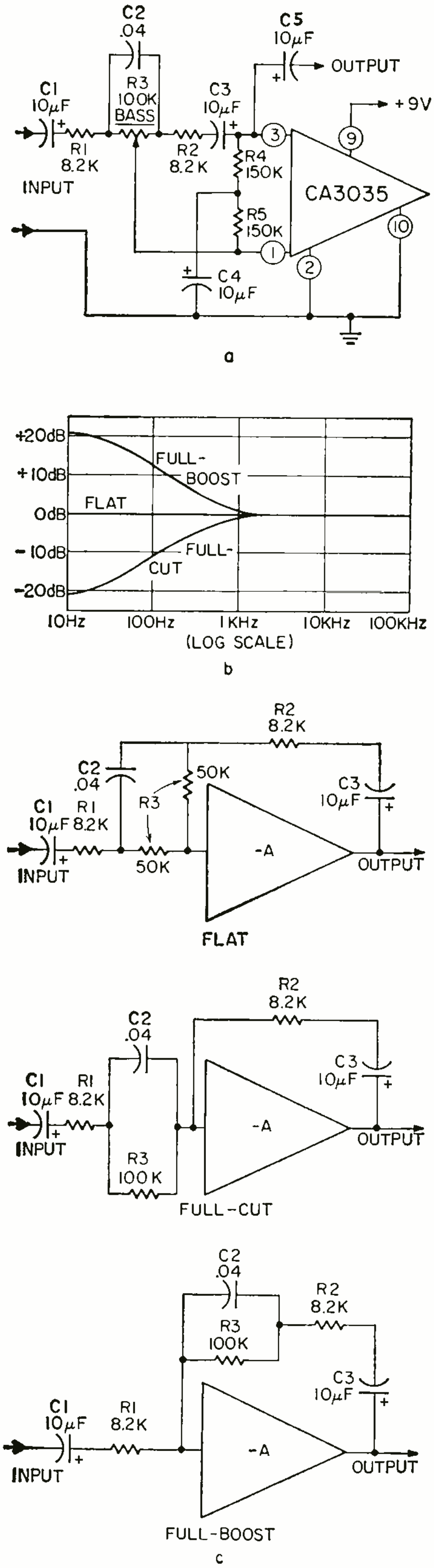


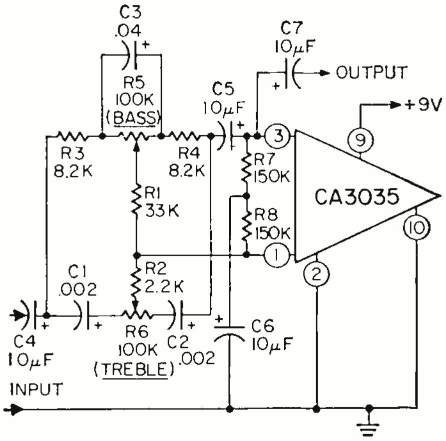
Fig. 20—Bass-control circuit corresponding to treble control in Fig. 19.

Nonlinear circuits

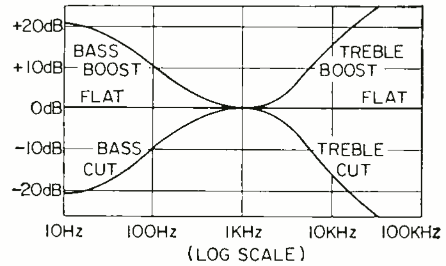
All the circuits that we have looked at so far have been used to give linear voltage amplification. Figure 22, however, shows a circuit that is deliberately designed to give nonlinear voltage amplification; the circuit's voltage gain in fact follows a semi-log scale. This form of amplification is obtained because germanium diodes D1 and D2 are used as negative feedback elements in the amplifier, and the forward current of a germanium diode varies in approximate proportion to the log of the applied diode voltage.

(turn page)

With near-zero applied voltage, the diodes act like very high resistances, so the circuit gain is high. With large applied voltages the diodes act like very low resistances, so the circuit gain is low.



a



b

Fig. 21-a—Full tone control with its response shown in graph at *b*.

With an input signal of 1 volt p-p, the circuit gives unity gain. With an input of 100 mV, the gain rises to 3.3, and with an input of 10 mV it rises to 16. The gain rises to 40 when the input falls to 1 mV p-p. The precise performance of an individual amplifier depends on the characteristics of the actual diodes used for D1 and D2, but will usually approximate to those mentioned above. The results are virtually independent of frequency over the range 10 Hz to 3 MHz.

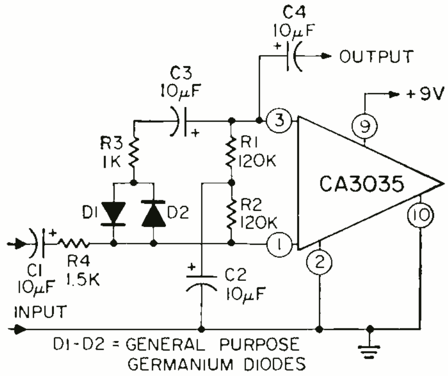


Fig. 22—Non-linear (semi-log) amplifier. Gain decreases as signal rises.

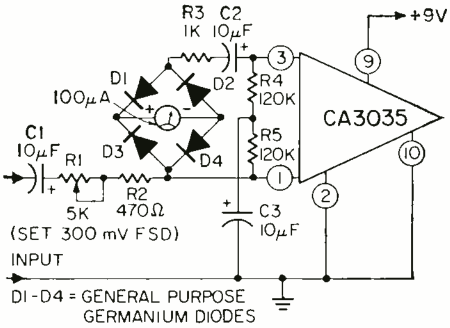


Fig. 23—High-performance ac millivoltmeter using amplifier 1 of the CA3035.

This nonlinear type of amplifier is particularly useful as an ac bridge-balance detector, in which case the output of the amplifier should be taken to the 300 mV rms range of an ac millivoltmeter. The output of an ac measuring bridge varies over very wide limits between the balanced and unbalanced states. Therefore it is necessary for the operator to frequently adjust the sensitivity of the output level indicator. But, if the bridge output is taken to the nonlinear amplifier, this sensitivity adjustment is virtually eliminated.

An interesting point about the circuit of Figure 22 is that, although it gives nonlinear voltage amplification, the magnitude of the negative feedback current through D1 and D2 is directly proportional to the magnitude of the circuits input signal. The circuit can thus be readily adapted as a high-performance ac millivoltmeter, by simply replacing D1 and D2 with a diode bridge rectifier and a 100µA meter, as shown in Figure 23.

The linearity of this ac millivoltmeter is excellent, and is typically better than 2% of full-scale deflection. In use, R1 is adjusted so that the meter reads full scale with 300 mV rms input signal applied. The circuit then gives a typical input resistance of about 2000 ohms, and gives meter readings that are within ±2 dB over the frequency range 10 Hz to 5MHz. The effective sensitivity of the basic millivoltmeter can, of course, be increased by wiring a ×10 or ×100 preamplifier between the input signal and the input of the millivoltmeter.

Figure 24 shows how the circuits of Figs. 22 and 23 can be combined to form a practical bridge-balance detector that gives a visual readout on a 100-µA meter. Here, amplifier 1 (between pins 1 and 3) is used as the semi-log amplifier, and amplifier 2 (between pins 4 and 5) is used as the ac millivoltmeter. The circuit needs an input of roughly 300 mV rms for a full-scale meter reading, and about 300 µV rms for 1/20th of full scale.

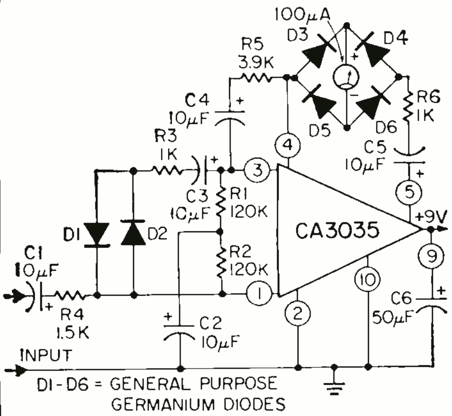


Fig. 24—Bridge-null detector made by combining circuits in Figs. 22 and 23.

Miscellaneous projects

In this final section of this story, we present a number of miscellaneous applications of the CA3035. The projects described range from a simple white-noise generator, to sine-wave oscillators and tone-selective amplifiers and switches.

Figure 25 shows a simple white-noise generator. Its output consists of a totally

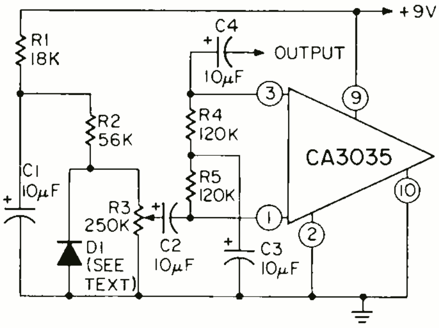


Fig. 25—White-noise generator using back-biased diode and amplifier 1.

random and constantly varying mixture of audio signals; the output amplitude of each individual signal frequency varies at random, but the mean amplitude of the mixed white-noise output is about 100 mV rms. The unit forms a useful signal source for use in special-effects musical instruments. White-noise is a basic ingredient of 'science fiction' types of music.

Circuit operation is quite simple. Germanium diode D1 is reverse biased via R1 and R2. The instantaneous reverse currents of a diode vary in a completely random manner (even though the mean reverse current is quite stable), so a low-level white-noise signal is developed at D1 cathode. Part of this signal is tapped off by R3 and is fed to the high-impedance input of amplifier 1, where it is amplified by about 44 dB, to be finally made available, at a low-impedance level, at a mean amplitude of about 100 mV r.m.s at output pin 3.

All germanium diodes generate white-noise; the mean amplitude of the generated signal is, however, roughly proportional to the diodes mean leakage current, so sub-standard diodes make the best generators. When building this project, therefore, it is recommended that you obtain a small selection of germanium diodes (of the type found in bargain

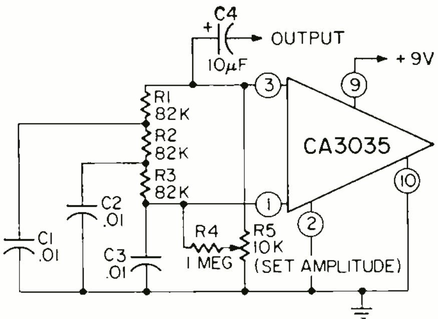


Fig. 26—Phase-shift oscillator. Frequency is 1 kHz with values shown.

packs from mail-order houses), and then try a number of them in the D1 position until one is found that gives a really good output. If the selected diode gives a very high output, adjust R3 to reduce the pin 3 output level to about 100 mV rms. If the selected diode gives a maximum mean output of about 100 mV rms, R3 can be eliminated from the circuit and C2 can be taken directly to the D1-R2 junction.

Amplifier 1 can be connected as a fixed-frequency phase-shift sine-wave generator as in Figure 26. Resistors R1, R2 and R3 act as biasing resistors, and also, together with C1, C2 and C3, as frequency-selective phase-shifting components. The circuit gives a low-impedance output at an amplitude of about 600 mV rms, at roughly 1 kHz. The precise frequency depends on the setting of amplitude control R5. When using the unit, set R5 so the output signal is *slightly* distorted when viewed on a scope. The output amplitude will then be stable with variations in operating temperature and output loading.

Amplifier 1 connected as a twin-T sine-wave generator, is shown in Figure 27. The frequency selective network is

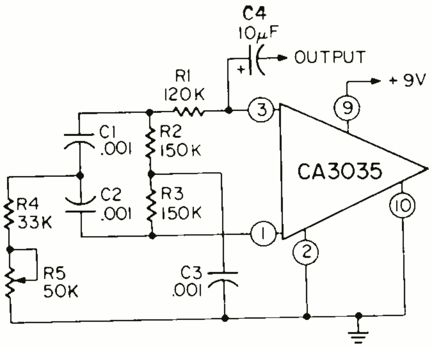


Fig. 27—Twin-T oscillator with output frequency of around 1 kHz. C3 is .002.

made up of R2, R3, R4 and R5 and C1, C2 and C3. The network is effectively driven from a constant-current source via R1, and the circuit oscillates only when R5 is reduced below a critical value. The circuit oscillates at about 1 kHz, and gives a low-impedance output at an amplitude of about 600 mV rms. An excellent sine wave is generated when R5 is adjusted so that oscillation only just starts, and the generated signal is quite stable with variations in ambient temperature and output loading.

Figure 28 shows how amplifier 1 can be used as a narrow-band tone selective amplifier, using Twin-T components R2, R3 and R4 and C2, C3 and C4. The cir-

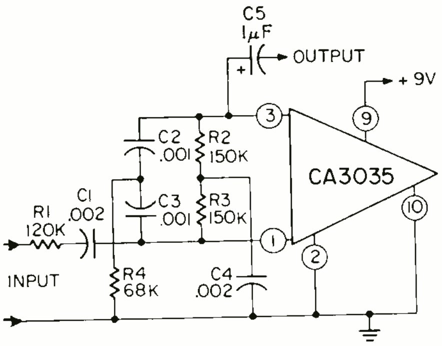


Fig. 28—Narrow-band selective amplifier, Using twin-T components.

cuit has characteristics similar to those of an L-C tuned amplifier with a Q of about 40. With the component values

(continued on page 96)

In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

WHO SPIKED THE COLOR?

THE PICTURE ON THE G.E. KD COLOR set chassis looked very odd, as though someone had thrown the colors at the screen or sprayed them on. A color-bar pattern showed a distinct smearing from one bar into the next, and a color picture had to be seen to be believed. There were color ghosts hanging out on all sides—and of all colors.

It was so bad I thought the set was out of convergence. Putting a crosshatch pattern on the screen cleared *that* up. It wasn't. Oh well, I didn't think it was going to be that easy anyhow. I was starting to feel pretty proud of myself for having tracked down an unusual agc trouble: No picture at all unless the agc control was completely CCW, and not much of one then. After fruitlessly checking the control for continuity and finding it good. I did the obvious thing and looked at the schematic.

The agc keyer circuit looked pretty simple at first. I checked the tube, the control, the 5.6 megohm plate resistor and the video signal on the grid with the scope. Everything was disgustingly good.

Eventually it came out. In this circuit, they are using a small positive dc voltage developed at the sound-detector diode—a sort of "dc restored" voltage for the *grid* of the agc keyer tube. This little diode was dead-shorted, upsetting agc bias!

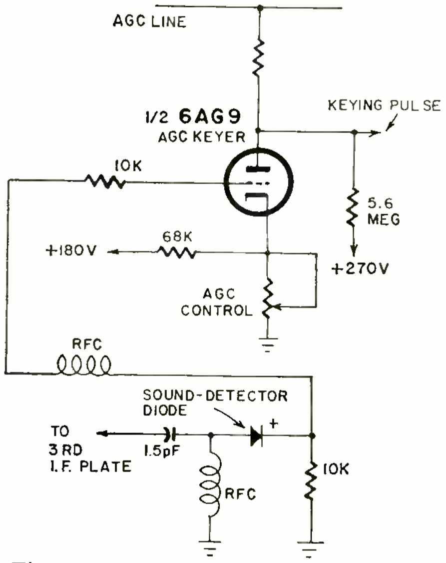


Fig. 1 above shows a partial schematic.

Anyhow, I was feeling pretty well satisfied with myself for having run this one down, and now here's

(continued on page 95)

Service Clinic

By **JACK DARR**
SERVICE EDITOR

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.

Hybrid tube needed

I've got an old car radio with a 12FR8 tube in it, or, I should say, out of it. I can't even find it in a tube substitution book. Is there a direct replacement?—B. H., Modesto, Calif.

This is a tube used in some Bendix radios. There is no direct replacement.

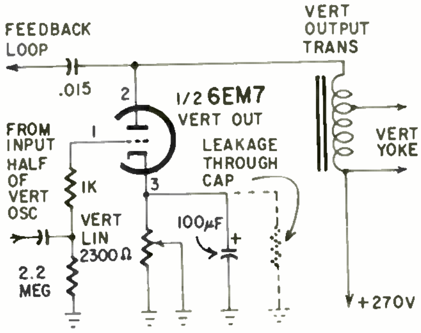
However, if you want to do the work, a 12EC8 from the same series is as near as you'll get. This is a triode-pentode, and you'll have to rewire the socket. Use a crystal diode to replace the original.

No Vertical Sweep

I've got a Curtis-Mathes 12A1 with no vertical sweep. Tube, vertical-output transformer and yoke check good: 270 volts on 6EM7 plate, 0 volts on the grid, and +45 volts on the cathode. Just a thin white line across the screen.

I jumped the heater voltage over to the grid, as you recommended once, but got no reaction. Can't figure it out!—J. G., Hatfield, Ark.

With no reaction from the substitute "signal" on the grid, the vertical output stage is completely *dead*. This normally means an open yoke or



transformer. However, since these parts are good, this must be an open *vertical-linearity control.*

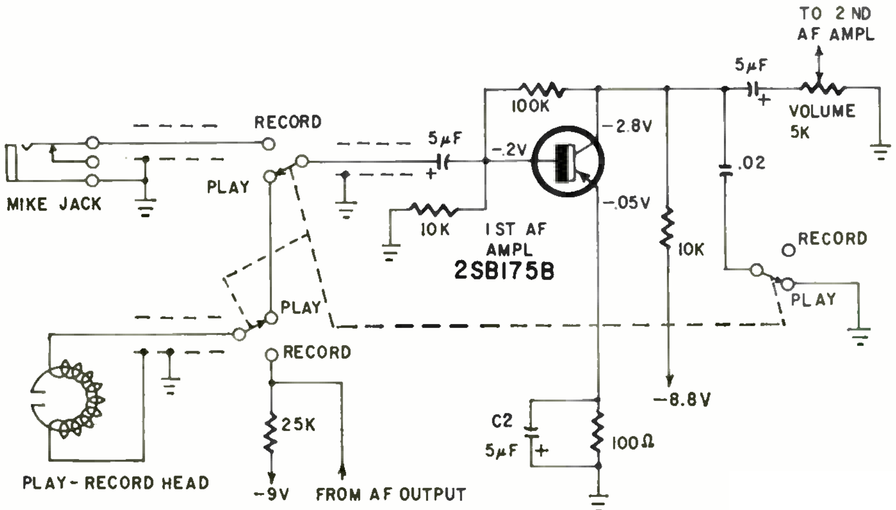
You're probably getting the dc voltage on the cathode because of a little leakage through the electrolytic cathode bypass. Replace both the capacitor and the 2300-ohm control.

Tape Recorder Distortion

I have quite a bit of distortion in a Star-Lite tape recorder on playback—probably records it, too. Voltages, etc. check out pretty close to the schematic in Sams Photofacts 592-11. Input coupling capacitor C1 doesn't seem to have any leakage. I get a sawtooth waveform across C2. Battery drain: 21mA. Any ideas?—E. F., Indianapolis, Ind.

Yep. This little recorder apparently uses dc bias. If there's an oscillator in there I can't see it. However, I don't like that "sawtooth waveform" across C2. This is the emitter bypass for the first stage, and if it's good it shouldn't have *any* waveforms across it.

An open emitter bypass will reduce the gain of a transistor amplifier and cause severe distortion. Key clue: the presence of almost the same signal voltage on both emitter *and* collector! Use the scope. (*turn page*)



Field adjustment of color afpc

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

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

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

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

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

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

Color-bar generator for use in Europe

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

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

Since they can't even agree on a set of standards for black-and-white, goodness knows what they'll wind up with in color! Your best bet would be to wait and see. Actually, the *sound* frequency would be the very least of the problems!

Circuit descriptions, schematics and construction details on color-bar generators for use in Europe have been described in such French technical magazines as *Le Haut Parleur*, *Television, Radio et Télévision, Radio Constructeur*, and *Toute l'Electronique*. You may find some of these magazines in a library in Quebec.

Drooping blue lines

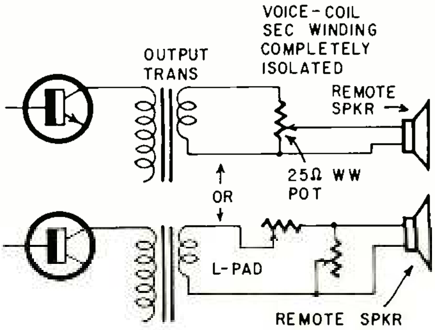
I bought an old CTC5 RCA chassis to experiment with and get color experience. I'm getting it! Works pretty well by now, but I'm having a problem with the horizontal blue lines. Can't get them straight; the blue droops, only at the left side of the screen. Any ideas?—B. L., Cedar Rapids, Iowa

This problem is likely to be in the *tilt* of the blue lines. The amplitude control varies the amount of line bowing, the tilt varies its shape. Adjust the amplitude control to maximum, then adjust the tilt control until you get the line bow in the middle of the screen. Readjust the blue amplitude, and the line should straighten out. Suggestion: you can sometimes get a "reverse" symptom in this kind of problem. Squint across the screen from the side to be sure. You may find that the red–green lines are actually the ones that bow.

Remote TV Volume Control

One of my customers wants a remote speaker with volume control on his transistor TV. Can I hook this up without damaging the output transistor? It's a Westinghouse V-2483 chassis.—R. W., Oakdale, N. Y.

Yes, if the remote control is one of the types that keep a load on the output transformer at all times—like

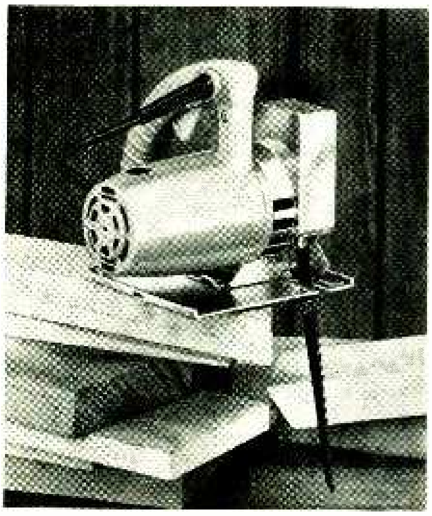


an L-pad or even a simple pot. In this chassis, the voice-coil circuit is completely isolated by the output transformer, just as in tube sets. **R-E**

NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

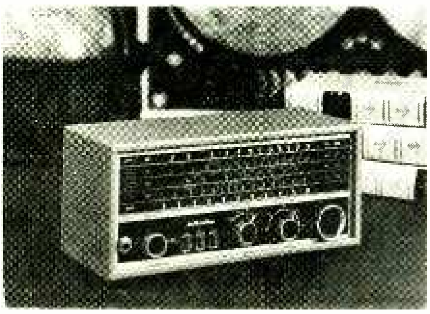
DOUBLE-INSULATED SAW, *Model 909XX,* 2-speed, uses high-impact, high-dielectric-strength, nonconductive material to give protection from shock. Cuts metal up to ½", pipe and thin-wall up to 2", as well as plastics and wood. Cuts



precision curves, circles and straight lines in 2 x 4's, 4 x 4's, and 6 x 6's. Powered by 6-amp, 110-volt universal ac motor giving 3400 1" strokes per minute. 6½ lb. $49.95. **WEN Products Inc.,** 5810 Northwest Hwy, Chicago, Ill. 60631.

Circle 46 on reader service card

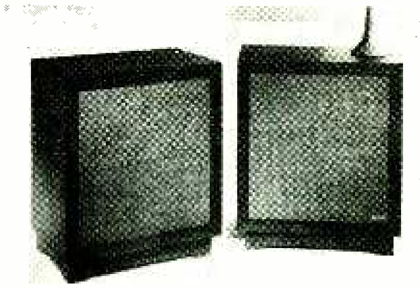
BROADCAST & SHORT-WAVE RADIO RECEIVER, *Star Quest, Table Model S-120A,* fully transistorized, covers AM (550–1600 kHz), short-wave band I (2.0–5.0 MHz), short-wave band II (4.8–11.5 MHz), short-wave band III (11.0–30.0 MHz). Has external power jack for battery such as 8 D-cells in series, 12-volt car battery or type 732 lantern battery for emergency monitor-



ing. Gives over 1 watt of push-pull audio with low distortion. Has high-sensitivity superheterodyne circuit, double antenna system, large illuminated slide-rule dial scale, bfo for listening to Morse code and single-sideband, automatic gain control. **Hallicrafters Co.,** 600 Hicks Rd., Rolling Meadows, Ill. 60008.

Circle 47 on reader service card

FLOOR SPEAKER, *The Vegas, Model M15T,* is 15" free-standing, 3-way speaker with optional base. Has removable grille cloths. $49.95 to $399. **University**



Sound, 9500 W. Reno, Box 1056, Oklahoma City, Okla. 73101.

Circle 48 on reader service card

TREASURE SEEKER KIT. *Model MD-90,* heterodyne-type metal detector is housed in rugged steel case. 2-piece aluminum handle with pick-up head molded of high-impact plastic, rubber hand grip and adjustable angle brackets. Battery, wire, solder, printed circuit board and instruction manual included. $29.95.—**Kits Industries, Inc.,** 729 Ceres Ave., Los Angeles, Calif. 90021

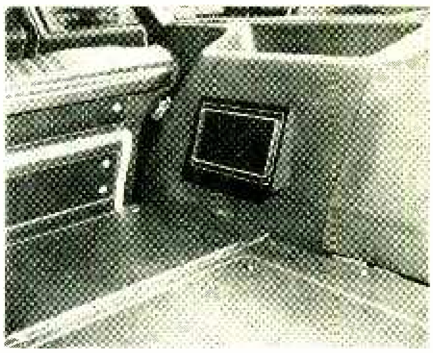
Circle 49 on reader service card

TUBE TESTER, *Mighty Mite Six, Model TC154,* uses field-effect transistors to allow technician more accuracy in tube

testing. Solid-state circuits, pushbuttons, and additional socket to check new and rarely used tubes. Brushed-steel vinyl-clad case. $89.50. **Sencore,** Addison, Ill.

Circle 50 on reader service card

CAR HI-FI SPEAKER, Poly-Planar, *Model A500,* has super-thin design requiring ⅞" mounting depth for car ceiling, kick panel, rear seat and door installation. Uses brackets for surface



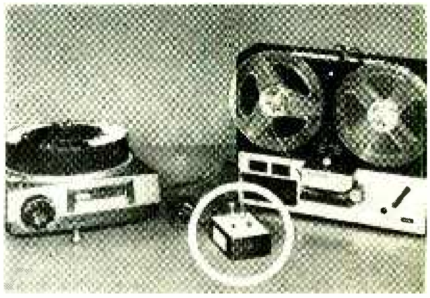
mounting or can be custom-flushed. Frequency response from 60 Hz to 20 kHz. Power capability 5 watts. Grille size, 6" x 10". Black with chrome trim. $11. **Magitran Co.,** Moonachie, N. J.

TELEPHONE AMPLIFIER, *model TA 100,* solid-state, battery-powered, portable, composed of amplifier and speaker units. Place telephone handset on cradle of amplifier with mouthpiece over "well," toward which user speaks. Turns off when phone is hung up. Six-month war-

ranty. White and harvest beige. Flyers MLA-664 and MLA-666. **RCA Parts & Accessories,** 2000 Clements Bridge Road, Deptford, N. J. 08096.

Circle 51 on reader service card

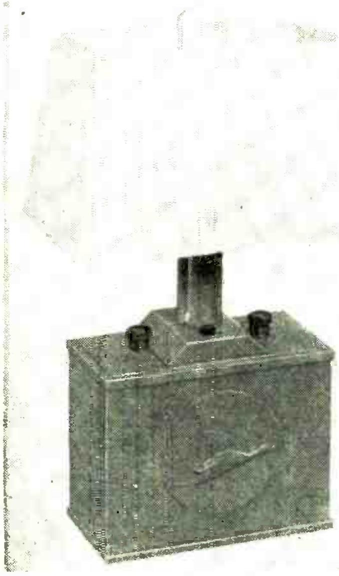
TAPE-SLIDE SYNCHRONIZER. Hook up, by audio cables, a stereo tape recorder (or monaural type with "Add-A-Track" and stereo playback) and slide



projector to synchronizer. Record in conjunction with particular slide being shown. Then hit slide-advance button on TSS (synchronizer), leaving special slide-advance signal on second channel of tape. Then, during playback, TSS changes slides automatically in coordination with recording made for that slide. To erase slide-advance cues, back the tape to point just before incorrectly positioned cue and then, with cue track channel in record mode, run tape without pressing cue button. This eliminates cue without interfering with recording. $19.95. No. 41,122. **Edmund Scientific Co.,** 380 Edscorp Bldg., Barrington, N. J. 08007.

Circle 52 on reader service card

INDOOR/OUTDOOR LIGHT, *Porta-Lite,* powered by the manufacturer's 6-volt No. 896 battery, provides 100 hours



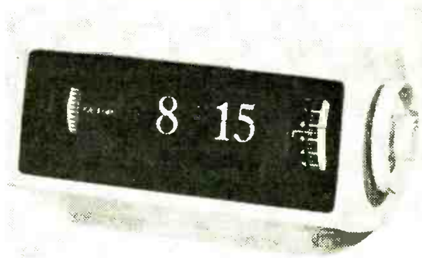
of intermittent light with No. 1651 bulb. For use during power failures, outdoors, in trailers and boats. Made from green or blue high-impact polyethylene, with hang-up loop. **Marathon Battery Co.,** P. O. Box 1246, Wausau, Wis. 54401.

FLOOR SPEAKER SYSTEM, *The President, US 5724,* has University Sound's 312 full-range, three-way, Diffaxial speaker with Diffusicone midrange and Sphericon tweeter, complemented by University's bass energizer and brilliance control. Medium-priced, Mediterranean-

style, enclosure has removable grille cloth so it can be matched to any color scheme. University offers speakers from $49.95 to $399.—**University Sound,** Box 26105, Oklahoma City, Okla. 73126.

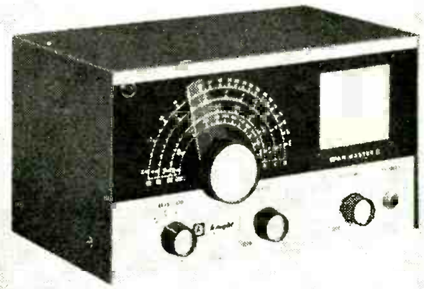
Circle 53 on reader service card

DIGITAL CLOCK, *Caslon 701,* desk/table alarm model. Can be set 24 hours ahead. Black flip cards with white numerals, internal light, Cycolac case, pre-



cision motor, 12 hours only, 117 V ac, 60 cycles. Frosty white, charcoal gray, and avocado green. Size 6 x 3 x 3½". Shipping wt. 3 lb. $30.—**Ropat-Caslon Inc.,** 5558 Centinela Ave., Los Angeles, Calif. 90066

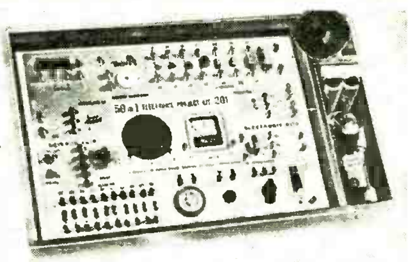
KNIGHT-KIT RECEIVER. *Spanmaster II,* four-band, shortwave-AM circuit, includes bfo. Calibrated vernier tuning, isolation power transformer for safety, fuses protect against overloads, front panel headphone jack. Bands: AM, 550–



1600 kHz; Shortwave: 1.5–4.5 MHz; 4–12 MHz; 11.5–30 MHz. Gray crackle finish steel cabinet. $29.95. **Allied Radio Corp.,** 100 N. Western Ave., Chicago, Ill. 60680

Circle 54 on reader service card

PROJECT KIT, *Science Fair,* makes over 50 battery-powered electronic circuits such as radio receivers and transmitters, test instruments, rain and burglar alarms, and tachometer circuit. Includes 2 tran-



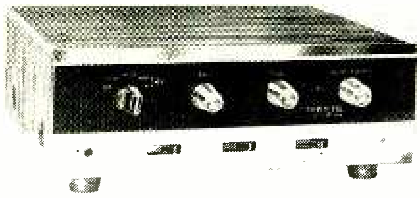
sistors and solid-state diode among over 40 parts, most mounted on large circuit board with solderless spring terminals and numbered parts connections. $17.95. Cat. No. 28-201. **Radio Shack,** 730 Commonwealth Ave., Boston, Mass. 02215.

Circle 55 on reader service card

STEREO AMPLIFIER, *Model LA-324,* solid-state, offers medium power (50 watts ±1 db, 40 watts IHF). Power bandwidth 35–30,000 Hz. Frequency response ±1.5 db 20–20,000 Hz. Channel separation 60 dB at 1 kHz. Hum and noise: Tuner and aux., −75 dB; mag phono, −60 dB; ceramic phono, −55 dB. Input sensitivity: Aux., 250

Circle 106 on reader service card

mV; tuner, 500 mV.; mag. phono, 2.3 mV.; ceramic phono, 80 mV. Speaker impedance: 4, 8, 16 ohms; headphone, 8 ohms. Controls: Concentric volume/balance, treble and bass, input selector, mono/stereo, remote/main speakers, and power on/off. Included are 18 transis-



tors, 4 diodes and 2 thermistors. Housed in simulated walnut vinyl-clad metal case with attractive black and brushed anodized aluminum front panel. For 105-120-V, 50/60-Hz ac with power fuse. $59.95. Stock No. 99-02206 WX. —**Lafayette Radio Electronics**, 111 Jericho Turnpike, Syosset, N. Y. 11791

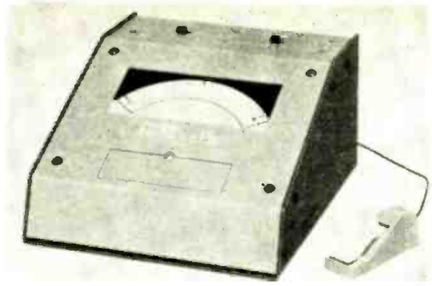
Circle 56 on reader service card

TUNER LUBRICANT, *Tun-O-Foam,* maintains lubricity from —40°F to 290°F. Clings to contacts, foams away dirt and corrosion, is nonabrasive, and cannot cause detuning. Replaces hydrocarbon structure in ordinary lubricants with syn-

thetic element. Especially effective on silver and gold-plated contacts. Six-month no-callback guarantee. 8-oz aerosol can. $2.39. **Chemtronics, Inc.**, 1260 Ralph Ave., Brooklyn, N. Y. 11236.

Circle 57 on reader service card

DARKROOM COMPUTER, *"Fotoval II," model PM-18,* determines paper grade and exposure for b & w prints. Put negative in enlarger, make 2 readings with exposure probe, adjust enlarging lens diaphragm, expose for indicated time and develop. Kit $62.00. Wired version, *model PMW-18,* $92.00. Probe for con-



version to color work will soon be available. **Heath Co.**, Benton Harbor, Mich. 49022.

Circle 58 on reader service card

ELECTRONIC SPRAY CHEMICALS. Cleaners, coolers, lubricants, insulators, and protectors for use in servicing TV, radio, record players, tape recorders,

computers, office machines, and broadcasting equipment. Six-month dealer/distributor warranty protects against defects. **RCA, Parts & Accessories**, Deptford, N. J. 08096.

Circle 59 on reader service card

TRIPOD, *Model T-2*, for CCTV cameras and viewfinders, provides 360° pan and ±90° tilt. Turntable rotates 360°. Adjustable from 27" to 69" high with telescoping legs and elevator column. Legs have

spikes (for outdoor use), rubber tips for indoor use. Anodized aluminum. Camera plate, 6½" x 8½". 5½ lb. $59.50. **CBC Closed Circuit TV Corp.**, 74 5th Ave., N.Y. **R-E**

Circle 60 on reader 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 81 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

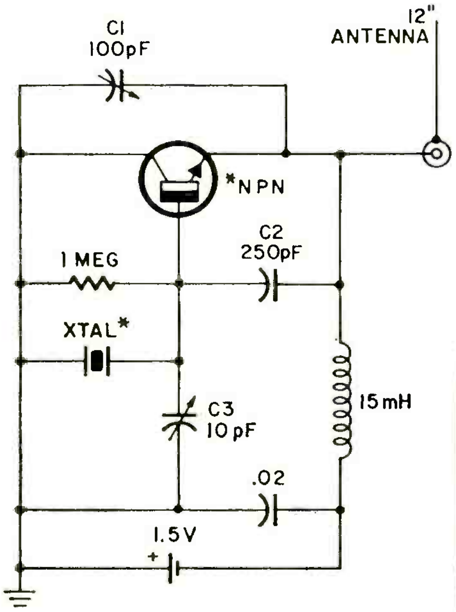
CAPACITOR REPLACEMENT guide. *The Replacers*, lists units in *Re-Place* capacitor replacement center, giving enough stock not too costly or too large to maintain. Features wide-range twist-prong listing having only 248 units covering same applications of 2000 competitive units. Included are wide-range tubular line, miniature electrolytics, dipped paper Mylar, ceramic disc, dipped mica, and wax-filled capacitors. Marketing Service Dept., **Cornell-Dubilier Electronics**, 50 Paris St., Newark, N. J. 07101.

READOUT CATALOG SHEET *S-181* offers data on six incandescent and neon modules for 6, 10, 14-16 and 24-28 volts, all ac-dc plus 150-160 Vdc and 110-125-Vac circuits. Specs are given for numeric readouts having ¾" and 11/32" high characters and auxiliary caption modules. Data on display capability of each module, maps used, accessories, dimensions, converters and translator-driver also provided.—Write to **Dialight Corp.**, 60 Stewart Ave., Brooklyn, N. Y. 11237 **R-E**

NOTEWORTHY CIRCUITS

CRYSTAL-OSCILLATOR CIRCUIT

A number of us have quartz crystals—of the frequency standard type, etc.—which have been ground to operate in the parallel-resonant mode. This means they must be connected in a high-impedance circuit, if they are to function properly. Vacuum tubes supplied this high impedance. but similar circuits using transistors flunked out miserably. The circuit shown in the diagram, however, uses a transistor yet operates the crystal at a high impedance. The original model, constructed some 8 years ago, employs a 200-kHz crystal, and with a 12-inch length of busbar wire as the antenna, it put out harmonics at sufficient intensity to permit checking the dial calibration of table-model radio receivers at 600, 1000, and 1400 kHz. Since these signals were supplied simultaneously, several receivers could be checked by as many individual checkers at the same time.



*SEE TEXT

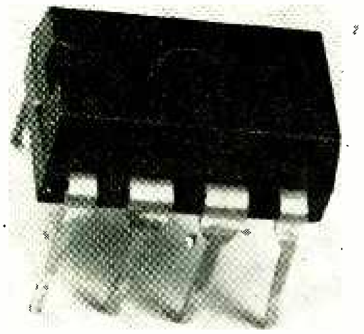
Component values given on the diagram are for the 200-kHz crystal, but with suitable substitutions in these values the circuit can be made to function equally well at any other desired frequency that is well within the upper limit of the transistor. Capacitors C1 and C2 supply feedback at the phase needed for sustained oscillation. Capacitor C1 was made variable to adjust the drive. This control also functions as a coarse frequency adjustment. C3 is the fine frequency control. These adjustments were made at the time the unit was put into operation initially, and for the purpose intended, required no adjustment thereafter. The transistor in the original model is a 2N168-A. Almost any transistor used for mixer-oscillator service can be substituted.

A further advantage of this circuit is that one side of the crystal, one side of the two variable capacitors, and one terminal of the power supply (the dry cell) are at ground potential. This not only makes construction easy, it also assures more stable operation. The unit consumed only 15 to 20 μA, and with the smallest dry cell available supplying the power, the unit was operated 24 hours a day, 365 days a year, continuously. The cell was changed at about yearly intervals.

The oscillator can be emitter modulated at audio frequency by applying the modulation signal in series with the dry cell. This signal should, of course, come from a fairly low-impedance source. An increase in frequency of a few Hz occurs when modulation is applied.—*Frank H. Tooker* **R-E**

NEW MINI PACK FOR POPULAR IC

The Fairchild μA741—successor to the μA709—is now being marketed in a Mini-DIP package which is only half the size of a standard 14-lead dual-in-line pack. The Mini-DIP features compact solid-block plastic construction with eight leads, all of them functional. This saves space and permits two μA741's to be plugged into a standard 16-pin DIP socket.



The new package measures 0.393 inch long, 0.256 inch wide and 0.150 inch high (excluding leads). The μA741 is an improvement on the μA709 in that it has such added features as latch-up protection, internal frequency compensation, offset adjustment control, low power consumption, input overdrive and short-circuit protection. The cost is $4.85 each for 1–24 quantities.

NEW TUBES AND

VVC TUNING DIODES

The SQ1716–SQ1750, 1N5461-A–1N5476-A and 1N5441-A–1N-5456-A make up three series of voltage-variable capacitance (VVC) diodes designed for electronic tuning, afc and harmonic generator applications. These diodes, made by MSI, are 400 mW units housed in DO-7 cases and have a maximum working voltage of 30 volts dc.

Series SQ diodes have nominal capacitances (with 4 volts reverse bias) ranging from 3 to 100 pF, tuning ratios of 2.40–3.00 Q's at $V_R=4$ volts and 50 mHz range from a minimum of 1200 for the 3-pF SQ1716 to 300 for the 100-pF SQ1750.

For the 1N series, minimum and maximum tuning ratios vary from 2.7 to 3.3. Capacitances at −4V range from 6.8 to 100 pF. The 1N5461–1N-5476 series has Q's ranging from 600 for the 6.8-pF unit to 200 for the 100-pF diode. Q's for the 1N5440–1N-5456 are somewhat lower. Nominal tolerance is 10%. Suffixes B and C indicate tolerances of 5% and 2%, respectively. For additional information on these VVC's, drop a line to MSI Electronics, 34-32 57th Street, Woodside, N.Y. 11377.

SEMICONDUCTORS

FAST-SWITCHING PNP TRANSISTORS

Two high-speed pnp transistor switches (the 2N5455 and 2N5456) are designed for a variety of saturated and nonsaturated switching applications. These Fairchild devices have a turn-on time of 20 nanoseconds maximum and a turn-off time of 30 nsec at 30 mA. Switching times are excellent over a range from 10 nA to 500 mA.

Housed in metal TO-52 cans, these transistors also features high-frequency operation (450 MHz at 30 mA) and low capacitance (6.0 pF max at 10 volts). The 2N5455 operates at up to 15 volts and the 2N-5456 handles up to 25 volts. In addition, the 2N5455 can sustain a collector saturation voltage of 0.5 volt at 300 mA: the 2N5456 a V_{CE} of 0.55 volt.

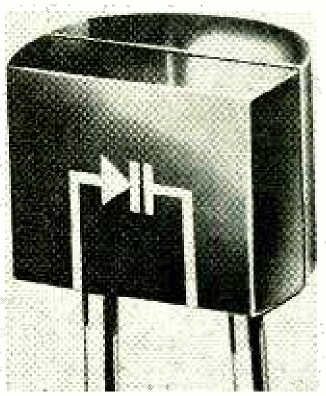
The 2N5455 is a complement to the 2N3013; the 2N5456 is a complement to the 2N3014.

Besides being suitable for complementary switching applications, these transistors can be used as rf oscillators up to several hundred MHz, as plated-wire memory drivers and in certain core-driver applications.

The 2N5455 and 2N5456 cost $4.50 and $5.40, respectively, in lots of 1 to 100. The SE2510 and SE2511, their epoxy equivalents, cost 53 and 60 cents, respectively.

PLASTIC-PACK VVC'S

Motorola's MV2101 through MV2115 are a line of silicon Epicap variable-voltage capacitance diodes in injection-molded plastic packages. They cover a range of 6.8 to 100 pF with a typical tuning ratio of 3, measured at reverse voltages of 2 and 30 volts. Minimum Q is 450, making

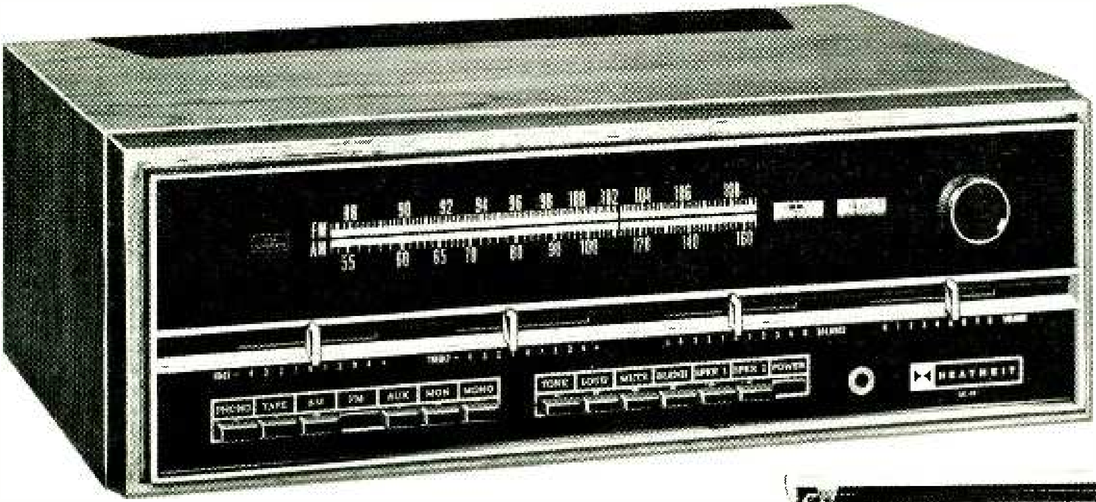


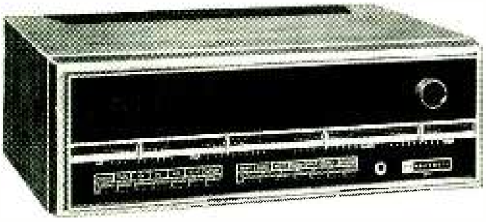
these diodes ideal for tuning and afc applications in FM and TV.

Encapsulated in two-lead TO-92 cases, these devices have a standard tolerance of 10%. Price is 60 cents in quantities of 100 to 999. **R-E**

More New Kits From

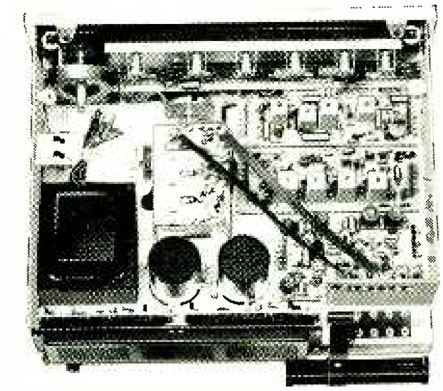
Introducing The Advanced New Heathkit 60-Watt AM/FM/FM Stereo Receiver





Heathkit AR-19

$225.00*



Third In The New Generation Of Superb Solid-State Receivers From Heath . . . And Low In Cost

• Advanced solid-state circuitry with 108 transistors, 45 diodes and 5 integrated circuits • 60 watts music power output at 8 ohms • Less than 0.25% Harmonic & IM Distortion at any power level • Frequency response from 6 to 35,000 Hz • Direct-coupled, transformerless outputs for lowest distortion and phase shift • Dissipation-limiting circuitry protects outputs from damage even with a short circuit • Assembled, aligned FET FM tuner has 2.0 uV sensitivity to give you more listenable stations • Ball-bearing inertia flywheel tuning for smooth, accurate station selection • Preassembled, factory aligned FM IF circuit board speeds assembly and eliminates IF alignment, gives 35 dB selectivity • Multiplex IC circuit provides inherent SCA rejection • Pushbutton Mute control attenuates between-station FM noise • Blend control reduces on-station FM noise with a push of a button • Tone-flat pushbutton disables bass & treble controls for perfectly "flat" response • New linear motion controls for volume, balance, bass & treble • Individually adjustable level controls for each input including tape monitor eliminate annoying volume changes when switching sources • Switches for two separate stereo speaker systems for stereo sound in two different locations • Center channel speaker capability • Two front panel tuning meters give exact station selection • Stereo indicator light • Front panel stereo headphone jack • 300 & 75 ohm FM antenna inputs • High fidelity AM reception • Built-in AM rod antenna swivels for best reception • Massive power supply includes section of electronically regulated power • New Heath modular plug-in circuit board design speeds assembly, aids servicing • Built-in Testing facilities aids construction, simplifies servicing • Circuit board & wiring harness construction for easy, enjoyable 25 hour assembly

Ahead of its time . . . those who want to hear stereo high-fidelity as it will sound in the 70's can begin right now, at a modest price, with the Heathkit AR-19. Its design is an extension of the advanced circuitry concepts first introduced in the AR-15. These receivers are truly of a new generation . . . they've expanded audio engineering horizons and set the pace for the 70's.

Field Effect Transistor And Integrated Circuit Design. The AR-19 uses advanced semi-conductor circuitry . . . including five integrated circuits, with a total of 108 transistors and 45 diodes. The pre-assembled FM tuning unit uses an RF field effect transistor to provide high sensitivity and low cross modulation with no overloading on strong local stations. In the AM RF circuit also, field effect transistors give superior sensitivity and large signal handling capacity.

Ideal For Most Home Stereo Installations. The AR-19 is just right for the medium and high efficiency speaker systems that are so popular today. It can form the nucleus of a fine stereo system . . . and will probably be the most attractive part, thanks to its rich oiled pecan wood cabinet and to the "Black Magic" front panel. The scale and dial readings appear only when the power is on.

Features To Aid The Kit Builder. All 8 circuits of the AR-19 snap in and out in seconds. Think of the resulting convenience and ease of assembly! In addition, the AR-19 has built-in test circuitry . . . two test probes with the front panel meter for indications. With it, the user can check out circuit parts without the need for expensive external test equipment. Proper use of this feature is fully covered in the manual.

Don't Wait For Something Better To Come Along . . . it'll be a long wait. Up-grade your stereo system now, with this outstanding receiver value.

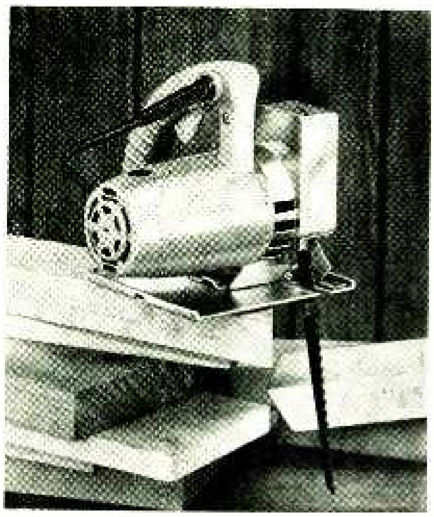
Kit AR-19, 29 lbs. **$225.00***
Assembled AE-19, cabinet, 10 lbs. **$19.95***

PARTIAL AR-19 SPECIFICATIONS — AMPLIFIER: Continuous power output per channel: 20 watts, 8 ohms. **IHF Power output per channel:** 30 watts, 8 ohms. **Frequency response:** (1 watt level) —1 dB, 6 Hz —35 kHz. **Power bandwidth for constant 0.25% THD:** Less than 5 Hz to greater than 30 kHz. **Harmonic distortion:** Less than 0.25% from 5 Hz to 20 kHz at 20 watts rms output. Less than 0.1% at 1000 Hz at 1 watt output. **IM Distortion:** Less than 0.25% with 20 watts output. Less than 0.1% at 1 watt output. **Hum and noise:** Phono input, —65 dB. **Phono input sensitivity:** 2.4 millivolts; overload, 155 millivolts. **FM: Sensitivity:** 2.0 uV, IHF. **Volume sensitivity:** Below measurable level. **Selectivity:** 35 dB. **Image rejection:** 90 dB. **IF Rejection:** 90 dB. **Capture ratio:** 2.5 dB. **Total harmonic distortion:** 1% or less. **IM Distortion:** 0.5% or less. **Spurious rejection:** —90 dB. **FM STEREO: Separation:** 35 dB at midfrequencies; 30 dB at 50 Hz; 25 dB at 10 kHz; 20 dB at 15 kHz. **Frequency response:** ±1 dB from 20-15,000 Hz. **Harmonic distortion:** 1.5% or less @ 1000 Hz with 100% modulation. 19 kHz & 38 kHz. **Suppression:** 50 dB. **SCA Suppression:** 50 dB. **AM SECTION: Sensitivity:** Using a radiating loop, 130 uV/M @ 1000 kHz. **Selectivity:** 25 dB at 10 kHz. **Image rejection:** 60 dB @ 600 kHz. 60 dB @ 1400 kHz. **IF Rejection:** 60 dB @ 1000 kHz. **Harmonic distortion:** Less than 2%. **Hum & noise:** —40 dB.

NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

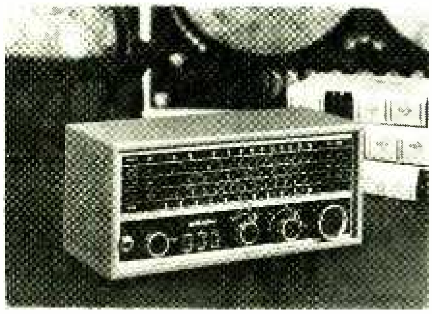
DOUBLE-INSULATED SAW, *Model 909XX,* 2-speed, uses high-impact, high-dielectric-strength, nonconductive material to give protection from shock. Cuts metal up to ½", pipe and thin-wall up to 2", as well as plastics and wood. Cuts



precision curves, circles and straight lines in 2 x 4's, 4 x 4's, and 6 x 6's. Powered by 6-amp, 110-volt universal ac motor giving 3400 1" strokes per minute. 6½ lb. $49.95. **WEN Products Inc.,** 5810 Northwest Hwy, Chicago, Ill. 60631.

Circle 46 on reader service card

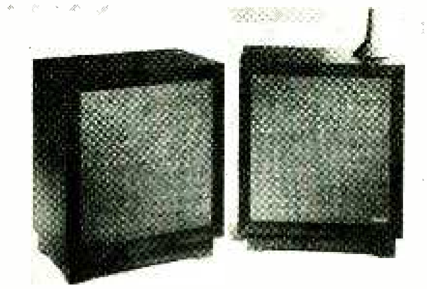
BROADCAST & SHORT-WAVE RADIO RECEIVER, *Star Quest, Table Model S-120A,* fully transistorized, covers AM (550–1600 kHz), short-wave band I (2.0–5.0 MHz), short-wave band II (4.8–11.5 MHz), short-wave band III (11.0–30.0 MHz). Has external power jack for battery such as 8 D-cells in series, 12-volt car battery or type 732 lantern battery for emergency monitor-



ing. Gives over 1 watt of push-pull audio with low distortion. Has high-sensitivity superheterodyne circuit, double antenna system, large illuminated slide-rule dial scale, bfo for listening to Morse code and single-sideband, automatic gain control. **Hallicrafters Co.,** 600 Hicks Rd., Rolling Meadows, Ill. 60008.

Circle 47 on reader service card

FLOOR SPEAKER, *The Vegas, Model M15T,* is 15" free-standing, 3-way speaker with optional base. Has removable grille cloths. $49.95 to $399. **University**



Sound, 9500 W. Reno, Box 1056, Oklahoma City, Okla. 73101.

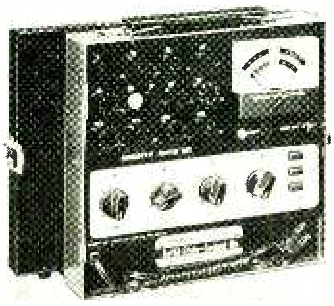
Circle 48 on reader service card

TREASURE SEEKER KIT. *Model MD-90,* heterodyne-type metal detector is housed in rugged steel case. 2-piece aluminum handle with pick-up head molded of high-impact

plastic, rubber hand grip and adjustable angle brackets. Battery, wire, solder, printed circuit board and instruction manual included. $29.95.—**Kits Industries, Inc.,** 729 Ceres Ave., Los Angeles, Calif. 90021

Circle 49 on reader service card

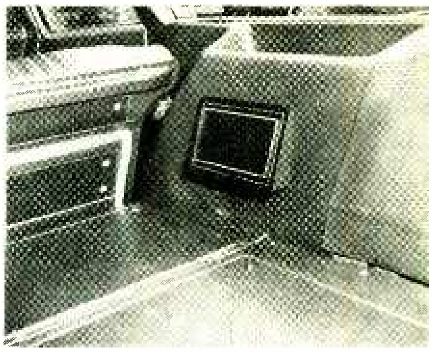
TUBE TESTER, *Mighty Mite Six, Model TC154,* uses field-effect transistors to allow technician more accuracy in tube



testing. Solid-state circuits, pushbuttons, and additional socket to check new and rarely used tubes. Brushed-steel vinyl-clad case. $89.50. **Sencore,** Addison, Ill.

Circle 50 on reader service card

CAR HI-FI SPEAKER, Poly-Planar, *Model A500,* has super-thin design requiring ⅞" mounting depth for car ceiling, kick panel, rear seat and door installation. Uses brackets for surface



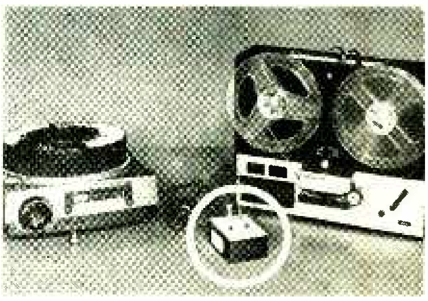
mounting or can be custom-flushed. Frequency response from 60 Hz to 20 kHz. Power capability 5 watts. Grille size, 6" x 10". Black with chrome trim. $11. **Magitran Co.,** Moonachie, N. J.

TELEPHONE AMPLIFIER, *model TA 100,* solid-state, battery-powered, portable, composed of amplifier and speaker units. Place telephone handset on cradle of amplifier with mouthpiece over "well," toward which user speaks. Turns off when phone is hung up. Six-month war-

ranty. White and harvest beige. Flyers MLA-664 and MLA-666. **RCA Parts & Accessories,** 2000 Clements Bridge Road, Deptford, N. J. 08096.

Circle 51 on reader service card

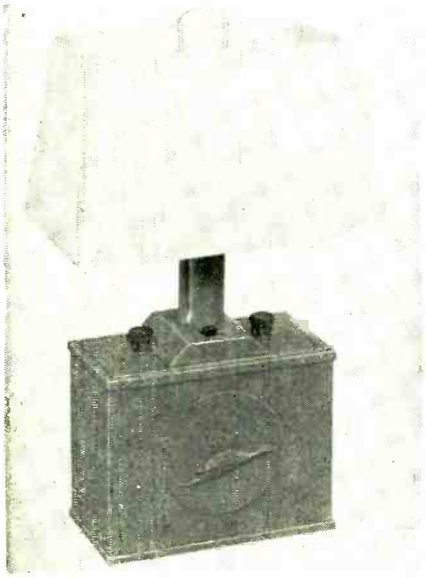
TAPE-SLIDE SYNCHRONIZER. Hook up, by audio cables, a stereo tape recorder (or monaural type with "Add-A-Track" and stereo playback) and slide



projector to synchronizer. Record in conjunction with particular slide being shown. Then hit slide-advance button on TSS (synchronizer), leaving special slide-advance signal on second channel of tape. Then, during playback, TSS changes slides automatically in coordination with recording made for that slide. To erase slide-advance cues, back the tape to

point just before incorrectly positioned cue and then, with cue track channel in record mode, run tape without pressing cue button. This eliminates cue without interfering with recording. $19.95. No. 41,122. **Edmund Scientific Co.**, 380 Edscorp Bldg., Barrington, N. J. 08007.
Circle 52 on reader service card

INDOOR/OUTDOOR LIGHT, *Porta-Lite*, powered by the manufacturer's 6-volt No. 896 battery, provides 100 hours

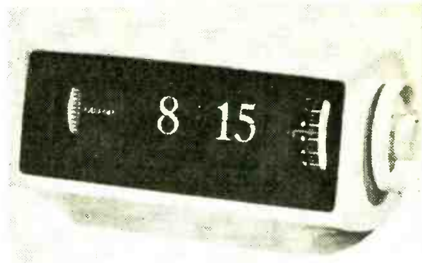


of intermittent light with No. 1651 bulb. For use during power failures, outdoors, in trailers and boats. Made from green or blue high-impact polyethylene, with hang-up loop. **Marathon Battery Co.**, P. O. Box 1246, Wausau, Wis. 54401.

FLOOR SPEAKER SYSTEM, *The President, US 5724*, has University Sound's 312 full-range, three-way, Diffaxial speaker with Diffusicone midrange and Sphericon tweeter, complemented by University's bass energizer and brilliance control. Medium-priced, Mediterranean-

style, enclosure has removable grille cloth so it can be matched to any color scheme. University offers speakers from $49.95 to $399.—**University Sound**, Box 26105, Oklahoma City, Okla. 73126.
Circle 53 on reader service card

DIGITAL CLOCK, *Caslon 701*, desk/table alarm model. Can be set 24 hours ahead. Black flip cards with white numerals, internal light, Cycolac case, pre-

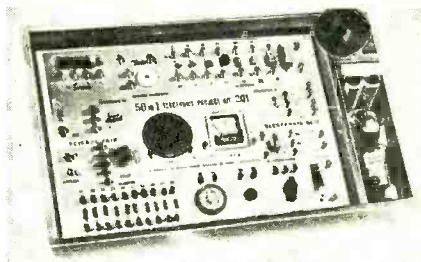


cision motor, 12 hours only, 117 V ac, 60 cycles. Frosty white, charcoal gray, and avocado green. Size 6 x 3 x 3½". Shipping wt. 3 lb. $30.—**Ropat-Caslon Inc.**, 5558 Centinela Ave., Los Angeles, Calif. 90066

KNIGHT-KIT RECEIVER, *Spanmaster II*, four-band, shortwave-AM circuit, includes bfo. Calibrated vernier tuning, isolation power transformer for safety, fuses protect against overloads, front panel headphone jack. Bands: AM, 550–

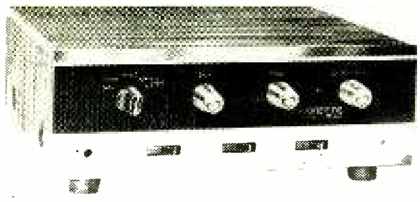
1600 kHz; Shortwave: 1.5–4.5 MHz; 4–12 MHz; 11.5–30 MHz. Gray crackle finish steel cabinet. $29.95. **Allied Radio Corp.**, 100 N. Western Ave., Chicago, Ill. 60680
Circle 54 on reader service card

PROJECT KIT, *Science Fair*, makes over 50 battery-powered electronic circuits such as radio receivers and transmitters, test instruments, rain and burglar alarms, and tachometer circuit. Includes 2 tran-



sistors and solid-state diode among over 40 parts, most mounted on large circuit board with solderless spring terminals and numbered parts connections. $17.95. Cat. No. 28-201. **Radio Shack**, 730 Commonwealth Ave., Boston, Mass. 02215.
Circle 55 on reader service card

STEREO AMPLIFIER, *Model LA-324*, solid-state, offers medium power (50 watts ±1 db, 40 watts IHF). Power bandwidth 35–30,000 Hz. Frequency response ±1.5 db 20–20,000 Hz. Channel separation 60 dB at 1 kHz. Hum and noise: Tuner and aux., −75 dB; mag phono, −60 dB; ceramic phono, −55 dB. Input sensitivity: Aux., 250 mV; tuner, 500 mV.; mag. phono, 2.3 mV.; ceramic phono, 80 mV. Speaker impedance: 4, 8, 16 ohms; headphone, 8 ohms. Controls: Concentric volume/balance, treble and bass, input selector, mono/stereo, remote/main speakers, and power on/off. Included are 18 transis-



tors, 4 diodes and 2 thermistors. Housed in simulated walnut vinyl-clad metal case with attractive black and brushed anodized aluminum front panel. For 105-120-V, 50/60-Hz ac with power fuse. $59.95. Stock No. 99-02206 WX. —**Lafayette Radio Electronics,** 111 Jericho Turnpike, Syosset, N. Y. 11791

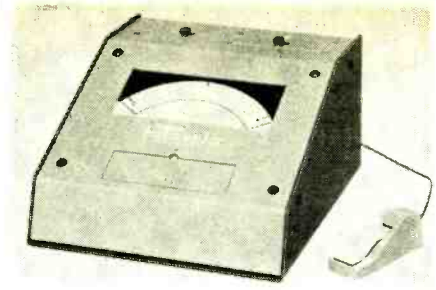
Circle 56 on reader service card

TUNER LUBRICANT, *Tun-O-Foam,* maintains lubricity from −40°F to 290°F. Clings to contacts, foams away dirt and corrosion, is nonabrasive, and cannot cause detuning. Replaces hydrocarbon structure in ordinary lubricants with syn-

thetic element. Especially effective on silver and gold-plated contacts. Six-month no-callback guarantee. 8-oz aerosol can. $2.39. **Chemtronics, Inc.,** 1260 Ralph Ave., Brooklyn, N. Y. 11236.

Circle 57 on reader service card

DARKROOM COMPUTER, *"Fotoval II," model PM-18,* determines paper grade and exposure for b & w prints. Put negative in enlarger, make 2 readings with exposure probe, adjust enlarging lens diaphragm, expose for indicated time and develop. Kit $62.00. Wired version, *model PMW-18,* $92.00. Probe for con-



version to color work will soon be available. **Heath Co.**, Benton Harbor, Mich. 49022.

Circle 58 on reader service card

ELECTRONIC SPRAY CHEMICALS. Cleaners, coolers, lubricants, insulators, and protectors for use in servicing TV, radio, record players, tape recorders, computers, office machines, and broadcasting equipment. Six-month dealer/distributor warranty protects against defects. **RCA, Parts & Accessories**, Deptford, N. J. 08096.

Circle 59 on reader service card

TRIPOD, *Model T-2*, for CCTV cameras and viewfinders, provides 360° pan and ±90° tilt. Turntable rotates 360°. Adjustable from 27" to 69" high with telescoping legs and elevator column. Legs have

spikes (for outdoor use), rubber tips for indoor use. Anodized aluminum. Camera plate, 6½" x 8½". 5½ lb. $59.50. **GBC Closed Circuit TV Corp.**, 74 5th Ave., N.Y. R-E

Circle 60 on reader 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 81 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

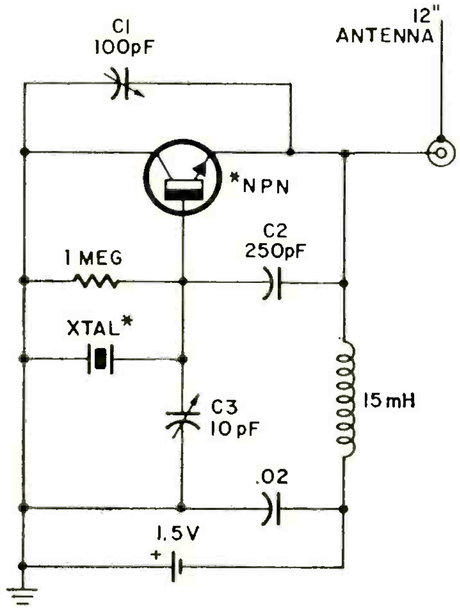
CAPACITOR REPLACEMENT guide. *The Re-placers*, lists units in *Re-Place* capacitor replacement center, giving enough stock not too costly or too large to maintain. Features wide-range twist-prong listing having only 248 units covering same applications of 2000 competitive units. Included are wide-range tubular line, miniature electrolytics, dipped paper Mylar, ceramic disc, dipped mica, and wax-filled capacitors. Marketing Service Dept., **Cornell-Dubilier Electronics**, 50 Paris St., Newark, N. J. 07101.

READOUT CATALOG SHEET *S-181* offers data on six incandescent and neon modules for 6, 10, 14-16 and 24-28 volts, all ac-dc plus 150-160 Vdc and 110-125-Vac circuits. Specs are given for numeric readouts having ¾" and 11/32" high characters and auxiliary caption modules. Data on display capability of each module, maps used, accessories, dimensions, converters and translator-driver also provided.—Write to **Dialight Corp.**, 60 Stewart Ave., Brooklyn, N. Y. 11237 **R-E**

NOTEWORTHY CIRCUITS

CRYSTAL-OSCILLATOR CIRCUIT

A number of us have quartz crystals—of the frequency standard type, etc.—which have been ground to operate in the parallel-resonant mode. This means they must be connected in a high-impedance circuit, if they are to function properly. Vacuum tubes supplied this high impedance, but similar circuits using transistors flunked out miserably. The circuit shown in the diagram, however, uses a transistor yet operates the crystal at a high impedance. The original model, constructed some 8 years ago, employs a 200-kHz crystal, and with a 12-inch length of busbar wire as the antenna, it put out harmonics at sufficient intensity to permit checking the dial calibration of table-model radio receivers at 600, 1000, and 1400 kHz. Since these signals were supplied simultaneously, several receivers could be checked by as many individual checkers at the same time.



*SEE TEXT

Component values given on the diagram are for the 200-kHz crystal, but with suitable substitutions in these values the circuit can be made to function equally well at any other desired frequency that is well within the upper limit of the transistor. Capacitors C1 and C2 supply feedback at the phase needed for sustained oscillation. Capacitor C1 was made variable to adjust the drive. This control also functions as a coarse frequency adjustment. C3 is the fine frequency control. These adjustments were made at the time the unit was put into operation initially, and for the purpose intended, required no adjustment thereafter. The transistor in the original model is a 2N168-A. Almost any transistor used for mixer-oscillator service can be substituted.

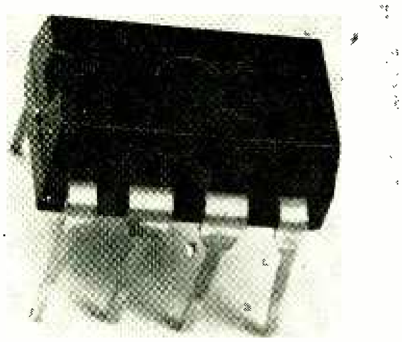
A further advantage of this circuit is that one side of the crystal, one side of the two variable capacitors, and one terminal of the power supply (the dry cell) are at ground potential. This not only makes construction easy, it also assures more stable operation. The unit consumed only 15 to 20 μA, and with the smallest dry cell available supplying the power, the unit was operated 24 hours a day, 365 days a year, continuously. The cell was changed at about yearly intervals.

The oscillator can be emitter modulated at audio frequency by applying the modulation signal in series with the dry cell. This signal should, of course, come from a fairly low-impedance source. An increase in frequency of a few Hz occurs when modulation is applied.—*Frank H. Tooker* **R-E**

Circle 110 on reader service card

NEW MINI PACK FOR POPULAR IC

The Fairchild μA741—successor to the μA709—is now being marketed in a Mini-DIP package which is only half the size of a standard 14-lead dual-in-line pack. The Mini-DIP features compact solid-block plastic construction with eight leads, all of them functional. This saves space and permits two μA741's to be plugged into a standard 16-pin DIP socket.



The new package measures 0.393 inch long, 0.256 inch wide and 0.150 inch high (excluding leads). The μA741 is an improvement on the μA709 in that it has such added features as latch-up protection, internal frequency compensation, offset adjustment control, low power consumption, input overdrive and short-circuit protection. The cost is $4.85 each for 1–24 quantities.

NEW TUBES AND

VVC TUNING DIODES

The SQ1716–SQ1750, 1N5461-A–1N5476-A and 1N5441-A–1N-5456-A make up three series of voltage-variable capacitance (VVC) diodes designed for electronic tuning, afc and harmonic generator applications. These diodes, made by MSI, are 400 mW units housed in DO-7 cases and have a maximum working voltage of 30 volts dc.

Series SQ diodes have nominal capacitances (with 4 volts reverse bias) ranging from 3 to 100 pF, tuning ratios of 2.40–3.00 Q's at $V_R=4$ volts and 50 mHz range from a minimum of 1200 for the 3-pF SQ1716 to 300 for the 100-pF SQ1750.

For the 1N series, minimum and maximum tuning ratios vary from 2.7 to 3.3. Capacitances at −4V range from 6.8 to 100 pF. The 1N5461–1N-5476 series has Q's ranging from 600 for the 6.8-pF unit to 200 for the 100-pF diode. Q's for the 1N5440–1N-5456 are somewhat lower. Nominal tolerance is 10%. Suffixes B and C indicate tolerances of 5% and 2%, respectively. For additional information on these VVC's, drop a line to MSI Electronics, 34-32 57th Street, Woodside, N.Y. 11377.

SEMICONDUCTORS

FAST-SWITCHING PNP TRANSISTORS

Two high-speed pnp transistor switches (the 2N5455 and 2N5456) are designed for a variety of saturated and nonsaturated switching applications. These Fairchild devices have a turn-on time of 20 nanoseconds maximum and a turn-off time of 30 nsec at 30 mA. Switching times are excellent over a range from 10 nA to 500 mA.

Housed in metal TO-52 cans, these transistors also features high-frequency operation (450 MHz at 30 mA) and low capacitance (6.0 pF max at 10 volts). The 2N5455 operates at up to 15 volts and the 2N-5456 handles up to 25 volts. In addition, the 2N5455 can sustain a collector saturation voltage of 0.5 volt at 300 mA: the 2N5456 a V_{CE} of 0.55 volt.

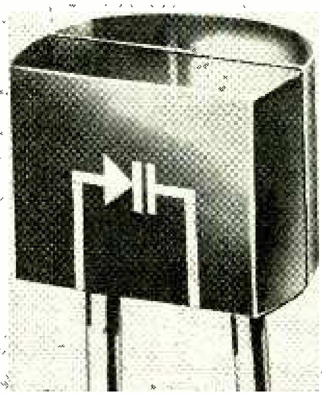
The 2N5455 is a complement to the 2N3013: the 2N5456 is a complement to the 2N3014.

Besides being suitable for complementary switching applications, these transistors can be used as rf oscillators up to several hundred MHz, as plated-wire memory drivers and in certain core-driver applications.

The 2N5455 and 2N5456 cost $4.50 and $5.40, respectively, in lots of 1 to 100. The SE2510 and SE2511, their epoxy equivalents, cost 53 and 60 cents, respectively.

PLASTIC-PACK VVC'S

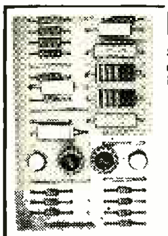
Motorola's MV2101 through MV2115 are a line of silicon Epicap variable-voltage capacitance diodes in injection-molded plastic packages. They cover a range of 6.8 to 100 pF with a typical tuning ratio of 3, measured at reverse voltages of 2 and 30 volts. Minimum Q is 450, making

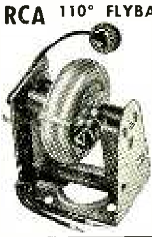


these diodes ideal for tuning and afc applications in FM and TV.

Encapsulated in two-lead TO-92 cases, these devices have a standard tolerance of 10%. Price is 60 cents in quantities of 100 to 999. **R-E**

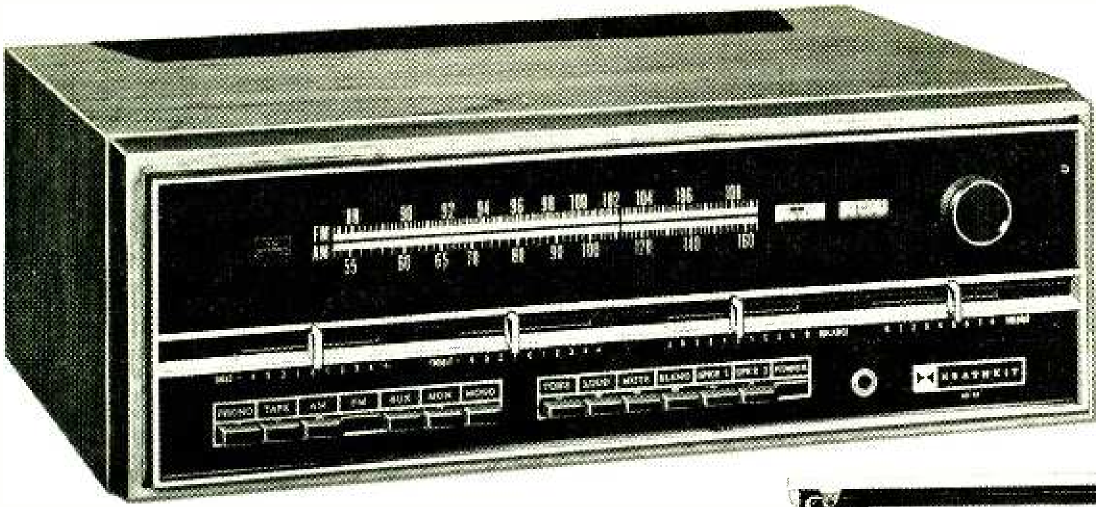
Circle 116 on reader service card

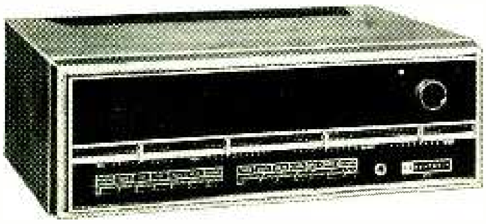




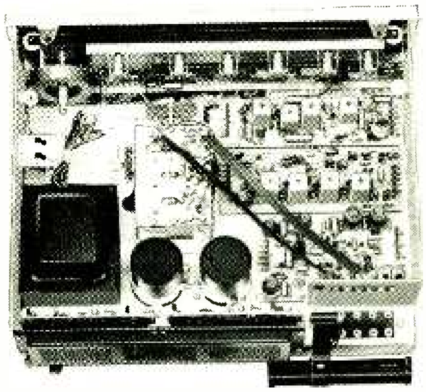
More New Kits From

Introducing The Advanced New Heathkit 60-Watt AM/FM/FM Stereo Receiver





Heathkit AR-19
$225.00*



Third In The New Generation Of Superb Solid-State Receivers From Heath . . . And Low In Cost

• Advanced solid-state circuitry with 108 transistors, 45 diodes and 5 integrated circuits • 60 watts music power output at 8 ohms • Less than 0.25% Harmonic & IM Distortion at any power level • Frequency response from 6 to 35,000 Hz • Direct-coupled, transformerless outputs for lowest distortion and phase shift • Dissipation-limiting circuitry protects outputs from damage even with a short circuit • Assembled, aligned FET FM tuner has 2.0 uV sensitivity to give you more listenable stations • Ball-bearing inertia flywheel tuning for smooth, accurate station selection • Preassembled, factory aligned FM IF circuit board speeds assembly and eliminates IF alignment, gives 35 dB selectivity • Multiplex IC circuit provides inherent SCA rejection • Pushbutton Mute control attenuates between-station FM noise • Blend control reduces on-station FM noise with a push of a button • Tone-flat pushbutton disables bass & treble controls for perfectly "flat" response • New linear motion controls for volume, balance, bass & treble • Individually adjustable level controls for each input including tape monitor eliminate annoying volume changes when switching sources • Switches for two separate stereo speaker systems for stereo sound in two different locations • Center channel speaker capability • Two front panel tuning meters give exact station selection • Stereo indicator light • Front panel stereo headphone jack • 300 & 75 ohm FM antenna inputs • High fidelity AM reception • Built-in AM rod antenna swivels for best reception • Massive power supply includes section of electronically regulated power • New Heath modular plug-in circuit board design speeds assembly, aids servicing • Built-in Testing facilities aids construction, simplifies servicing • Circuit board & wiring harness construction for easy, enjoyable 25 hour assembly

Ahead of its time . . . those who want to hear stereo high-fidelity as it will sound in the 70's can begin right now, at a modest price, with the Heathkit AR-19. Its design is an extension of the advanced circuitry concepts first introduced in the AR-15. These receivers are truly of a new generation . . . they've expanded audio engineering horizons and set the pace for the 70's.

Field Effect Transistor And Integrated Circuit Design. The AR-19 uses advanced semi-conductor circuitry . . . including five integrated circuits, with a total of 108 transistors and 45 diodes. The preassembled FM tuning unit uses an RF field effect transistor to provide high sensitivity and low cross modulation with no overloading on strong local stations. In the AM RF circuit also, field effect transistors give superior sensitivity and large signal handling capacity.

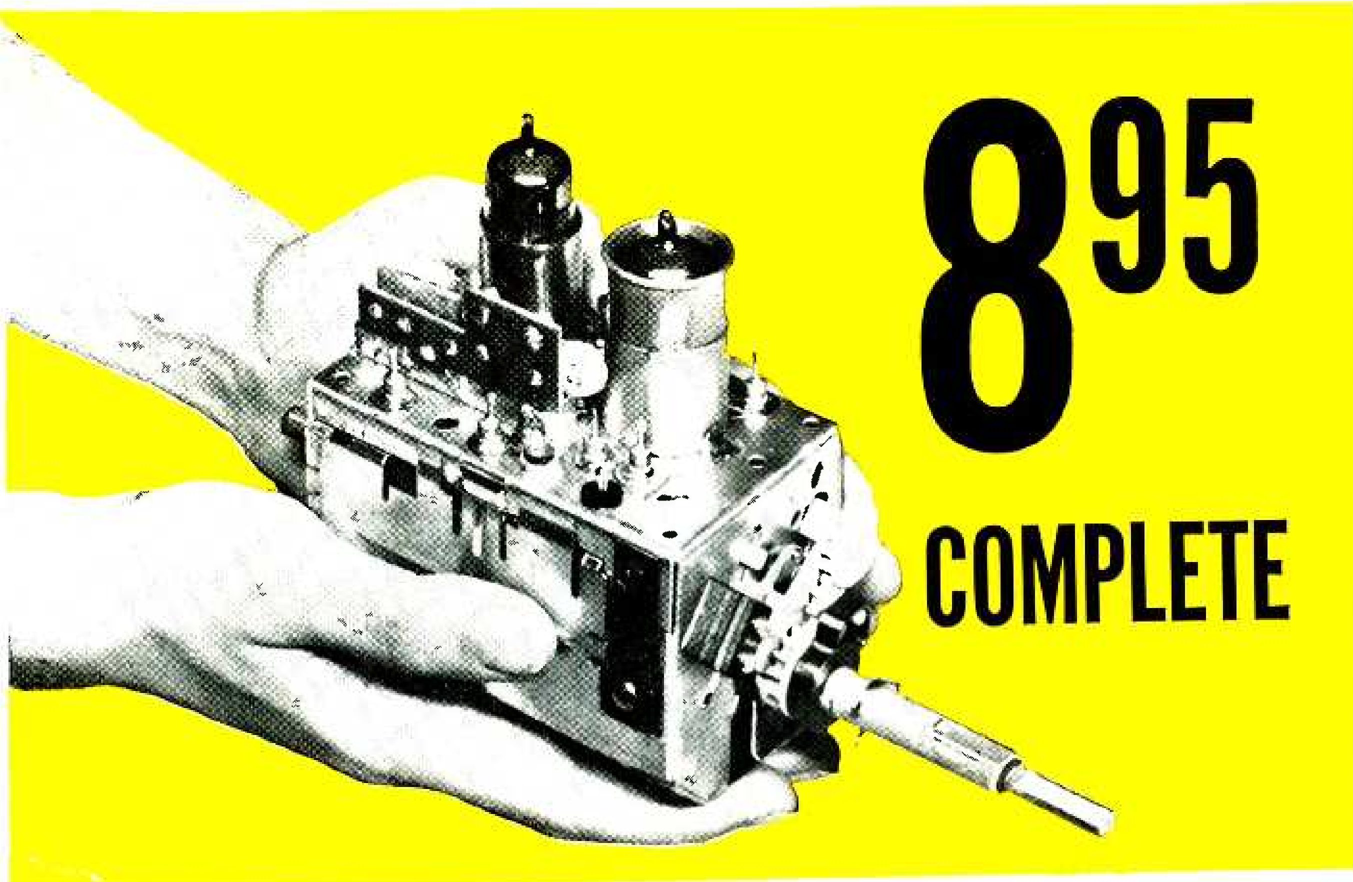
Ideal For Most Home Stereo Installations. The AR-19 is just right for the medium and high efficiency speaker systems that are so popular today. It can form the nucleus of a fine stereo system . . . and will probably be the most attractive part, thanks to its rich oiled pecan wood cabinet and to the "Black Magic" front panel. The scale and dial readings appear only when the power is on.

Features To Aid The Kit Builder. All 8 circuits of the AR-19 snap in and out in seconds. Think of the resulting convenience and ease of assembly! In addition, the AR-19 has built-in test circuitry . . . two test probes with the front panel meter for indications. With it, the user can check out circuit parts without the need for expensive external test equipment. Proper use of this feature is fully covered in the manual.

Don't Wait For Something Better To Come Along . . . it'll be a long wait. Up-grade your stereo system now, with this outstanding receiver value.

Kit AR-19, 29 lbs. **$225.00***
Assembled AE-19, cabinet, 10 lbs. **$19.95***

PARTIAL AR-19 SPECIFICATIONS — AMPLIFIER: Continuous power output per channel: 20 watts, 8 ohms. **IHF Power output per channel:** 30 watts, 8 ohms. **Frequency response:** (1 watt level) —1 dB, 6 Hz —35 kHz. **Power bandwidth for constant 0.25% THD:** Less than 5 Hz to greater than 30 kHz. **Harmonic distortion:** Less than 0.25% from 5 Hz to 20 kHz at 20 watts rms output. Less than 0.1% at 1000 Hz at 1 watt output. **IM Distortion:** Less than 0.25% with 20 watts output. Less than 0.1% at 1 watt output. **Hum and noise:** Phono input, —65 dB. **Phono input sensitivity:** 2.4 millivolts; overload, 155 millivolts. **FM: Sensitivity:** 2.0 uV, IHF. **Volume sensitivity:** Below measurable level. **Selectivity:** 35 dB. **Image rejection:** 90 dB. **IF Rejection:** 90 dB. **Capture ratio:** 2.5 dB. **Total harmonic distortion:** 1% or less. **IM Distortion:** 0.5% or less. **Spuriaus rejection:** —90 dB. **FM STEREO: Separation:** 35 dB at midfrequencies; 30 dB at 50 Hz; 25 dB at 10 kHz; 20 dB at 15 kHz. **Frequency response:** ±1 dB from 20-15,000 Hz. **Harmonic distortion:** 1.5% or less @ 1000 Hz with 100% modulation. 19 kHz & 38 kHz. **Suppression:** 50 dB. **SCA Suppression:** 50 dB. **AM SECTION: Sensitivity:** Using a radiating loop, 130 uV/M @ 1000 kHz. **Selectivity:** 25 dB at 10 kHz. **Image rejection:** 60 dB @ 600 kHz. 60 dB @ 1400 kHz. **IF Rejection:** 60 dB @ 1000 kHz. **Harmonic distortion:** Less than 2%. **Hum & noise:** —40 dB.



Castle, the pioneer of television tuner overhauling, offers the following services to solve ALL your television tuner problems.

● OVERHAUL SERVICE — All makes and models.

(1960, or later)

VHF or UHF tuner	$9.95
UHF-VHF combination (one piece chassis)	$9.95
TRANSISTOR tuner	$9.95
COLOR tuner (Guaranteed color alignment . . . no additional charge)	$9.95

Overhaul includes parts, except tubes and transistors.

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.
UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

And remember—for over a decade Castle has been the leader in this specialized field . . . your assurance of the best in TV tuner overhauling.

Remove all accessories . . . or dismantling charge will apply.

● CUSTOM REPLACEMENTS

Exact replacements are available for tuners that our inspection reveals are unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

● UNIVERSAL REPLACEMENTS

Prefer to do it yourself?

Castle universal replacement tuners are available with the following specifications.

STOCK No.	HEATERS	SHAFT Min.*	SHAFT Max.*	I.F. OUTPUT Snd.	I.F. OUTPUT Pic.	PRICE
CR6P	Parallel 6.3v	1¾″	3″	41.25	45.75	8.95
CR7S	Series 600mA	1¾″	3″	41.25	45.75	9.50
CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

These Castle replacement tuners are all equipped with memory fine tuning, UHF position with plug input for UHF tuner, rear shaft extension and switch for remote control motor drive . . . they come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

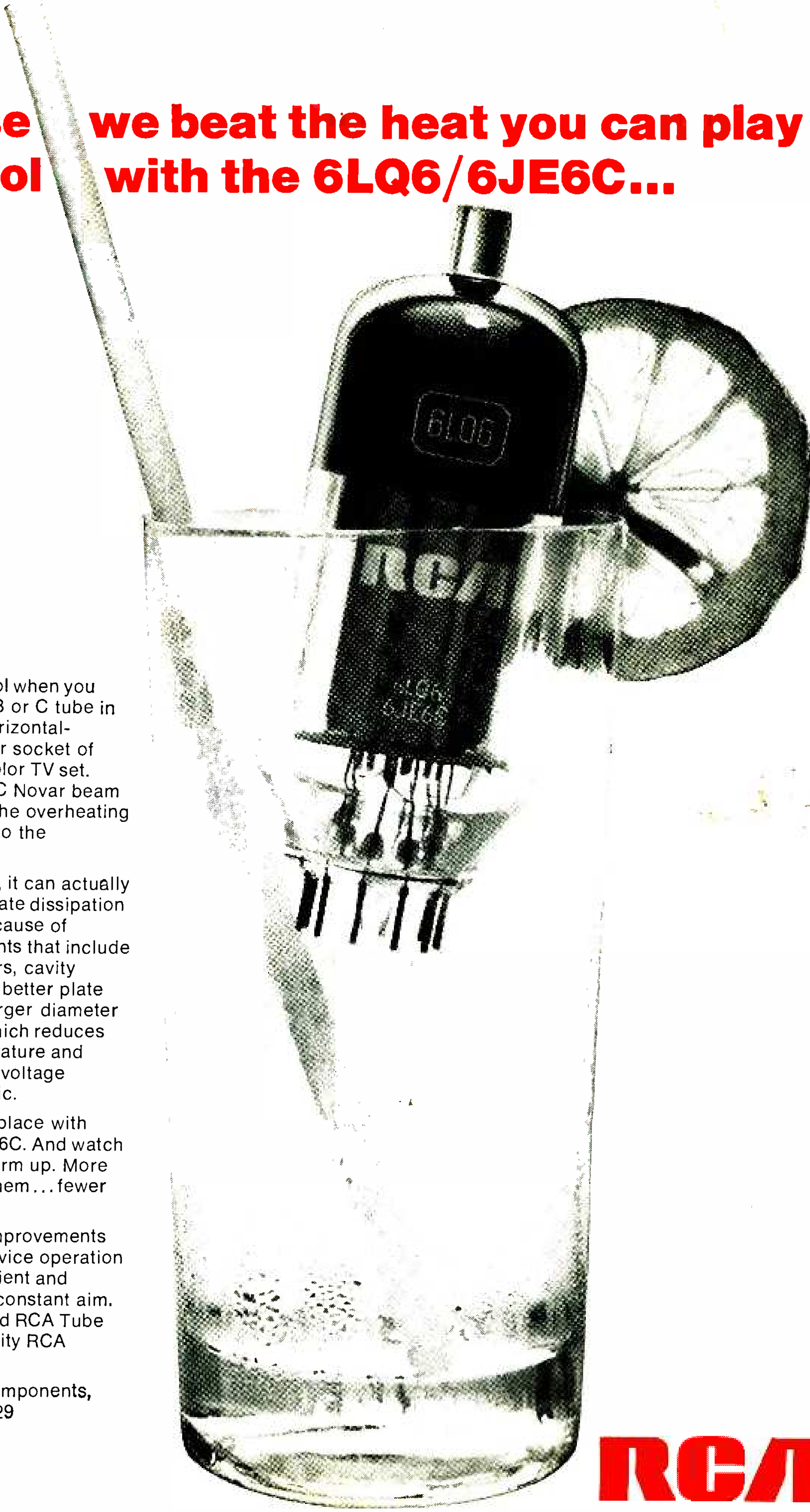
Order universal replacements out of Main Plant (Chicago) only.

CASTLE TV TUNER SERVICE, INC.

MAIN PLANT: 5715 N. Western Ave., Chicago, Illinois 60645
EAST: 41-96 Vernon Blvd., Long Island City, N.Y. 11101

Circle 142 on reader service card

Because we beat the heat you can play it cool with the 6LQ6/6JE6C...



Yes, you play it cool when you replace a 6JE6A, B or C tube in the demanding horizontal-deflection-amplifier socket of your customer's color TV set. RCA's 6LQ6/6JE6C Novar beam power tube beats the overheating problem common to the other tubes.

As a matter of fact, it can actually withstand 200 W plate dissipation for 40 seconds because of design improvements that include repositioned getters, cavity plate designed for better plate dissipation, and larger diameter screen grid wire which reduces screen grid temperature and improves the high voltage cutoff characteristic.

So play it cool. Replace with the RCA 6LQ6/6JE6C. And watch your customers warm up. More confidence from them . . . fewer call-backs for you.

Innovations and improvements that make your service operation more reliable, efficient and profitable are our constant aim. See your Authorized RCA Tube Distributor for quality RCA receiving tubes.

RCA Electronic Components, Harrison, N.J. 07029

RCA