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Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

ALL ABOUT ACTIVE FILTERS
Don Lancaster Tells It

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How Sansui Does It

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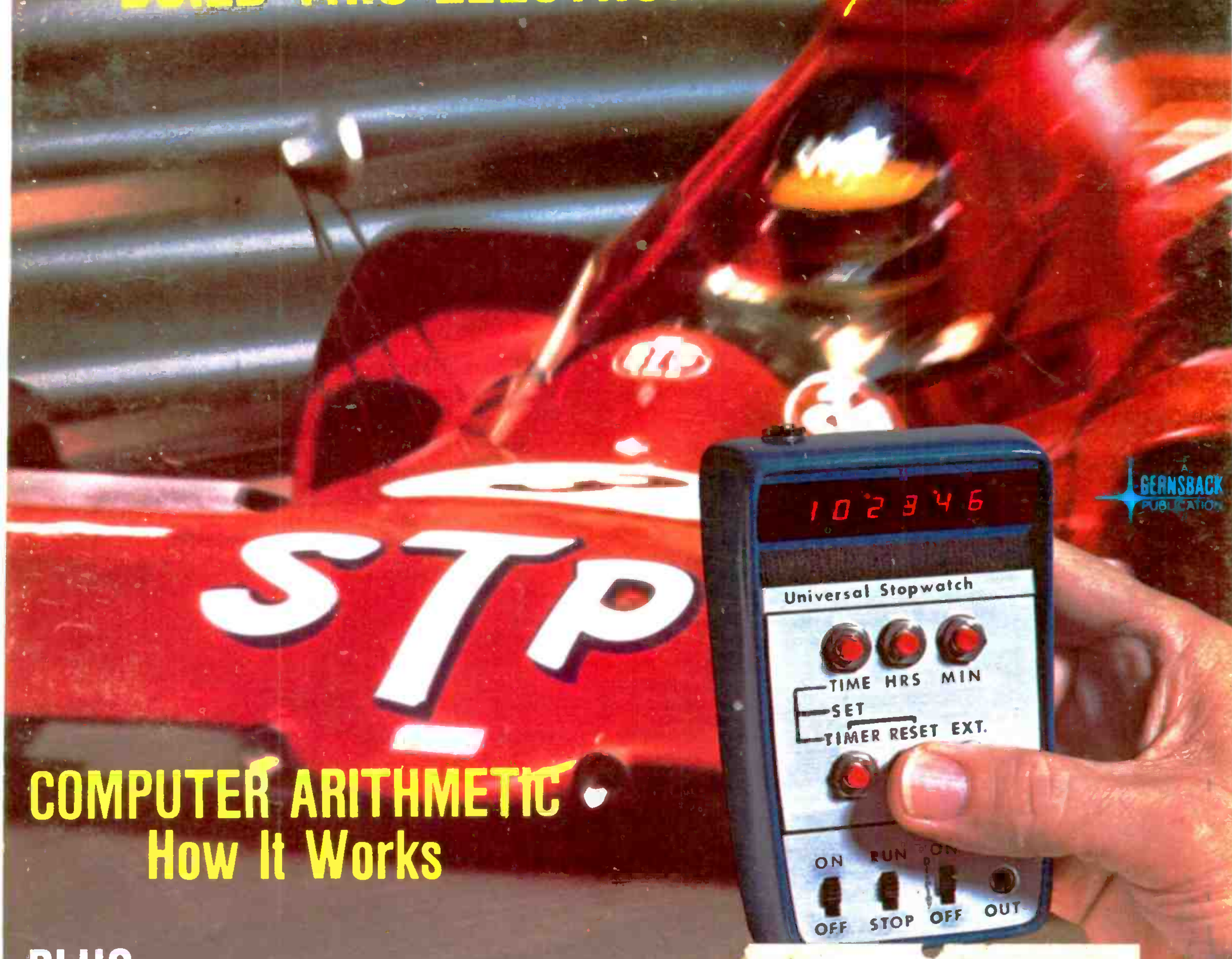

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Bob Scott's T

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Latest, all solid state version of the sensational signal circuit analyzing timesaver originated by Castle.

Invaluable for locating the break in the tuner and i.f. signal chain or analyzing agc system defects in tube TV receivers . . . essential for speedy location of signal circuit defects in modular IC, solid state and hybrid TV receivers.

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Specifications

Inputs:	300 ohms balanced VHF antenna terminals, electrically isolated. 75 ohms 40 MHz amplifier (Ch. #1) RCA phono jack, electrically isolated.
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Tuning Range:	All 12 VHF TV channels, plus Ch. #1 40 MHz amplifier position for testing UHF tuners. High stability of 40 MHz amplifier permits two Mk. IV Subbers to be cascaded for high level 40 MHz output signal from any VHF channel.
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Size & Weight:	6.5"x 6.5"x 3.25" exclusive of control knobs and handle. 1.5 lbs complete with batteries.
Accessories:	"Mastermatchcoupler" output cable with RCA phono jack termination. "Mastermatchcoupler" output cable with alligator clip terminations. UHF tuner test cable.

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Radio-Electronics

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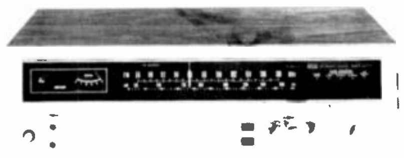
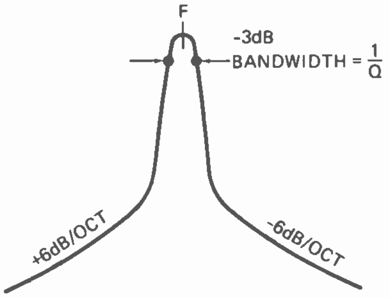


VARIOMATRIX means better 4-channel sound from your record player. Learn how this recent development operates. **. . . see page 35**



ACTIVE FILTERS make sharp rolloffs both possible and practical. Learn how they work and what they will and won't do.
. . . see page 42

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

Radio-Electronics, November 1973, Vol 44, No. 11. Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York City 10003. Second-class postage paid at New York, N. Y. and additional mailing office. One-year subscription rate: U.S.A., U.S. possessions and Canada, $7. Pan-American countries, $8. Other countries, $8.50. Single copies 60¢. ©1973 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

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looking ahead

Another videodisc

Paris, France—New home videodisc systems are cropping up with the same regularity that videotape systems were proposed a couple of years ago. The latest to surface is a long-rumored laser-optical system developed by Thomson-CSF, the audio-visual branch of the huge French electrical-electronics firm, Thomson-Brandt. Thomson has indicated that it is nearly ready to think about commercialization of its system and has staged demonstrations for television manufacturers of the world, including American set makers.

Thomson hasn't yet released details on its system, but it belongs to the same family as videodiscs demonstrated by Philips of Holland and MCA Disco-Vison of Universal City, Cal. The latter two systems, as previously described in this space, bounce laser light from reflective discs spinning at a speed synchronized with television's frame rate. The Thomson system differs in that it uses a transparent disc, and the scanning laser light shines through the disc. Thomson has given no date for public showing or marketing, but is making a strong effort to have its own system adopted as the world standard.

In addition to the three laser-optical systems, two other techniques are employed in videodisc systems announced so far: (1) Mechanical pressure pickup with flexible disc, used in the Telefunken-Decca-Teldec German-British system now in pilot production. (2) Electrostatic, or capacitance, system which is understood to be employed by RCA. All of the systems are designed to play at least 20 minutes of color per 12-inch record, except the Teldec mechanical system, which gives 10 minutes' playing time on an eight-inch disc.

'Video card'

Details about another simple and potentially low-cost home color TV playback system have been released by Digital Recording Corp., Scarborough, N.Y. Working with Battelle Development Co., DRC says it has succeeded in compressing 30 minutes of monochrome programming onto a 5-by-7-inch piece of film, and hopes to have a color version with stereo sound soon. The recording is made by converting the video signal to digital pulses which switch a laser beam on and off. Scanned vertically across the photographic plate, the laser makes a series of dots. The system records only the differences between successive pictures, thereby making possible high-density recording in a small area.

Playback equipment directs a switched laser to the film by a scanning wheel containing four lenses, revolving at 3,600 rpm. The video cards are duplicated by standard photographic processes. DRC says home playback attachments for color TV should cost about $200, and processing of a 30-minute video card about 50 cents, exclusive of the cost of the program, of course.

Trouble in videoland

Although dreams of home video systems continue to be rosy, the one company already in the business of providing color VTR's to the consumer is finding the going rough. Cartridge Television Inc., which has been manufacturing home videotape decks for Admiral, Sears, Teledyne and Montgomery Ward, has filed a petition of involuntary bankruptcy in New York federal court. Whether it's just growing pains for a new product or a basic consumer reluctance to accept videoplayers can't yet be determined. However, at press time, the prospects appeared good for the infusion of new capital and resumption of operations.

More Chromacolors

Another major name has left the color picture tube manufacturing business. Philco-Ford has sold its tube plant in Lansdale, Pa. to Zenith, which will expand it and convert it to the manufacture of its patented Chromacolor negative-matrix tube. Philco, which has been in the picture tube manufacturing business virtually since the start of television, thus joins Admiral and Motorola as TV makers who have left the tube business. The remaining U.S.-based color tube makers are General Electric, RCA, Sylvania, Westinghouse and Zenith—recently joined by Sony, which is establishing Trinitron manufacturing facilities in California, near its new American television plant.

Quick color

Color TV warmup time has been a real problem in the past, and it has been tackled by keeping tube filaments warm when the set is off, at the cost of extra electrical power to the set owner. With the advent of solid-state sets, the picture tube has become the weak link, and for quick-on performance its heater is the only one left to be preheated. Now Philips has developed a picture tube which provides a quick picture without preheating. The trick is a very small coiled cathode which reaches operating temperature in five seconds, as opposed to 15 to 30 seconds in the standard tube. The tube offers the added advantage of a saving of about 20% in power consumption when the set is turned on, in addition to the economy of eliminating preheating. American tube makers may be expected to emulate the Philips quick-heating cathode design.

Television's junk heap

The American public has junked more than 99,000,000 television sets since the start of the TV era. Nevertheless, more than half of the TVs ever sold—105,300,000—are still in use. These facts are brought to light in an analysis made by Sylvania's Research Department and published in the 1973-74 edition of *Television Factbook*. The tabulation shows that more than 205 million television sets have been produced in the United States since the start of post-war telecasting.

Surprisingly, the Sylvania research shows that some 1,600,000 color TV sets joined the junkpile last year and were replaced. This means that close to 20 percent of color sales last year were replacements. In 1973, it's expected that 2,200,000 color sets will be scrapped and that 24 percent of the sales will be replacements for old color sets rather than first color sets introduced into homes. The survey shows that the public now owns 62,800,000 monochrome sets and 42,500,000 color sets. Sylvania estimates that the average life of a black-and-white or color set is about the same—10 years.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

Spacecraft electrical system to be computer controlled

NASA is now testing and evaluating a new system for controlling electrical power in advanced spacecraft. In present aerospace electrical systems, heavy wire feeders lead from the power source to cockpit switches and circuit breakers, to permit the flight crew to control the electrical loads. In the new approach, called Automatically Controlled Electrical System (ACES) by its developer, the Westinghouse Aerospace Division, the feeders run from the generator to various load centers. These are located in electrical "centers of gravity" for various parts of the craft, and are so placed as to minimize feeder lengths. Power is switched at these points by solid-state controllers remotely controlled from the cockpit. Thus reliability is increased and feeder voltage drops and conductor weight are minimized.

The remote controllers are hybrid switching circuits. The dc controller consists of a power transistor which is the actual power switching element, current and voltage sensors, and a control circuit for on, off, trip, and voltage limiting.

NASA ENGINEER T. D. JEFFCOAT punches a combination of load and power for a simulation run into the data entry panel in the cockpit test setup at NASA's Manned Spacecraft Center. The five consoles in the background simulate the electrical loads for the nose, electronics, air lock, intervehicular activity and tail compartments of a hypothetical space shuttle vehicle.

The ac controller has an SCR power switch, voltage and current sensors and a control that provides a shaped trip characteristic as well as on-off control.

All electrical loads are controlled and sequenced with logic programmed into the distribution control center, a general purpose digital computer. Signals from the control switches and sensors are transmitted to it on multiplexed data buses, logic equations are performed and control signals sent back to turn the power controllers on or off. Indication signals from the remote points are also processed and transmitted to the craft status indicators. The display panel shows system status and also provides for manual control.

ACES automatically sheds loads to prevent overloading the power sources if a portion of the generating capacity is lost. Up to 12 priority programming schedules can be selected as required.

Two of the systems have been supplied for testing to NASA by Westinghouse.

Deaf child learns from teddy bear

Teddy, a stuffed brown bear, is an educator, whose eyes beam at the success of his pupils. He is also the pet of 3-year-old Nicola Stapleton, of Bedfordshire, England, who is at the same time Teddy's pupil.

Nicola, born practically deaf, has some remnants of hearing. "She can hear, with the help of powerful amplifiers, over a limited frequency range," explains her teacher, Mrs. Gwyneth Cobb of the Bedfordshire Deaf Children's Society. "But when she begins to talk she cannot hear her own voice. How was I to put it over to children like Nicola that they are making sounds?"

Teddy was the answer. Rigged up by a couple of fellow Society workers, he is equipped with a microphone and an amplifier that supplies output signals to small lamps in his eyes. When Nicola makes a sound, Teddy's eyes light up with pleasure.

"Teddy was a success from the word go," says Mrs. Cobb. "Nicola first hugged the bear, then prodded and poked it. At 2½ years, she was in the gurgling stage, where she makes sounds from pure excitement. When Teddy's eyes lit up for the first time she was baffled, but in no time at all she came to realize that it was sound coming from her that worked the eyes."

Teddy's eyes flash an authentic red, like those of other bears, which is why they may not look too bright in the black-and-white photo. But why is he wearing the headphones? Nicola is fitted permanently with ultra-powerful earphones, but sound from the amplifier and headphones is more controllable. "Nicola has to use them, so I put them on Teddy," says Mrs. Cobb. "Then Nicola wants to wear them, too."

NICOLA AND TEDDY, WITH MRS. COBB

Gerald F. Rice winner of latest Gernsback award

A resident of Jamaica, NY, Gerald F. Rice, is the recipient of the Hugo Gernsback Scholarship Award for 1973. This award is a $125 grant given each year to a student in each of nine leading home-study electronics schools. The candidates for the award are selected by the schools, and Mr. Rice was selected on the basis of an excellent academic record with the school, his deep involvement with electronics studies, and scholarship need due to partial disability.

A sheet-metal worker, he was disabled by an industrial accident in 1970. Although four severed fingers on his left hand were sewn back into place and 50 per cent of the capability of the hand restored, he was unable to continue at his trade.

His father had been an RCA employee, and had sparked an interest in electronics in his son, who now decided to turn to that field. Enrolling in Home Entertainment Systems course of the Bell

(continued on page 12)

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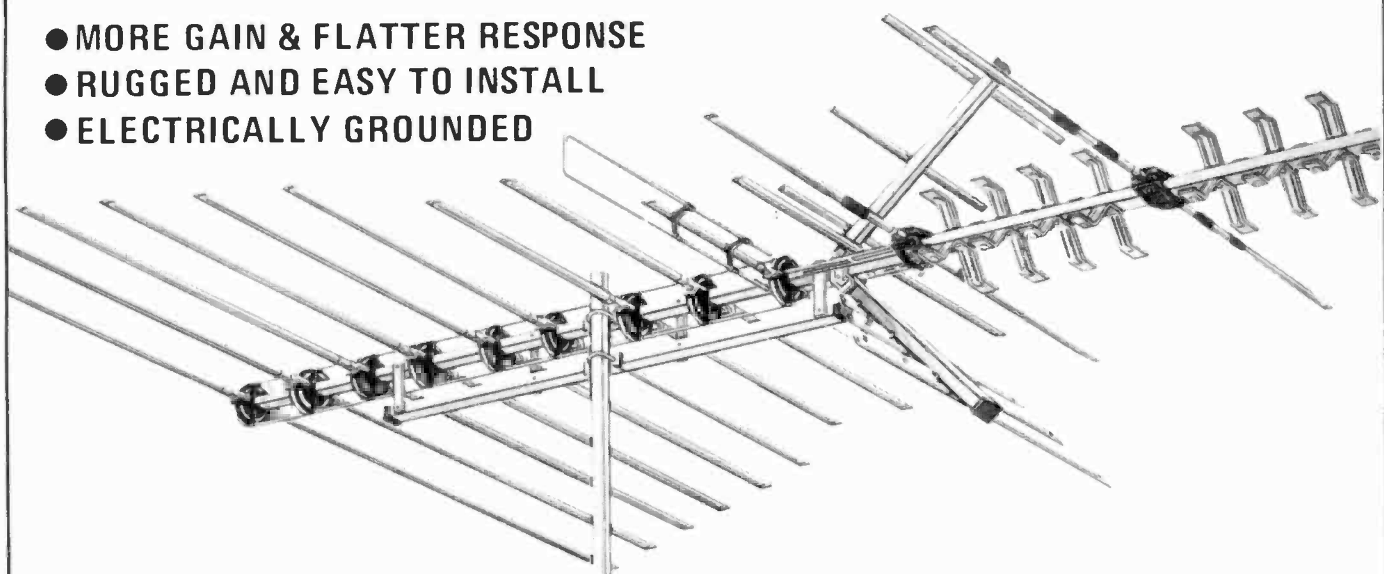

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because: ______________________

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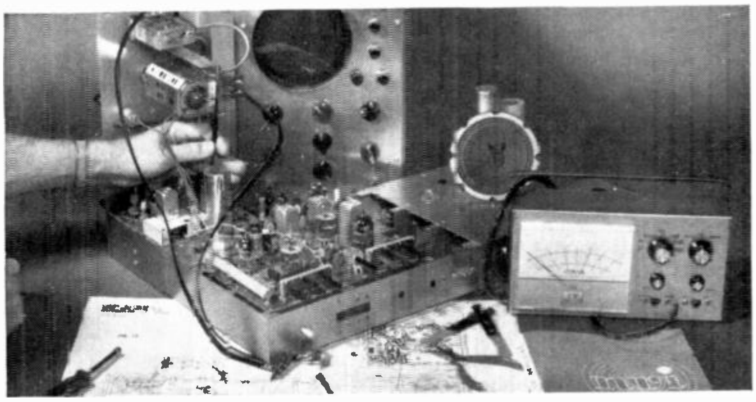
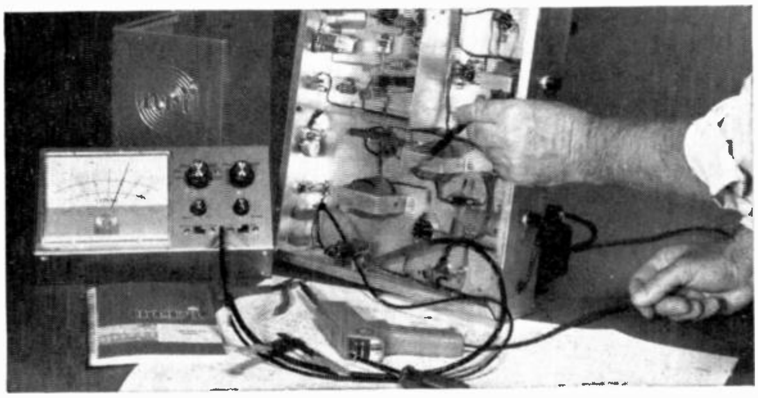
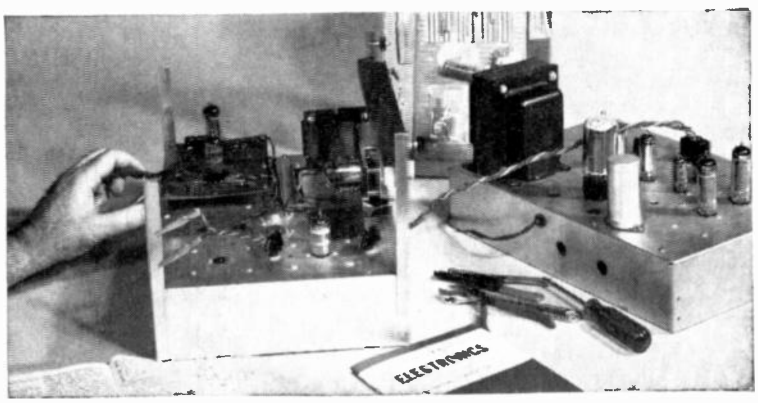
NRI FIRSTS *make learning Electronics fast and fascinating—give you priceless confidence*



FIRST to give you Color TV training equipment engineered specifically for education—built to fit NRI instructional material, *not* a do-it-yourself hobby kit. The end product is a superb Color TV receiver that will give you and your family years of pleasure. You "open up and explore" the functions of each color circuit as you build.



FIRST to give you true-to-life experiences as a Communications Technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 25-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and trouble shooting become a matter of easily remembered logic.



FIRST to give you completely specialized training kits engineered for business, industrial and military Electronics Technology. Shown is your own training center in solid-state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multivibrators and the latest types of integrated circuits are included in your course.

There is so much to tell you about this latest "first" in home training from NRI, you must fill in and mail the postage-free card today to get the full story of the Complete Computer Electronics course and the amazing digital computer you build and use as you learn.

Planned from the start to include specially designed training equipment in the pioneering NRI tradition, this exceptional new course succeeds in combining kits with NRI "bite-sized" texts to give you an easy-to-understand educational package. But, unlike other home training, this is not a general electronics course. Lessons have been specifically written to stress computer repair. You perform a hundred experiments, you build hundreds of circuits. Included are over 50 modern, dual-in-line TTL integrated circuits you use in the construction of your computer. You use professional test equipment. In addition to your digital computer, you build and use your own solid-state voltohmmeter and oscilloscope. Because you work with your hands as well as your head, your training is as much *fun* as it is education.

Train with the leader—NRI

As it has in other fields of home-study Electronics training, NRI has taken the leadership in computer training because the "Computer Age" continues to leap ahead. Qualified men are urgently needed, not only as digital technicians and field service representatives, but also for work on data acquisition systems in such fascinating fields as telemetry, meteorology and pollution control. Office equipment and test instruments also demand the skills of the digital technician. Like other NRI courses, this exciting new program can give you the priceless confidence you seek to walk into a technician's job and know just what to do and how to do it. Mail the postage-free card for the FREE NRI Catalog. No obligation. No salesman will call. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

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new & timely *(continued from page 6)*

& Howell Schools, with the help of the Veterans' Administration, which is assisting in tuition to the extent of 90 per cent, he is now working five hours a day

on the home study course, and reading chemistry, physics and math to increase his knowledge. Once he obtains employment, he plans to continue his study—toward a degree in electronics technology.

Radio pioneer dies at 81

Jay G. Gilfillan, co-founder with his brother, the late S. W. Gilfillan, of the Gilfillan radio and radar company, died in Los Angeles July 18. He was 81 years old.

Founded in 1912, the Gilfillan company originally extracted precious metals such as platinum and iridium. In the 1920's, it became one of the most prominent radio manufacturers of the country, being especially popular on the West Coast.

During World War II, the Gilfillan brothers, working with the Massachusetts Institute of Technology, built important ground-controlled-approach (GCA) radar aircraft landing systems. Gilfillan became a part of the ITT system in 1964.

Mr. Gilfillan is survived by his wife, two children and five grandchildren.

Pay CATV demonstrated in two Pennsylvania cities

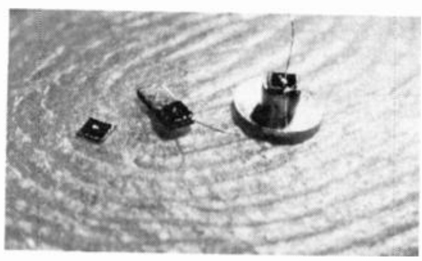
"Channel 100," a form of pay cable TV, may soon make its debut in many of those cable TV systems whose franchises permit making special charges for given programs. Demonstrated recently over CATV systems in Harrisburg and Easton, the new approach promises current movies, blacked-out sporting events, concerts, plays and other live entertainment, as well as instructional programs such as home study courses in foreign languages, speed reading, guitar playing, etc.

The channel space needed for Channel 100 would be leased from the cables by Optical Systems Corp. of Los Angeles, developers of the system. Material would be supplied the CATV system by microwave, video tape or movie film, or combinations of these.

Payment will be handled with a "black box" into which the customer inserts previously purchased credit-card-size tickets. The Channel 100 program then appears on his TV screen. Present plans for current movies are that a single ticket would entitle the customer or members of his family to view the movie as many times as they wish during the week that it runs. Cost would vary from $2.25 for an individual week to $1.50 on a "season pass" basis. Prices for special programs like sporting events or concerts would vary according to the event.

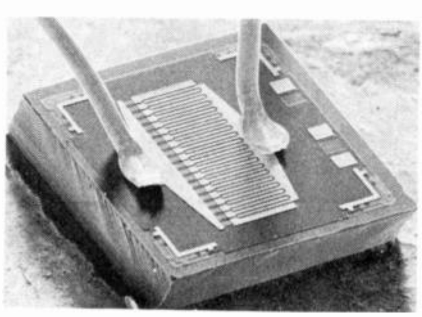
Micro-units for Microwaves

These two photographs are a dramatic demonstration of the miniaturization achieved in solid-state construction. The top is of a few microwave



diode chips, made by Raytheon in Waltham, Mass. The ridgy surface on which the units are photographed is the tip of an index finger!

The other photo is of a Siemens 3-GHz power transistor, mounted on a thin-film circuit measuring only 0.6 x 0.6 *millimeter!* The small dark bands at left are resistors, used to keep the current



load-uniform to each emitter strip.

The Raytheon devices are put together with the help of microscopes—the Siemens photograph owes its quality to the fact that an *Autoscan* electron scanning microscope was used to make the photograph, giving the impression of a much larger object photographed by ordinary means.

New light-carrying fiber has only 5 dB loss per km

A high-efficiency optical fiber just developed by Bell Laboratories scientists makes it possible to fabricate an efficient light-carrying fiber from a single material. Up to the present, optical fibers have been made with two materials: a center core—glass or liquid—and a surrounding outer cladding. Fibers made with different glass materials may have contained impurities that caused transmission losses.

Three Bell scientists, S. E. Miller, E. J. Marcatili and P. Kaiser, selected a glass that showed a very low transmission loss as an unclad fiber. Then they developed a unique configuration that made it possible to form the glass into an optical fiber without any additional materials. One design has three components, as shown in the photograph: an outer tube, a transverse partition across the tube that acts as a supporting plate for the center rod.

The assembly is then drawn into a hair-thin fiber. In drawing, all parts are brought into close contact, but the contact is not intimate enough to permit escape of light from the rod, even though plate, rod and tube are made of the same type of glass.

Home TV receivers are becoming more useful

Two devices, both using the screen of an ordinary TV set as an output, are being introduced by Cassette Sciences, of Los Angeles.

The first, a movie film player, connects to the TV by clipping two wires to the antenna terminals. It will accomodate a 12,000-foot film. Playing time for super-8 film will be 60 minutes, for 16-mm film, 33 minutes. The 8-mm version is expected this Fall, the 16-mm unit next Spring. Price for either will be around $500.

The computer terminal connects to the telephone to contact the local Cas-

(continued on page 14)

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set couplers—2-way splitters—band separators—matching transformers reduced up to 31%

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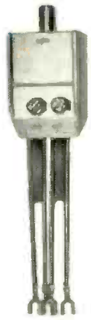
Check with your distributor for new low pricing on these items.

Reduced 31%

CC-482 82 CH. 4-SET COUPLER—Deluxe low loss coupler connects four TV-FM sets to a single 300 ohm downlead. Efficient coupler circuit provides a maximum amount of signal to each receiver. Specially designed for color, black and white and stereo.

Reduced 31%



CS-387 75 OHM V-U-FM BAND SEPARATOR—Band Separator for making connection between 75 ohm coaxial download and separate 300 ohm antenna terminals of TV set and FM receiver. Features latest printed circuit design for low loss, high isolation and perfect match. Excellent for quality color and FM stereo reception. Connector included.

Reduced 14%

CS-285 300 OHM V-U BAND SEPARATOR—High quality, low loss Band Separator for adapting single 300 ohm downlead to separate 300 ohm VHF and UHF antenna connections of TV set. Perfect match insures perfect color and black and white reception.

Reduced 18%

CS-380 300 OHM V-U-FM BAND SEPARATOR—Latest Band Separator design adapts 300 ohm downlead to separate VHF and UHF antenna terminals of TV set and provides FM stereo thru handy no-strip screw terminals. Unique printed circuit design has extremely low loss, excellent match and high isolation for perfect color and FM stereo.

Reduced 22%

CS-175 75 OHM V-U BAND SEPARATOR—Quality 75 ohm Band Separator for attaching coaxial cable to separate 300 ohm antenna terminals of TV set. Features printed circuit and latest circuitry for low insertion loss and perfect color transmission. Connector included.

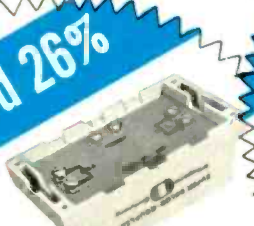
uced 28%

CC-33 82 CH. 2-SET COUPLER—Inexpensive coupler for connecting two TV or FM sets to a single 300 ohm downlead. Features handy no-strip terminals for easy connection.

Low Price! NEW

T-12BLK 82 CH. MATCHING TRANSFORMER—Compact indoor Matching Transformer for attaching coaxial cable to 300 ohm antenna terminals of TV or FM receiver. Packed 6 per poly bag, 8 bags per master carton. Connectors included.

Reduced 26%



CC-282 82 CH. 2-SET COUPLER—Efficient 300 ohm coupler connects two TV-FM sets to a single 300 ohm downlead. Input and output connections are handy no-strip type for easy installation. Quality circuitry insures perfect color and black and white reception.

Low Price! NEW

LS-27 82 CH. LINE SPLITTER—High quality line splitter for dividing a single 75 ohm coaxial cable into two trunk lines. Indoor type with transformer network features excellent match. Connectors included.

WINEGARD ANTENNA SYSTEMS
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Circle 80 on reader service card

new & timely

(continued from page 12)

sette Services time-sharing computer, and to the TV as a read-out device. Up to 16 lines of information, with 64 characters per line, can be placed on the TV screen.

Cassette Sciences expects that by the end of the year, when the machine will reach the market, some 20 programs—ranging from chess to calculus—will be available. As with the movie player, target retail price is $500.

FAA initiates new era in air traffic control

Computer-driven radar displays showing the identity and three-dimensional positioning of aircraft went into action at the Los Angeles Air Route Traffic Control Center in the middle of June. Controllers in the Center will spend some months learning how to use the new equipment before the facility becomes fully operational late this year.

The new system reads out the aircraft's identity, range, bearing, altitude and other flight information directly on the controller's radar scope. The current system reads out only range and bearing.

80 YEARS OF RECORDING HISTORY was presented to the visitors at the annual Audio Engineering Society meeting in Los Angeles. More than 40 pieces of equipment, old records, photos and other material were put on display by John T. Mullin, professional recorder development manager of 3M's Mincom division. Mullin owns about 90 per cent of the equipment. At the right, one of the first pieces of electrical recording apparatus, as supplied by Bell Labs to Columbia and Victor in 1925. At left is one of the first recording microphones, and at the extreme left, part of a Berliner "Trade Mark" phonograph that dates back to about 1895. R-E

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letters

TV TYPEWRITER NOTES AND COMMENTS

The overwhelming response by our readers to the article "Build A TV Typewriter" by Don Lancaster in the September 1973 issue of **Radio-Electronics** has been staggering. We are just getting out from under the thousands of requests we have had for the TV Typewriter brochure and offer our apologies to those readers who have encountered delays in obtaining their copies of the brochure.

This same tremendous response has created shortages in the parts needed to build the TV Typewriter and, therefore, we are listing here several possible sources of parts.

Southwest Technical Products Corp., 219 West Rhapsody, San Antonio, Texas 78216, has the following parts for this project: etched and drilled fiber glass circuit boards for timing, memory and cursor at $5.75 each; the main frame circuit board is $9.75 each; set of MOS circuits consisting of the 2513, 2518 and six 2524's—price for a *tested* set of these eight IC's is $49.50. No other parts are available from Southwest. Keyboards are sold out.

Many of the 7400 series of IC's are available from regular advertisers in **Radio-Electronics.** Check the ads in the back of the book. The 74177 which is directly interchangeable with the 74197 is harder to get. Poly Paks, P.O. Box 942R, Lynnfield, Mass. 01940, offered this IC for $2.10 in their ad in the October issue.

Potential sources for keyboards that appear to be suitable follow. Keyboards are available in a limited quantity on a first-come first-served basis only.

B&F Enterprises, 119 Foster Street, Peabody, Mass. 01960, model KB-3, (surplus) non-decoded alphanumeric keyboard is $24.50 plus postage; KB-01 (surplus) teletype format ASCII encoded keyboard is $44.50.

Hansen Associates, P.O. Box 806, Ridgewood, N.J. 07451, has a supply of new keyboards available, $98.00 each plus postage.

Solid State Sales, P.O. Box 74D, Somerville, Mass. 02143. New Raytheon ASCII encoded units are $60.00 each plus postage.

KA Electronic Sales, 1312 Slocum Street, Dallas, Texas, microswitch keyboards (surplus) are $50.00 each plus postage.

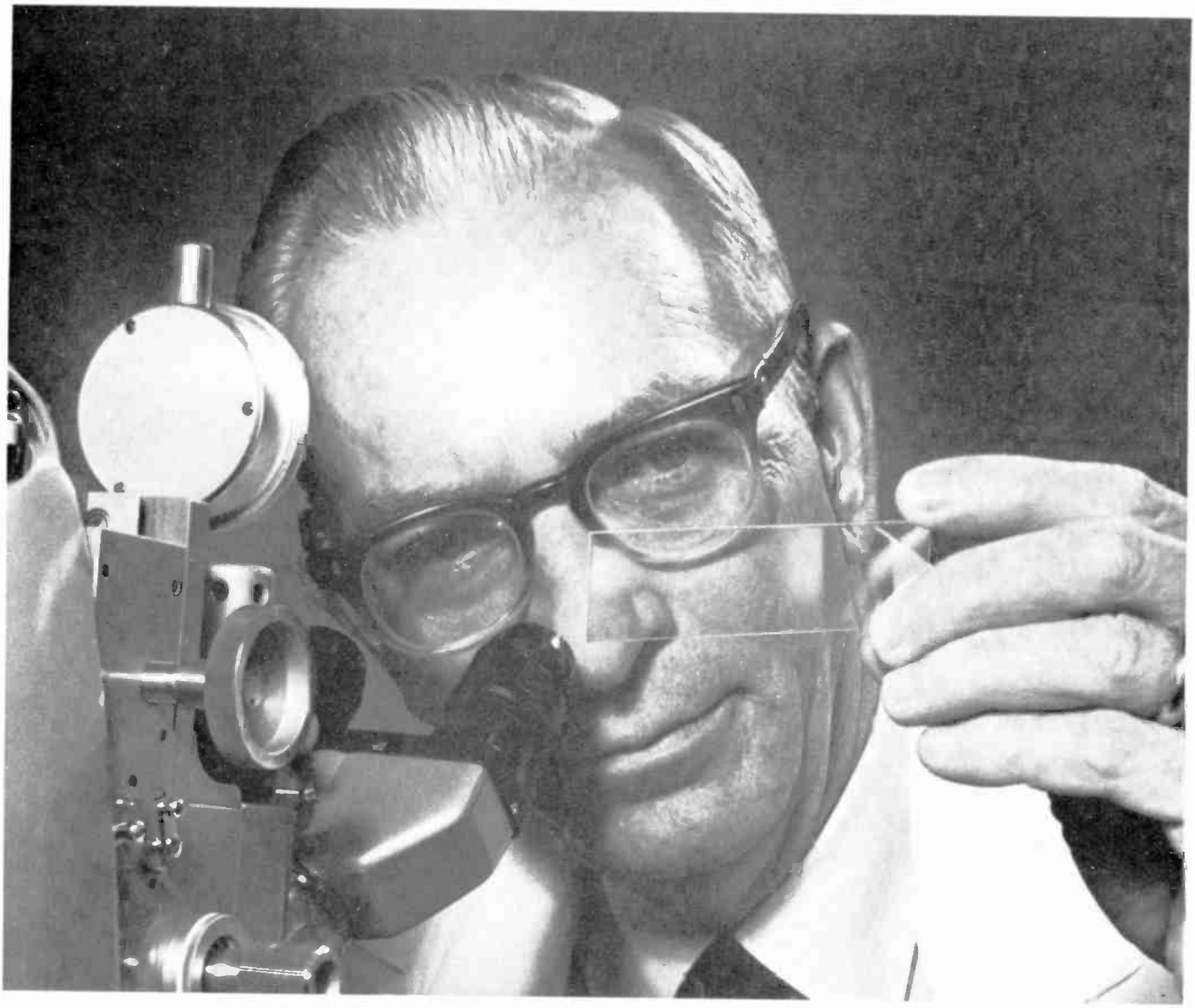
The power transformer is available from Signal Transformer Company, One Junius Street, Brooklyn, N.Y. 11212 at $6.00 plus postage.

Molex sockets are available from Force Electronics, 343 South Hindry Avenue, Inglewood, Calif. 90301. The sockets (09-52-3103) are 34¢ each. The matching pins (09-64-1101) are 39¢ per 10-pin assembly. Minimum order $10.00 plus 50¢ postage.—*Editor*

DON LANCASTER COMMENTS

Here are some additional comments

(continued on page 22)



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(James Gupton's address available upon request).

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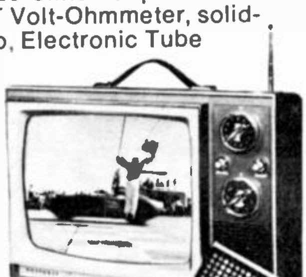

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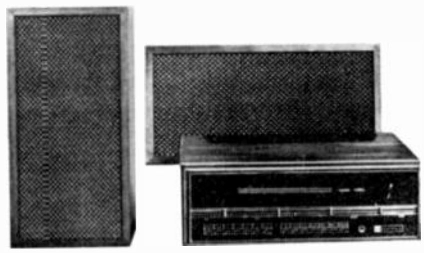

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(continued from page 16)

from Don Lancaster which may help answer other reader questions:

A color TV set has a *video* bandwidth of only 2.5 MHz; a black and white set has slightly more. This limits the number of characters per line to 32 or possibly 40, if an unmodified stock TV is to be used, particularly an economy one. Commercial terminal systems of 72 or 80 characters per line use special video systems with bandwidths of almost 10 MHz.

More memory can be added, but since the memory is the most expensive part, it very much ups the cost. Considering the limitations on video bandwidth and overscan on an unmodified TV, it would be difficult to do more than 512 characters per page. Of course, if you want to modify the TV, you can get denser displays.

If you want an all-the-time fixed memory, use a read-only-memory or data selector instead of the shift registers used. There is no memory device I know of that is cheap enough to use with the TV typewriter, can be written into very rapidly and simply, and still keeps its information when power is disconnected. Mag core comes close, but is complex and hard to use on a small system. So do erasable ROM's, but it takes a while to program them. Next year, we'll probably see better devices; right now, I don't know of any. Most terminal applications don't need memory through power-down times anyway, and those that do can run on stand-by power.

At least ⅓ and preferably ½ the scan in each direction must be saved for retrace and blanking, particularly on economy TV's.

To obtain full interlace (The only time you either need or want full interlace is when you must superimpose your message on top of an existing, uncontrollable program source.) you get horizontal and vertical signals from the system you are going to superimpose the characters on. These must be separate and not combined as EIA sync. They also must be TTL compatible. You compare the two horizontal outputs with a phase detector such as the Motorola MC4044 and derive an error signal to correct the 4.56 MHz oscillator phase lock loop style. The crystal is removed and replaced with a capacitor and the voltage control input is driven by the error output of the phase detector. Cost of this modification is under $10, but custom engineering is involved for each application.

Baudot and EBDIC and SELECTRIC codes are generated on the keyboard simply by redefining the key matrix, and possibly adding a flip flop or two. At the TV TYPEWRITER end, you have to add a read-only-memory such as the Harris PROM 0512 and another flip flop to convert to ASCII, or you can sometimes use commercial code converters.

We are trying to work up add-on's, but I am swamped with work right now, and they won't be immediately available. Custom engineering at this time, even at our incredibly exorbitant rates, simply isn't available. My thanks to the incredible number of readers responding to this project.—*Don Lancaster* R-E

My kid made it. Found a picture in a book.

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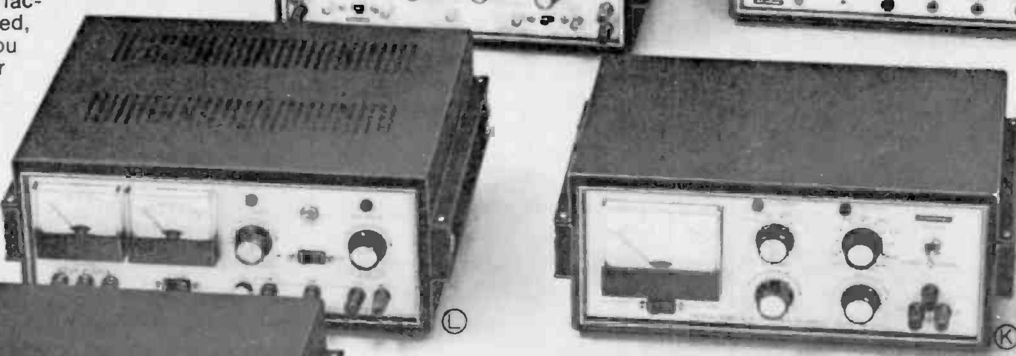

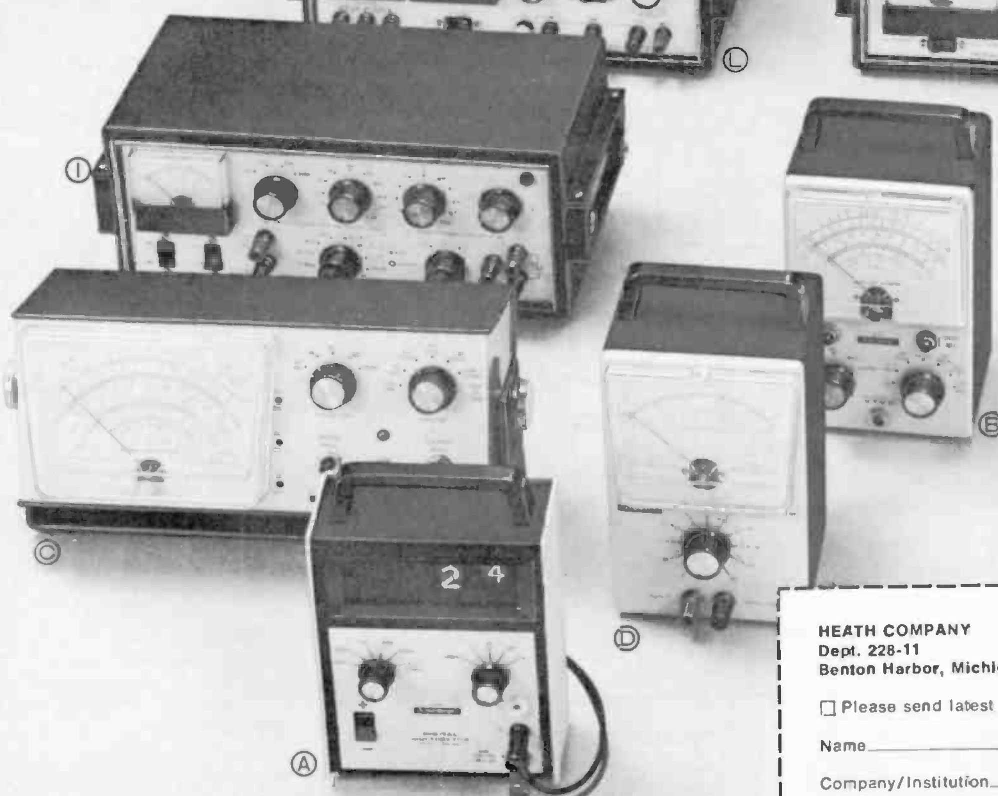

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ELECTRONIC MATCHES

by JACK DARR
SERVICE EDITOR

ELECTRONIC PRINCIPLES ARE POPping up all over these days. Now, they're in your pocket and everywhere else. Here are two applications.

The first is a fully electronic lighter. It's fueled by butane, which isn't new. But in place of the old "Thumb-Buster" spark wheel this one, made by the well-known Ronson Co., has a fully electronic ignition system!

This is actually a "super-miniaturized" version of the capacitor-discharge ignition system used on racing cars! Fig. 1 shows an exploded view. One battery, one capacitor, a diode and a step-up transformer, with spark electrodes to do the actual igniting.

All this is operated by the switch button, which opens the butane burner valve at the same time that it fires the spark. The whole thing is compact, no larger than other lighters.

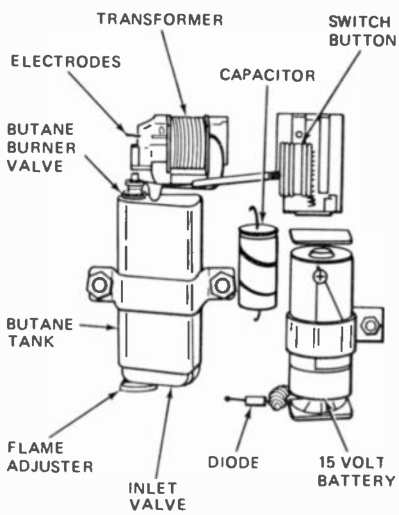

FIG. 1

The second device is another "lighter." This one has even fewer parts, and is used to ignite gas flames for welding torches, stoves, or any kind of gas-burning device. It works on another well-known principle of electronics; this time the heart of the device is a special piezoelectric element. When a piezoelectric crystal is compressed, or struck, it generates a pulse of voltage. In the application we're most familiar with, this reaction makes music in a phono cartridge.

Fig. 2 is a cross-section of the heart of one of these units. This is a handheld type, for any application requiring portability. A specially designed piezoelectric element, in the form of a rod, is mounted so that two crystals have their positive ends connected together. This places two elements effectively in parallel, to increase the current flow.

A hammer is mounted, with a spring, so that it can be cocked and then tripped to strike the end of the piezoelectric unit. When it does, a high voltage is generated. This is fed through a series resistor to the arc electrodes at the tip, the "discharge plug". The resistor is included to make the arc more efficient in igniting a gas-air mixture. It prolongs the arc discharge.

There's not much of anything to "service" on these! About the only thing that can make trouble is an accumulation of dirt or grease between the arc electrodes. These can be cleaned by carefully poking a toothpick between them. This unit actually develops up to 14 kilovolts.

The unit shown here is a home device, intended for lighting gas stoves. Industrial types are also made, for furnaces, heaters, etc. These come from Panasonic. **R-E**

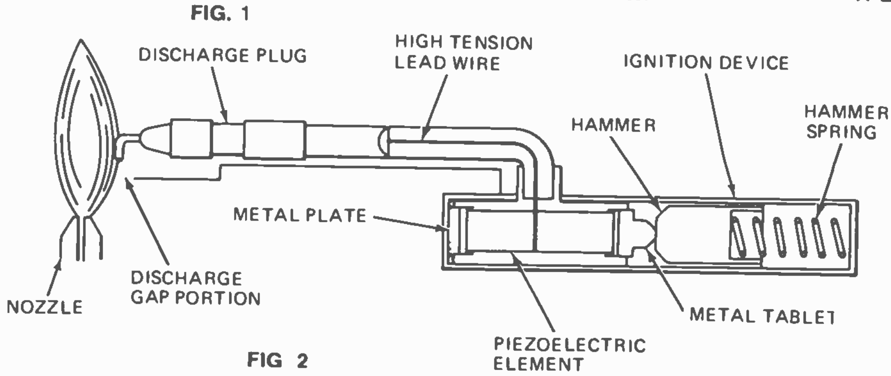

FIG 2

equipment report

Data Precision 245 Digital Multimeter

Circle 95 on reader service card

GOOD THINGS COME IN SMALLER AND smaller packages these days. A perfect example of this is the Data Precision Corp. model 245 DMM (Digital Multimeter). This 4½ digit multimeter will sit in the palm of your hand. It's 5½" wide, 3½" deep and 1¾" high. It will read ac and dc voltages, ac or dc current, and resistance on a total of 21 ranges. All of these, except the two high-voltage ranges on ac and dc, have the handy 100% overrange feature. In other words, on the 0 to 1-volt range, you can read up to 1.9999 V. (The last digit indicates hundreds of *microvolts.)*

If you go over the maximum on any range, the digits go out, leaving the decimal point and polarity indicator lit. Four ranges are used for all measurements; 1.0, 10, 100 and 1000. The decimal point shifts automatically when the range switch is moved. The only thing that could be confusing here is the resistance range. This plainly states that it is "k-ohms". So, the 0 to 1 scale here means 1000 ohms full scale, which will overrange up to 1.9999. A reading of 1.5000 means "1.5 thousands" or 1500 ohms.

The model 245 DMM is powered by a rechargeable internal battery pack. The charger comes with it. The display uses 7-segment characters. These are bright enough to be read in sunlight.

This is a highly accurate little jewel. All measurements can be read to within 0.005%, and the various scales are accurate to within 0.03% of reading ±1 LSD (Least Significant Digit or the last one on the right).

With this degree of accuracy, this meter could be classed as a lab-type instrument. However, it is certainly handy around the shop, when you need precision readings. For example, I wanted to make a frequency-run on a large guitar amplifier. I cobbled up a voltage divider, hooked it across the output of my audio generator, then connected the model 245 across the little one, set on the 0 to 1 vac range. I wanted a 50-mV standard input signal at each frequency. No problem. Just twiddle the attenuator until the display reads .0500 and there you are. The ac voltage ranges of the 245 have a very good high-frequency response.

Sidelight: one of the "old grouch" objections to digital displays is the odd readings on ohms ranges. Some digital meters will rock or hunt with the prods open, which is disconcerting. Here is a solution; the 245, with prods open, has the equivalent of an overrange reading, so the display simply goes out. Incidentally, the resistance scales have an accuracy of 0.07% to 0.25% over the whole range.

A very complete instruction book comes with each unit. This includes not only operating data, but recalibration instructions.

The model 245 uses a unique patented circuit. They call it a "Tri-Phasic Analog-to-Digital Converter". The basic circuit is similar to the dual ramp A/D converter. However, this is divided into three phases. During Phase I, the 245 automatically servos each circuit, to determine the accumulated zero-offsets in the analog integrator loop. This automatically "sets everything to zero". In Phase II, the signal to be measured is fed, after conditioning, to the converter integrator. At the end of Phase II, Phase III starts; the input is disconnected from the A/D converter, and the reference signal, of opposite polarity, connected. This senses the zero-level on the integrating capacitor, and the end of conversion. If this is within normal range, it is read out. If it is overrange, the overload circuits are activated, and this condition is read out. The whole process takes only 400 ms.

A fascinating little instrument, and a very useful one. It should find a place in every electronics shop, no matter what field you're in. **R-E**

Circle 11 on reader service card

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 Circle 12 on reader service card

BUILD THIS Digital Stopwatch

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by W. L. GREEN*

THROUGHOUT THE AGES, MAN HAS created myriad devices for the purpose of indicating and measuring time. They range from water clocks and sundials in ancient times, to mechanical escapement and tuning fork timepieces in more modern times. The National Bureau of Standards transmits time of day and precise frequency and time intervals via radio stations WWV, WWVB and WWVH.

The quartz-crystal oscillators these standards are derived from, are accurate and stable to 1 part in 10^{12} (0.0000314 second per year). A large number of high-cost instruments are available that can accurately display and/or measure time. And there are others that can control the start, stop and on time of another device. But few will do all these things.

The Universal Stopwatch/Timer is a pocket sized (5"x3"x1¼") battery operated digital stopwatch, clock and control timer. It will do all of the above mentioned things at a reasonable price. (Under $50 for the three-digit readout version, see parts list.)

Its large, bright 0.27" high LED display is readily visible in high ambient light areas, and, depending on the timebase and source of power used, its accuracy can be maintained between a few seconds per day, to a fraction of a second per year, calibrated to WWV.

Although the Stopwatch may be used as a very accurate 12 or 24-hour clock, its other uses are somewhat more outstanding. For aerial, boat or automobile rally navigation, it acts as an elapsed-time indicator. It will do the same job for automobile, animal and human racing. In addition, the Stopwatch has many uses in the darkroom, because of its internal coincidence detector, which may be set for start/stop delays of up to 24 hours.

Its use is simple, and once the operation is mastered, many other uses will be found, ranging from cooking an egg for precisely 3 minutes, to measuring the time it takes for a model rocket to reach its apogee after liftoff.

Technical description

The small size of the stopwatch results from the use of a single MOS/LSI integrated circuit. In this 24-pin ceramic package is the logic to provide the 1-Hz time-base signal from the external clock, the time and timer counters (six digits each), gating for the time and timer set switches, the coincidence detector for the timer, the multiplexer and decoder for the display. (See block diagram, Fig. 1).

The accuracy at low cost is made possible by the MC1455 timer IC. This 8-pin plastic package houses 2 comparators, a flip-flop and several

*President, Alpha Electronics

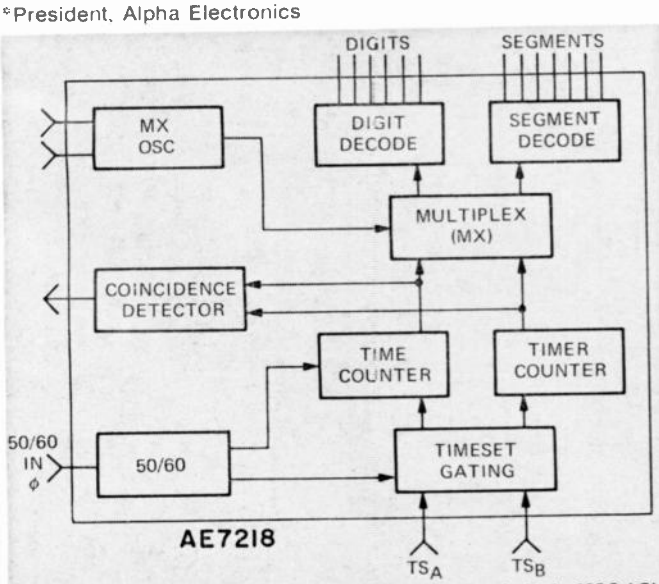


FIG. 1—PARTIAL BLOCK DIAGRAM shows contents of single MOS LSI IC that forms the heart of the timer.

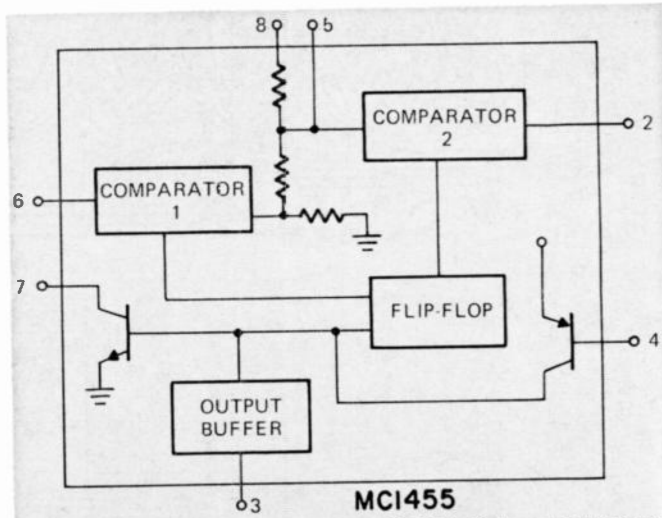


FIG. 2—THIS BLOCK DIAGRAM is the MC1455 IC timer that houses two comparators, a flip-flop, plus several transistors for reset, external timing capacitor discharge and output buffering. In this circuit it is used as an astable MVB.

transistors for reset, external timing capacitor discharge and output buffering. (See block diagram, Fig. 2.)

In this particular application, it is wired as an astable multivibrator with a nearly symmetrical output square wave, whose frequency is, within limits, independent of the supply voltage, and whose temperature stability is .005% C. This output signal is fed to the θ input on the AE7218 MOS IC. Its frequency may be set to 50/60 and 500/600 Hz, depending on the application of the Stopwatch. The time-shared outputs from the segment and digit lines on the IC, are buffered by the 13 npn transistors.

These transistors supply voltage to the segments of the display in parallel, and return the cathodes of each individual digit to ground at the appropriate time—when the data at the segments is true for that digit. The associated resistors are for current limiting and logic return at the bases of the driver transistors. The resistors connected to the MC1455 set its duty cycle and frequency, in conjunction with capacitor C1. The adjustable resistor allows precise adjustment of the clock's frequency to 50/60 or 500/600 Hz.

The oscillator frequency is independent of supply voltage drift, because it is determined by the *ratio* of R1 and R2 + R3 and the value of timing capacitor C1. Capacitor C1 charges to ⅔ of V+ thru R1, R2 and R3, and discharges to ⅓ of V+ through R2 and R3. The device is free running because the voltage on the timing capacitor is fed back to the trigger input.

How to build one

Construction is not difficult or lengthy, and anyone with some experience in electronic kit construction should have little difficulty building it. One word of caution, however, as with any MOS device, the AE7218 IC must be carefully handled to avoid damage to the inputs by static electricity. Do not use a soldering gun after this IC has been installed.

The PC layouts are shown in Figs. 3 and 4. The parts layout is in Figs. 5 and 6. A set of etched and drilled PC boards is available (see parts list) or you may make your own. Install and solder all the jumpers, resistors and capacitors on the main board first, (jumpers go on the foil side) then the diodes and transistors, being sure to observe polarity. (A "C" on the board indicates the diode cathode).

Now install IC1 and solder it. Then remove the conductive packing from the pins of IC2 and carefully install and solder it using fine solder and a small *soldering iron*. Be sure to align the identifying marks as shown. Insert and solder the jumpers on the display circuit board (on the foil side). Then install and solder the individual digits on the board noting that the identifying notches on one of the narrow edges of each digit goes toward the bottom of the board. These digits are installed up-side down so that the decimal points of the second and fourth digit separate the hours, minutes and seconds of the display.

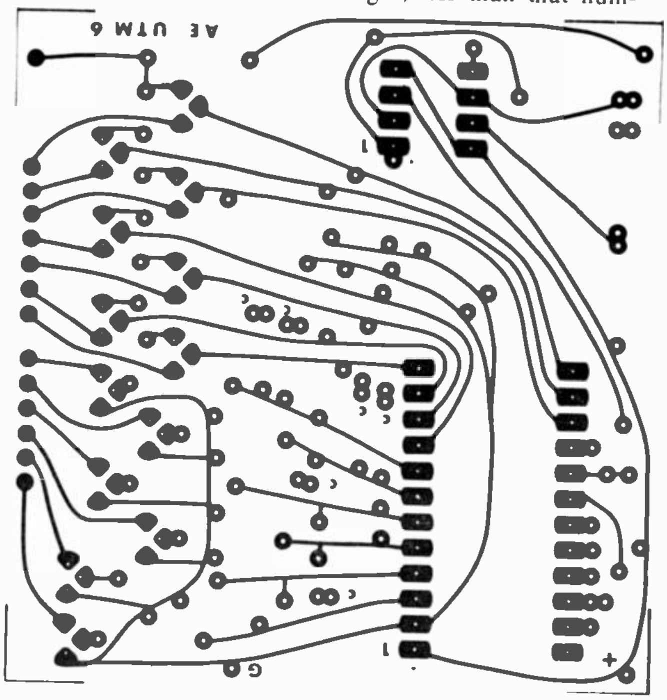
Although the display board is laid out for six digits, less than that num-

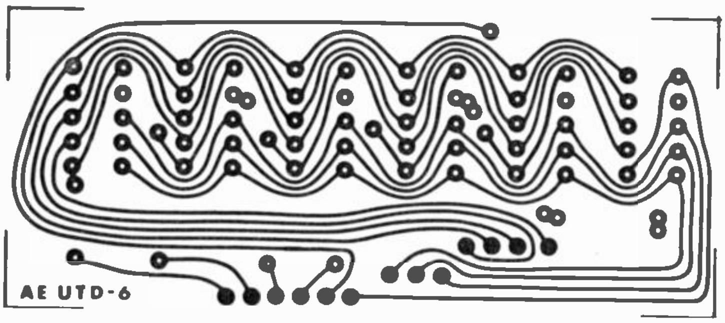
FIG. 3—FOIL PATTERN for the main circuit board. This board, full size, is 5 inches wide.

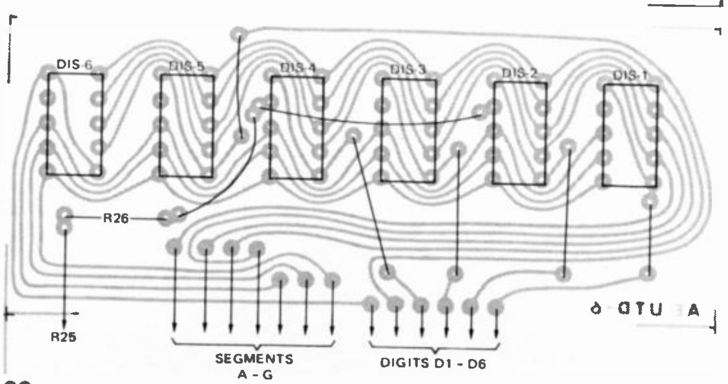
FIG. 4—(below) FOIL PATTERN for the display board. Actual size of the board is 5½ inches wide.

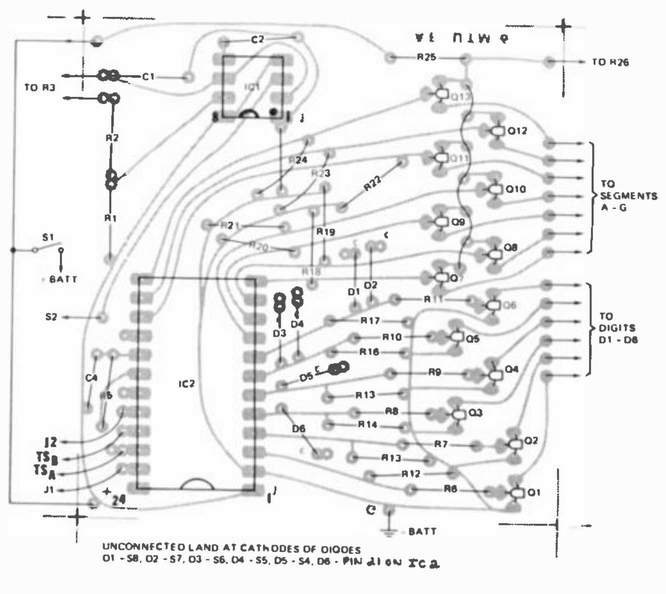
FIG. 5—(bottom below) DISPLAY board showing parts placement.

FIG. 6—(below right) MAIN board showing parts placement.









ber may be used, as dictated by the application. Install the display module in an appropriate case (a case like the one shown is available, see parts list) along with the time set switches and input and output jacks and wire them all to the main circuit board.

As mentioned before the Stopwatch can be powered by internal batteries, conventional or Ni-Cad, or by an external dc source. This can be an ac/dc power supply, or with an adapter, directly from the cigar lighter socket in an auto. The only requirements for this source of power, is that it be between 7.5 and 14 volts and capable of supplying 100 mA.

A display on/off switch is included to increase the useful battery life between charges when the unit is operated from its internal batteries. In addition to the options of the number of digits in the display and the type of power source used, the Stopwatch may be wired for 12 or 24 hour time display. Connect a jumper from D1's cathode to IC2 pin 22 for 24 hour operation, or leave as shown for 12 hour display.

The θ input of IC2 must be fed a 60 Hz or 600 Hz signal unless a diode is connected from IC2 pin 5 (anode) to pin 22 (cathode), in which case the θ input will function properly with an input signal of 50 Hz or 500 Hz. Either way, the 50 or 60-Hz signal will cause the seconds digits (first two from right) to read seconds and tens of seconds, or tenths of seconds and seconds if 500 or 600 Hz is supplied at this point.

As mentioned earlier R3 may be adjusted to provide these clock frequencies from the MC1455 timer IC. Two resistors and a switch in place of R3 allow selecting the time-base frequency. An external source of power, reasonably well regulated, will give accuracies of a second or two per day. If greater accuracy is required, two alternate methods of time base generation may be used.

The first is the simplest and uses the 60-Hz power line frequency (see Fig. 7). This method, of course, limits the portability of the Stopwatch. The other method is to use a crystal oscillator and divider to give accuracies on the order of a fraction of a second per year. A schematic for this type oscillator is shown in Fig. 8. With this type of time base, the unit can be operated from a portable power source. An additional feature or function of the Stopwatch is that the timer output may be used with one external transistor, capacitor and transformer, to drive a small speaker used as an audible alarm (see Fig. 9).

The output from the speaker will be about 700 Hz pulsing at 1 Hz. Figure 10 shows the external power control device. The pulsing signal at the timer output jack is rectified by the diode and filtered by the capacitor and applied to the gate of the SCR. When the SCR fires it supplies current to the relay coil and energizes the relay. The relay will remain energized until the timer signal is removed *and* the reset switch in the SCR's anode circuit is depressed.

The normally open and normally closed positions of the 6V relay enable the power control to turn an external load on, or off, upon command from the timer output on the Stopwatch.

PARTS LIST—MAIN CIRCUIT BOARD

R1, R4—1000 ohms, ¼W, 10%
R2—470,000 ohms, ¼W, 10%
R3—pot, 1 megohm, multiturn
R5—18,000 ohms, ¼W, 10%
R6 thru R11—4700 ohms, ¼W, 10%
R12 thru R24—27,000 ohms, ¼W, 10%
R25—100 ohms, ¼W, 10%
R26—220 ohms, ¼W, 10%
C1, C2—0.01 μF, 15V
C3—220 μF, 15V, electrolytic
C4—100 pF.
Q1 thru Q13—MPS5172
D1 thru D6—1N914 or 1N4148
IC1—MC1455 or 555 timer IC
IC2—AE7218, Mostek MK5007
DIS1 thru DIS6—FND70244 LED, Fairchild
S1, S2, S3—spst slide
S5, S6, S7, S8—spst pushbutton, N.O.
S4—spst, pushbutton, N.C.
J1, J3—phone jack, closed circuit
J2—phone jack, open circuit
BATT—7.5 to 14V, Eveready E401 mercury; E-90 alkaline; OB70T Ni-Cad
Case, PC boards, wire, tubing, hardware.

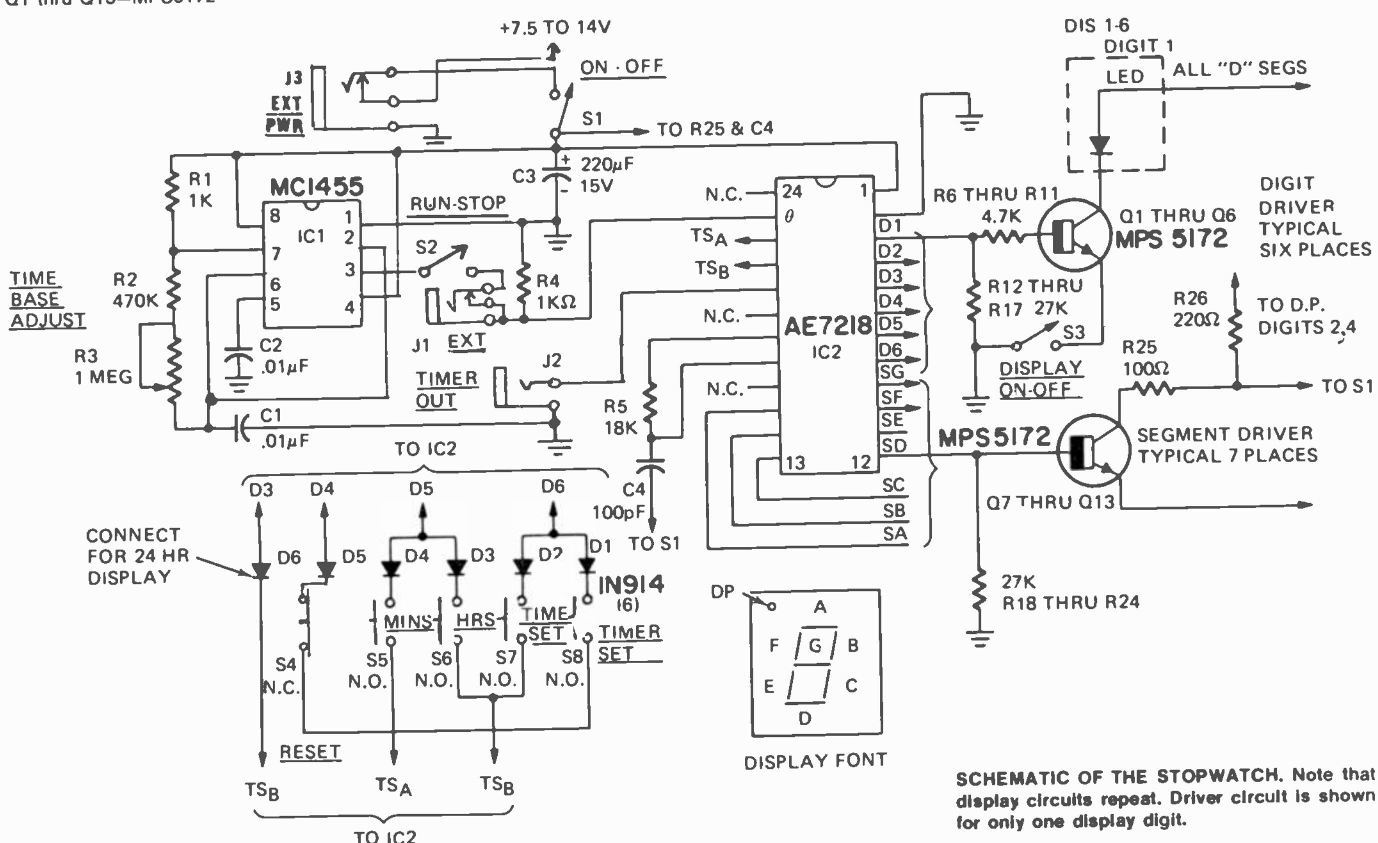
The following parts are available from Alpha Electronics, P.O. Box 1005, Merritt Island, Fla. 32952.

Set of two etched and drilled circuit boards. **UTX-6-SET—$4.00** PPD US

LED display digit, 0.27" high. Fairchild **FND70244—$3.50 per digit** PPD US

IC1 & IC2 (MC1455 & AE7218) **UTIC-SET—$28.50 for both** PPD US

Complete kit with case and all parts except display digits and batteries, **UKT—$39.00** PPD US



SCHEMATIC OF THE STOPWATCH. Note that display circuits repeat. Driver circuit is shown for only one display digit.

The power supply for the power control in the author's model is one of the battery eliminator types and supplies around 9 volts to the SCR and relay, but a conventional supply may be used.

Operation and use

When power is first applied, or when the power supply drops below 7.5V or is interrupted, the display will present all 8's. Depressing and releasing the TIME SET switch will clear the display and display 12'00'00 (6 digit displays only) or all zeros if the unit is wired for 24 hour operation. With the RUN/STOP switch in the RUN position, the far right seconds digit will step one count ahead per second.

If the TIME SET switch is depressed again, the first two digits will reset to zero and remain there until the switch is released. The RUN/STOP switch will stop the count, but will not reset the counter. Either of these switches may be used alone or together to control the counting of the Stopwatch.

If the HOURS switch is depressed, the hours digit steps at the rate of 2 Hz per second. If the MINUTES switch is depressed, the minutes digit step the same way. Depressing the MINUTES and HOURS switches together steps the tens of minutes digit. The same thing happens to the timer counter if the TIMER SET switch is depressed and the HOURS and MINUTES buttons are depressed. For proper operation of the timer, the RESET button must be depressed on both the Timer, *and* the Power Control, if it is used, after the time and timer have been set. The RESET button will disable the TIMER OUTPUT. The EXT jack is a closed circuit type, and when a plug is inserted into it the clock will not reach the θ input on IC2.

A breakwire connected between the terminals on this plug will stop the count when the wire is broken. For instance, in a foot race, the breakwire is stretched across the finish line, and when the race starts, the RUN/STOP switch is moved to RUN, starting the count. When the breakwire is broken, the count will stop, indicating the elapsed time of the race. Photocells may also be used, (if properly conditioned to provide very low on resistance) to either make or break the circuit or both, across the EXT jack.

When using the unit as a control timer, the power control is plugged into the TIMER OUTPUT, the time counter set to zero, and the timer counter set to indicate the amount of delay until the power control switches states.

To reset the power control, depress and RESET buttons on the Stopwatch and the power control. The TIMER OUTPUT from the Stopwatch will automatically reset itself one hour after it has triggered, and will trigger only once during a 24 hour period, unless the TIME or TIMER SETS are reset, even if the unit is set up for 12 hour operation.

The above mentioned time periods are valid only for a 50/60 Hz-input clock. They will be 1/10th the value indicated if the clock is set at 500/600 Hz. The frequency of the MC1455 timer may be set with any one of several reference sources.

One way is to feed the signal from the timer into a frequency counter or to the vertical plates of an oscilloscope, with the 60-Hz line on the horizontal plates, and adjusting R3 for a square but stable Lissajous pattern.

CHU or WWV may also be used for a trial and error adjustment. If the crystal controlled time base is used, the most accurate possible adjustment will be by beating the 1 MHz signal against WWV. Have a good (timing?) time. R-E

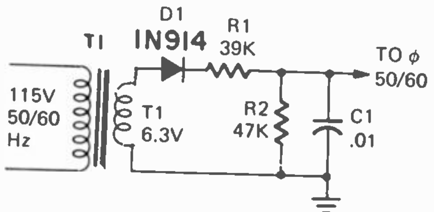
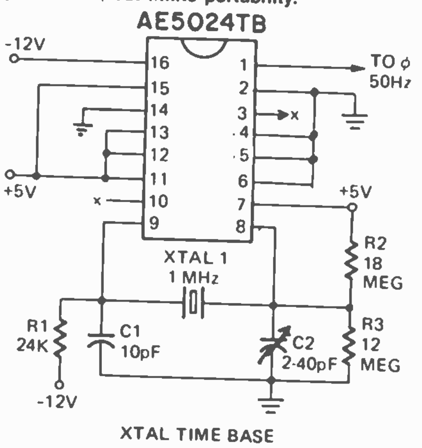


FIG. 7—SIMPLE AC SUPPLY can be used to power unit, but limits portability.



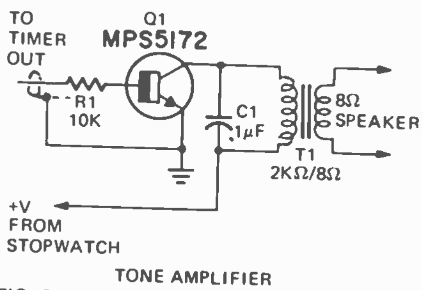


FIG. 8—(top) CRYSTAL OSCILLATOR and frequency divider provides portable accuracy. FIG. 9—(above) TONE AMPLIFIER drives speaker to act as audible alarm.

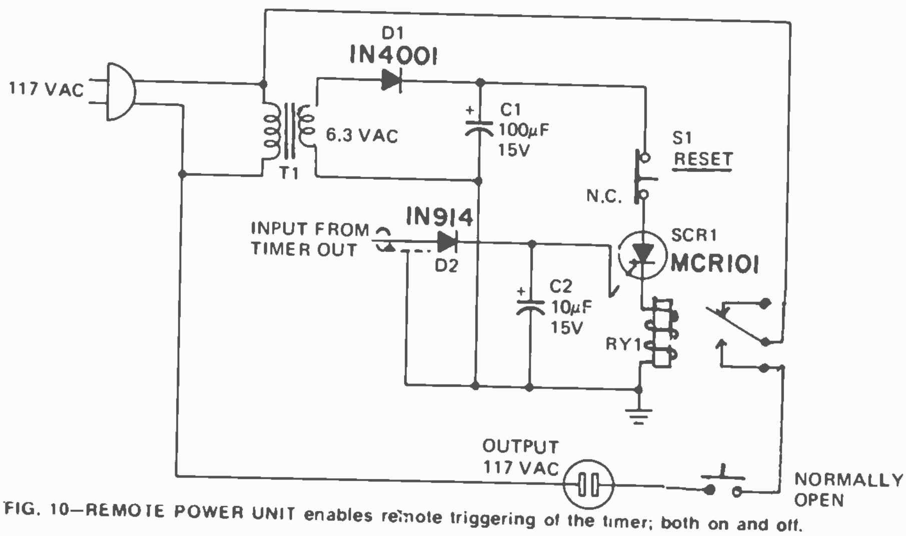


FIG. 10—REMOTE POWER UNIT enables remote triggering of the timer; both on and off.

PARTS LIST (AUXILLIARY)

(Power Control)

C1—100 µF, 15V electrolytic
C2—10 µF, 15V electrolytic
D1—1N4001
D2—1N914
RY1—6V relay, Sigma 25PA1
S1—spst pushbutton N.C.
SCR1—MCR101
T1—primary, 117 Vac; secondary, 6.3 Vac

(Power Line Time Base)

R1—39,000 ohms, ¼-watt 10%
R2—47,000 ohms, ¼-watt 10%
C1—0.01 µF, 15V
D1—1N914
T1—primary 117 Vac; secondary 6.3 Vac

(Crystal Time Base)

R1—24,000 ohms, ¼ watt, 10%
R2—18 megohms, ¼ watt, 10%
R3—12 megohms, ¼ watt, 10%
C1—10 pF
C2—trimmer, 2-40 pF
IC1—AE5024-TB, Mostek MK5009
XTAL1—1 MHz parallel resonant quartz crystal

(Tone Amplifier)

R1—10,000 ohms, ¼ watt, 10%
C1—0.1 µF, 15V
Q1—MPS5172
T1—Primary; 2000 ohms; secondary, 8-ohms; 8-ohm speaker

The following parts are available from **Alpha Electronics, P.O. Box 1005, Merrit Island, Fla. 32952**

6-V relay, **25PA1—$2.85** PPD US
MCR101 **SCR-$0.70** PPD US
AE5024-TB **IC—$19.45** PPD US

4-Channel QS Matrix

another road to 4-channel records

The race for universal acceptance of one 4-channel matrix stereo system is still being run all-out. You studied the SQ system in June; now here's the dope on QS

by LEONARD FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

Although the majority of matrix-encoded quadraphonic records sold in the United States are encoded using the SQ matrix system proposed by CBS (see **Radio-Electronics**, June 1973 page 44), acceptance of this matrix format is anything but world-wide. In Japan, in fact, the so-called "regular matrix", or QS matrix, is favored by several manufacturers and record producers.

The basic difference between the regular-matrix system and the CBS-SQ system arises from a fundamental difference in opinion as to what the ideal sound distribution field for four-channel reproduction should look like. CBS champions the idea that left-to-right channel separation should be maximized, and that front-to-back separation can be sacrificed in the process—or enhanced by means of gain-riding "logic" circuits.

Regular matrix proponents maintain that separation should be uniform from channel to channel around the entire sound field. Sansui, in particular, takes this "uniform" separation idea (originally proposed by Peter Scheiber in this country) and adds phase-shifting angles during the encoding and decoding process that provide apparent greater separation, but measurable separation is only 3 dB between any dominant channel and its two flanking channels. As we shall see presently, this uniform sound field idea also permits the use of a rather sophisticated form of enhancement logic which Sansui calls "Variomatrix".

The basic encoding formulas for the Sansui system are:

$$L_t = L_f + .414R_f + jL_b + j0.414R_b$$
$$R_t = R_f + .414L_f - jR_b - j.414L_b$$

Where L_t and R_t are the matrix-encoded left and right signals applied to the record groove, L_f, L_b, R_f and R_b are the left-front, left-back, right-front and right-back signals and +j and -j represent +90° and -90° phase angles respectively. If four equal amplitude signals (one for each of the four channels) are encoded at a given instant using these formulas, vector diagrams of the content of each of the two composite L_t and R_t signals appear as in Fig. 1. It is apparent that when such an encoded record is played on a conventional stereo phonograph, both front and back left information are reproduced at full amplitude, while right-front and right-back are attenuated about 7.6 dB in the left speaker. The reverse is true for the right speaker.

Sansui decode matrix

The first and simplest form of Sansui matrix decoder used fixed matrix coefficients to yield the following:

$$L_f' = L_t + .414R_t$$
$$R_f' = R_t + .414L_t$$
$$L_b' = -j(L_t - .414R_t)$$
$$R_b' = j(R_t - .414L_t)$$

(Prime (′) notations indicate that outputs are not, and can never be *identical* to the original input signals in any 4-2-4 matrix systems.)

If each of these matrix decode equations is solved in terms of the original four input signals, L_f, L_b, R_f and R_b the following output signals are obtained at the respective channels.

$$L_f' = 1.171L_f + .828R_f + j.828L_b$$
$$R_f' = 1.171R_f + .828L_f - j.828R_b$$
$$L_b' = 1.171L_b + .828R_b - j.828L_f$$
$$R_b' = 1.171R_b + .828L_b + j.828R_f$$

By "lowering the volume control" slightly to obtain unity coefficients for the desired or dominant signal outputs in each case, the results become:

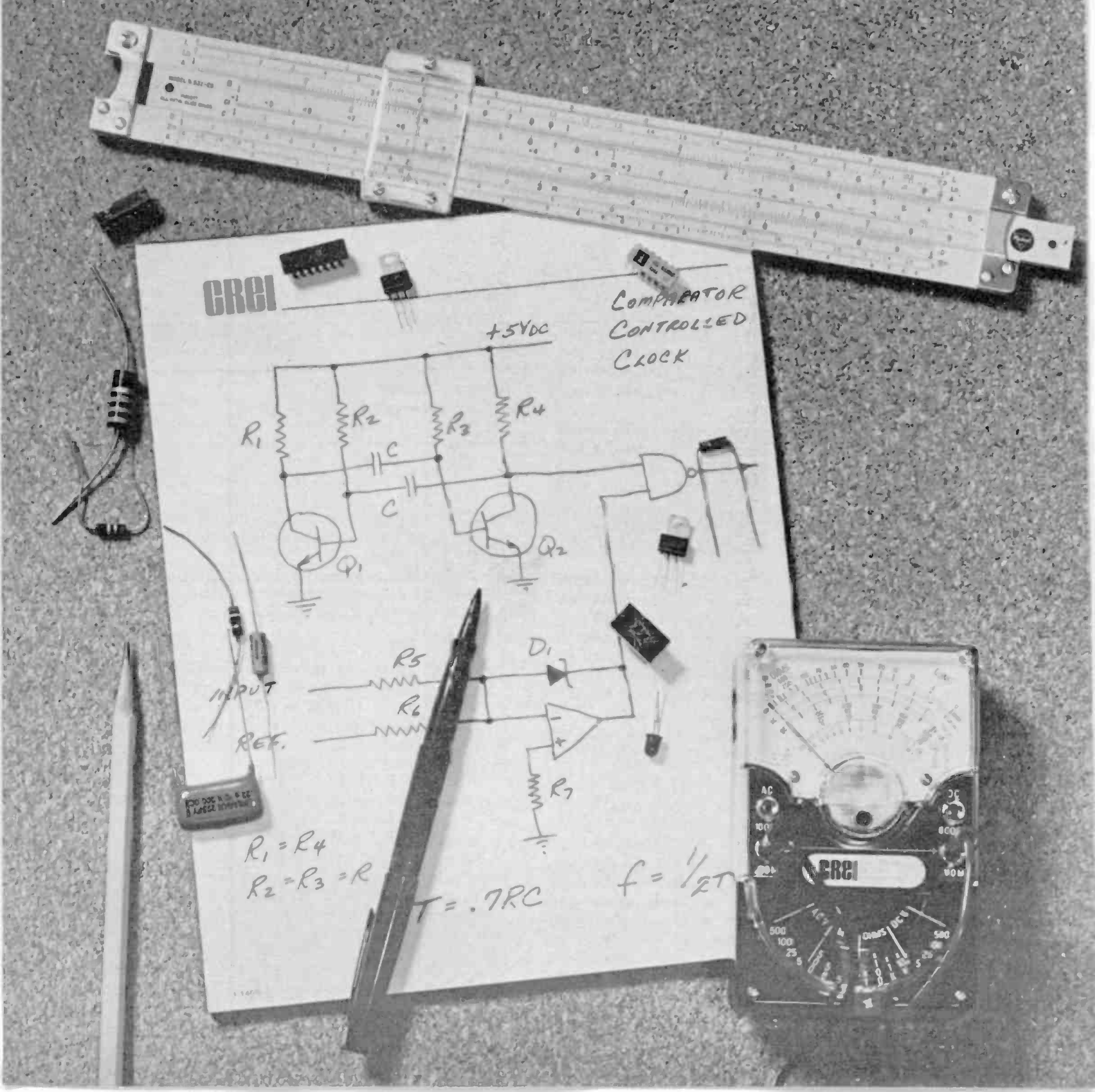
$$L_f' = L_f + .707R_f + j.797L_b$$
$$R_f' = R_f + .707L_f - 1.707R_b$$
$$L_b' = L_b + .707R_b - j.707L_f$$
$$R_b' = R_b + .707L_b + j.707R_f.$$

The symmetry of sound distribution inherent in this encode-decode approach is shown in Fig. 2. The asterisk (*) in each square of the diagram shows where the desired sound is supposed to be (e.g., front left) while the arrows indicate sound amplitude and phase for each of the four loudspeakers in each of the eight situations shown. In the case of the left-only desired signal we see that full amplitude of that signal is heard from the left-front speaker,

(continued on page 40)

CREI—the <u>only</u> home-study college-level training

and now



while the left-back and right-front speakers reproduce the same signal at an amplitude reduced by 3 dB. The diagonally opposite channel produces *no* output ("infinite" separation) whenever a corner-only signal is to be reproduced.

Because only those speakers which flank the desired speaker are operating under the "corner"-only conditions, the listener's attention is further focused towards the desired source of sound. As a result, this simple dematrixing can produce a fairly satisfactory four channel illusion despite the minimal separation figures. It is, in fact, the same separation obtained with the CBS-SQ system when that system is decoded by only a simple matrix. The difference is that cross-talk in the QS system appears at flanking speakers, whereas cross-talk in the SQ system appears in a diagonally opposite speaker and a speaker along the same wall (left or right) as the desired sound.

A simplified diagram of the basic Sansui decoding matrix circuit is in Fig. 3. Here the necessary phase inverters (to provide "minus" signals) and phase shifting networks (to provide the required ±j factors) are shown in their appropriate positions in the signal paths. The potentiometers shown establish the correct coefficients (in this case, 0.414) required by the matrix decode equations shown earlier.

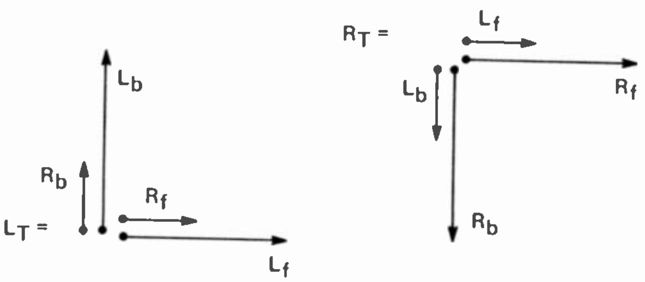


FIG. 1—VECTOR REPRESENTATION of Sansui encoded, left and right composite 4-channel matrix signals when the amplitude of all four signals is equal.

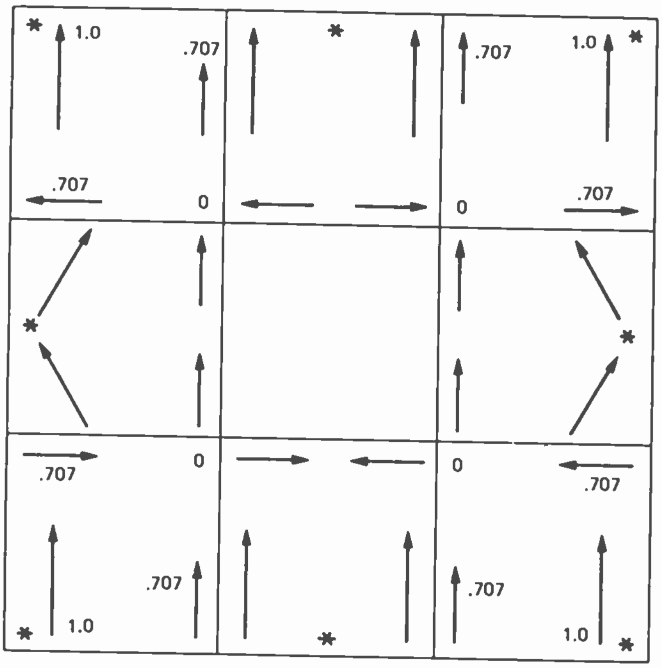


FIG. 2—SIGNALS PRODUCED IN THE SIMPLE Sansui QS system when original signal desired is as indicated by the asterisk (*) in each of the eight conditions shown.

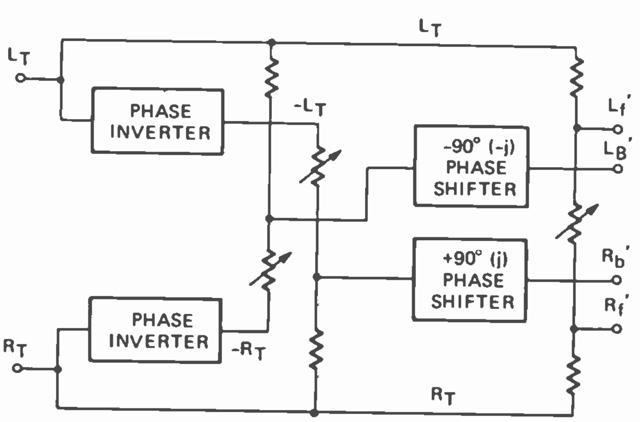


FIG. 3—BASIC CIRCUIT ELEMENTS required for QS simple matrix decoding.

Introducing the Variomatrix

Not too long after Sansui introduced this simple matrix decoder, they followed up with a decoding technique called *Variomatrix.*

Suppose, for the moment, that only a left-front and right-front signal are being encoded, and that each has an amplitude of 1 The encoded signals will consist of:

$$L_t = L_f + .414R_f;\ R_t = R_f + .414L_f$$

If we were to add these two signals together ($L_t + R_t$) and add to that total the *difference* between the two signals, we obtain:

$$(1.414L_f + 1.41R_f + (.586L_f - .586R_f) = 2.0L_f + .828R_f.$$

Instead of 3 dB of difference between the two signals, we now have over 7.6 dB of difference or separation. Taking it a step further, if we add to the sum of the two composite signals 2.41 times the *difference* between the two signals, we obtain:

$$(1.41L_f + 1.41R_f) + 2.41(.586L_f - .586R_f) =$$
$$1.41L_f + 1.41R_f + 1.41L_f - 1.41R_f = 2.82L_f.$$

The output from the L_f channel now contains *only* an amplitude of L_f, with the original crosstalk from R_f *cancelled out* by the choice of the coefficient, 2.41. Of course, we have oversimplified the situation by stipulating only L_f and R_f signals at this instant (no back signals) but it should be clear that under these circumstances, it would be equally possible to obtain a cross-talk free R_f signal in the right speaker—this time by *subtracting* 2.41 times the difference between these L_t and R_t encoded signals from the sum of these same two signals. If there *were* back signals present during this experiment, applying the 2.41 coefficient would increase their intensity in the *front* channels beyond that of the desired signals. However, if there were some way to vary this coefficient over a wide range, depending upon whether signals predominated in front or back, it would be possible to instantaneously impart greater separation to each of the channel outputs on a continuously variable basis.

That's where the name Variomatrix comes from. Instead of having fixed coefficients built into the decoder, these matrix coefficients are made to vary by sensing whether the dominant signal is towards the front or towards the back. In the example cited, if the situation had been reversed and sound was supposed to predominate at the rear (either left or right rear), the 2.41 coefficient would have had to approach zero, and another matrix coefficient, used to extract back left or back right information would have had to approach 2.41. This time we would be dealing with an L_t signal consisting of $jL_b + j.414R_b$ and an R_t signal consisting of $-jR_b$-$j.414L_b$ and, if we desired a pure L_b' signal we would matrix as follows:

$$(L_t - R_t) + 2.41(L_t + R_t), \text{ or}$$
$$(jL_b + j.414R_b + jR_b + j.414L_b + j2.41L_b + jR_b - j2.41R_b - jL_b) = j2.82L_b.$$

Again, if it were a right-back signal that were dominating, the formula for decoding would have applied the 2.41 coefficient in the equation

$$R_b' = (L_t - R_t) - 2.41(L_t - R_t)$$

and when this equation is expanded in terms of the original L_b and R_b contributions, the results would have been $j2.82R_b$.

Phase sensing is vital

The unique feature of the Variomatrix idea is that it uses phase information rather than amplitude information to determine what the various matrix coefficients shall be. Because of the particular encoding equations used in a QS Regular Matrix system the front-back ratio is directly proportional to the difference in the phase angle of the L_t and R_t signals. This phase difference is plotted in Fig. 4 and is equal to 90° when front-back amplitude ratio is one-to-one, and approaches 180° when the back-to-front ratio approaches infinity (all sounds at the back, no sounds in the front channels).

The block diagram in Fig. 5 shows how this phase comparison is used to alter the matrix coefficients for the front and back matrix networks. L_t and R_t signals are applied to a phase discriminator (after limiting). The outputs of the phase discriminator are fed to gain control amplifiers which vary the contribution of the L_t - R_t signal, in the case of the front matrix; and the L_t + R_t contribution in the case of the back channel matrix. The actual QS decoders being marketed today allow the coefficients to vary between 0.3 and 2. With this much variation available, a left-front signal, encoded using Sansui Regular matrix parameters can be reproduced from the left front speaker with cross-talk in the remaining speakers reduced to the amounts shown in Fig. 6.

Multiple signals

The examples we have shown up to this point involve applying a single signal to the encoding process. Under musical conditions, of course, two, three or all four channels may be called upon to reproduce different sounds at the same time. Thus, under actual musical conditions, the matrix coefficients change from moment to moment with a time constant of approximately 10 ms. Sansui claims. This time constant helps mask sound directionality while at the same time improving instantaneous inter-channel separation, without changing overall output levels. Obviously, if two or more signals dominate the sound field equally, the Variomatrix's nominally high separation capability must be compromised, and the way in which separation capability varies as front-back ratio changes is illustrated in Fig. 7.

The vertical axis of the graph indicates the signal level at the four output terminals of the decoder with a 1-kHz signal fed into the L_f input of the *encoder*. At the same time, a 3-kHz signal of varying level is fed into the L_b input of the encoder. Since the QS matrix in both encoding and decoding is rotationally symmetrical, only the separation of the L_f channel is measured in relation to the other channel. A plot referencing other channels would produce the same results.

The horizontal axis of Fig. 7 shows the ratio between the signal levels fed to the L_f and L_b terminals of an encoder. The right hand region of the graph is where the L_f signal is larger than the L_b signal. The left hand region is where the L_b input is greater than the L_f signal. From the graph we note that when only the 1-kHz L_f signal is applied, there is at least 20 dB of separation as far as the other three speakers are concerned. As the 3 kHz signal is fed with increasing amplitude to the L_b encoder input channel, it gradually causes reduced separation between the L_f program heard over the correct speaker and the amount of L_f heard from the other three speakers. When the L_b signal reaches the same level as the L_f signal, remaining

(continued on page 90)

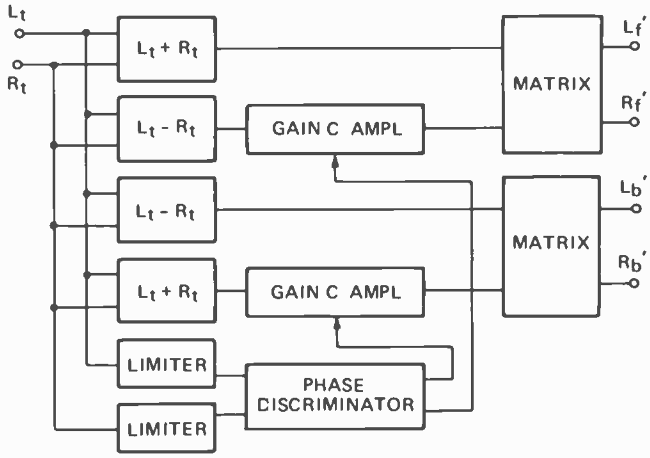


FIG. 5—BLOCK DIAGRAM OF QS Variomatrix decoder.

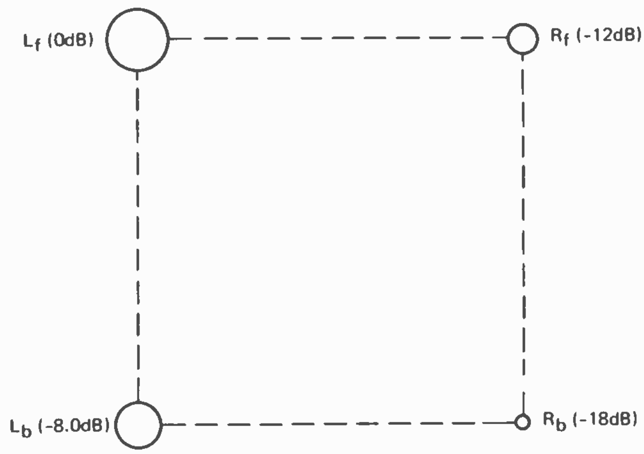


FIG. 6—DECODER OUTPUTS FROM EACH SPEAKER for an L_F signal, when front and back variable matrix coefficients are varied over the range from 0.3 to 2.0.

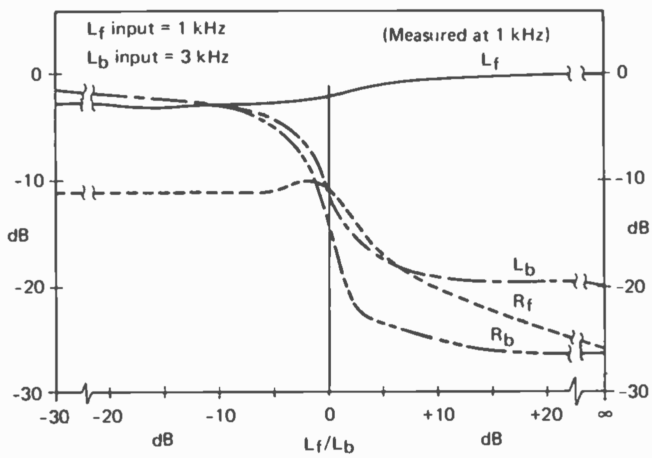


FIG. 7—SEPARATION OF A LEFT-FRONT SIGNAL as a second signal (L_B) is added in Variomatrix decode system

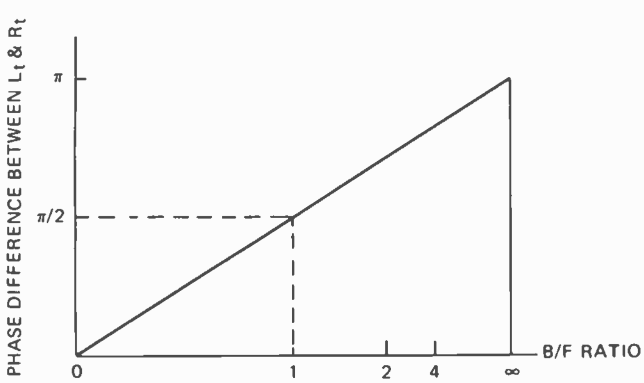


FIG. 4—PHASE RELATIONSHIP between QS encoded L_T and QS encoded R_T.

How Active Filters Work

Here are full details on how to build filters with op-amps instead of inductors. This stable and reliable method works for practically all audio and sub-audio low-pass, bandpass, and high-pass designs

by DON LANCASTER

FOR YEARS, PEOPLE WORKING ON CIRCUIT theory have been trying to do-in the inductor. This is especially true in the audio and sub-audio regions where inductors are inherently big, expensive, difficult to adjust, and subject to fields and hum pickup. After a lot of false trys and some rather poor ways of going about this, a batch of solid, reliable methods now exist that can do the job. Almost all these methods use low cost, readily available operational amplifiers. In most of the methods, the energy storage of an inductor is simulated by taking energy from a power supply and delivering it at the right point and in the right amount in a circuit to simulate exactly the bahavior of an inductor.

Actually most methods don't work *directly* on replacing inductors. Instead, they look at the whole picture and attempt to come up with a *functionally equivalent* circuit that does exactly the same thing that the original one did, but internally does it in a wildly different way. These functionally equivalent circuits are often called *active filters,* and an active filter is simply any circuit that uses at least one operational amplifier or its equivalent to simulate exactly a circuit that normally would need at least one inductor to get the same result.

A filter itself is any frequency selective network. Three popular styles are the *low-pass* filter that passes only low frequencies and stops higher ones; the *bandpass* filter that passes only a few or a range of median frequencies; and a *high-pass* filter that allows only high frequencies to reach its output. A rumble filter on a turntable is a high-pass filter. The tuning on an AM radio is a bandpass filter, and the treble cut control on a hi-fi is a form of low-pass filter.

A comparison

Before we go into the nuts and bolts details of how to build your own active filter, let's compare a simple active low-pass filter with an equivalent low-pass passive one (see Fig. 1). And, if we wanted to, we could select the L-C ratio of the passive filter or the ratio of C1 and C2 in the active filter to get a response that looks like Fig. 2.

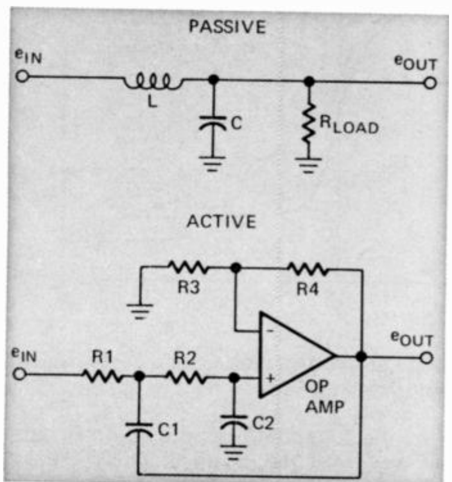


FIG. 1—LOW-PASS FILTERS. The passive L-C type is simpler, the active is more versatile.

The way we get the response differs for the two circuits, but the result is the same. In the passive filter, the inductive reactance increases and the capacitive reactance decreases as we increase frequency, shunting more and more signal to ground. In the active filter, we essentially have two cascaded R-C sections at very high frequencies that also shunts the signal to ground. The problem is that if we left the amplifier out of the circuit, the response would droop very sloppily and very badly around the cutoff frequency.

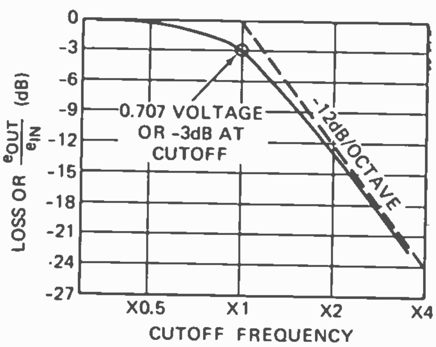


FIG. 2—RESPONSE OF LOW-PASS FILTER. Slope shown is 12 dB per octave.

What the op amp does is use circuit *feedback* via C1. It takes energy from the supply and introduces it in the middle of the R-C network to simulate exactly the same effect as energy storage in the inductor. Thus no R-C network by itself can ever hope to be as good as an L-C one, but an R-C network with some energy feedback controlled by an op amp is another story, and you can replace virtually any L-C network with a group of op amps, resistors, and capacitors. In fact, there's even things you can do actively that you can't with conventional circuits. Gain for instance.

We picked this particular response because it has the maximum possible *flatness* in the passband. It is called a *Butterworth* filter. If we try to steepen the response without adding any more parts, we'd get a hump in the passband, and the size of the hump would decide the *initial* but not the ultimate rate of falloff. Filters with humps are called *Chebycheff* filters if the humps are in the passband and *Elliptical* filters if the humps are both in the passband and the stopband. We could also make the response less flat and more gradual. This would improve the pulse response and overshoot at the expense of tilt in the passband and a more gradual rolloff. The best of these is called a *Bessell* filter. The term that controls the shape of the filter *near the cutoff frequency,* but not at very low or very high frequencies is called the *damping* of the filter. The damping is controlled by the L/C ratio in the passive filter and the C1 to C2 ratio in the active filter, or by holding C1 and C2 constant and changing the ratio of R3 and R4.

We picked the Butterworth here because it is the most popular and the easiest to use. We'll stick with Butterworth filters all the way through this story. Other types are just as easy to build. All you have to do is move the damping and cutoff frequencies around a bit.

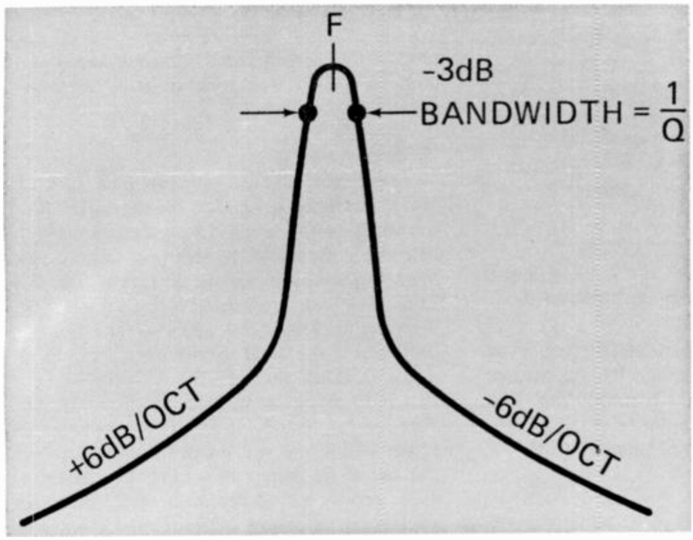
If we wanted something steeper than a 12-dB-per-octave rolloff, we'd have to add more parts. Two inductors and a capacitor would give you a 18-dB-per-octave filter, and two inductors and two capacitors would give you a 24-dB-per-octave rolloff, and so on. We call this the *order* of the filter. Second-, third-, and fourth-order filters have rolloff rates of 12, 18, and 24-dB-per-octave, and are the most popular normally used. Normally it takes one op amp for a second or third-order filter and two for a fourth.

Note that the damping of the filter controls the response near cutoff, particularly the flatness in the passband, the time delay and overshoot, and the *initial* rate of falloff. The order of the filter controls the ultimate or *asymptotic* rate of falloff for the filter.

Why go active?

The operational amplifier serves as a gain block with a very high input impedance and a very low output impedance. Its essential function is to provide for energy feedback to simulate the effect of energy storage in an inductor. Two nice benefits are the ability to drive any load and to use higher impedance (and almost always cheaper) components. So what are the benefits of an active filter? What do we gain and what do we lose when we go active?

The first and obvious thing we lose is the inductor, along with its cost, size, difficulty of adjustment, and sensitivity to hum and other magnetic fields. Note also that the passive filter has a load resistor. The value of this resistor is critical, for if you change it, the relative effects of the reactance changes of the inductor and capacitor



change and the response shape or the cutoff frequency may change. This is not true of the op amp active filter, for the op amp can drive most any reasonable load without changing the filter's response. We can vary the load from an open circuit down to anything the op-amp can reasonably drive without changing the response.

The input to the op amp is a very high impedance. This means you can use high-impedance resistors and capacitors for a given response at a given frequency. The benefits here are obvious. A high-impedance resistor costs the same as a low-ohms one, but a high-impedance capacitor is much smaller, and much cheaper.

Passive filters are inherently lossy, and the best we could expect to hope for would be slightly less than unity gain. With op amps and active filter designs, you sometimes can design for any circuit gain you want. Those we're going to show you have gains above unity.

Another big benefit is tuning. Large variable capacitors are nonexistent, while large variable inductors are expensive and a pain to adjust. On the active side, we have resistors R1 and R2 and surely changing them will change the response. For this particular circuit, we have to change *both* at once to change frequency without hurting the damping and response shape. This is easy to do with a dual pot, and we can easily get at least a 10:1 range. Even for slight tuning adjustments, the resistors are easy to change to get exactly the response you need. Because of this, active filters are generally more tuneable and easier to adjust than passive ones.

A final benefit is a bit subtle, but very important when we want a fancier higher order filter with faster cutoff slopes. We can *cascade* active filter blocks without any interaction, since they are free from fields and mutual inductance and since they generally have a high input impedance and a low output impedance. Cascadeability is a very big benefit. You normally can't simply cascade identical stages, for what was a -3-dB point becomes a -6 and so on. What you do is take the math expression for the higher order filter you want and *factor* it into second-order terms, and then build each second-order term separately. Generally, the individual block responses will be less damped and appear peaked when compared to the final result.

Disadvantages and problems

If active filters are so good, why doesn't everybody use them? First and foremost, it's because very few people understand or appreciate what they are and what they can do. But, over and above this, there are some limitations and disadvantages to their use. Let's take a closer look.

Obviously, we need some supply power and the noise characteristics of the op amp can effect very low-level signals. More important is the high-frequency limitations of the operational amplifier. As you increase operating frequency, an op amps open-loop gain decreases and its phase characteristics change so that you are limited to the upper frequency you can handle with a given operational amplifier.

For amplifiers like the 741 style or its dual and quad combinations, a reasonable upper frequency limit for active filters is between 20 and 50 kHz for low-pass and high-pass versions, and between 2 and 5

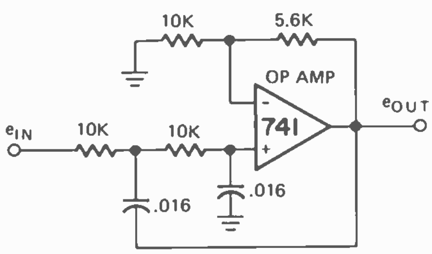


FIG. 3—ACTIVE FILTERS HAVE GAIN. Passive types are lossy circuits.

kHz for bandpass designs. If you go to a higher performance internally compensated amplifier such as the *National* LM318, you can work up into the hundreds of kilohertz. Finally, if you go to really exotic op amps you can work higher, and even microwave active filter structures have been built. Thus, we have an upper audio limit for active filters built with the cheapest available op amps and a fractional megahertz limit for op amps in the $3 to $5 class.

Bandpass filters need more gain for resonance and thus are generally limited to lower frequencies. One way around the problem is to distribute the problem among two or more op amps so that each only has to provide some of the gain.

The low-frequency limit is another story. It's decided mostly by how much you want to pay for big capacitors and how high you're willing to let impedances get. With FET op amps, this can be a bunch, and operation down below 0.1 *Hertz* is certainly possible. Thus active filters are ideal for such sub audio work as brain wave research, seismology, geophysics, and fields like this.

One limitation, and the big one, is called the *sensitivity* problem. You have to ask how the individual components in the active filter are going to change the response if they are out of tolerance or drift with time. For instance, if a particular parameter such as a gain or a capacitance value happens to have a sensitivity of 0.5, the result is a 5% change in cutoff frequency or damping for a 10% change in component value. On the other hand, if a 1% variation makes a 50% change in something you've got problems. This is clearly ungood. When picking a way to build active filters, you have to be aware of the sensitivity problems and how to use them. The method we'll be showing you in a minute is very well behaved at fixed low gains and for lower to moderate Q bandpass designs.

A final limitation is one of method. There are about a dozen good and proven ways to design active filters. These all vary with their ease of understanding and what they can and cannot do. Some can't handle all three basic responses. Some allow single resistor tuning; others allow separate tuning of bandpass gain, center frequency, and Q. Some are well behaved at certain gains, but at others are too highly sensitive or actually unstable. You have to pick a method that works for you, is reliable, behaves well, and

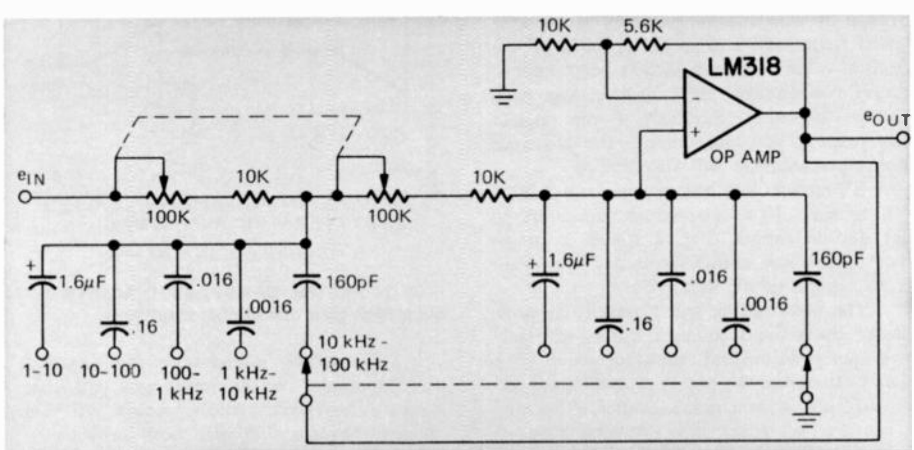


FIG. 4—AN ADJUSTABLE LOW-PASS FILTER covering from 1 Hz to 100 kHz in five frequency ranges. Switched capacitors select the bands, ganged potentiometers do the variable tuning.

does what you want it to. The one we'll be showing you is very easy to understand, stable and forgiving of component variations for fixed low gains, and useable in the bandpass case for low to moderate Q's. It usually takes two resistors simultaneously adjusted to tune, and in the bandpass case, you cannot separately set the Q, gain, and center frequency without a major change in components.

The method is called the *Sallen-Key* or Voltage Controlled Voltage Source (VCVS) method, and first appeared in the March 1955 *IRE Transactions on Circuit Theory*. Other popular filter methods are called the *Integrator Lag*, the Biquadratic *Section*, the *Multiple Feedback*, and the *State Variable*. Another type of active filter uses the *gyrator* or *impedance converter* but these generally take a bunch of parts and have a high-impedance output.

Building your own

So, now we should know *why* we'd want to use active filters, and *where* to go to get complete design details, let's concentrate on *how* to actually build one. Here's a second-order Butterworth low-pass filter with a cutoff frequency of 1 kHz and a gain of 1.6 (see Fig. 3).

The response is identical to the curve in Fig. 2 with f = 1 kHz, 2f = 2 kHz, and so on. As with any low-pass active filter, there must be a low dc impedance to ground at the source. Thus your source has to be less than 10,000 ohms and must provide a route to ground for the op amp's bias current. Again, the response is Butterworth, giving us the flattest possible passband, and an attenuation of -3 dB or 0.707 amplitude at the cutoff frequency, and smoothly falls off at -12 decibels per octave. This means that in the stopband as you double frequency, you get only one quarter the amplitude, and so on.

The above circuit looks deceptively simple and it is except, that a "magic" gain of 1.6 has been used that lets you use equal resistors, equal capacitors, and still have the desired shape. Change anything from the above, and the mathematics behave wildly. The circuit is forgiving of component variations and 5% components should be more than adequate for practically all uses.

To change frequency (in Fig. 1) you change R1 and R2 to identical values, or you simultaneously change C1 and C2 to new values. Raising R lowers the operating frequency. Raising C lowers the operating frequency. Thus, a 5000-ohm value instead of 10,000 ohms puts you at a 2 kHz cutoff frequency, and so on. A 0.032 μF capacitor value puts you at 500 hertz and so on. If you change one capacitor, you *must* change the other. Similarly if you change one resistor, you *must* change the other, or the response shape will also change.

It's easy to see how we can use a dual pot to tune 10:1 and switch capacitors to get decade ranges. Fig. 4 shows a circuit that covers any cutoff frequency you want from 1 hertz to 100 kHz:

The pot rotation will generally be nonlinear since the frequency varies inversely with pot rotation and resistance value. One way to linearize the pot is to use a dual audio log pot, with a normal taper if the dial is on the pot shaft and a reverse taper if the dial is on the panel.

If you just want one frequency different from 1 kHz, just calculate the capacitor value you need and change the capacitors, or change the resistors. It's simply the ratio of the capacitors equals the ratio of the frequencies and vice versa for the resistors.

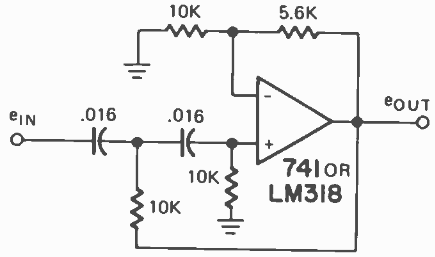


FIG. 5—IN HIGH-PASS FILTERS, the R and C shunt and series elements are transposed.

High-pass designs

The high-pass filter is a snap—you inside the circuit out and by a network principle called *duality* you're done. Fig. 5 is a 1-kHz Butterworth, second-order high-pass circuit.

We can now see another big advantage to the "magic" gain value of 1.6—this circuit lets us switch from highpass to lowpass with a 4pdt switch without any change of component values.

Steeper skirts

We can cascade two low-pass second-order sections to get a fourth-order Butterworth with a 24-dB-per-octave cutoff. We can't use identical sections, but we can make everything identical except for R4 (the feedback resistor) on each section. Finding the right R4 takes a lot of math, but here's the final circuit (see Fig. 6). It has an overall gain of 2.5:

The response is twice as good as before on a decibel scale. The passband is twice as flat and still drops only to -3 dB at the cutoff frequency of 1 kHz. The attenuation drops at 24-dB-per-octave, meaning that every doubling of frequency gives you only one-sixteenth the power and so on.

The higher performance circuit is somewhat harder to tune, since you simultaneously have to change four capacitors or four pots. Quadriphonic audio pots are a neat way to handle the tuning and they are reasonably available. Highpass to lowpass switching can be handled by a 8-pole-double-throw switch or two ganged 4-pole-double-throw pushbuttons, arranged so one is up when the other is down and vice versa.

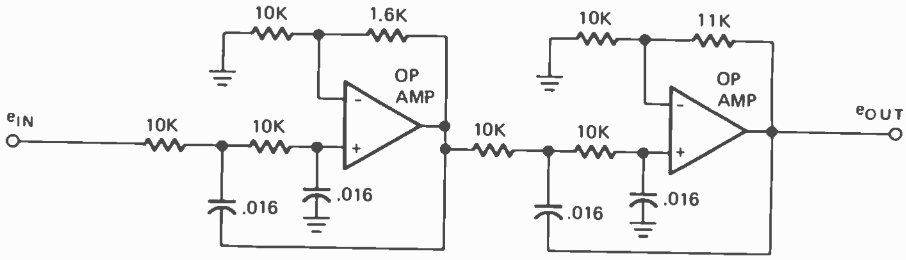


FIG. 6—TWO LOW-PASS SECTIONS IN CASCADE produce a fourth-order Butterworth filter with a rolloff slope of 24 dB per octave. The circuit's overall gain is about 8 dB.

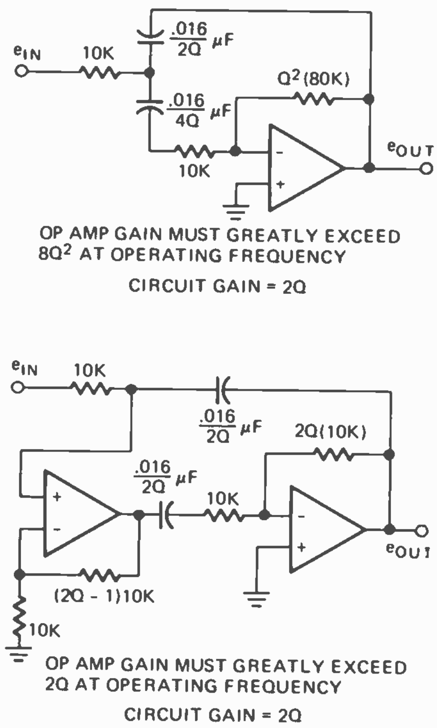


FIG. 7—ACTIVE BANDPASS CIRCUITS require high-gain operational amplifiers.

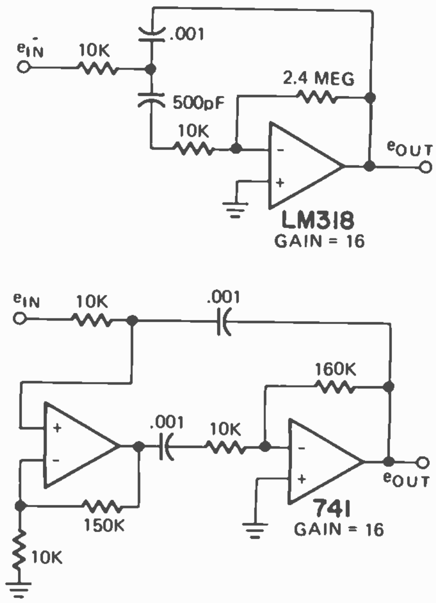
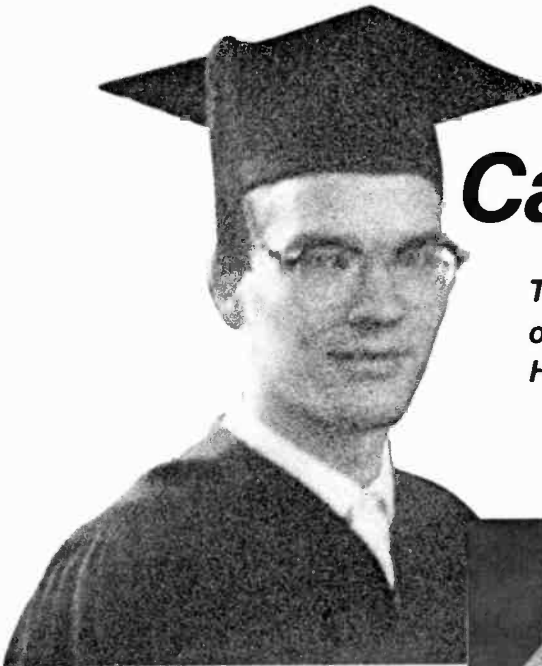


FIG. 8—CIRCUIT CONSTANTS for bandpass circuit where Q is 8 and frequency is 1 kHz.

You simply interchange the resistors and capacitors on the input and you now have a highpass circuit. Again, if you change frequency, change both resistors or both capacitors to identical new values, or else the response shape will also change.

Other orders and shapes of active filter

(continued on page 71)



Careers in Electronics

The high-school graduate has countless opportunities in electronics open to him. Here is a brief look at just a few of them

by JAMES A. GUPTON

EDWARD ALDREN CLIMBING down the ladder of the Lunar Module to walk on the moon.

"THE EAGLE HAS LANDED . . ." ACROSS 250,000 miles of space, from a spacecraft in orbit around the moon, came the voice of Michael Collen, July 20, 1969, to announce the successful landing of the first man on the moon. Within hours, the world saw and heard Neil Armstrong step from the ladder of the LM onto the surface of the moon and say, "That's one small step for man, one giant leap for mankind."

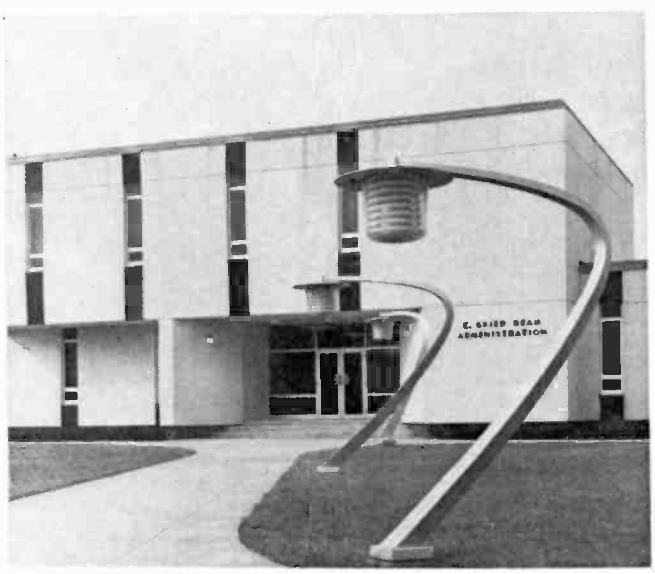
For centuries, man has dreamed about making the journey from earth to the moon. The dream began long before the dawn of the science of electronics. Yet it was electronics that made this journey possible. It was electronics that navigated the spacecraft through uncharted deep space, monitored the life support equipment and the physical health of the crew, controlled everything from launch to landing of the spacecraft and maintained the voice and television communications between the moon and earth.

This fascinating science of electronics is just under 70 years of age, but it is still in its infancy. Millions of new jobs will be created in electronics during the next decade. There will be a new super technician—the Engineering Technician—who will rise from the ranks of the nation's high school graduates.

The Engineering Technician will be in great demand. He will outnumber scientists and engineers by a ratio of 3:1. His job: be the "right arm" in research in the physical sciences, and in medical electronics. The Engineering Technician is no dream. He is real, he exists and his numbers are increasing daily.

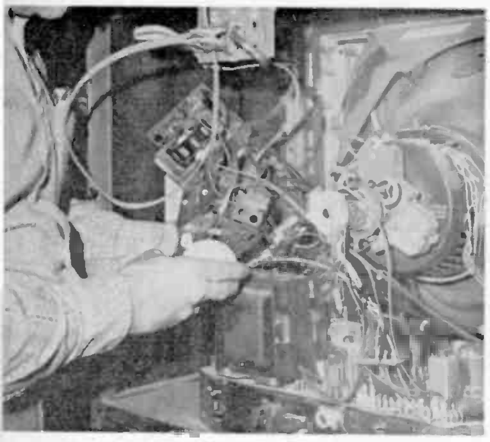
Every year our public and private high schools graduate more than 2 million seniors. Most don't continue on to college, many who do never complete the requirements for graduation. These 1.5 million young men and women are potential Engineering Technicians. They are needed in home entertainment, in broadcast engineering and in all of communications. Many will find electronic careers in the military, still others will qualify for electronic careers in state and federal agencies.

Becoming an Engineering Technician is not easy. Formal education

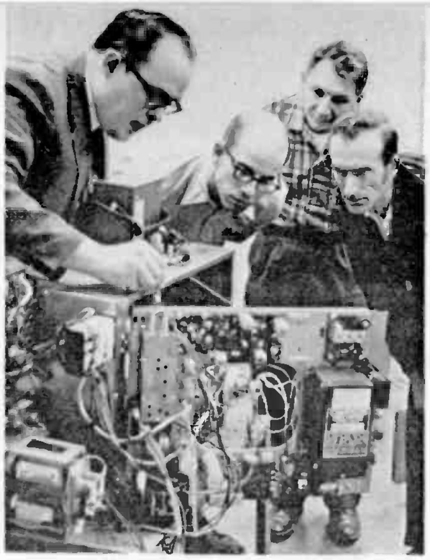


JUNIOR COLLEGES offer academic credits to those who wish to pursue their education to earn a college degree. Photo courtesy Gaston Country Junior College, Gastonia, N. C.

ELECTRONIC LOGIC and computer technology courses can be taken at many junior colleges Here's a look at the computer lab at Gaston county Junior College.



COLOR TELEVISION TECHNICIANS learn through correspondence courses. Photo, Quality Television Service, Charlotte, N. C.



THERE ARE NO ENTRANCE EXAMS or age barriers with correspondence school training. Courtesy Bell & Howell Schools

TWO-WAY RADIO TECHNICIANS require an FCC license to perform their precision work. Courtesy Two-Way Radio, Charlotte, N. C.

in electronics and years of on-the-job training to develop engineering experience are necessary. The technician, too, must acquire a good background in basic electronics before he can seek employment in his chosen field. However, getting your electronic training may be much easier than you expect. Let's explore some of the training possibilities available to the high school graduate.

Public school adult education

Over the years, high schools have launched programs for adult education. Here one can complete requirements for a high-school diploma or attend part-time night classes to expand your knowledge and skills in trade courses.

Basic electronics and specialization in radio and television receiver repair lead the list for most public adult education programs. Usually given three nights a week, these basic electronic courses require approximately nine hours a week for 39 weeks. Generally, these courses parallel the normal school year. Your basic training may be no further away than your nearest high school.

Technical education centers

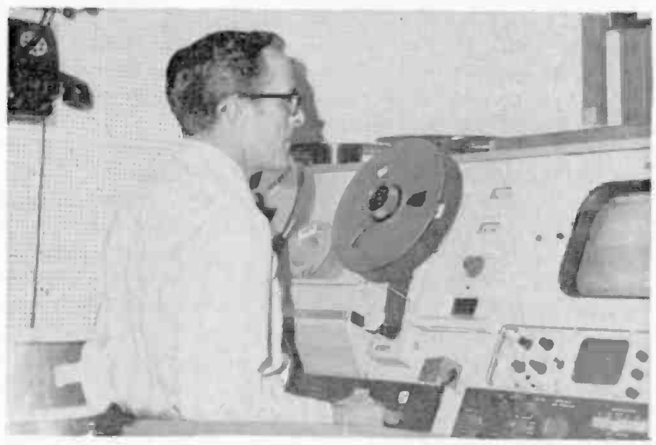
Technical education began to develop in the early 1960's when many states created special technical education agencies. Their multi-county sponsored technical centers have often become junior colleges awarding associate degrees in applied science. Like high-school adult programs, the technical education centers offer both technology and trade courses.

In electronics, your degree programs will require two years of study on a full-time basis or four years part-time. The trade programs usually run 12 months for full-time students and two years for part-time students.

Military schools

If you are classified A-1, you should consider one of the military electronic schools. The Dept. of Defense, which combines all branches of our military forces, lists over 40 military schools that train enlisted men in some form of military electronics.

VIDEO TAPE recording is one of the latest innovations in broadcast television. Photo courtesy TV station WBTV, Charlotte, N. C.



THIS RADAR will not net you a traffic ticket . . . it guides your plane to a safe landing. FAA Approach Radar Control, Douglas Municipal Airport, Charlotte, N. C.

AIR TRAFFIC control is under the FAA. Only the very best electronic technicians are entrusted with the safety of air line passengers. FAA Control tower at Douglas Muncipal Airport Charlotte, N. C.

ELECTRONICS STUDENTS in lab at Florence-Darlington Tech. Ed. Center, Florence, S.C.

AIR FORCE RADIO service technicians at work on airborne radio gear. USAF photo.

AT FLIGHT STATIONS for training as fleet replacement flight crew. U.S. Navy Photo.

Graduates get well-paying and challenging positions, along with world-wide travel. Guided missiles, nuclear ships, radar, air-traffic control and television broadcasting are just a few of the many electronic careers available through these schools.

Junior colleges

Here, also, one can earn an associate degree in applied science in two academic years as a step towards becoming an Engineering Technician. You may later transfer to a full-scale electronics program at a four-year college.

EARN YOUR FCC ticket . . . Many correspondence school grads become licensed broadcast radio and television engineers. Courtesy Cleveland Institute of Engineering

Apprenticeship programs

If you don't have time or a desire for formal training in electronics, give thought to on-the-job or apprenticeship training. Under the direction of the Department of Labor, apprenticeship programs incorporate classroom training with full-time employment. Apprentices follow a schedule of work progress and related book knowledge which leads to journeyman status in four years. Your apprentice's pay will be approximately 50% of what a journeyman gets; increases come as you add skills and knowledge. When you complete the four-year apprenticeship program, you receive a Certificate of Completion and become eligible to take city, county or state journeyman license examinations.

Correspondence schools

Another semi-formal approach for the graduate who does not have the time for formal education in electronics is a correspondence school. This type of training requires a strong-minded individual who can drive himself on.

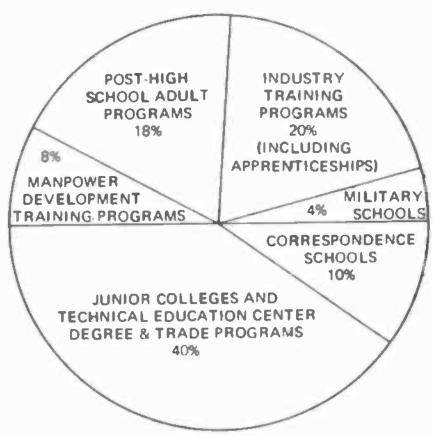
Correspondence courses offer the same basic electronic knowledge as more formal education programs; they lack only classroom discussion. Their laboratory practice is probably superior because you must assemble each lesson from parts while more formal schools have their students perform experiments on prefabricated plug-in modules.

A correspondence course requires 12 to 24 months to complete, depending on the time you have available. One school graduates over 5,000 students each year, which shows the popularity of this kind of training.

Which electronics technician schooling is the best? It depends on you. No school has a magic funnel to pour knowledge into you. Remember that the super technicians of today and tomorrow will come from high school graduates who prepare themselves for success. Even today there is a drive on to elevate the electronic technician to Engineering Technician. The Institute for the Certification of Engineering Technicians, striving to make the technician an ever more valuable member of the engineering team, recognizes three levels or grades of Engineering Technician: (1) the Associate Engineering Technician, (2) the Engineering Technician, and (3) the Senior Engineering Technician. Age, training, and experience are the criteria for the various grades.

Warning: when experience alone is the qualification for certification, the applicant must have the endorsement of three professional engineers and must also successfully complete an entrance examination.

To paraphrase Neil Armstrong, a high-school senior should make plans now to continue his education after graduation for his own "giant leap" in electronics. R-E



TECHNICIAN TRAINING by sources. Surely you can fit into one of these groups.

TECHNICAL TOPICS

by ROBERT F. SCOTT
TECHNICAL EDITOR

YOU HAVE ALWAYS SHOWN CONSIDerable interest in automotive electronics—particularly in the areas of safety and convenience—so when I saw the circuit in Fig. 1, I knew that I had to bring it to you.

On most cars built in the last two or three years, the parking lights are always on whenever the headlights are turned on. The safety factor in this arrangement is that if one headlight fails, an oncoming driver can immediately identify your vehicle as an automobile and determine its position on the road. Too, the oncoming driver is not likely to think that your vehicle is a motorcycle.

The circuit in Fig. 1, described by Mr. C. S. Fisher in *Electronics Australia*, shows a simple way to add this safety feature to your car. If the leads to the parking lights and headlights are available at the switch or some convenient spot under the dashboard, simply connect a diode (D1) between the lines to the parking light line and the "dip" switch as shown. If the light lines are more accessible in the fender wells or behind the grille, then you can use two diodes (D2 and D3) between the parking lights and the high- and low-beam lines.

Note that the diodes are connected so they are forward-biased when the headlights are turned on and back-biased when the parking lights alone are turned on. The diodes must be able to handle the total current of the two parking lights.

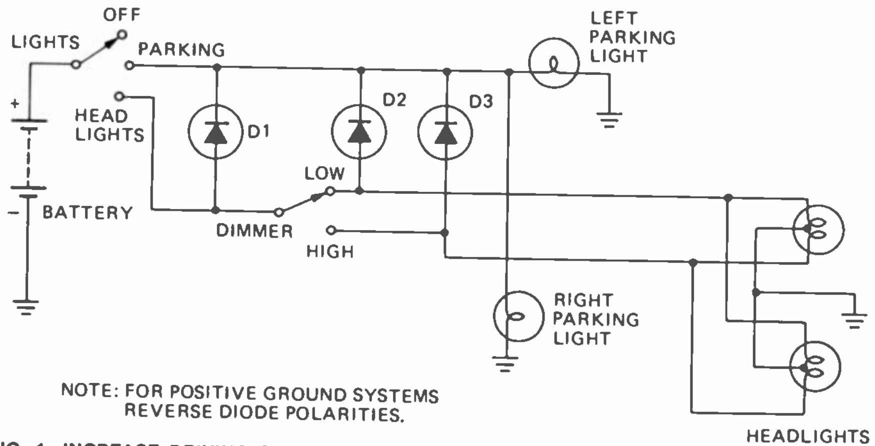


FIG. 1—INCREASE DRIVING SAFETY by tying parking lights to headlights as shown. With dual headlights, just connect D1 between the lines to the parking and low-beam lamps.

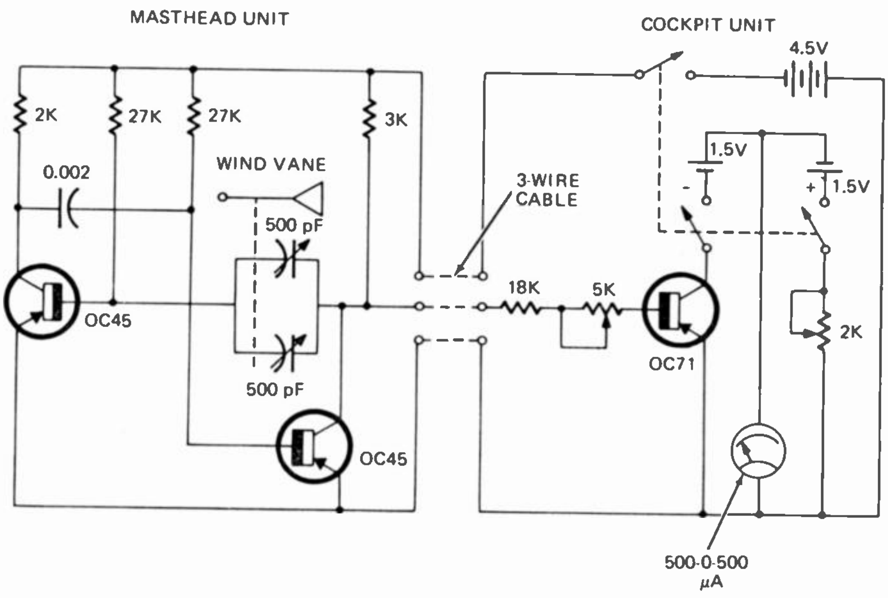


FIG. 2—SAILING DINGHYS and luxury yachts perform best at a critical angle between the heading and apparent wind direction. This circuit helps you get the most from your boat.

Something for the yachtsman

When sailing to windward, the performance of a sailing dinghy or yacht is determined by the relative angle between the boat heading and the apparent wind direction. During a study of the performance of sailing vessels by the Department of Aeronautics and Astronautics at Southampton (England) University, an electronic device for indicating the apparent wind direction was developed. This device (Fig. 2), described in *Wireless World*, is simple enough to be used on even the smallest sailing craft.

The masthead unit consists of a multivibrator whose time constant is controlled by a variable capacitor rotated by a wind vane. A simple zero-center transistor voltmeter measures the variation in the mark-space ratio of the multivibrator signal and indicates it as the angle between the boat heading and wind direction over a range of 0 to 120 degrees.

The capacitor in the masthead unit is a 2-gang 500-pF variable like that found in some old trf broadcast radios. You can substitute a 3-gang 365-pF unit. The vane is formed by extending the capacitor shaft and drilling the extension for a 10-inch length of 18 gauge steel rod. One end of the rod carries a plastic vane and the other a lead counterweight.

It is essential that friction be reduced to a minimum in the capacitor rotor. This can be done by replacing the rotor wipers with flexible copper braid and by cleaning the bearings and re-lubricating with a trace of clock oil. Install a setscrew to limit shaft rotation to 110 degrees. The circuit board carrying the multivibrator is mounted on the tuning capacitor

A selection of four practical circuits. Featured are one for your car and one for your boat. A 3-minute time delay and an audio filter are for the ham and SW listener.

and both are mounted vertically on the masthead as in Fig. 3. A 3-wire cable connects the transistor to the indicator.

To calibrate the device, open the capacitor plates 55 degrees, set the wind vane to point directly ahead of the boat and use the 2,000-ohm pot to zero the meter. Turn the vane 45 degrees on *either* side of the "dead ahead" position and set the 5,000-ohm pot so the meter reads plus *or* minus 450 μA as appropriate. As Fig. 4 shows, a 10-μA change is equivalent to a 1-degree change in heading or wind direction.

Time delay for transmitter control

In almost all high-power ham and broadcast transmitters, the tubes in the power supply and rf and af circuits should be allowed to reach full operating temperature before B-plus voltage is applied. In some equipment, a delay of up to 3 minutes should elapse between application of the filament and B-plus plate voltages.

Many broadcast transmitters are located out in the boondocks and are unattended, so some means must be provided for the necessary time delay and to provide for power interruptions. Similarly, many air conditioners, freezers and refrigerators require a minimum delay before power is reapplied following a power interruption.

Here is an electronic time-delay circuit (described by W. T. Maloney, in *Electronic Engineering*, London, England) that delays application of plate power up to 3 minutes, reapplies power immediately upon interruptions of up to 5 seconds and provides proportional delays for longer interruptions.

The circuit, Fig. 5 is based on a timer using a 2N2647 unijunction transistor. When the filament switch is closed, power is applied to the filaments and to the 50-volt control supply. RY2 is energized so its contact closes, connecting timing capacitor C1 to the 2N2647 emitter through the normally closed contacts of RY1. The capacitor charges through R1, R2 and D1 until it reaches a level equal to the unijunction's peak-point emitter voltage. (This is the point where the emitter-base-1 diode junction is forward biased and emitter current flows. The peak-point voltage can be considered as the unijunction's trigger level. The time required for C1 to charge to the peak-point voltage is determined by the setting of R5.)

At this point, C1 discharges

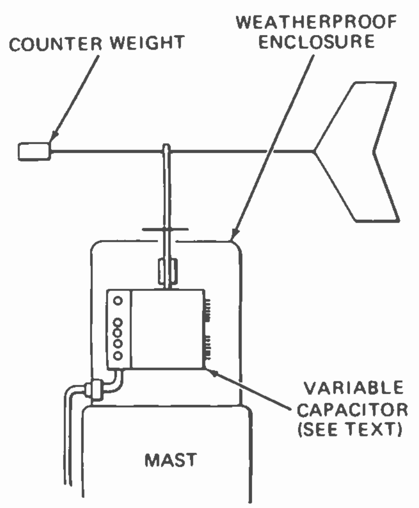


FIG. 3—WIND VANE on masthead controls mark-space ratio of a simple multivibrator.

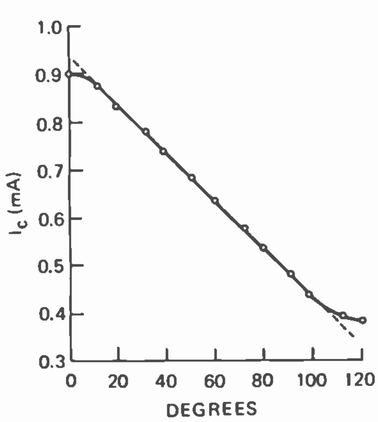


FIG. 4—CALIBRATION CURVE for the meter is linear over approximately 110 degrees.

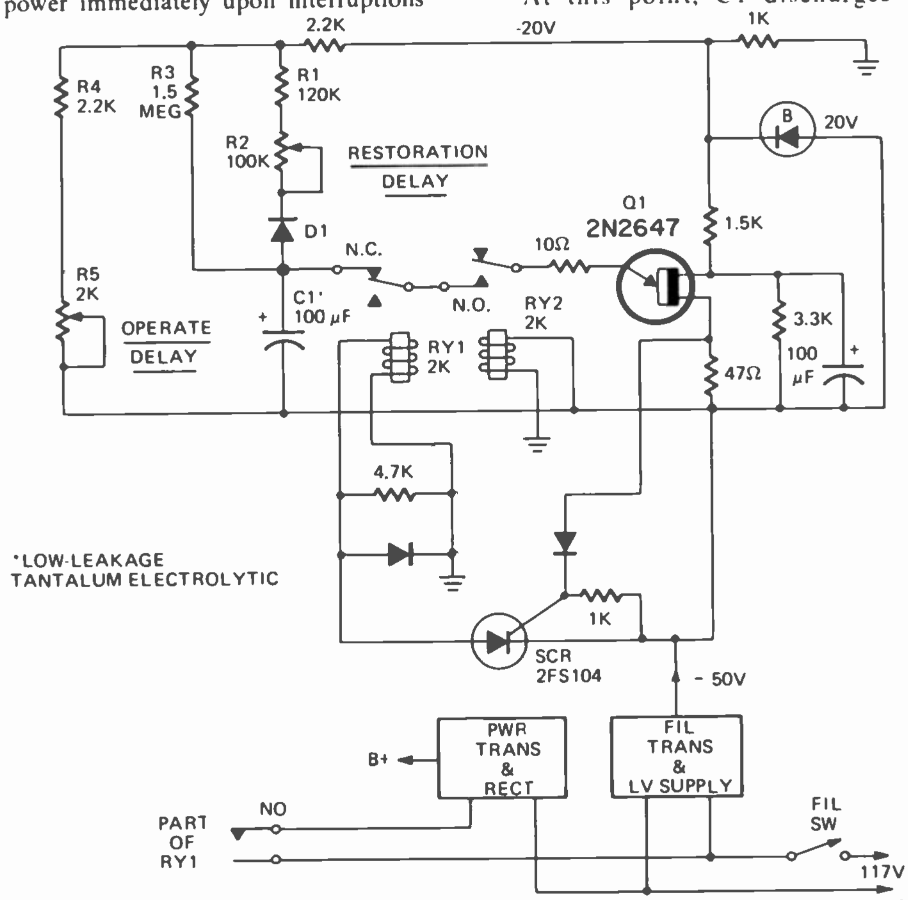


FIG. 5—TIME-DELAY CIRCUIT FOR TRANSMITTERS insures that the mercury-vapor rectifiers and high-power tubes reach operating temperature before B+ is applied.

through the emitter-base-1 junction and develops a voltage drop across the 47-ohm base-1 resistor. The voltage pulse across this resistor turns on the SCR and energizes RY1. The normally open (N.O.) contacts switch on the transmitter plate supply and the normally closed (N.C.) contacts break the circuit between C1 and the unijunction emitter. Capacitor C1 now charges to the level of the 20-volt line.

If the power is interrupted, the control voltage is removed and C1 starts to discharge through D1, R1, R2, R4 and R5. Relay RY2 is de-energized and its contact opens, preventing C1 from discharging through the emitter-base-1 diode of Q1. Filament and control voltages are applied as soon as power is restored. RY2 is energized, closing its contacts.

If power is restored within 5 seconds, C1 has not yet discharged below Q1's peak point voltage level, and Q1 fires the SCR and turns on the plate supply. If power is not restored before the charge on C1 drops below Q1's trigger level, the timer recycles and the time delay in reapplication of plate power is equal to the time required for C1 to charge to the Q1 trigger level. Potentiometer R5 is adjusted for the original time delay (3 minutes) and R2 determines the time delay after a short power interruption.

Phone and CW filter

Many inexpensive communications receivers can be improved and made more immune to interference by limiting circuit bandwidths to the minimum required for the particular mode of transmission. Fig. 6, from the amateur-radio column of *Le Haut-Parleur*, shows phone/CW filters that can be added to many receivers. Positions 1 and 2, for CW, provide passbands centered on 900 Hz with bandwidths of 400 and 200 Hz, respectively. Position 3 provides a bandwidth of from 300 to 3000 hertz for AM reception. Position 4 provides normal audio response with a resistive attenuator to provide the same amount of attenuation as the bandpass filters.

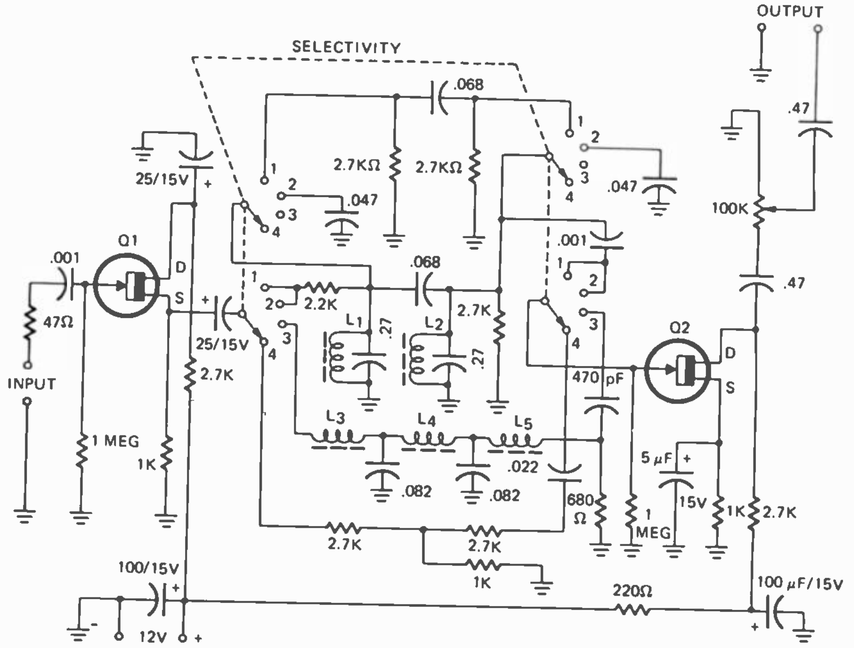
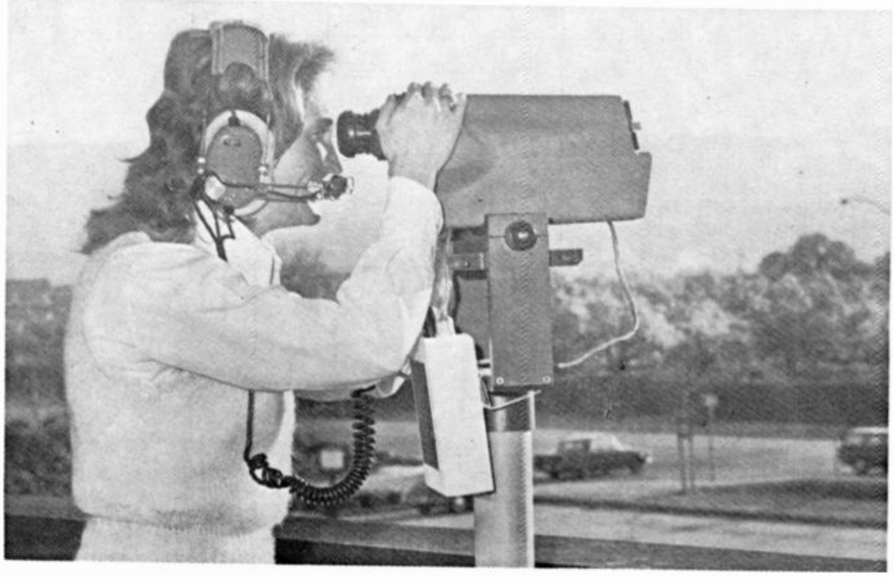


FIG. 6—SELECTIVE AUDIO FILTER for inexpensive ham-band and shortwave receivers. Its three degrees of selectivity should prove valuable in direct-conversion sets.

Transistors Q1 and Q2 are type EC300 FET's. Any similar N-channel FET may be used. Source-follower Q1 matches preceding high-impedance audio circuits to the filter networks while Q2 compensates for the filter attenuation. Toroids L1, L2, L3 and L5 are 88-mH units and L4 is a 124-mH toroid. These inductors are available as surplus components from several mail-order sources. R-E

laser communications

A new lightweight, hand-held laser communications system is now being tested by the Los Angeles police department. The instrument, demonstrated by Stabilized Optics Corp. of Cupertino, CA, operates with an infrared laser beam and has a range of at least 12 miles under good visibility conditions. Using infrared light as a carrier, with a beamwidth of only a quarter of a degree and an average power of half a watt (25 watts peak) transmissions are virtually undetectable.



The Los Angeles police are testing the unit primarily for communication between helicopters and police cars.

The 6-pound unit has a monoscope (one-eyed telescope) for keeping the other station in the beam, a radar transmitter with a 7 kHz pulse rate, and a modulation system that transforms voice messages into a digital code that is applied to the 7-kHz pulse frequency of the laser. The receiver translates the digital signals back into voice frequencies.

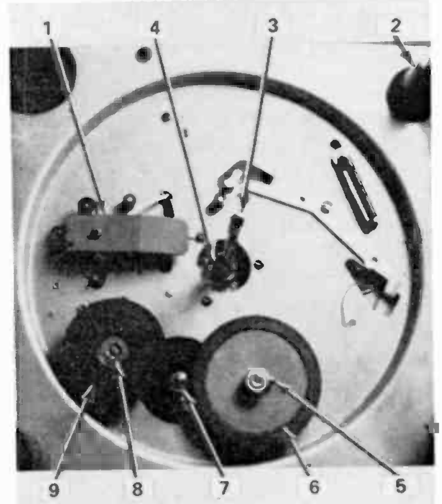
The specified range is 12 miles, but the system has had no difficulty in working up to 20 miles between airplanes and ground.

Particularly useful in police work, the system could also be used for communications between ships or planes, ship-plane or plane-airport communications. As a straight digital transmitter without voice modulation, it could be used for data transmission within cities, relieving pressure on overcrowded radio bands.

Servicing Record Changers- 21 basic steps

Record changers can be a problem to repair. Try the procedure spelled out in this article and eliminate the headaches

by ELLIOT S. KANTER



1. A.C. SWITCH
2. OVER ARM SHAFT
3. SPINDLE
4. PLATTER BEARINGS
5. DRIVE WHEEL SET SCREW
6. DRIVE WHEEL (NOT ON ALL TURNTABLES)
7. MOTOR SHAFT & PULLEY
8. IDLER WHEEL RETAINING SCREW (MIGHT ALSO BE "C" CLIP)
9. IDLER WHEEL

ACCORDING TO THE LATEST STATISTICS, home entertainment systems (stereo–hi-fi) represent a major portion of the average consumer's electronic investment. Stereos come in all sizes, shapes and prices from a budget-stretching portable to the most elaborate custom-installed system imaginable.

Basically, each system consists of some source or sources (tuners, tape players or record-players) an amplifier and speakers. It would be safe to say, that everyone reading this article has at least one record player or changer in his home, and frequently it needs repair or adjustment. Fortunately, the electro-mechanical record changer can be serviced quite adequately if you have the proper tools and know the proper techniques.

We will examine and repair a typical record changer and completely service it to the extent of rebuilding its motor. The techniques described in the motor disassembly portion are applicable to any small motor (drill, kitchen appliance, hair dryer, etc.) and will prove a useful aid in their repair.

Before we can begin to service the record changer, we must make sure we have the proper tools. A suggested list of tools and materials are in Table 1. These items represent a maximum investment of about $15.00, depending on how many of them you already have. Very few items are critical and a multitude of substitutes and sources are listed.

Figure 1 shows a common automatic turntable used by a great many manufacturers of home stereo systems. All systems, with only one or two exceptions will have the components described in this article and can be serviced in the same manner. Before we can service the system, we must first remove the platter to get at the various mechanisms. Using a screwdriver (Fig. 1) pry loose the C clip which holds the platter in place and remove the platter by lifting straight up. If the platter fails to lift freely, spray a little degreaser to free the main shaft and permit easy removal.

TABLE I
BASIC TOOLS & MATERIALS

ITEM AND ACCEPTABLE SUBSTITUTE
⅛-inch screwdriver
¼, ⅜, 7/32-inch wrench or Socket wrenches
Q-Tips or cotton swabs
Rubber Magic or denatured alcohol
Phono-Lube (GC1223) or General purpose oiler
Paper toweling (kitchen)
Degreaser (spray) or Tune-O-Wash

OTHER TOOLS NOT REQUIRED BUT HANDY
Universal changer power cord
4-lengths (approx 3-inch each) ½-inch wood dowel
Strobe-disc
Chain-nose pliers
Spray cleaner, Windex, 409
Spray wax

FIG. 1—TYPICAL RECORD CHANGER. Note that there is usually only a single C-clip holding the platter in place.

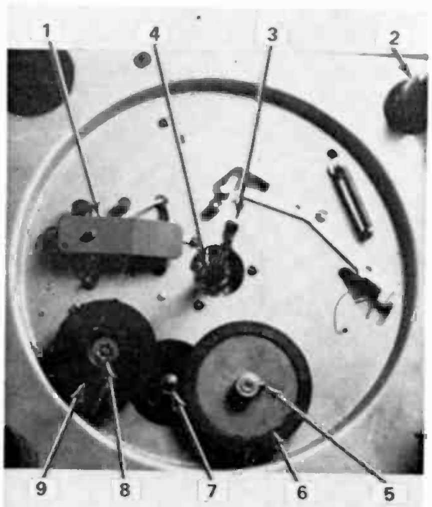
FIG. 2—DEAD RUBBER from idler wheels is a frequent troublemaker. Careful cleanup offers the best solution.

Figs. 2 and 3 are closeups of the inner mechanism of the typical record changer. Basically, most problems center around the idler wheel (Fig. 2) and the motor bearings (Figs. 6 and 7).

The idler wheel and the drive wheel (if the unit has one) are made of a rubber-type material and have a tendency to become brittle with age or develop a film which tends to cause slippage.

The motor shaft and bearings are subjected to dirt, grease build-up and a condition referred to as bearing freeze-up. This particular problem is a result of accumulated dirt, hair and grease which results in the bearings(s) becoming frozen or locked and the motor then overheats with absolutely no platter movement. In other cases, it creates a low-torque condition.

The cam-assembly identified in Fig. 5 is not usually a problem causer,



1. A.C. SWITCH
2. OVER ARM SHAFT
3. SPINDLE
4. PLATTER BEARINGS
5. DRIVE WHEEL SET SCREW
6. DRIVE WHEEL (NOT ON ALL TURNTABLES)
7. MOTOR SHAFT & PULLEY
8. IDLER WHEEL RETAINING SCREW (MIGHT ALSO BE "C" CLIP)
9. IDLER WHEEL

FIG. 3—WITH THE PLATTER OFF here's what you are likely to see. All important parts are identified.

unless the turntable has been rotated counter-clockwise. If this is the case, it is best to secure a replacement assembly as there are a number of tiny pins and levers which have been damaged beyond repair. The newer free-wheeling turntables are not subject to this kind of damage.

The actual overhaul of the record changer goes like this.

1. Remove the idler wheel and the drive wheel (if the unit has one) by loosening the screw(s) or removing the C clips holding it in place.

2. Saturate a piece of towelling with Rubber Magic and rub the edges of both wheels to remove the dead rubber and all traces of film (Fig. 4).

FIG. 4—CLEAN IDLER AND DRIVE wheels thoroughly. Dry with a separate piece of clean towelling.

After thoroughly rubbing the edge(s), go over it again with a clean towel to remove all traces of residue.

3. Completely clean the shaft the idler wheel was mounted on and also the motor pulley. A cotton swab moistened with Rubber Magic will facilitate a thorough cleaning.

4. After the idler wheel shaft has been cleaned apply a drop of lubricant (oil or Phono-Lube) and allow it to drip down the shaft.

5. Remove the C clips (Fig. 6) holding the motor to the bottom of the record changer.

6. Scribe (scratch) a mark on the motor housing (Fig. 8) for alignment purposes.

7. Remove the motor from the base and disassemble by removing the screws.

8. Refer to Fig. 11, and liberally spray the upper motor bearing and shaft with the degreaser. Then, apply a drop of lubricant to the shaft and work it (the shaft) in and out of the top bearing. Continue adding lubricant a drop at a time until the shaft shows no trace of dirty oil deposits or grease and spins freely. At this point apply a single drop of lubricant to the top bearing and set the assembly aside.

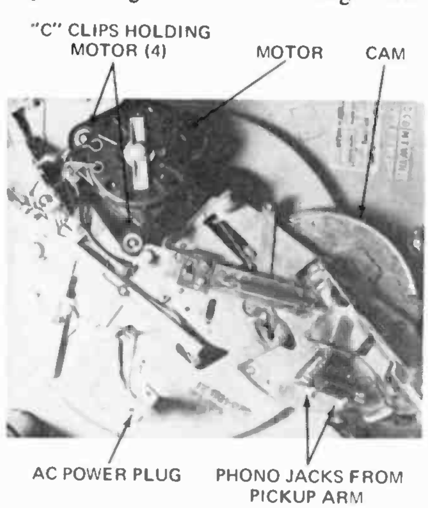


FIG. 5—CAM ASSEMBLY is usually not a problem unless turntable has been accidentally rotated backwards.

FIG. 6—C CLIPS hold the motor in place. Remove them, then the motor, to get at the upper motor bearings.

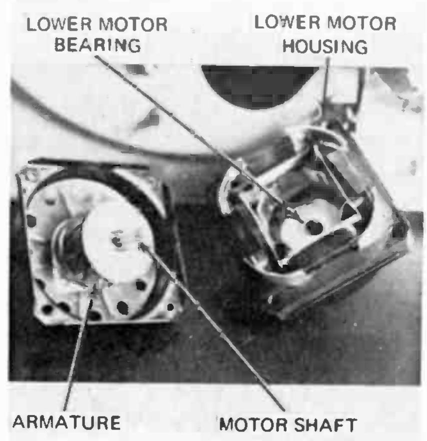


FIG. 7—CHECK THE LOWER BEARING for traces of dirt or other foreign matter. Clean with cotton swab.

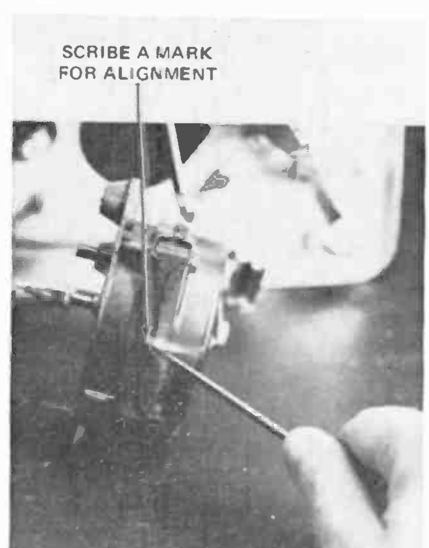
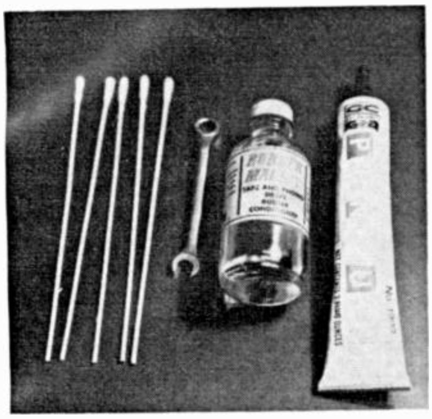


FIG. 8—SCRIBE A MARK on the motor housing to insure proper replacement positioning when you finish.

9. Examine the lower bearing (Fig. 7) for any traces of dirt or foreign matter. Spray it completely with the degreaser. Saturate a swab with oil and clean the inner surfaces of the bearing. Rotate the swab in the bearing opening while adding a drop or two of oil to clean the side surfaces.



TURNTABLE CLEAN-UP KIT consists of cotton swabs, hypodermic-type oiler, solvent, and lubricant.

10. After cleaning and freeing the lower bearing, apply a single drop of lubricant to the bearing opening and set it aside.

11. Reassemble the motor, line up the mark made in step 6. Before tightening the screws down, tap (lightly) the lower bearing housing with a screwdriver handle while spinning the shaft. This balances the motor shaft and insures that it is correctly seated in both the upper and lower bearings. Now tighten the screws completely. At this point you could utilize the 'universal' power cord to check motor operation, this is not necessary.

12. Replace the motor and secure it with the four C clips removed in step 5.

13. Using a saturated towel (Rubber-Magic), wipe the inside rim of the platter clean of rubber residue (Fig. 9).

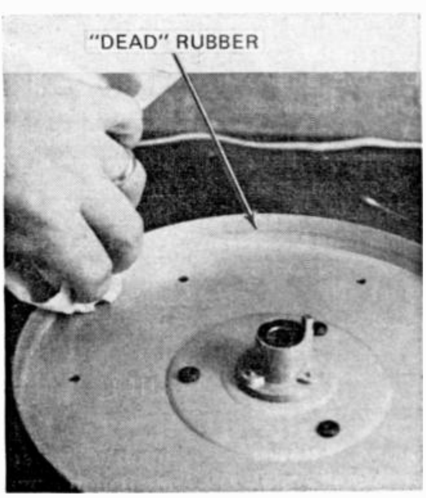


FIG. 9—WIPE THE INSIDE RIM of the platter clean of rubber residue. Use a towel saturated with solvent.

14. Refer to Fig. 3 and remove the platter bearings. Clean and lightly lubricate them and replace in *same* order removed.

15. Lightly apply a tiny amount of Phono-Lube to moving parts located on the underside of the changer. Too little lubricant is much better than too much!

FIG. 10—IDLER WHEEL HEIGHT must be set properly to insure that the motor pulley mates properly.

16. Carefully replace the cleaned idler wheel and the drive wheel on their respective shafts, and secure. Manually operate the speed selector and observe the relative position the idler wheel takes in respect to the motor pulley. It should be approximately centered in each of the increments of the pulley (16-33-45-78). If it is not centered use the idler wheel height adjustment (Fig. 10) to raise or lower the wheel as required.

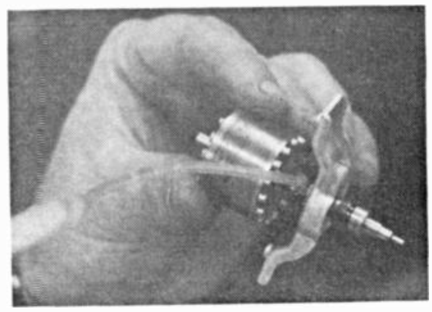


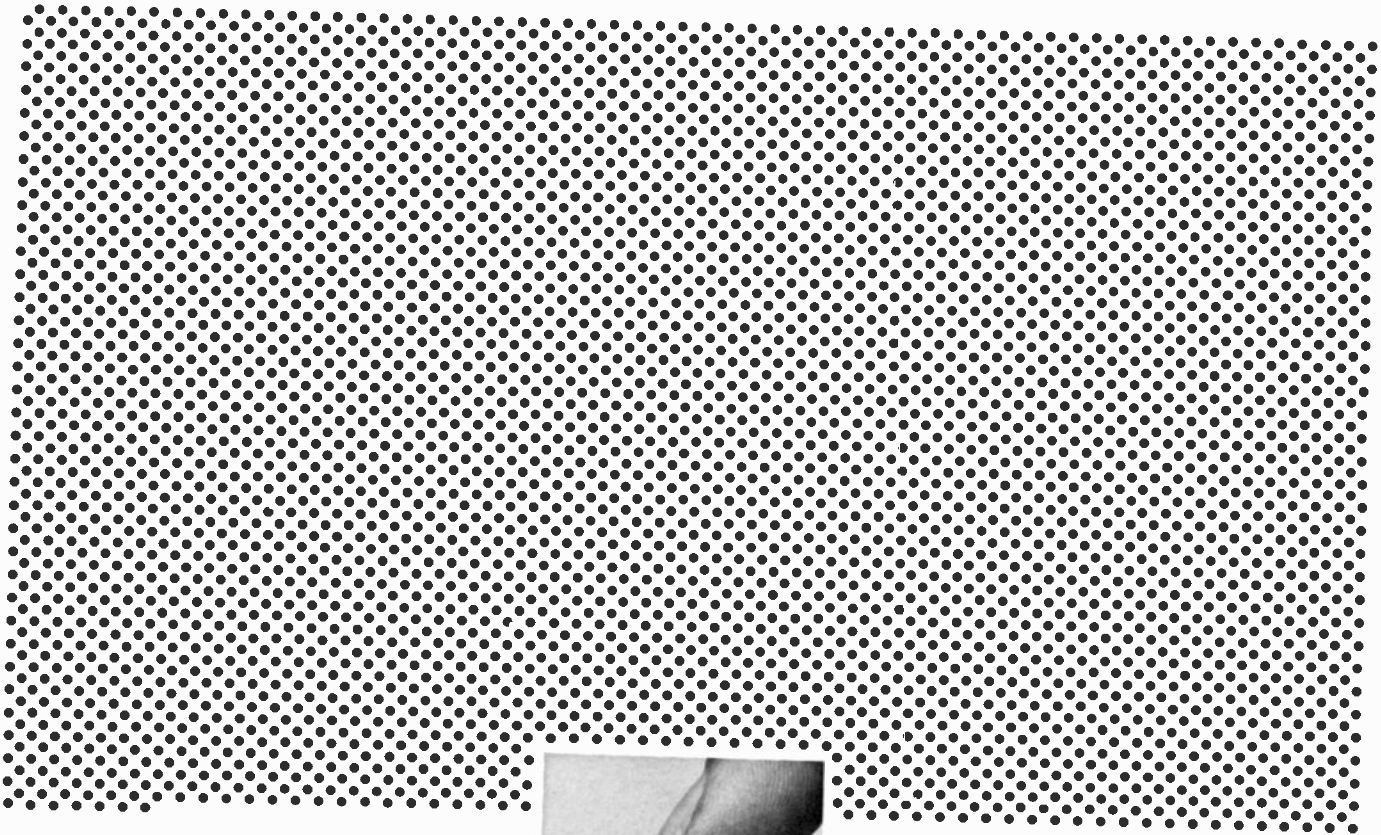
FIG. 11—DEGREASE, THEN LUBE the upper motor bearing before replacing the motor on the turntable.

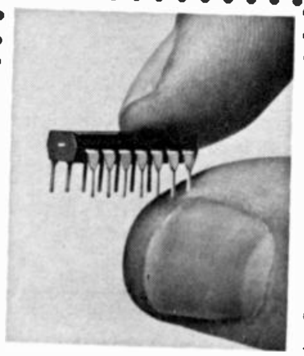
17. Replace the platter with a slight spinning (clockwise) motion to seat the platter and position the idler

(continued on page 71)

TABLE II—TROUBLESHOOTING CHART

SYMPTOM	CAUSE & CURE
Audio:	
1. Buzz in output one or both channels	Poor ground connection to cartridge, turntable, bad connection to cartridge, check and correct.
2. One channel dead, phono only	Shielded cable open, or bad wire in pickup arm, test cable by substitution, repair or replace.
3. Muddy sound, distortion	Glob of dust/dirt on stylus, or worn stylus; remove dirt or replace stylus.
4. Intermittent sound, low output	Test cartridge by lightly applying pressure to pickup arm while playing *OLD* record, if pressure corrects problem, replace cartridge.
Mechanical:	
1. Arm slides across record	Bad stylus, replace.
2. Arm sets down too soon/late	Readjust set-down, adjustment screw located in rear of pickup arm assembly, turn as required.
3. Won't auto-cycle	Check overarm, must be free, clean and oil, if bent, straighten, check, clean idler wheel.
4. Arm sets down in middle of record	Check to see size is set for 12-inch, or speed for 33⅓ rpm.
5. Won't turn	Motor frozen, clean, free bearings, oil as described in text.
6. Slows in cycle or erratic speed	Clean and reface idler wheel, oil upper motor bearings (1-2 drops) check idler wheel height.
7. Won't cycle 45's	Check speed, idler wheel height, replace 45 adapter.





4,000 functions in a single LSI circuit. *The functions of four thousand separate transistors, represented by the dots above, can now be performed by the LSI circuit shown in the photo.*

LSI...will it make or break your job future?

The development of LSI (large scale integration) technology in the 1970's is the dawn of the newest revolution in Electronics. It means that many of today's job skills soon will be obsolete. But at the same time, it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the Science of the Seventies and how you can learn it right at home.

LSI circuits, some no bigger than a bumblebee, are bringing about a fantastic new Industrial Revolution. Already these miracles of micro-circuit technology are a part of exotic equipment that saves lives, works complicated mathematical formulas in an instant, or tells time within a tolerance of two seconds per year.

LSI's may also put you into a whole new and more rewarding career . . . or put you out of a job!

In the fall of 1972, BUSINESS WEEK reported, "Because of its fast pace of innovation, the U. S. semiconductor industry leads the world. In the LSI market, U. S. domination is even more pronounced."

A single LSI circuit now can perform the function of more than 4,000 components and scientists predict that the use of electron beams to trace the circuit patterns will soon make it possible to put 10,000 transistors and similar devices on a silicon chip a few millimeters square.

Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new computer/calculator that weighs only nine ounces, fits easily into a shirt pocket, yet in a split second performs logorithmic, trigonometric and mathematical functions with a single keystroke and 10-digit accuracy. And new, extremely accurate watches consisting only of a quartz crystal, LSI circuits and a solid-state time display take only minutes to assemble.

And this is only the beginning.

Soon kitchen computers may keep the housewife's refrigerator stocked, her menus planned, and her calories counted. Her vacuum cleaner may creep out at night and vacuum the floor all by itself.

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

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

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

New Opportunities for Trained Men

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

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

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

There simply won't be enough college-trained engineers to go around. So men with high school educations who have mastered the fundamentals of electronics theory may soon fill really interesting, high-pay jobs as engineering aides, technicians and service specialists.

How To Get the Training You Need

You can get the up-to-date training in electronics fundamentals you need and do it at home in your spare time without giving up your present job or income. Cleveland Institute of Electronics courses are specially designed for home study and feature AUTO-PROGRAMMED® Lessons. Even if you have no experience in Electronics or had trouble studying before, CIE courses help you advance faster and easier than you would have believed possible. You learn at your own pace.

Unlike a classroom situation where you have just one instructor throughout the course, at CIE you get help from a number of instructors. Each is selected on the basis of his specialized knowledge of a particular area of Electronics. In this way, you benefit from the combined knowledge of our entire staff.

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RE-24

Circle 13 on reader service card

Understanding COMPUTER Arithmetic

THE LARGE SCALE AVAILABILITY OF economical electronic calculators has stimulated a revived interest in electronic arithmetic. Sure, everyone knows electronic computers and calculators use a binary number system, but how does the binary system change a series of keyboard entries into a solution? In this article, the latest in a continuing series on electronic calculators, the binary system will be thoroughly explained, and some fundamental binary counting circuits will be described.

The first computing systems were mechanical and used familiar number systems to perform calculations. The abacus and more complex mechanical calculating machines operate with the decimal system since their mechanical nature makes it possible to form the ten digits required for the decimal system. The abacus, for example, signifies decimal numbers by bead placement, while more sophisticated mechanical calculating machines do the same thing using gears that have an appropriate number of teeth.

The use of binary or two-digit number schemes for control and arithmetic operations is not new. The early player piano is an excellent example of how a simple on/off code (absence or presence of a hole in a paper scroll) can be used to control a relatively complex instrument. The simplest type of electronic circuit that gives a two-position code is the on-off switch. The logic functions of the basic mechanical on-off switch can be automated by using conducting or nonconducting transistors, relays, SCR's, FET's, and other bistable components.

While the binary system is basically simple, most people find it awkward at first since they have been conditioned to count with the traditional base 10 or decimal system. To design and use binary logic, it is important to understand the binary numbering system. Fortunately the system is relatively easy to understand if a few basic rules are remembered.

In any number system, the position of a digit determines its significance as well as the digit value. Consider, for example, the number 732:

$$\begin{aligned} 732 = 7 \times 10^2 &= 700 \\ 3 \times 10^1 &= 30 \quad \text{add} \\ 2 \times 10^0 &= 2 \\ \hline & 732 \end{aligned}$$

This breakdown of a number shows that the position of each digit determines which power of ten the digit is to be multiplied by. For readers a little rusty in math, any number raised to the 0 power equals 1 ($10^0 = 1$; $2^0 = 1$; etc.). Also, any number raised to the 1 power equals itself ($10^1 = 10$; $2^1 = 2$; etc.). The binary system has the same position characteristics as the decimal system, except that the multiplier is a power of 2 instead of 10. Also, the binary system allows only two digits: **0** and **1**.

The following example shows the composition of a typical binary number:

$$\begin{aligned} 1001_2 = 1 \times 2^3 &= 8 \\ 0 \times 2^2 &= 0 \\ 0 \times 2^1 &= 0 \quad \text{add} \\ 1 \times 2^0 &= 1 \\ \hline & 9_{10} \end{aligned}$$

Note: *Subscript* $_2$ *denotes binary system while subscript* $_{10}$ *denotes decimal system*

You can test your understanding of binary numbers by performing the above operation for several binary numbers. In addition to improving one's understanding of binary arithmetic, the technique is handy for converting binary to decimal notation.

The following table has the binary numbers for 0 through 9 already worked out:

Decimal (Base 10)	Binary (Base 2)
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

The four-digit binary numbers shown in the table are important in calculator operation. They are called binary coded decimal or BCD for short. The significance of BCD is that all ten decimal digits can be represented by a four-digit binary code.

Now that binary numbering has been explained, let's get into arithmetic. Binary addition is performed in a similar manner to decimal addition. The only difference is that a carry occurs if the sum of two binary digits is greater than 1. The following examples demonstrate this principle:

(a) $1 + 1 = 10_2 = 2_{10}$

(b) $10 + 101 = 111_2 = 7_{10}$

(c) $11 + 11 = 110_2 = 6_{10}$

(d) $1011 + 1101 = 11000_2 = 24_{10}$

To gain a better understanding of binary addition, try several other examples and check the results by converting to the decimal system and adding.

Binary subtraction uses similar techniques, and in most computing circuits subtraction is performed by *complementary addition*. Multiplication is normally performed by repetitive addition, and division by repetitive subtraction. The result of these operations is highly significant since all four basic arithmetic operations can be performed with a binary adder circuit.

Binary calculations may seem slow when done by hand, and repetitive addition and subtraction to multiply and divide may seem inefficient. But electronic counting circuits are so fast that binary operations are performed quite rapidly. For example, a typical calculator, such as the MITS 1440, can add two 56-digit binary numbers in less than a millisecond and can multiply the same numbers in approximately 180 ms. The MITS 7400 scientific calculator is even faster and can add two 76-bit binary numbers in approximately 120 ms.

*President, Micro Instrumentation and Telemetry Systems, Inc. (MITS)

The arithmetic of the computer and its relative, the calculator, is performed by combinations of logic circuits. Graphic symbols for logic elements simplify schematics and make understanding and troubleshooting easy.

by H. EDWARD ROBERTS*

Logic circuits

Three basic types of gating circuits can be used to implement almost any logic requirement. They are AND gates, OR gates, and NOT circuits. An example of a typical complex logic requirement is a BCD to 7-segment decoder. This logic circuit converts the BCD code for a decimal number into the correct drive signals for a 7-segment display. Over 70 gates are required to do this conversion. Fortunately for the logic designer, 7-segment decoders are available as single integrated circuits from many semiconductor manufacturers. There are many other cases where single IC's are available for complex logic operations, but there are also many where the logic designer must build up circuits with individual gates.

Before describing the various types of logic circuits in more detail, a few words on symbology are in order. Until very recently, literally dozens of logic symbol systems were in use. Fortunately a standard set of symbols has been developed and is known as MIL-SPEC 801B. These standard symbols are now used by most semiconductor manufacturers, and they are used in this article.

AND gates

The AND gate is a circuit which requires a 1 signal on all of its inputs to give a 1 signal at the output. Any other condition will produce a 0 on the output. Normally 1 is represented by a high voltage state while 0 is represented by a low or zero voltage. Fig. 1 shows the standard logic symbol for an AND gate.

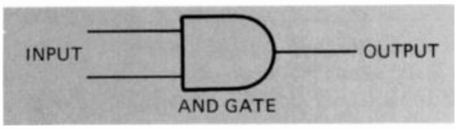


FIG. 1—GRAPHIC SYMBOL for the AND gate—one of the basic logic elements.

OR gates

The OR gate will produce a 1 on its output when a 1 appears on any of its inputs. If there is no 1 at the input, the output will always be 0. The standard logic symbol for an OR gate is shown in Fig. 2.

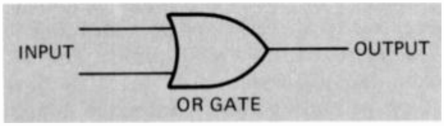


FIG. 2—OR-GATE SYMBOL is concave on the input side and pointed on the output side.

NOT circuits

A NOT circuit is simply an inverter that complements the input signal. Since there are only two binary states, it follows that a NOT 1 is a 0 and vice versa. The NOT circuit is represented as a triangle.

NAND and NOR gates

In practice the most common logic circuits are NAND and NOR gates. These circuits are simply AND and OR gates followed by an inverter (NOT circuit) on the output. The symbols for NAND and NOR gates are shown in Fig. 3. Note the symbol for the NOT circuit which follows two of the symbols.

The operating rule for a NAND gate is that a 1 on both inputs will produce a 0 on the output. The operating rule for a NOR gate is that a 1 on either input will produce a 0 on the output. Note that the preferred symbol for both gates as shown in Fig. 3 condenses the triangle NOT gate into a small circle at the output. This same shorthand technique can be used where the input requires a 0 to activate the output. Fig. 4 demonstrates this important concept in logic design and analysis with the appropriate symbols. The reader should verify that the circuits are really equivalent by tracing various input conditions through each.

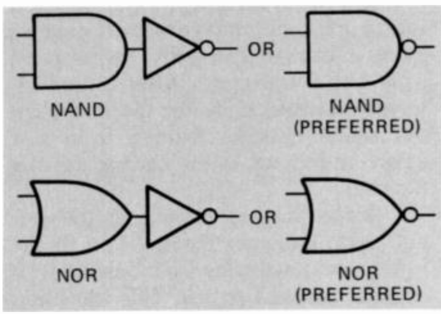


FIG. 3—GRAPHIC DIAGRAMS of logic circuits are simplified by preferred symbols.

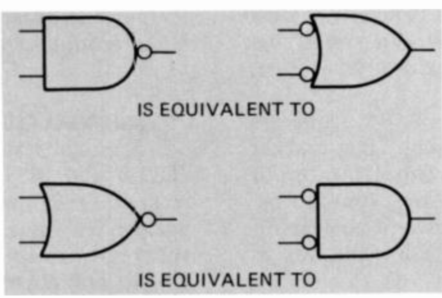


FIG. 4—THE SMALL CIRCLE on the lead shows inversion occurs at the circuit output.

Binary adder circuit

Now that the basic logic circuits and functions have been explained, let's connect several together to form a practical system. Fig. 5 shows how several gates can be connected to form a two-bit binary adder. To illustrate how this adder operates, assume that input bit B_1 is a 0 and bit B_2 is a 1. A 0 and 1 into A_1 produces a 0 on the output, and this indicates there is not a carry in the answer. The output of 0_1 is a 1 and the inverter I_1 also has a 1 output. The two 1's into A_2 results in a 1, the correct sum of 1 and 0, on the output of A_2. To verify operation of the adder, try other combinations and see if they result in correct answers.

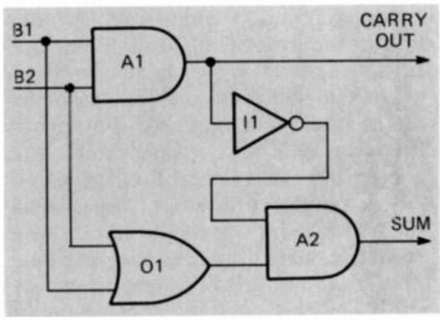


FIG. 5—A TWO-BIT BINARY ADDER is formed from 2 AND's, 1 OR gate and inverter.

Flip-flops

Three classes of flip-flops are commonly used in computing circuits: bistable multivibrators, monostable multivibrators, and astable multivibrators. All flip-flops have two outputs, and these outputs are always complements of one another. For example, if one output is a 0, the other will be a **1** and vice versa.

1. Bistable Multivibrators have many forms, but all are characterized by their ability to maintain an output condition until this state is changed by a new input. This type of flip-flop is by far the most common in digital circuitry. They are used to store data in memories and shift registers, count, act as frequency dividers, remember status of logic circuits, and in other operations. The most common bistable flip-flops are the J-K, the R-S, T, and D. It is beyond the scope of this article to discuss each flip-flop individually, but knowing each changes its output state only when directed to do so by the input permits an understanding of any particular type. All that is required is to study the input logic table for each flip-flop in question. This information is provided by the manufacturer in the device's specification sheet.

2. Monostable Multivibrators (monostable flip-flop) has only one stable state and always returns to this state a predetermined time after being activated. The time period is usually determined by an R-C time constant. Monostables are used primarily for synchronization and timing, and the number of them in a particular logic circuit is generally quite small in relation to the number of bistable circuits. In fact, many experienced designers judge the merits of a logic design by the number of monostable flip-flops it incorporates (the more used, the poorer and less efficient the design).

3. Astable Flip-Flops, also known as free-running multivibrators, have no stable state. Instead, they oscillate with a period usually determined by an R-C time constant. This type of circuit is commonly used as the basic timing generator or clock in most calculators. The frequency stability of astable circuits is limited to about ±20% in most production designs, and these relatively large errors prevent its use in precision timing circuits.

Typical flip-flop applications

Typical flip-flop applications include counting and frequency division, operations which can be performed by a typical type "T" flip-flop. The type "T" flip-flop shown in Fig. 6 has the

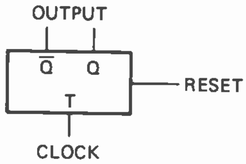


FIG. 6—TYPE "T" FLIP-FLOP's output changes state when input switches from 1 to 0.

characteristic that whenever the input signal at T changes from a **1** to **0** state, the output of the flip-flop will change. In the figure, the bar over output Q̄ is read "not Q", meaning it is inverted from the Q output. The input labeled RESET will clear the flip-flop by setting the Q̄ output to **1** and the Q output to **0**.

To see how a circuit containing only three type T flip-flops can be used for counting and frequency division, see Fig. 7. Fig. 8 is a timing diagram which shows the relationship of the flip-flop outputs (Q) to one another and the input signal.

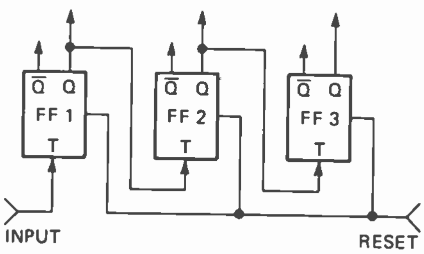


FIG. 7—DIVIDING BY EIGHT is easy. Use three "T" flip-flops connected as shown.

Before the flip-flops are activated, a reset pulse is applied to set all the flip-flops in the counter to zero. At t_0 the input signal changes from a **1** to a **0** and this causes FF1 to change from a **0** to a **1**. Even though this output is fed to FF2, no change occurs on FF2 since a change can only be initiated by a **1** to **0** transition. After a time interval determined by the clock, the input signal changes from a **0** to a **1** again and there is no change in any flip-flop.

When the unit starts into the second cycle (changes from a **1** to **0**) the input signal activates FF1 causing it to change from a **1** to a **0**. This transition causes FF2 to change from a **0** to a **1**, again with no effect on FF3. To see how the input signal pulses effect the various flip-flops and the resulting outputs, refer to Fig. 8 and trace the input signal through the remainder of the cycles shown.

The timing diagram in Fig. 8

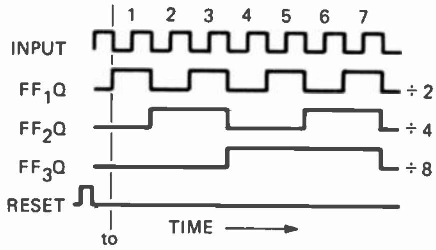


FIG. 8—TIMING DIAGRAM shows the instantaneous relationship of input to the outputs.

shows that the output frequency of FF1 is only half the input frequency. Similarly, the outputs of FF2 and FF3 are a fourth and an eighth of the input frequency respectively. This clearly demonstrates the frequency divider characteristic of the bistable flip-flop.

In addition to frequency division, the flip-flop chain shown in Fig. 7 is extremely useful as a counter. For example, consider the outputs of all three flip-flops after three input cycles:

FF3	FF2	FF1
0	1	1

011 is the binary equivalent of the decimal 3, the number of input cycles which have occurred. This shows that the flip-flops have counted the number of incoming pulses and have recorded the number by placing the least significant digit in FF1 and the most significant in FF3. The counting operation can be verified by checking the output states during the sixth cycle (see Fig. 8):

FF3	FF2	FF1
1	1	$0 = 6_{10}$

This concludes our discussion of electronic arithmetic and logic. The next article in this series will describe memories for electronic calculators, and then we will be ready to discuss the organization of the various subsystems in an actual, working calculator. **R-E**

VERTICAL BUZZ, G-E SF CHASSIS

The buzz comes from laminations in the vertical output transformer. Heat from resistor R404 can soften the transformer wax. This allows the laminations to vibrate, causing the buzz.

To remedy the problem, remove R404 from its bracket. Remove one screw and disassemble the bracket from the transformer and electrolytic capacitor. Bend bracket 90 degrees as shown in the drawing. Reassemble the bracket and R404. Allow the transformer to cool about one hour before applying power. This will allow the wax to harden.

Caution: In SF1600 series receivers, slide R404 down in the clip so there is at least ½ inch between R404 and the bottom cover of the vhf tuner. In SF2200 series receivers, maintain at least 1 inch space between R404 and the antenna terminal assembly.—*G-E Television Service Bulletin*

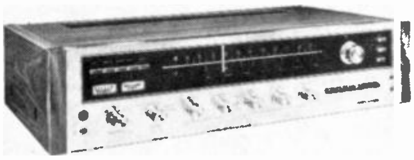
MAGNAVOX SPEAKERS—FUSIBLE RESISTORS

Speaker systems such as the models 1S8757 through 1S8759 and 1S8762 through 1S8766 have a fusible resistor in series with the positive lead to the speakers. It protects against excessive current flow in the event of a shorted speaker voice coil. This fusible resistor is rated 0.225 ohm, 2 watts and is part No. 240104-3.

Because of the protective characteristics of this device, use only the exact replacement.—*Magnavox News Letter*

equipment report

Lafayette LR-4000 4-channel receiver



Circle 92 on reader service card

THOUGH LAFAYETTE RADIO ELECTRONics chooses to term their LR-4000 quadrisound receiver an "SQ Receiver," in actual fact the LR-4000 is an *all-modes* 4-channel receiver, instantly ready to accommodate any present or future 4-channel signal source.

The basic package consists of an AM/FM stereo tuner, four identical pre/power amplifiers for stereo front and stereo rear, complete duplicate controls for each stereo pair, virtually every imaginable input and output connection, and of course, their full logic (with wavematching) decoder which provides three types of decoding: 1) Composer A, which is derived ambient (synthesizer) from stereo records; 2) Composer B, supposedly another type of stereo program ambient sound decode, but really a basic SQ decoder; 3) SQ, a full logic SQ decoder. Any program signal passing through the front amplifiers can be processed through the decoders. Also, any front signal can be fed front-rear stereo—appearing as stereo in both the front and rear speakers.

Front stereo inputs are provided for ceramic and magnetic phono and tape. Discrete 4-channel inputs are provided for aux 1, aux 2 and tape. Two tape recorder outputs are provided, one from the front inputs before the SQ decoder and one for discrete 4-channel, which is after the SQ decoder.

Amplifier power outputs are provided for main and remote front and rear speakers and front and rear phones. Individual on-off switches are provided for the main and remote speakers. Additional signal features include an FM detector output (should the FCC approve discrete 4-channel broadcasts), front panel stereo microphone inputs and a stereo tape output.

The sound distribution is determined by a single, uncluttered function switch; six positions give the user 2CH (stereo through front and rear speakers), Composer A, Composer B, SQ, discrete and reverse.

The receiver section features an AM/FM stereo tuner with a center channel FM and AM/FM signal strength meters, and a stereo beacon. Push switches are used for input selection, main and remote speakers, 4-channel tape monitor, 2-channel tape monitor, stereo-mono mode selection, high filter, loudness compensation and an FM mute. Concentric front/rear controls are used for volume, balance, bass, midrange and treble.

Just as there's no compromise in input/output connections, so too is there no compromise in the LR-4000's performance, especially the sound quality which was notably clean with unusually low distortion.

The measured performance of the LR-4000 (not manufacturer's specs) was an FM sensitivity of 1.6 μV IHF with 55 dB of quieting at 5 μV. Full limiting was obtained with 8 μV. At the standard test signal input of 1000 μV the frequency response measured +0.2/-2 dB from 20 to 15,000 Hz at a distortion of 0.4% THD; S/N ratio was 72 dB. The stereo separation measured 32 dB at 1000 Hz. The selectivity proved excellent. bringing in those closely spaced stations normally heard only on high-performance receivers.

From each stereo amplifier pair (front and rear) the power output *per channel* was 26.6 rms watts into 8 ohms at all frequencies from 20 to 20,000 Hz, at a distortion no higher than 0.08% THD at any frequency—shown in the latest accepted amplifier specifications as 26.6 rmsW/8 ohms/0.08% THD/20-20,000 Hz.

The frequency response at 26.6 rmsW/8 ohms/20-20,000 Hz was +0.2/-1.8 dB. The magnetic input was essentially *dead quiet* with a 72 dB S/N ratio.

The full logic decoder worked very well, and is the difference between hearing a "pleasant something" as matrix 4-channel or an almost spectacular surround-sound. On most program material the full logic SQ decoder would seem to *lock* onto the primary sound direction and expand its depth, almost approximating a discrete 4-channel effect. On rare musical arrangements a slight degree of *pumping* could be heard as the logic or wavematching expanded the volume in a particular direction. But in the majority of cases the full logic SQ decoder produced an almost natural, and almost discrete effect, along with a very high degree of center-front to center-back separation (measured as 18 dB).

Part of the reason a receiver of this capability and high-performance comes with a relatively low price tag of $499.95 lies in the full logic SQ decoder. Unlike many other partial-logic or even basic SQ decoders which utilize discrete components—several handfulls of components, the LR-4000 has a substantial part of the necessary decoder circuits in an IC, which represents a considerable savings in components and assembly.

One thing's for certain, the user will never suffer from obsolescence for the LR-4000 has sufficient inputs and switching capacity to accommodate adaptors for CD-4 discrete, Brand X matrix decoders, 4-channel tape and just about anything else someone can dream up for a "new dimension" to quadriphonic sound.

Model A Transistor Curve Tracer

Circle 93 on reader service card

THE JUD WILLIAMS MODEL A DYNAMIC Transistor Curve Tracer is the latest version of what its maker claims is the first service-type transistor curve tracer. This versatile instrument will check practically all kinds of semiconductors; bipolar and FET transistors, UJT's, SCR's, Zener, detector and power diodes, switching diodes, and you name it. It will do this either in or out of circuit. All you need is the

(continued on page 99)

Step-By-Step TV Troubleshooter's Guide

Foreign-brand TV agc subsystems can be tough to repair if you don't try to understand them. Learn why

by STAN PRENTISS

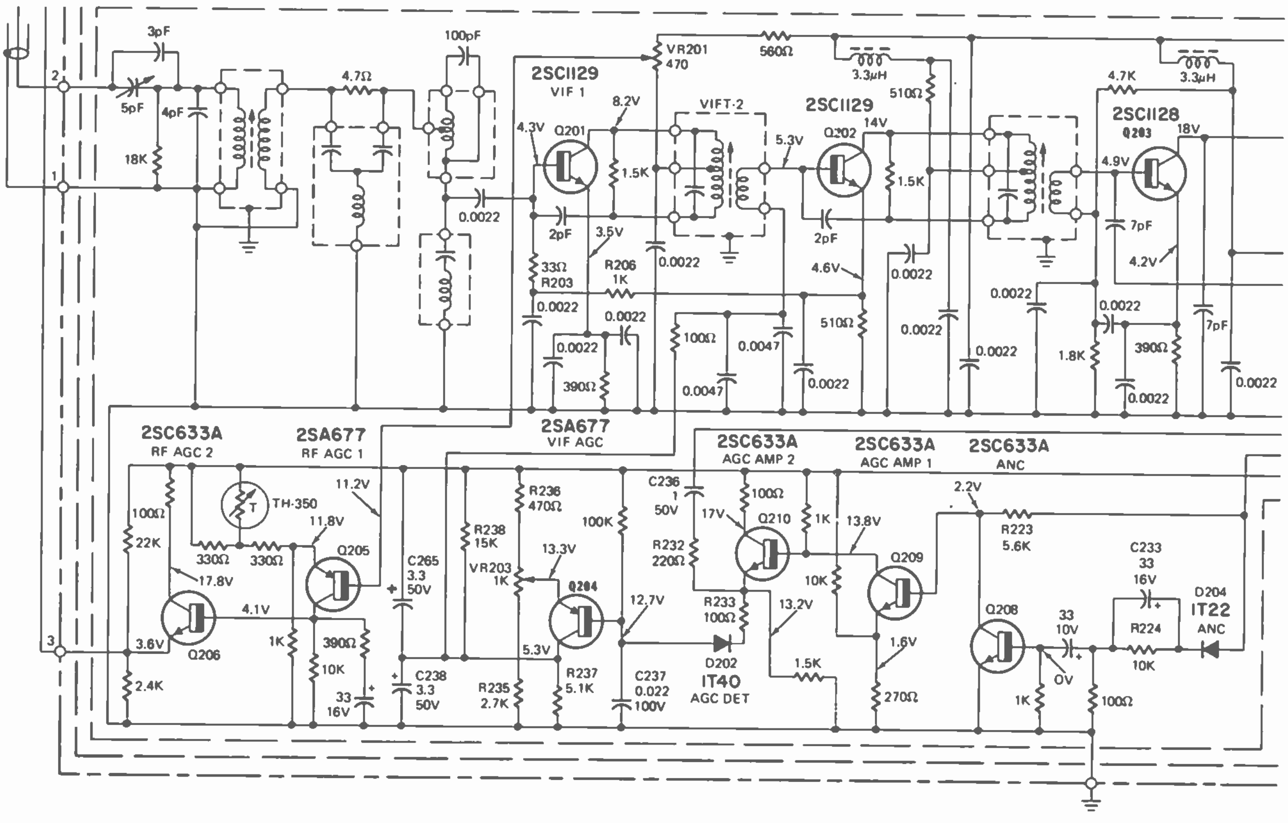
REALLY, NO AGC SUBSYSTEM IS easy. By one method or another, it's an ac-to-dc closed loop converter whose input is dependent on its output and vice versa. Some 25 years ago manufacturers used to simply rectify part of the video i.f. signal, filter it carefully and return the resulting dc as negative bias for the tube r.f. and initial i.f. stages . . . a procedure that was all right as long there was little external noise and carrier level fluctuations weren't rapid (slow airplanes).

With increasing electromagnetic disturbances, however, keyed agc was introduced to overcome the slowness of "brute force" agc and make it additionally effective in fringe areas where signal-to-noise ratios are lower. Now, means have been found to increase the speed of what is currently known as "peak" detection and rapidly deal with any noise problems, so that once again there are keyed and non-keyed agc subsystems.

Sony is an excellent example. Fig. 1 shows Sony's i.f. strip, automatic noise canceller (ANC), and five stages of agc amplification and detection. Composite video from the emitter of 1st video amplifier Q207 appears at the junction of diode D204 and R223 where D204 and C233-R224 peak detect sync pulses only and pass them at very low level in ac coupling to the base of the Q208 automatic noise canceller. At 200-mV p-p, these sync pulses are not large enough to overcome the 0.6 V_{BE} (base-to-emitter) drop of Q208, and therefore this transistor remains cut off. But with noise spikes substantially exceeding sync amplitudes, Q208 switches on and pulls the base of Q209 to ground, cutting off all agc (and sync) for the usual microsecond or so noise duration, a period not normally recognized by the unsuspecting eye.

Without noise, Q209 and Q210 are simply a pair of amplifiers for composite video, with output from the emitter of Q210 going on to the sync separator through R232 and C236 and also through R233 to D202. Even though D202 appears to be back biased by having 13.2Vdc on its cathode and 12.7Vdc on its anode. It is not because negative-going video is biasing this diode on. This charges C237 to an average dc value commensurate to the amplitude of the incoming sync tips . . . a process Sony terms "peak" detection. Divider resistors R235, R236 and variable VR203 now put a 13.3V forward bias on the emitter of Q204. The collector of this transistor then develops an average of 5.3V as *forward* bias for the base of Q202 and, through its emitter (with a 0.7V drop), across R206 and R203 to the base of Q201. Note that the Q204's collector is heavily filtered by series capacitors C238, C265 and resistors R238 and R237. Note also the agc at Q202's emitter returns to the base of Q201. It prevents agc from directly loading the first video i.f.

With agc sensitive transistors responding to forward (positive) bias, ac voltage drops as dc current increases beyond linear transistor design levels. As a result the dc voltage across



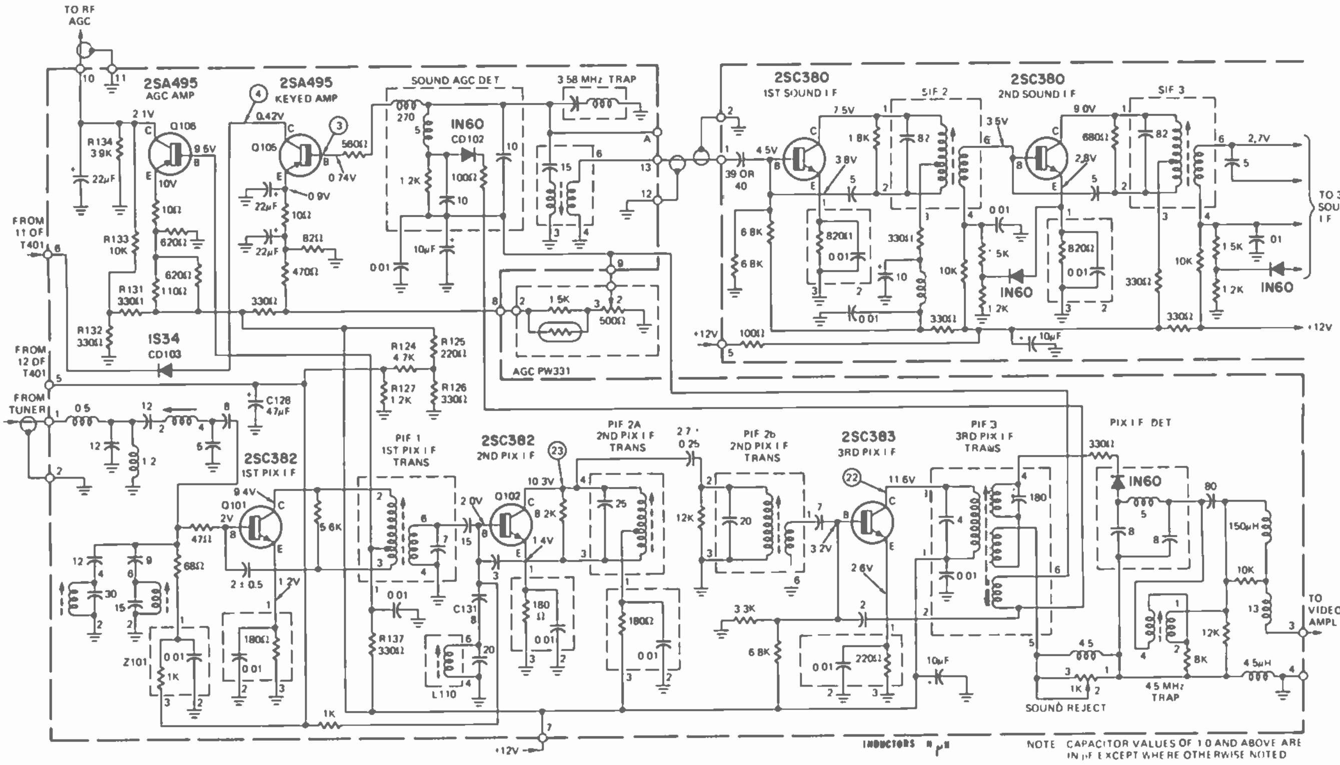


FIG. 2—TOSHIBA TAC-334 KEYED AGC and all positive biased output agc amplifier is a circuit not often seen in the United States.

RF TRANSISTOR ADJUST VR201 becomes less as Q201 conducts more. When the base of Q205 drops low enough, (11.2V as shown in Fig. 1) this delayed amplifier conducts positively and turns on emitter follower Q206. This transistor's positive output voltage will then increase proportionately to effectively forward bias any *bipolar* rf transistor in the tuner.

What if you had a FET? Reverse the Q206 connections and take the opposite output from its collector. FET's, you should know (or remember), take reverse and not forward bias to pinch off their normally conducting depletion-mode N channels. How does Sony now make its "peak" detection effective? Probably through the small propogation delays of its agc transistors and selected time constants. ANC Q208 is obviously used here as a fast switch that can only conduct negatively.

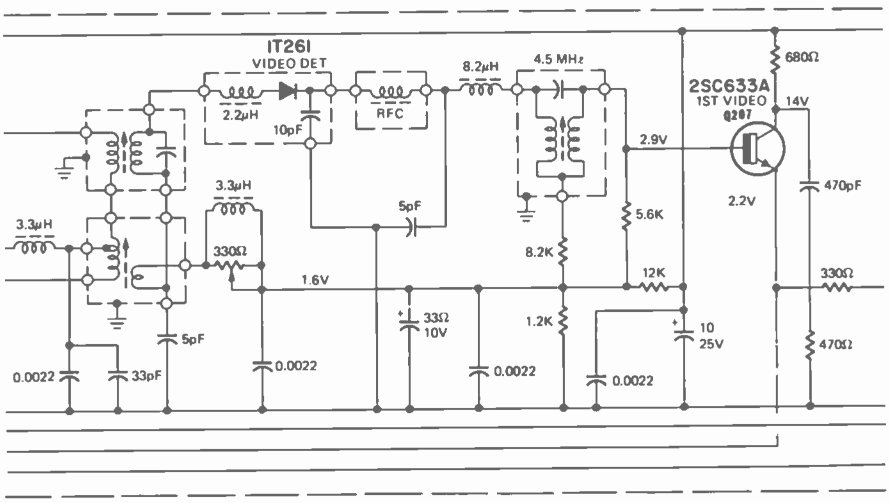


FIG. 1—SONY KV-1500 NOISE CANCELLER and peak defeating agc system. Look at it now and be prepared before you see one in your shop.

Toshiba's keyed agc

This is a somewhat different and more conventional *keyed* agc subsystem (Fig. 2), but just as interesting. The audio-video envelope is picked off the lower secondary of the third video i.f. transformer and germanium diode CD102 actually detects both agc sync and the difference beat of the 4.5-MHz intercarrier sound. Manufacturer's waveforms show a very small keyed amplifier Q105 base input and larger collector "output" both in negative phase. Therefore, there is no signal amplification, simply current. So 12V p-p pulses appearing at the collector of Q105 are actually from the terminal 11 winding on the flyback transformer and are used to forward bias diode CD103 and supply collector potential for Q105.

As negative horizontal sync pulses from the transmitting station and flyback pulses from the receiver's high voltage section coincide, Q105 conducts positive current through CD103 and plug board terminal 6, back through flyback (T401) windings 11 and 12, with return through plug board terminal 5 to charge 47-μF C128; developing voltage across R124 through R127—another approximately 30 msec time constant. Consequently, as the charge across C128 varies with the amplitude of incoming horizontal sync tips, forward bias is routed through Z101 and the top of C131,L110 to the bases of 1st pix. i.f. Q101 and second video i.f. Q102, respectively.

A positive bias agc rf amplifier

Sounds unusual? Certainly, but it works—as you will soon see. Forward bias for agc r.f. amplifier Q106 is from the centertap of the first video i.f. transistor across R137. Just as before, a considerable dc drop at this point will produce a less positive voltage to bias Q106 on. Note that this transistor has 10V at its emitter, 9.5V at its base and 2.1V at its collector—all dc voltages. With more negative-going input potentials, Q106 turns on more and its positive output increases. But how?

The same 12V power source sup-

(continued on page 68)

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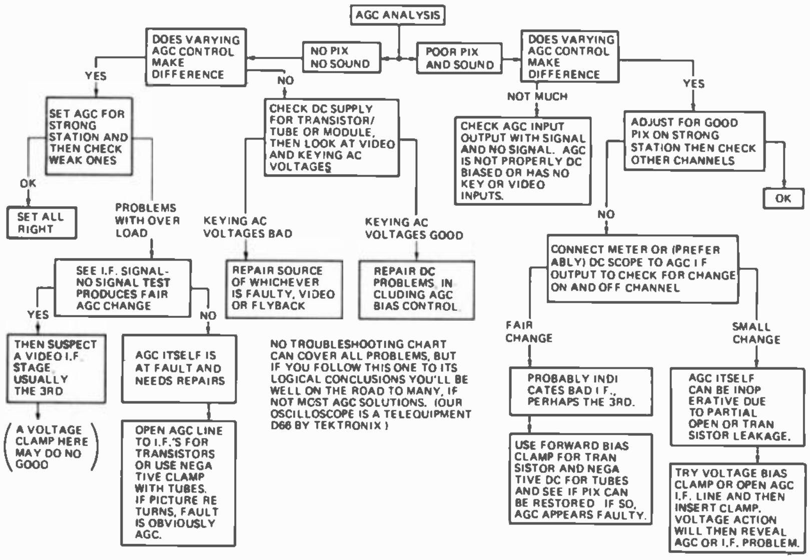

NO TROUBLESHOOTING CHART can cover all problems, but if you follow this one to its conclusions you'll be on the road to most agc solutions.

plies the Q106 collector and emitter. R131 and R132 are both 330-ohm resistors, and equal resistors divide the supply voltage in half, or 6 volts. Then voltage divider R133 and R134 again drops this 6V to 1.68V since $E_o = (6V \times 3.9K)/(3.9K + 10K)$. Obviously, the agc rf amplifier is conducting since its collector reading is 2.1V. As Q106's base input increases, this transistor becomes more and more a variable resistor, shunting R133 and delivering greater positive potential to its collector because of *decreased* collector load resistance; and, therefore, the *bipolar* rf transistor is forward bias-controlled to reduce its ac output.

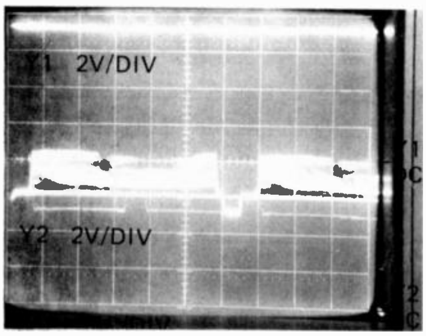

FIG. 3—VIDEO-SYNC INPUT (lower trace) and agc i.f. output. These waveforms seen when receiver operates normally.

Troubleshooting agc circuits

By now, one hopes you've become a firm believer—it's written in the book! It's also true that the amplitude of sync pulse tips are constant as broadcast from the television station—with no interruptions—and constitute about 30% of any fully modulated waveform, from zero (carrier cutoff) at the transmitter to zero (peak white) at the receiver. Therefore, under ordinary circumstances, there's very little change in agc output unless the entire composite waveform (including horizontal sync peaks) is disturbed by changing signal conditions. Keyed agc was initially developed to overcome signal noise interruptions and to respond very quickly so that video-sync amplitude variations could be acted upon rapidly and provoke as little line scan interruption as possible. The old brute force method turned out to be an average, rather than line-by-line amplitude assessment and would react quite slowly, perhaps not too much over the entire 16.664 msec length of a complete field.

Today, however, with keyed and peak detection, reactions will be rapid and securely lock the dc loop that must either be broken and/or the entire circuit thoroughly analyzed before any agc problem can be solved. A large capacitor to ground from the flyback has been suggested as a way to shunt the agc keying pulse, but some newer sets will have their vertical circuits affected by this too, and certainly many receivers of all types use this same pulse for color sync keying as well. So let's get back to tried and true methods and we can't go wrong. First, understand the circuit . . . then in vacuum tube sets, *clamp* the agc bus to the video i.f. with a negative bias and vary this with received station signal to see if you can bring the set to life. In solid-state receivers, find some means (even pulling an agc transistor) to open the connection to the i.f. transistors (or IC), and use increasing positive forward bias to try and put video on the screen. You may also select an off channel to check maximum rf and i.f. gain. We'll show variations in the troubleshooting chart, but these are the fundamentals for them all.

Fig. 3 is a typical composite video input waveform with well-defined sync pulse, feeding an i.f. agc amplifier. At 2V/div. it's riding around 6V at a p-p amplitude of 3V. Its dc output voltage, however, is a normal 7.2V, and will remain at about this level unless the amplitude of the horizontal sync tips are disturbed. However, try cocking the tuner off channel, which simulates an agc or i.f., rf failure. Obviously there is no incoming video, its dc voltage rises slightly, and the incoming "signal" is simply noise. But look what's happened to the forward i.f. agc! It's decreased from 7.2V positive to a nominal 6V, and that's where it stays! As you can readily see, both ac and dc voltages must be together in this agc system for it to work. Just ask your nearest, trusty oscilloscope. **R-E**

R-E's substitution guide for replacement transistors

PART IX

compiled by ROBERT & ELIZABETH SCOTT

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107

DM—D. M. Semiconductor Co., P.O. Box 131, Melrose, Mass. 02176

GE—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735

IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245

MAL—Mallory Distributor Products Co., 101 S. Parker, Indianapolis, Ind. 46201

MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036

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

SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N1982	NA	T-233	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N1983	RS276-2009	T-53	GE-63	ICC-53	TR-21	PTC 123	HEP-53	SK 3124	RT-102	ECG 123A	ZEN 102
2N1984	RS276-2009	T-53	GE-63	ICC-53	TR-21	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1985	RS276-2009	T-53	GE-63	ICC-53	TR-21	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1986	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1987	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1988	RS276-2009	T-53	GE-20	ICC-53	TR-87	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1989	NA	T-56	GE-17	ICC-714	TR-87	PTC 144	HEP-714	SK 3039	RT-113	ECG 108	NA
2N1990	NA	T-714	GE-18	ICC-714	NA	PTC 123	HEP-714	NA	NA	NA	NA
2N1991	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1992	RS276-2009	T-50	GE-63	ICC-50	TR-19	PTC 144	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N1993	RS276-2001	T-641	GE-5	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1994	NA	T-641	GE-5	ICC-641	NA	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	NA
2N1995	NA	T-641	GE-8	ICC-641	NA	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	NA
2N1996	NA	T-641	GE-5	ICC-641	NA	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	NA
2N1997	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 102	HEP-254	SK 3005	RT-118	ECG 100	ZEN 305
2N1998	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 102	HEP-254	SK 3005	RT-118	ECG 100	ZEN 305
2N1999	NA	T-2	GE-1	ICC-2	NA	PTC 107	HEP-2	SK 3005	NA	ECG 160	ZEN 300
2N2000	RS276-2005	T-254	GE-1	ICC-254	NA	PTC 135	HEP-254	NA	RT-121	ECG 102A	ZEN 305
2N2001	RS276-2005	T-254	GE-1	ICC-254	NA	PTC 135	HEP-254	NA	RT-121	ECG 102A	ZEN 305
2N2002	RS276-2021	T-51	GE-21	ICC-51	TR-54	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2003	RS276-2021	T-51	GE-21	ICC-51	TR-54	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2004	RS276-2021	T-51	GE-21	ICC-51	TR-54	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2005	RS276-2021	T-51	GE-21	ICC-51	TR-54	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2006	RS276-2021	T-51	GE-21	ICC-51	TR-31	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2007	RS276-2021	T-51	GE-21	ICC-51	TR-31	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2008	NA	T-714	GE-18	ICC-714	NA	PTC 125	HEP-7114	NA	NA	NA	NA
2N2009	NA	T-3	GE-9	ICC-R1101	NA	NA	HEP-R1101	NA	NA	NA	NA
2N2010	NA	SR-1002	NA	ICC-R1101	NA	NA	HEP-R1101	NA	NA	NA	NA
2N2011	NA	SR-1003	NA	ICC-R1102	NA	NA	HEP-R1102	NA	NA	NA	NA
2N2012	NA	SR-1005	NA	ICC-R1103	NA	NA	HEP-R1103	NA	NA	NA	NA
2N2013	NA	SR-1005 /3	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2014	NA	SR-1005 /4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2015	NA	T-704	NA	NA	TR-36	NA	NA	NA	NA	NA	NA
2N2016	NA	T-704	NA	NA	TR-36	NA	NA	NA	NA	NA	NA
2N2017	RS276-2018	T-243	GE-63	ICC-243	IRTR-87	PTC 117	HEP-243	SK 3024	RT-114	ECG 128	NA
2N2022	NA	T-2	GE-1	ICC-2	TR-17	PTC 109	HEP-2	NA	NA	ECG 160	ZEN 300
2N2032	NA	T-704	GE-14	ICC-S5001	NA	NA	HEP-S5001	SK 3039	RT-113	ECG 108	NA
2N2033	NA	TS-3020	GE-66	ICC-S5000	NA	PTC 110	HEP-S5000	NA	NA	NA	NA
2N2034	NA	TS-3020	GE-66	ICC-S5000	NA	PTC 110	HEP-S5000	NA	NA	NA	NA
2N2035	NA	TS-3020	GE-66	ICC-S5000	NA	NA	HEP-S5000	NA	NA	NA	NA
2N2036	NA	TS-3020	GE-66	ICC-S5004	NA	NA	HEP-S5004	NA	NA	NA	NA
2N2038	RS276-2009	T-53	GE-18	ICC-53	TR-87	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2039	RS276-2009	T-53	GE-18	ICC-53	TR-87	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2040	RS276-2009	T-53	GE-18	ICC-53	TR-87	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2041	RS276-2009	T-53	GE-18	ICC-53	TR-87	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2048	NA	T-2	GE-9	ICC-2	TR-14	PTC 109	HEP-2	NA	NA	ECG 160	ZEN 300
2N2049	NA	T-714	GE-18	ICC-S3011	TR-87	NA	HEP-S3011	NA	NA	NA	NA
2N2059	RS276-2003	T-3	GE-1	3	TR-35	PTC 109	HEP-3	NA	NA	ECG 160	ZEN 301
2N2060	NA	T-714	GE-18	NA	TR-87	PTC 123	NA	NA	NA	NA	NA
2N2061	RS276-2006	T-230	NA	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2062	RS276-2006	T-230	NA	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2063	RS276-2006	T-230	NA	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2064	RS276-2006	T-230	NA	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2065	RS276-2006	T-232	NA	ICC-232	TR-35	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2066	RS276-2006	T-232	NA	ICC-232	TR-35	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2067	NA	T-230	GE-3	NA	TR-16	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N2069	NA	T-230	GE-3	ICC-625	TR-01	PTC 114	HEP-625	SK 3009	RT-124	ECG 104	NA
2N2070	NA	T-230	GE-3	ICC-625	TR-01	PTC 114	HEP-625	SK 3009	RT-124	ECG 104	NA
2N2071	NA	T-230	GE-3	ICC-625	NA	NA	HEP-625	NA	NA	NA	NA
2N2072	NA	T-230	GE-3	ICC-625	NA	NA	HEP-625	NA	NA	NA	NA
2N2075	NA	T-233	GE-4	ICC-233	NA	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2076	NA	T-233	GE-4	ICC-233	NA	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2077	NA	T-231	GE-4	ICC-231/233	NA	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327
2N2078	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327
2N2079	NA	T-233	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2080	NA	T-231	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2081	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327
2N2082	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327
2N2083	NA	T-2	GE-1	ICC-638	TR-17	PTC 109	HEP-638	NA	NA	ECG 160	NA
2N2084	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	SK 3006	NA	ECG 160	ZEN 301
2N2085	RS276-2002	T-641	GE-59	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N2086	NA	T-714	GE-18	NA	TR-87	PTC 144	HEP-714	NA	NA	NA	NA
2N2087	NA	T-714	GE-18	NA	TR-87	PTC 144	HEP-714	NA	NA	NA	NA
2N2089	RS276-2003	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	NA	ECG 126	ZEN 311
2N2090	RS276-2003	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	NA	ECG 126	ZEN 311
2N2091	RS276-2003	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	NA	ECG 160	ZEN 311
2N2092	RS276-2003	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-635	SK 3007	NA	ECG 126	ZEN 311
2N2093	RS276-2003	T-3	GE-50	ICC-3	TR-17	PTC 107	HEP-3	SK 3008	NA	ECG 160	ZEN 301
2N2094	RS276-2009	T-736	GE-18	ICC-736	IRTR-51	PTC 123	HEP-736	SK 3122	RT-102	ECG 123A	ZEN 120

NA = NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N2095	RS276-2009	T-736	GE-51	ICC-736	NA	NA	HEP-736	SK 3122	RT-102	ECG 123A	ZEN 120
2N2096	RS276-2009	T-736	GE-20	ICC-736	TR-17	NA	HEP-736	SK 3122	RT-102	ECG 123A	ZEN 120
2N2097	RS276-2009	T-736	GE-9	ICC-736	TR-17	PTC 107	HEP-736	SK 3122	RT-102	ECG 123A	ZEN 120
2N2098	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2099	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2100	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2101	NA	NA	NA	NA	TR-26	NA	NA	NA	NA	NA	NA
2N2102	NA	T-714	GE-66	ICC-714	IRTR-87	PTC 144	HEP-714	SK 3024	RT-114	ECG 128	NA
2N2104	RS276-2021	T-51	NA	ICC-51	NA	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2105	RS276-2021	T-51	NA	ICC-51	NA	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2106	RS276-2018	T-243	GE-63	ICC-243	IRTR-87	PTC 117	HEP-243	SK 3024	RT-114	ECG 128	NA
2N2107	RS276-2018	T-243	GE-63	ICC-243	IRTR-87	PTC 117	HEP-243	SK 3024	RT-114	ECG 128	NA
2N2108	RS276-2018	T-243	GE-63	ICC-243	IRTR-87	PTC 117	HEP-243	SK 3024	RT-114	ECG 128	NA
2N2137	RS276-2006	T-230	NA	ICC-230	TR-01	PTC 114	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2138	RS276-2006	T-230	GE-3	ICC-230	TR-16	PTC 114	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2139	RS276-2006	T-232	NA	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2140	RS276-2006	T-232	NA	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2141	RS276-2006	T-232	NA	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2142	RS276-2006	T-230	GE-16	ICC-230	TR-16	PTC 114	HEP-230	SK 3009	RT-124	ECG 104	ZEN 325
2N2143	RS276-2006	T-232	GE-16	ICC-230/232	TR-16	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104	ZEN 325/326
2N2144	RS276-2006	T-232	GE-16	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2145	RS276-2006	T-232	GE-3	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2146	RS276-2006	T-232	GE-3	ICC-232	TR-16	PTC 105	HEP-232	SK 3009	RT-124	ECG 104	ZEN 326
2N2147	RS276-2006	T-232	GE-16	ICC-232	NA	PTC 138	HEP-232	SK 3014	RT-124	ECG 104	ZEN 326
2N2148	RS276-2006	T-232	GE-16	ICC-232	TR-01	PTC 138	HEP-232	SK 3014	RT-127	ECG 121	ZEN 326
2N2152	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 213	ZEN 327
2N2153	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 213	NA
2N2154	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 213	NA
2N2155	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 105	NA
2N2156	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 213	NA
2N2157	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 104	NA
2N2158	NA	T-237	GE-4	ICC-237	TR-03	PTC 106	HEP-237	SK 3012	NA	ECG 213	NA
2N2159	NA	T-233	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2160	RS276-2029	T-310	NA	ICC-310	IR-2160	NA	HEP-310	NA	NA	ECG 6400	ZEN 129
2N2161	RS276-2009	T-53	NA	ICC-53	IRTR-51	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2162	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2163	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2164	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3118	RT-115	ECG 159	ZEN 101
2N2165	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2166	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2167	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2168	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2169	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2170	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2171	RS276-2005	T-254	GE-1	ICC-254	TR-05	PTC 102	HEP-254	SK 3005	RT-118	ECG 100	ZEN 305
2N2172	RS276-2005	T-254	GE-1	ICC-254	TR-05	PTC 102	HEP-254	SK 3005	RT-118	ECG 100	ZEN 305
2N2173	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 135	HEP-253	NA	RT-121	ECG 102A	ZEN 304
2N2175	RS276-2005	T-251	GE-22	ICC-251	TR-30	PTC 103	HEP-251	SK 3118	RT-126	ECG 106	ZEN 303
2N2176	RS276-2005	T-251	GE-22	ICC-251	TR-30	PTC 103	HEP-251	SK 3118	RT-126	ECG 106	ZEN 303
2N2177	RS276-2005	T-251	GE-22	ICC-251	TR-30	PTC 103	HEP-251	SK 3118	RT-126	ECG 106	ZEN 303
2N2178	RS276-2023	T-252	GE-22	ICC-252	TR-30	PTC 103	HEP-252	SK 3114	RT-115	ECG 159	NA
2N2180	RS276-2003	T-3	GE-1	ICC-3	TR-12	PTC 109	HEP-3	NA	NA	ECG 126	ZEN 301
2N2181	RS276-2021	T-51	NA	ICC-51	TR-30	PTC 131	HEP-51	SK 3114	NA	ECG 159	ZEN 101
2N2182	RS276-2021	T-51	NA	ICC-51	TR-30	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2183	RS276-2023	T-52	GE-21	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2184	RS276-2023	T-52	GE-21	ICC-52	TR-30	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2185	RS276-2023	T-52	GE-21	ICC-52	TR-30	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2186	RS276-2023	T-52	GE-21	ICC-52	TR-30	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2187	RS276-2023	T-52	GE-21	ICC-52	TR-30	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2188	NA	T-2	GE-9	ICC-2	TR-17	PTC 102	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N2189	NA	T-2	GE-9	ICC-2	TR-17	PTC 102	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N2190	NA	T-2	GE-9	ICC-2	TR-17	PTC 102	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N2191	NA	T-2	GE-9	ICC-2	TR-17	PTC 102	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N2192	NA	TS-3001	GE-63	ICC-S3001	TR-17	PTC 133	HEP-S3001	SK 3039	RT-113	ECG 108	NA
2N2193	NA	T-729	GE-17	NA	TR-87	PTC 144	HEP-S3011	SK 3039	RT-113	ECG 108	NA
2N2194	RS276-2009	T-53	GE-63	ICC-53	TR-87	PTC 136	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2195	NA	TS-3020	GE-63	NA	TR-87	PTC 144	HEP-S3001	SK 3039	RT-113	ECG 108	NA
2N2196	NA	T-729	GE-17	NA	TR-72	PTC 133	HEP-S3020	SK 3039	RT-113	ECG 108	NA
2N2197	NA	T-729	GE-17	NA	TR-72	PTC 133	HEP-S3020	SK 3039	RT-113	ECG 108	NA
2N2198	NA	T-714	GE-18	NA	TR-87	PTC 125	HEP-713	SK 3124	RT-100	ECG 123	NA
2N2199	NA	T-2	GE-9	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2200	NA	T-2	GE-51	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2201	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA
2N2202	NA	NA	NA	NA	TR-87	NA	HEP-714	NA	NA	NA	NA
2N2203	NA	NA	NA	NA	TR-87	NA	HEP-714	NA	NA	NA	NA
2N2204	NA	T-240	GE-12	NA	TR-87	PTC 104	HEP-714	SK 3021	RT-128	ECG 124	NA
2N2205	RS276-2009	T-50	GE-20	ICC-50	TR-53	PTC 123	HEP-50	SK 3124	RT-102	ECG 123A	ZEN 100
2N2206	RS276-2009	T-50	GE-20	ICC-50	TR-53	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2207	NA	T-638	GE-9	ICC-638	NA	PTC 107	HEP-638	SK 3006	NA	ECG 126	ZEN 313
2N2208	RS276-2003	T-635	GE-1	ICC-635	TR-12	PTC 109	HEP-635	SK 3006	NA	ECG 126	ZEN 311

NA = NOT AVAILABLE

(continued next month)

SERVICING RECORD CHANGERS
(continued from page 53)

wheel. Replace the retaining C clip and any trim you might have had to remove to gain access to the clip.

18. Refer to Fig. 2 and apply a single drop of lubricant to the over-arm shaft assembly. Work the arm up and down to insure proper lubrication.

OPTIONAL STEPS

19. Place 4 dowels, one under each corner to support the changer slightly off the bench. Connect the universal power cord to the changer and plug into an ac outlet. Place a strobe disc on the turntable and test for correct speed. The pattern should appear stationary.

20. Thoroughly clean the changer using a liquid spray cleaner for metal surfaces, and spray wax for the wooden surfaces.

21. Replace the changer in the unit and performance test. If any problems are noted consult trouble chart (Table II).

The complete changer just described requires about 45-minutes. While these simple overhaul techniques will solve about 80% of your record-changer problems, Table II gives you additional hints for servicing problems. **R-E**

ACTIVE FILTERS
(continued from page 44)

are just as easy to do.

Bandpass designs

Bandpass filters are generally much harder to design and more subtle to use. About all we have room for here is to show you two circuits that will do the job (see Fig. 7). They're shown for any Q at a center frequency of 1 kHz. And here in Fig. 8 are the same circuits for a Q=8: (1 kHz)

The two-amplifier job requires far less stable gain and works better for higher Q's and higher frequencies. Either circuit gives you the equivalent of a single series "pole" or tuned RLC circuit. This circuit, like its passive counterpart has a nasty feature that you must allow for. Its response starts falling off very steeply either side of resonance, but for very low or very high frequencies, it falls off at a more gradual rate of six decibels per octave. The response shape looks like the diagram in Fig. 9.

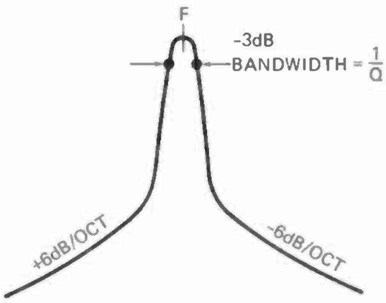

FIG. 9—BANDPASS RESPONSE CURVE measured at 3-dB point depends on circuit Q.

Normally, you cascade several poles to get the desired bandpass response. If we put the poles on top of one another, we get a very sharp response that is not very flat in the passband. We can control the response shape by staggering the poles in frequency and by altering their Q. Spreading the poles flattens out the passband, until finally you get a dip in the middle if you go too far. Another more formal way to design is to build a lowpass filter that does the job you want and then use a math process called *transformation* to get the desired bandpass shape. When you only need two poles, the simplest thing is to sit down with a breadboard and experiment with the Q and staggering for the response you need (the circuit moves around just like the lowpass and bandpass ones do by simultaneously changing capacitors or resistors); this is also a trivial problem for any computer that speaks BASIC, but the math is a bear otherwise. That's about all the details on bandpass design we have room for here. If enough readers are interested, we can put together another story with complete design curves for the two-pole bandpass designs in some other issue. **R-E**

BUILD IN ACTIVE FILTER

Next month in Radio-Electronics Don Lancaster presents complete details on how to build an active filter to meet your own needs. Don't miss it.

R-E's Service Clinic

The customer was right— Color is a mess!

Messy color is a problem that requires a logical attack

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.

THE BLACK AND WHITE PICTURE IS clear, sharp and with good contrast. Yet the customer is telling the truth when he says, "The color is a *mess!*"

Turn the color control completely off; good picture. When it's turned up to normal, "mess" is the only word for it. Large, smooth colored objects, such as talking-heads, aren't too bad. Put a color-bar pattern on it, and this doesn't look too bad, either. Yet on a long-shot of a crowd, where faces are about an inch or so in size, they show distinct vertical bands of red, green and blue, followed by colors ringing, and colored ghosts all over the place. For another confusing symptom, the grid waveforms on the picture tube look almost normal.

Now you could be in deep trouble. However, if you know what to look for, where to look for it, and above all *how* to look for it, it's not too bad.

Step No. 1: find out what *is* working, by plain old observation. The tuner, i.f., video stages, picture tube, agc, brightness, color, tint control, *and* the 3.58-MHz oscillator. (The oscillator must be working or we wouldn't get any color.) This is definitely *not* a loss of color sync, either.

So what's left? The bandpass amplifiers, and perhaps the demodulators. The last one is not too likely, since the rocker pattern on the picture tube grids usually shows that these are OK. So we are left with a problem in the bandpass amplifiers. Now, *what* is it, and what *kind* of a fault is it?

Reasoning will tell us. This is not a short-circuit. If it was, it would be more apt to kill the color signal entirely. So this is some kind of an *open circuit* (and not one in the signal-path, either; we have signals). Something in the color circuits is *ringing*. This causes the miscoloration, and the most significant clue of all, the ghosts which are present *only* in the color signals. Turn the color off, and they go away.

I said open circuit, because this must be caused by something which is open, and not affecting dc voltages. One very good suspect is a bypass capacitor, like the one at the bottom of the bandpass-amplifier transformer primary in Fig. 1. It puts the bottom

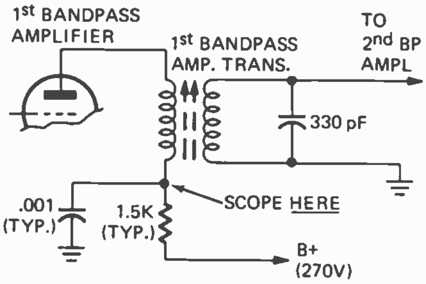

FIGURE 1

of this winding at ac ground potential. If it's open, this sets up a feedback loop, the transformer rings, and away we go.

Simple test; put the scope probe right on the bypass capacitor. At the high frequency of the color signal, it doesn't take a very large capacitor to bypass it. Somewhere from a .001 μF to a .01 μF is common. If you see *anything* at all in the way of a signal at this point, look out. The bypass capacitor isn't doing the job. Turn the scope gain up as high as you can. It doesn't take very much feedback signal to upset things for three feet in all directions.

Want to double check? Bridge a good capacitor across this one, and see if it changes the symptoms. Should have no effect at all, if the junction is properly bypassed. Check all bypassed points like this. In some sets using transformers in the demodulators, check their bypassing, too. In one set, an open bypass on a demodulator transformer caused the screen to turn half gold and half blue.

That's one. Another is a defective winding on one of the bandpass amp transformers. This won't be an open winding, in transformers which have only two windings without taps. This would break the signal-path, and

(continued on page 78)

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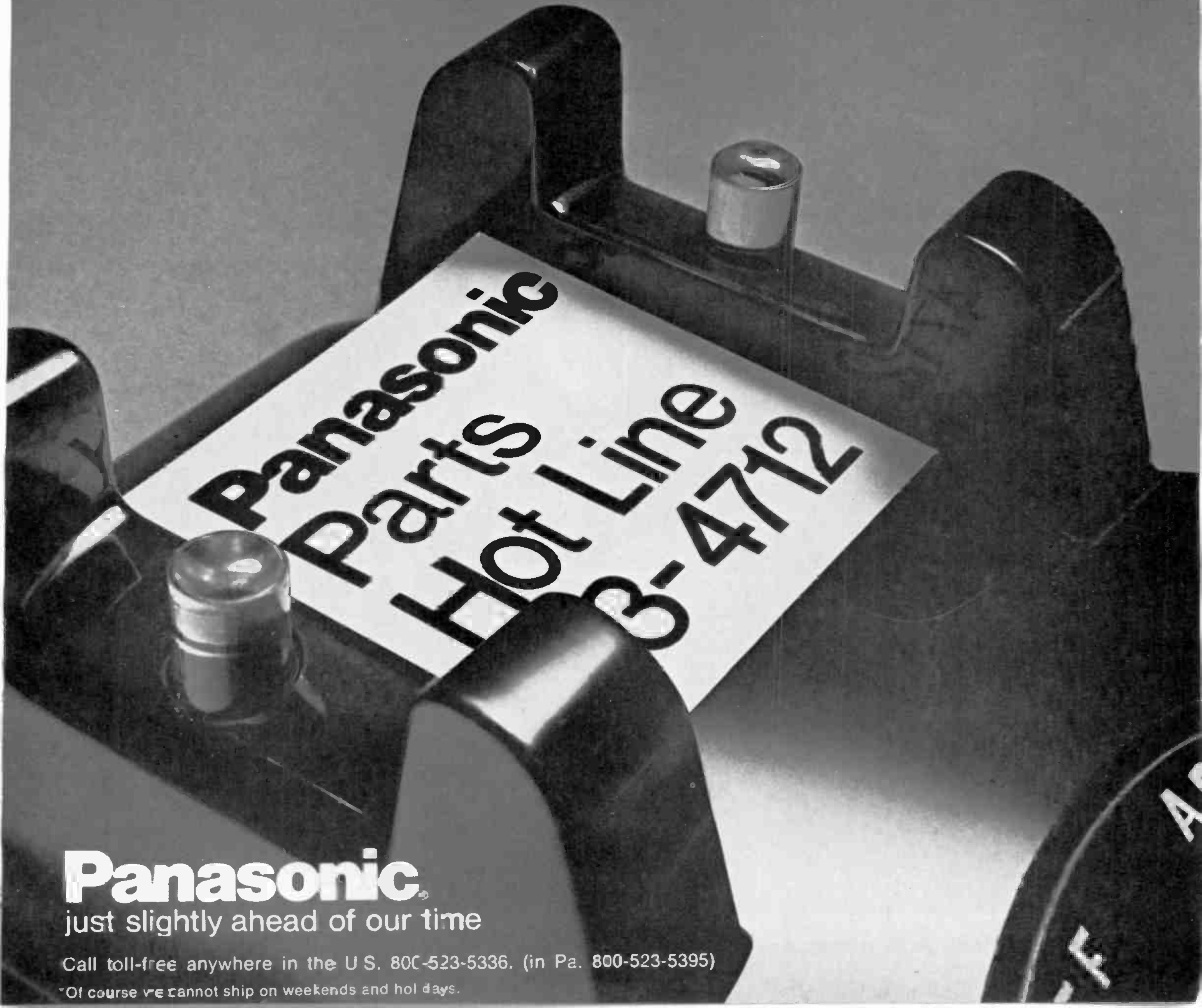

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2. **NEW GR-104C Portable Black & White TV.......129.95*** Now the ultimate portable TV has positive detent tuning on all 72 UHF channels as well as VHF. All solid-state circuitry, plus brilliant 12V shell bond picture tube puts black & white entertainment anywhere. Plugs into wall outlet, or runs from 12-volt DC automotive system with adapter included — or becomes completely self-contained with optional rechargeable battery-pack base. Mailing weight, 35 lbs. Optional GRA-104-3 battery pack 42.95*, 9 lbs. Outdoor Sun Shield GRA-104-2, 1.95*, 1 lb.

3. **NEW GD-1003 Electronic Air Purifier...........$139.95*** An easy-to-build 3-evening project. Removes 99% of airborne pollen and 95% of all other contaminants. Has 2-stage electronic operation; washable collector cell; replaceable charcoal filter; 2-speed fan; attractive walnut and gold finish. Purifies air in 20' x 20' room in minutes. Mailing weight, 55 lbs.

4. **NEW AS-1039 Ultra-efficient Speaker System.....$44.95*** Just 5 watts drives it to booming volume. Uses 8-in. woofer in vented bass reflex enclosure and exponential rectangular horn tweeter with separate level control. Response, 70 to 15,000 Hz. Impedance, 8 ohms. Maximum input 25 watts. Walnut-tone vinyl covered cabinet and green, brown and gold grille board shipped assembled. Measures 21" H x 12" W x 10½" D. Mailing weight, 36 lbs.

5. **NEW AS-1042 Acoustic Suspension Speaker.....$34.95*** Uses 8" long throw woofer and 3½" shallow cone/dome tweeter for flat frequency response from 40 to 18,000 Hz. External high-frequency control tailors the "highs" to your environment. Requires as little as 10 watts, can handle up to 25. 8 ohms impedance. Walnut-tone vinyl covered cabinet and brown and black grille board shipped pre-assembled. Measures 19" H x 10" W x 8¼" D. Mailing weight, 27 lbs.

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8. **NEW GD-1018 Solid-state Lamp Dimmer..........$7.95*** Controls lamp brightness from full illumination through mood-setting dimness to complete invisibility. For single and multiple lamps not exceeding 300 watts total. Extends filament life, eliminates the need for costly 3-way bulbs. A great starter kit. Can be assembled easily in 1 evening. Mailing weight, 2 lbs.

9. **NEW CM-1045 Small-engine Tune-up Meter......$39.95*** Solid-state tach/dwell/volt/ohm meter for all 2 and 4 cycle engines, 1 through 4 cylinders. In many cases permits checking entire small-engine ignition without tearing down flywheel assembly. Built-in tachometer has handy snap-on inductive pickup, reads from 0-3000, 0-15000 rpm. Completely portable, uses 3 1.5-volt batteries (not supplied). Mailing weight, 5 lbs.

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11. **NEW GD-600 Photoelectric Lamp Switch..........$5.00*** Low-cost home protection in a simple, enjoyable kit. Solid-state circuitry turns light on at dusk, turns it off at dawn. Adjustable sensitivity control sets switch to operate at various levels of light and darkness. Can be used with single or multiple lamps not exceeding 300 watts total. Easy, single circuit board design can be assembled in 1 evening. Mailing weight, 1 lb.

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Circle 100 on reader service card

SERVICE CLINIC

(continued from page 72)

you'd probably have no color at all. This kind of problem will show up in circuits like those used in RCA CTC-39 and others, which have a tapped secondary winding on the bandpass transformers. One part of the winding can open, and the signal will still get through.

Since the normal impedance of the transformer is upset, it will ring.

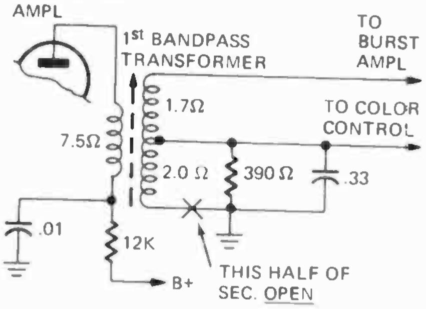

FIGURE 2

There's a very simple test for one of these; just grab the transformer with your fingertips. (Most of these are not shielded). If this causes the symptoms to change drastically, or even disappear completely, there you are. Check continuity of all windings, especially the secondary. Fig. 2 shows one of these.

Last one (although we'll probably find others later on). An *undamped* bandpass transformer winding. In some of the earlier sets, a damping resistor was connected across the secondary. If you happened to get the wrong bandpass transformer, it will fit the holes in the board, but the damping resistor will be hanging loose. Results; same old thing—transformer rings like a bell. Same check; grab the transformer between your fingers (see Fig. 3).

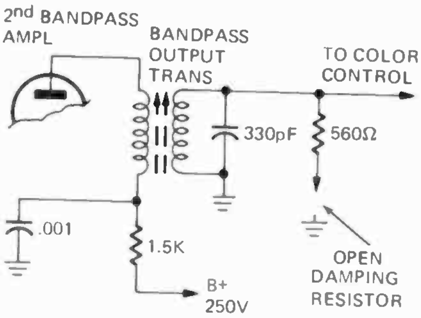

FIGURE 3

Although I haven't seen a verified case of this as yet, there would be a definite possibility of trouble if the center-tap of an output bandpass transformer secondary should either

(continued on page 80)

SOUTHWEST TECHNICAL PRODUCTS CORPORATION

219 W. RHAPSODY

SAN ANTONIO, TEXAS 78216

PHONE: 512 DI 4-3140

November, 1973

Dear Radio-Electronics Readers,

This month I would like to tell you about another kit that we have sort of been keeping quiet about. Our new "Universal Digital Instrument." This instrument began life as Don Lancaster's "Digital Grinchwal" in the Nov. 1972 issue of Radio-Electronics. With Don's help we have redesigned the package and made this into a really outstanding piece of test equipment. As you can see from the picture, we have put it in a rugged all steel case with an epoxy enamel finish. The power supply batteries are a larger size for increased battery life and best of all, we have mounted the connector pins foı the two parts directly on the chassis to make this a true plug-in system. The capacity plug-in is shown in the picture. This is our kit No. UC-1 and the price is only $24.95. The other plug-ins in the series will have similar crazy low prices due to the Mostek "divide by almost anything" programable divider (MK5009) that is in the mainframe portion of this instrument. Since you have purchased the time base too when you bought the mainframe, and since the output of the timebase can be programmed by the plug-in module, many neat things can be done with the system. Would you believe a digital clock? Yes, even a digital clock with four decade counters and no modulo 6 ability. The mainframe is yours for only $59.95. It features a full four (4) digit readout (not 2½ like others in this price range). This gets you everything you need except the batteries for the mainframe. Naturally this includes things like a G-10 fibreglass circuit board and first quality standard numbered parts. What else would you expect from us? In addition to this you get a huge (for us) nine page assembly and check out manual.

At this time we have Frequency Counter, Timebase, Timeperiod and Capacity plug-in modules. Available in the next few months will be a Volt-Ohmmeter, A-D Converter and Tach. Others are being planned. We feel that this kit should be an outstandingly useful instrument for anyone working with electronics.

Some of you out there have had a long wait for this kit, but now we think that supplies have caught up enough, and our parts deliveries have gotten close enough to "on schedule" to let everyone have a chance to buy one of these. We also would be happy to send you a FREE catalog listing details on this and our other kits. Just drop us a card, or circle our number on the reader service card in the back of this magazine.

Sincerely,

Dan

Daniel Meyer

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
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Circle 17 on reader service card

SERVICE CLINIC

(continued from page 78)

open or become ungrounded at a lug. The ohmmeter will catch any of these, as far as the open circuits is concerned.

There is also a possibility that one of the electrolytic capacitors in the dc voltage supply could allow the feedback loop to set up through the power supply. Check these with the scope, or by brudging, or both.

These are weird troubles; yet, if you know what to look for, and where to look, they're not at all hard to dig out and cure. R-E

reader questions

TAPE PLAYER WON'T CHANGE TRACKS

This auto-tape player will not change tracks. Even with the panel pushbutton, nothing happens.—W.H., Dunlap, Iowa

Most of these use a solenoid to move the head for track-changing. Check the dc voltage across the solenoid terminals while holding the TRACK CHANGE button down. If you get voltage, disconnect the solenoid and check it for continuity. In several of these, you'll find a diode shunted across the coil, for transient suppression. If it shorts, the solenoid won't work.

VERTICAL TROUBLE

This Zenith 14N22 has a bad case of vertical foldover. What's the most likely cause and which capacitor in this circuit is the most critical?—R.M., Wellsburg, W. Va.

All of them. However, with foldover, the most likely one would be the coupling capacitor between the input-section plate and output-section grid. See if it's leaky.

LOST SYNC

This Magnavox U21 chassis won't stay in sync. If it's set up for a good picture, it soon loses sync, both vertical and horizontal. I need help.—J.B., Va. Beach, Va.

No, you need some *sync*. Since you are losing both vertical and horizontal sync, look for a loss of output in the stage that handles *both:* the sync separator. Check the amplitude of the composite sync output, on the plate of the 6AN8, or possibly the 12AU7 sync inverter. Also bridge that 30-μF electrolytic on the +260 volt line.

IONIZERS AND AIR-CLEANERS

I want to build some things like ionizers, and electrostatic air cleaners. Where can I find parts for these?—A.B., Fremont, Ohio

The Triad Transformer Co., 305 N. Briant, Huntington, Ind. 46750, makes quite a few special high-voltage power supplies for such things. They'll be happy to send you a bulletin on them. As a matter of fact, the high-voltage power supply of a junked TV set could be used too.

NO RED SETUP LINE?

I have two "funnies". On a CTC-19 RCA chassis, I get no red line on the screen in Service position. Yet, I can get a bright red raster for purity, black and white picture good, color pix good. Pix guns check OK on tester.

I've also got an intermittent loss of the video signal, at the 12HG7 plate, but plenty at the grid. What gives?—J.B. New York, N.Y.

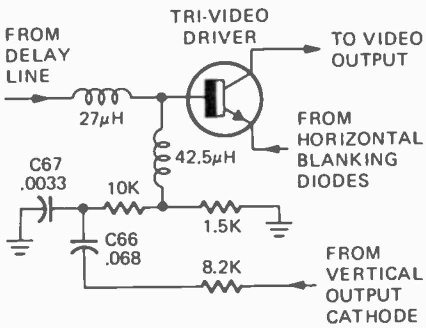
For the intermittent loss of video, check all of the solder joints on the PC board, between the 12HG7 plate and the pix tube cathodes. Peaking chokes, etc.

For the "No red line" symptom, FORGET IT! Since you have a good B/W picture, all three guns can conduct properly. If the color picture is good, this clears all color circuitry. Seriously speaking, this is probably an intermittent contact on the SERVICE switch. If everything else works, it's in fine shape.

VERTICAL RETRACE

I'm getting too much vertical-retrace line pattern on a Zenith 20Y1C38. With the brightness turned up quite a bit, it isn't too bad, but when the brightness is down to normal it is bad. Can't find it.—A.T., Schenectady, N.Y.

The vertical blanking in this chassis goes to the *base* of the 2nd video amplifier transistor. This is a busy little rascal; vertical blanking to its



base, horizontal blanking to its emitter, and video straight through!

There's an RC network in the base circuit, going to the cathode of the 6HE5 vertical output tube (see diagram). Check these out; open C66 or leaky C67 will reduce the amplitude of the vertical blanking pulse. Also, check the 2nd video transistor, for leakage.

VTVM DRIFT

My Heathkit IM-13 vtvm has a drift. When it's on dc volts, the meter needle slowly swings to the right, all the way off scale. Acts up on ac volts, also. The ohms scale seems to be OK.—E.N., Hensall, Ont.

The most likely cause for this would be an unbalanced "meter tube". This Heathkit uses the "meter between cathodes" circuit, standard in many VTVM's. If the two triodes of the tube have unequal emission, or grid emission, you'll get this kind of trouble.

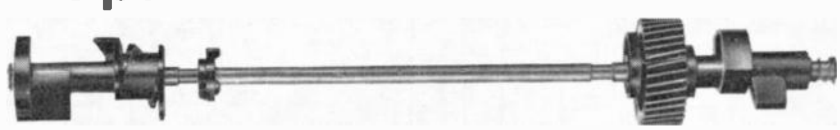
Age a new 12AU7 tube, by letting it sit in the tube-tester all day with only the filament voltage on it. Then try it. Recalibrate the meter on dc volts as per the instructions. You *might* have to try one or two new tubes, but I doubt it. One good tube will usually do it.

I.F. TRANSISTORS OVERHEAT

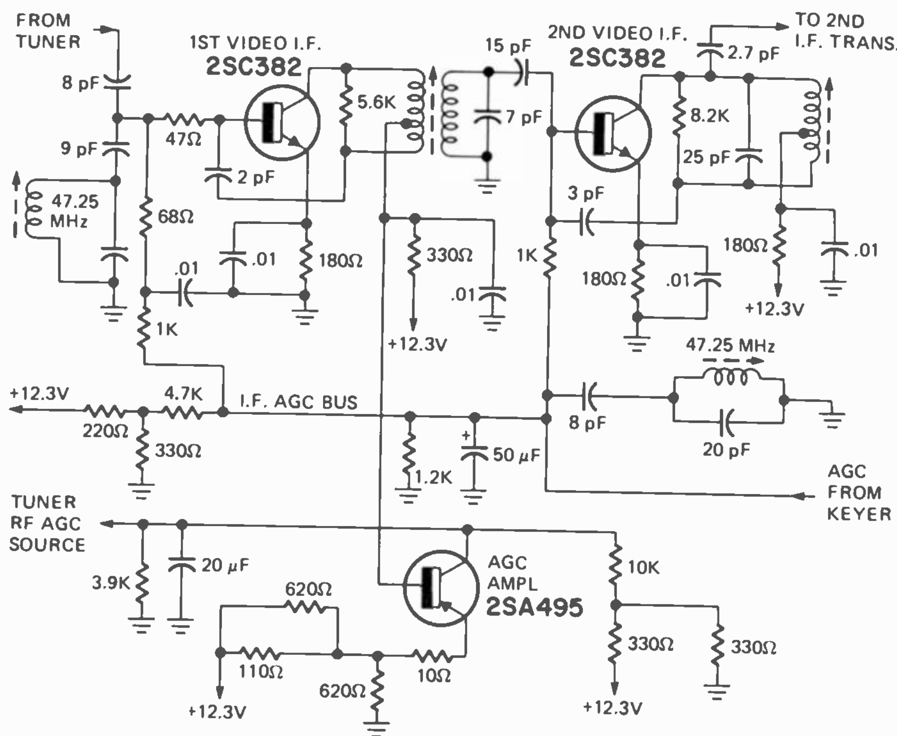
The two i.f. transistors in this Sears (Toshiba) 12" color TV get hot and I lose video and audio in about a minute. Cooling them will bring it back, momentarily. New transistors didn't help; dc voltages are correct while it is work-

Circle 19 on reader service card

Circle 20 on reader service card



Circle 21 on reader service card



ing.—P.B., Philadelphia, Pa.

Try this: override the agc bias and see if the trouble stops. Sams Photofacts gives the normal range of agc voltage as + 1.33 to 2.14 volts. If this helps, then check the agc transistor; you'll probably find that it is leaking and causing this trouble. The emitter voltages on these two transistors will give you a good idea as to what's going on. If they go up as the set plays, the transistors are drawing more and more current, indicating a bias problem.

INTERMITTENT FUSE BLOWING

I've got a Sentinel 1U-816C color TV that blows the B+ fuse at odd intervals, usually about an hour after it's turned on. I've replaced the damper tube, and checked the horizontal output, etc, but I haven't found it yet.—R.T.C., San Rafael, Calif.

There are two ways to attack this kind of problem. One is the brute-force method, which is putting a big fuse in it, turning it on and waiting to see what catches fire. This is often a very good way to do it, but you must keep a close watch, to avoid any further damage. (Like burning up a perfectly good flyback, or something nice, like that!)

Probably the easiest way is to start 'monitoring' things, to get the general area of the trouble pinned down. Set the horizontal output tube on a 'cathode-break' adapter, and note the current. Another one is to make up a pilot light socket with a plate cap on one end and a clip on the other; take off the output tube plate and put this in series. Put a 500 mA pilot light in it.

Now hook a meter on the boost voltage somewhere, and then turn it on. If the overload is somewhere in the horizontal output tube load, the pilot light will flare up when the current rises. The boost voltage may go down, or even go up, depending on what is happening.

Another good point would be the bias or cathode-current of the high-voltage regulator tube.

Intermittent shorts or flashovers in the high-voltage regulator, high-voltage rectifier or even the focus rectifier will also do this, so you might try replacing these tubes first just to make sure.

SNOWY I.F.

In a Magnavox transistor TV, I've run into quite a few that develop excessive snow. This seems to happen within a few weeks after they have been sold. Do you have any ideas as to what could be done to help this?—A.C., Miss.

For one thing, transistor i.f.'s in many sets will have one position of the agc control that will cause snow, even on a strong signal. You might try readjusting the agc in the home, to see if this helps. Alternate; cook these sets as long as possible while they're still on the floor.

I have heard one, recently, which I pass along without comment. A field engineer for a well-known test-instrument company says that transistors will *change* in characteristics during the first few hours of use. Your experience might tend to bear this out; it would take some careful experimentation to verify it. R-E

new products

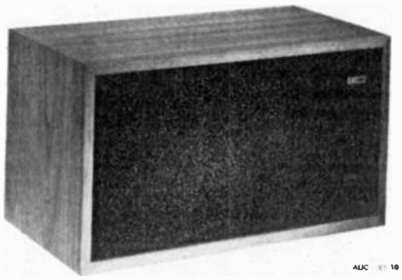
More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

RECORD RACK comes knock-down; consists of two sides, multiple supporting bars and self-threading screws and is easy to assemble. Holds up to 50 albums and has sliding pressure locking rings to keep fewer than 50 albums straight and in place. Albums are tilted for easy identification.

Transparent smoke walls and crystal clear supporting bars. Also available is 8-track rack; $8.00 each.—**Shapecraft Corp.**, 475 Park Avenue South, New York, N.Y. 10016.

Circle 31 on reader service card

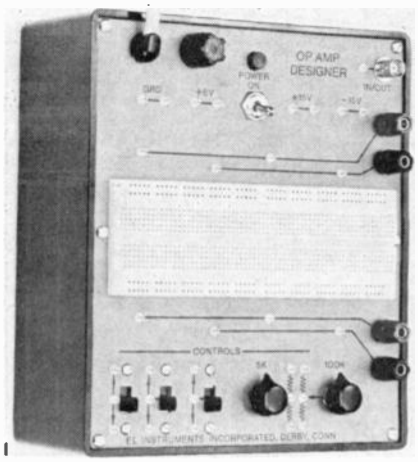
LOUDSPEAKER SYSTEM, *ADC-XT 10* is a two-way, three-driver system. Bookshelf size unit has 37 Hz to 20 kHz response ±3 dB. High-frequency drivers: two 2½" viscous impregnated cone tweeters with 1¼" diameter effective radiating surface. Low-frequency driver: 10" with high-compliance suspension and high power handling construction.



Oiled walnut; air-tight cabinet. 23¾" x 13" x 11¾"; foam grille; $115.00.—**Audio Dynamics Corp.,** Pickett District Road, New Milford, Conn. 06776.

Circle 32 on reader service card

CIRCUIT DESIGNER gives the beginner and experienced user a design unit where op-amps, CMOS, etc., can be readily used. Features a ±15V @ 50 mA current-limited power supply as well as a ±5V dc regulated output at 100 mA. All outputs are short-circuit protected. Has two linear rotary potentiometers (5000 and 100,000 ohms nominal resistance) and three slide switches (spdt). Kit form models from $45.00; assembled models from $85.00.—**E&L Instruments, Inc.,** 61 First Street, Derby, Conn. 06418.



Circle 33 on reader service card

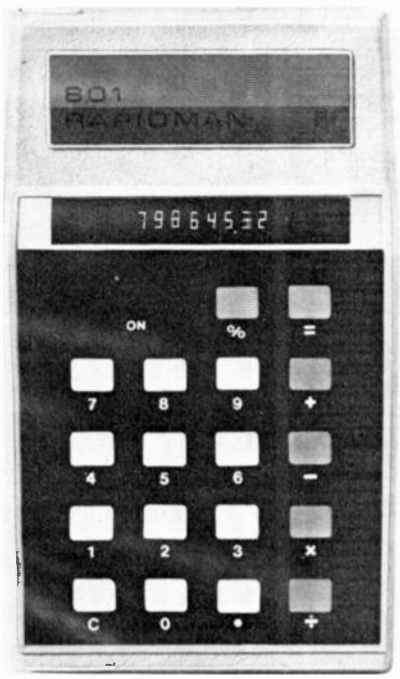
COMPUTER CALCULATOR, *HP-80.* All you do is make a few entries and in seconds your problem is solved. Pre-programmed with 36 separate financial capabilities (plus the basic four functions) that include: constant storage, square root, future date given number of days, future value of an amount compounded, present value of an annuity, number of periods for a mortgage and true equivalent annual rate.

Displays up to 10 significant digits. Automatic decimal point positioning, selective round-off, indicators for improper operations and low battery condition. Solid-state electronics and LED display. Operates on ac or rechargeable batteries. 9 oz.; 5.8"L x 3.2"W x 0.7 to 1.3"H. Temperature operating range: 32°F to 104°F (0°C to 40C). $395.00 includes battery pack, 115/230V ac adapter/recharger, Quick Reference Guide, operating manual and safety

travel case.—**Hewlett Packard,** Advanced Products Division, 10900 Wolfe Road, Cupertino, Calif. 95014.

Circle 34 on reader service card

POCKET CALCULATOR, *Rapidman 801* is an 8-digit calculator that performs four basic arithmetic functions, mixed or constant calculations, chain division and



multiplication. Floating decimal point system is used in entry and answer. Indicators show negative sign and overflow entry/answer. Can obtain square or powers of a number, negative powers of numbers, reciprocals, do automatic percentage calculations, automatic percentage add-ons and discounts, etc. Supplies automatic round-off and can operate in either full floating point or adding machine mode. Single key for entry correction and clearing of calculator.

Powered by standard 9-volt disposable battery or rechargeable nickel-cadmium battery with optional recharger. Can also be ac line-operated with adaptor. Single chip, large-scale IC. 5¾" x 3⅜" x 0.9"; 8 oz.; $119.95.—**Rapid Sales Corp.,** 29245 Stephenson Highway, Madison Heights, Mich. 48071.

Circle 35 on reader service card

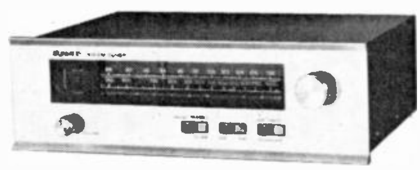
UHF PREAMPLIFIERS, *SCMA-U series.* Used on channels 14-70; each has its own low noise-figure rating etched directly on nameplate together with channel number. Typical noise figures are 3.5 dB for all channels from 14-50, guaranteed maximum not exceeding 4.0 dB and 4.5 dB for channels 51-70. Minimum gain is 22 dB for any of the available channels.

Mounted on single glass-epoxy PC

board; powered by −21 volts that can be duplexed on signal cable; 3" x 5" x 2". Equipped with type F input and output-monitoring connectors. Output-monitoring connector provides back-matched −20 dB test signal that permits performance monitoring and antenna orientation while unit is mounted on tower. CATV operator price $139.00.—**Blonder-Tongue Laboratories, Inc.,** One Jake Brown Road, Old Bridge, N.J. 08857.

Circle 36 on reader service card

AM & FM STEREO TUNER, *AF-6* combines the FM-5 multiplex tuner features with newly designed AM circuits. Extends audio range without inhibiting selectivity to provide best possible AM reception. Two other switch-selected audio bandwidth positions provide usuable re-



ception of less perfect signals for normal reception and for high interference conditions. Twelve-section LC design i.f. filter provides selectivity of 20 dB at 10 kHz and 55 dB at 20 kHx. Agc characteristic provides easy listening to signals from 50 to 500,000 μV. 10 kHz notch filter reduces off channel interference. 60 dB image rejection; 70 dB i.f. rejection; less than 2% distortion. Three preassembled circuit boards and front end are completely aligned.—**Dynaco, Inc.,** 3060 Jefferson Street, Philadelphia, Pa. 19121.

Circle 37 on reader service card

FM MODULATION METER, *ECM-5* covers all bands from 30 to 50 MHz. Features peak reading meter that has a special time constant circuit that causes the needle to deflect upscale rapidly and downscale slowly. Deviation of any FM transmitter can be accurately adjusted between 0 and 25 kHz using voice or tone modulation. Frequency selection is

crystal controlled.

Built in or external antenna; all solid-state construction; battery powered. battery condition indicator. $75.00 less batteries and crystals. Crystals $7.10 each for all frequencies except 146.94 MHz $3.75 each.—**ECM Corp.,** 412 North Weinbach Avenue, Evansville, Ind. 47711.

Circle 38 on reader service card

4-CHANNEL AMPLIFIER, *AA-2010* uses four conservatively-rated amplifiers that produce 260 watts into 4 ohms (4 x 65), 200 watts into 8 ohms (4 x 50), 120 watts into 16 ohms (4 x 30). All new decoder circuitry decodes all matrix encoded records currently available and handles any discrete 4-channel material at flip of mode switch. Built-in decoder enhances recorded stereo material and stereo FM by reproducing out-of-phase ambience common to 2-channel pro-

gramming.

Individual amplifier sections are controlled in pairs that provide two complete and independent stereo systems if desired. Pushbuttons activate speaker pairs in any combination up to eight speakers—or two complete 4-channel systems. Twenty imput level controls—enough for up to five 4-channel program sources—can be adjusted beneath the chassis. $359.95.—**Heath Company,** Benton Harbor, Mich. 49022.

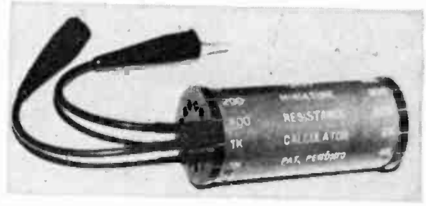
Circle 100 on reader service card

CD-4 DISC DEMODULATOR, *QD-240* reproduces discrete 4-channel sound from all CD-4 discrete records. Connect between stereo turntable and 4-channel amplifier or receiver. Demodulates the signal into four distinct channels. Sound separation is read on front panel by a large illuminated panel meter. 3-position function switch allows a choice between 2-channel, 4-channel auto or direct. 4-channel auto position provides an automatic switching function between 4-channel and 2-channel sound sources.

Signal-to-noise ratio to more than 70 dB, frequency response of 20 Hz to 15 kHz, left/right separation of 30 dB, using standard test signal of 1 kHz. Test record included to enable user to adjust for maximum separation. $139.95.—**U.S. Pioneer Electronics Corp.,** 178 Commerce Road, Carlstadt, N.J. 07072.

Circle 40 on reader service card

MINIATURE RESISTANCE CALCULATOR, *R-1* has over 825 different values. To use as substitution box: plug one lead into 0 ohms, plug additional lead into desired value. If value desired is not shown, plug lead into the next higher range and move the 0-ohm lead to subtract the difference. As step decade: plug lead into 0 ohms and move



second lead. Will decade in steps of 1K, 10K, 100K, up to 11 megohms.

As automatic voltage divider: connect 0 ohms to ground and connect a high value with second lead to voltage source. Can get up to 25 different voltages at the same time from one ac or dc source. Less than 1 lb.—**Lee Electronic Labs, Inc.,** 88 Evans Street, Watertown, Mass. 02172.

Circle 41 on reader service card

BOOSTER COUPLERS for TV reception. Designed for pegboard display.

Vhf/uhf/FM *model PC4382BP* (one 300-ohm input—four 300-ohm outputs) $48.15; vhf/uhf/FM *model PC4782BP*

Circle 83 on reader service card

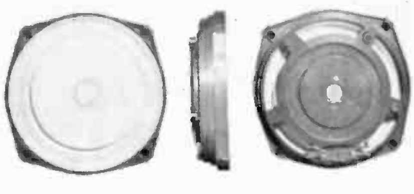
Circle 26 on reader service card

(one 75 or 300-ohm input—four 75-ohm outputs) $51.30; vhf/FM *model PC4312BP* (one 300-ohm input—four 300-ohm outputs) $37.65; vhf/FM *model*

PC4712BP (one 300-ohm or 75-ohm input—four 75-ohm outputs) $43.95.—**JFD Electronics Corp.**, 1462 62nd Street, Brooklyn, N.Y. 11219.

Circle 42 on reader service card

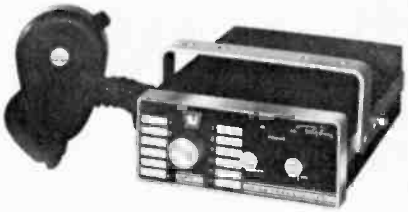
REPLACEMENT SPEAKER, *model RP6* is a Poly-Planar plastic speaker that directly replaces conventional 5¼" cone speakers in all applications. Wide frequency range 5¼" pin-cushion speaker



design can handle 10 watts rms power, but is only 1⅛" deep. Response is 55 Hz to 20 KHz, 8 ohms; $7.95.—**Magitran Co.**, 311 East Park Street, Moonachie, N.J. 07074.

Circle 43 on reader service card

FM TRANSCEIVER, *HR-2B* puts out 15 watts of power on any of its 12 crystal controlled transmit channels for the 144-148 MHz spectrum. Receiver section has sensitivity rating at 0.35 μV, 20 dB quieting and an audio output of 3 watts.



Features a noise compensated squelch system; channel 1 crystal for 146.94 MHz is factory installed.

Transmit channels are provided with individual trimmer capacitors in point-to-point or repeater applications. Built-in VSWR bridge limiting circuitry protects against open or shorted antenna conditions. Operates on 13.8 volts dc power supply with low current drain factor. 2¼" x 5½" x 7½"; $229.00 complete with plug-in, hand-held, high Z ceramic mike, transmit and receive crystals for channel 1 position and mobile mounting bracket.—**Regency Electronics, Inc.**, 7900 Pendleton Pike, Indianapolis, Ind. 46226.

Circle 44 on reader service card

BIOFEEDBACK MONITOR, *Stock No. 1635* enables the user to listen to and see his Alpha-Theta brainwaves. Has ultra-sensitive electrode headband that slips on or off (no creams or solutions).

Hooked to an amplifier, it filters brainwaves and signals an audible beep for each Alpha or Theta wave passed. Monitoring button simulates and identifies the Alpha sound. Both audio and visual feedback.

Fully portable; 8" x 3" x 4"; 24 oz.

Circle 28 on reader service card

Circle 28 on reader service card

Operates on two 9-volt batteries; $124.50.—**Edmund Scientific Co.,** 380 Edscorp Bldg., Barrington, N.J. 08007.

Circle 45 on reader service card

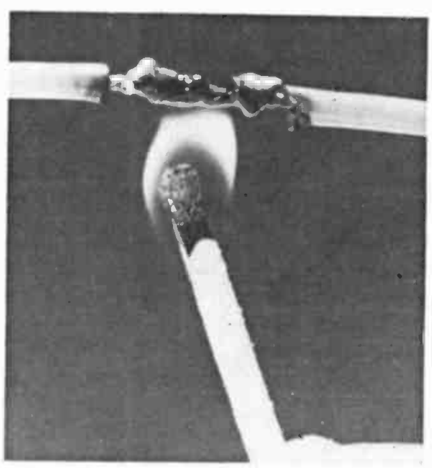
TV MARKER/SIGNALYST, *WR-525A* services TV receivers and CATV, MATV and closed-circuit systems. Can be used with sweep-alignment generators to check TV tuners and overall rf/i.f. receiver alignment on all vhf and many uhf channels.

Continuously tuned unit is calibrated for fundamental signal output on picture-carrier frequencies and provides dual picture and sound sweep-alignment

markers when modulated with 4.5-MHz signal. Connections for external video input make it possible to modulate the unit with dot, cross-hatch or color-bar signals from external generator or with video output from TV receiver. Can produce pattern or picture on any vhf channel. Modulated harmonic output will produce patterns or pictures on many channels within the uhf TV range. 4½" x 3½" x 3"; powered by single 9 volt battery or from external power supply; $46.50.—**RCA Commercial Engineering,** Harrison, N.J. 07029.

Circle 46 on reader service card

TAPE SOLDER. Twist your wires together, wrap them with a piece of Tape Solder and melt it with a match, candle or cigarette lighter flame. No soldering iron needed. Ideal for on-the-spot wiring



and repairs, installing light fixtures, automotive accessories, while camping, etc. 100 pre-cut pieces 89¢.—**Radio Shack,** 2617 West 7th Street, Fort Worth, Tex. 76107.

R-E

Circle 47 on reader service card

Circle 29 on reader service card

Circle 30 on reader service card

new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.

ASSEMBLY-DISASSEMBLY HANDBOOK. 36-pages of up-to-date operational procedures for asolder extraction, coating removal and component lead forming techniques for sensitive and expensive electronic assemblies and components. Each technique is explained and illustrated.

Features fully illustrated and easy-to-understand descriptions of the advanced PACE-developed products and systems that are used to apply these techniques. Complete with glossary of technical terms.—**Pace, Inc.**, 9329 Fraser Ave., Silver Spring, Md. 20910.

Circle 48 on reader service card

RADIO & TV TUBES CATALOG. 48-page catalog contains individually-priced tubes, tube and continuity checker, antennas, battery charger as well as cutting pliers, stereo headphones, pool alarm kit, electronic cleaner and car equipment (gas siphon pump, emergency starting cables and trunk lid ties). Also contains soldering gun and iron, desoldering bulb and electric pencil engraver.—**Cornell Electronics Co.**, 4217 University Avenue, San Diego, Calif. 92105.

Circle 49 on reader service card

EXPANDING THE ART OF TAPE RECORDING is a 24-page booklet that describes how various accessories or extensions to a tape recorder are engineered. Features: microphone and impedance converters, service accessories, special-effects accessories, pause/repeat control accessories, timer controls, remote controls, reels and reel adapters as well as trouble-shooting chart.—**Teac Corp. of America**, 7733 Telegraph Road, Montebello, Calif. 90640.

Circle 50 on reader service card

TV TEST EQUIPMENT & ACCESSORIES CATALOG, *1973-1* is a 15-page catalog that contains test rig, transverter, CRT tester, cross-reference yoke and convergence adapters, black & white brighteners, color brighteners, service accessories, service extensions, replacement CRT sockets and leads and service kits Many illustrations.—**TeleMatic**, 2245 Pitkin Avenue, Brooklyn, N.Y. 11207.

Circle 51 on reader service card

1974 ELECTRONICS CATALOG *NO. 740.* 244-page catalog features: antennas, alarms, auto radios, speakers & tape players, hi-fi amplifiers, 4-channel equipment, power supplies, power tools, marine equipment kits, table & portable radios, security equipment, speakers & speaker systems, switches, tape recorders, decks, players, cartridge, cassette & reel-to-reel, telephones & accessories, tools, hardware, closed circuit TV, TV sets, wire & cable, watches and walkie-talkies. Contains many illustrations and prices.—**Olson Electronics**, 260 South Forge Street, Akron, Ohio 44327. **R-E**

Circle 52 on reader service card

4-CHANNEL QS MATRIX
(continued from page 41)

separation is a bit over 10 dB in terms of L_t heard in the remaining three speakers.

Finally, as the 3-kHz L_b signal increases further in level, separation of the L_f signal decreases to minimum values (as heard in the L_b and R_b channels) and remains over 10 dB as heard in the R_f channel. Of course, at this time the separation of the 3-kHz L_b signal increases to over 20 dB with respect to its related and unwanted channels, but that would be shown on another similar graph in which L_b separation is referenced.

One important point made by Sansui is describing this system and its virtues, is the fact that even relatively low-level signals retain their total energy output in this process, rather than being attenuated as they are in some gain-controlled logic systems.

Multiple usage

The variable gain control required in the Variomatrix system is provided by a regular matrix and the FET circuit shown in Fig. 8. The output signal of transistor Q1 which is controlled by changing the effective emitter resistance (the FET impedance is across R_e) is matrixed with the other composite signal (L_t + R_t) or (L_t − R_t) to control inter-channel separation. Gain of the FET as a function of gate-source voltage (V_{gs}) is shown in Fig. 9.

In addition to bias changes caused by the output of the phase discriminator of Fig. 5, it is possible to have a fixed amount of bias applied to the FET to provide for different matrix settings, such as those offered on Sansui's own decoders and late-model receivers. These products have QS settings, Concert Hall settings (which provide primarily ambience effects for the listener), Phase Matrix settings (which approximate CBS-SQ decoding) and QS Synthesizer settings (intended primarily for enhancing stereo records to give a four channel effect). When the mode switch is set to the straight QS position, the FET bias is set as V_p so that the variable matrix operates only in the opening (higher gain) direction. For the Concert-Hall mode, it is set near point "b" for the front channel matrix only. The front channel matrix is "closed" only if the rear signal is stronger than the front signal. For the "Phase Matrix" mode, bias is set near point "a", so that both the front and rear decoding matrixes operate only in the *closing* direction and for the QS Synthesizer mode, bias is set near V_p or point "a".

The front-back Variomatrix principle discussed here can be further augmented by additional circuits, similar to those shown in the block diagram of Fig. 5, which operate to sense phase relationships between left and right domi-

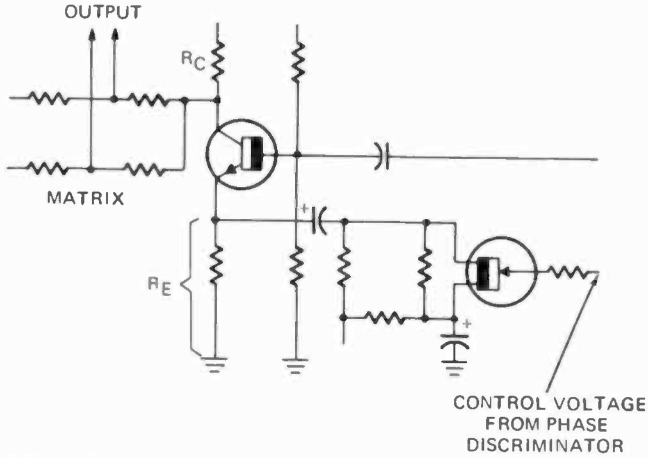
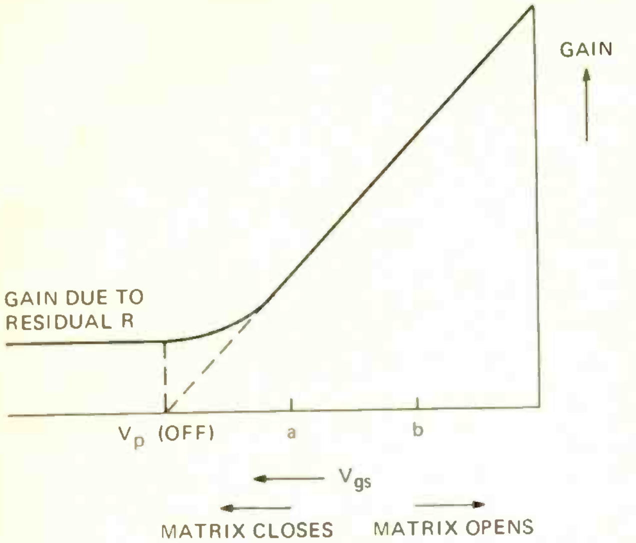


FIG. 8—FET USED AS A VARIABLE GAIN CONTROL following a matrix network for Variomatrix action.



POINT A: POINT WHERE L AND R ARE CLEARLY SEPARATED.

POINT B: POINT WHERE THE BLEND INSIDE THE ENCODER (Δ = 0.414) IS ALSO CANCELLED AND L_f AND R_f ARE SEPARATED BY APPROXIMATELY 10dB.

FIG. 9—FET BIAS CHARACTERISTIC used to set mode selection points.

nance, providing two orders of control and further improvement of instantaneous separation capabilities in all four channels. With this additional refinement, Sansui claims maximum inter-channel separation of 20 dB or more for all channels.

Another refinement involves the division of matrix parameters into two frequency bands—high and low. In the left-right variable matrix portion of the new decoder circuits, low frequency matrix coefficients remain fixed while high-frequencies are acted upon by the varying coefficients. In the front-back sensing circuitry, high-frequencies are treated with fixed coefficients while low frequencies are subjected to variable coefficients. Sansui has found that this technique helps to overcome such secondary problems as "floating surface noise" and unstable localization of high-frequency instruments.

How does it sound?

I have had an opportunity to hear Sansui's latest Vari-omatrix decoders on more than one occasion and can testify that with properly encoded material I was hard pressed to tell the difference between matrix reproduction and the original discrete tapes from which the recordings were made. The engineering effort expended by Sansui on their QS system and its refinement has been prodigious. In terms of bandwidth utilization, Sansui has certainly shown that it is possible to convey much more 'information" in two channels than would have been thought possible a few years ago. **R-E**

Just don't know what we'd do without you TV technicians. By the way, I've got a set in my camper that's been acting funny, and . . .

next month

DECEMBER 1973

- **New Color TV Circuits**
  The winds of change are ever blowing through the labs of the TV circuit designer. Here's a onceover of the new circuits appearing in the 1974 color sets.

- **Remote Control For Color TV**
  Boy has remote control changed! See how the new ones work.

- **Slotted Mask Picture Tubes**
  Jack Darr tells how these new masks in combination with in-line guns improve the performance of color picture tubes.

- **COSMOS—Why Is It So Good?**
  All about this new kind of low-power IC. Learn how it manages to operate on microwatts of power.

- **New Approaches To Speaker Systems**
  Len Feldman explores the principles behind the British Industries Venturi and the Electro-Voice Interface. You'll be fascinated by the story of how these speaker systems work.

PLUS
Appliance Clinic
Replacement Transistor Guide
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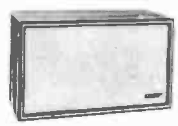

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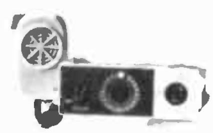
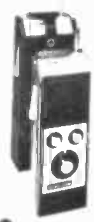
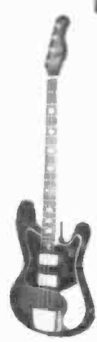


Micro 23 2-Way CB Radio



Dyna-Com Walkie-Talkies



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***SECURITY & YOU* published by Hydrometral, Inc., Rockford, Ill. 61101. 8¼ x 5¼ in. 112 pp. Softcover, $1.00.**

This easy-to-understand book tells all you need to know about protecting your home, office or car against would-be intruders. It explains complete home and business protective systems plus valuable information on locks, lights and other deterrent devices along with the fascinating history of security through the years.

***BUILD YOUR OWN HOME & CAR SECURITY* published by Motorola HEP Semiconductors, Phoenix, Arizona. 8¼ x 5¼ in. 106 pp. Softcover, $1.25.**

This book presents unique and useful projects for the hobbyist and experimenter. These projects have been individually designed, constructed and tested by professional alarm system engineers. Each project is prepared and described in a manner that allows a fairly inexperienced person to construct a worthwhile unit with ease and at the same time, gain some basic knowledge of alarm electronics. Ten different construction projects are included, ranging from a moisture sensor alarm to a photoelectric alarm to a door/window alarm to a voltage sensing car alarm to a high-power electronic siren. Two additional chapters present a basic introduction to alarm theory and necessary construction hints and descriptions of the types of components used to build the projects in this article.

***INTRODUCTION TO THE UNIFIED THEORY OF ELECTROMAGNETIC MACHINES* by M.G. Say. Harper & Row, Inc., 10 East 53rd Street, New York, N.Y. 10022. 5¼ x 8½ in. 198 pp. $8.00.**

This book regards all electromagnetic conversion devices—limited, motion as well as rotary—as variants on the common theme of gap energy. Simple general principles for the development of force and torque then lead to a variety of ways of realizing the devices. This approach uses the system concept with its accent on dynamic rather than on steady-state conditions. The book shows how the physical principles lead readily to the circuit concept upon which advanced works rely in their treatment of generalized theory. Many solved examples are presented.

***EASI-GUIDE TO HI-FI STEREO* by Forest H. Belt. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46268. 5¼ x 8¼ in. 160 pp. Softcover, $3.50.**

Gives the hi-fi novice a broad outline of the variety, quality and expense of basic musical sound equipment and associated music sources. Aids in planning the home music system arrangement and offers directions in the search for the right equipment. Chapters included are: what a music system is, various components of a music system, factors to be considered in the listening area, language of hi-fi, equipment selection, antennas, installation, adjustment, trouble-shooting and 4-channel sound.

***HI-FI PROJECTS FOR THE HOBBYIST* by Leonard Feldman. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46268. 5¼ x 8¼ in. 144 pp. Softcover, $3.95.**

Complete information is given about tools, techniques and materials used in each project. Detailed instructions are given on how to design a printed circuit, how to etch the boards and how to mount the components. Each chapter contains background information about the nature of the project—how it works, why it is needed and how it is used. Projects include: phono preamp, loudness control, multiple speaker switching, four-channel adapter, small speaker enclosure, and IC FM stereo adapter.

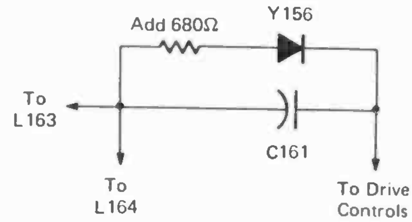
***INSTALLING & SERVICING ELECTRONIC PROTECTIVE SYSTEMS* (Tab Book No. 605) by Harvey Swearer. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 5½ x 8½ in. 256 pp. Hardbound, $7.95; softcover, $4.95.**

This up-to-date handbook explains how to select the right system for any particular job, how to estimate costs, how to install and check the system and even how to build and expand one's business, train help and finance the operation. Text discusses all the basic systems and then starting with sensing and detecting methods, proceeds with individual chapters on the various types of alarm systems—electromechanical, photoelectric, ultrasonic, microwave, proximity, audio and visual, seismic, vibration and stress intrusion and specialized systems such as night viewing devices, vehicular alarms, etc. Appendix carries the complete Federal Crime Insurance regulations and provides glossary and complete list of manufacturers and suppliers. Over 160 illustrations. R-E

technotes

BLOOMING PICTURE

When either Y155 or Y156 diode fails in the General Electric N-2 chassis, add a 680-ohm, ½-watt 10% resistor in series with the anode side of Y156 as shown in the diagram.



Splice the resistor into the anode side of Y156 and insert the assembly into the circuit board where Y156 was removed. This will cure the problem which is basically due to internal arcing in the picture tube.—*G-E Service Talk*

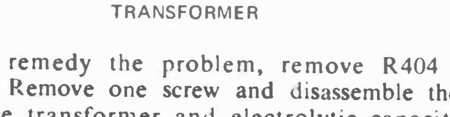
MAGNAVOX SPEAKERS—FUSIBLE RESISTORS

Speaker systems such as the models 1S8757 through 1S8759 and 1S8762 through 1S8766 have a fusible resistor in series with the positive lead to the speakers. It protects against excessive current flow in the event of a shorted speaker voice coil. This fusible resistor is rated 0.225 ohm, 2 watts and is part No. 240104-3.

Because of the protective characteristics of this device, use only the exact replacement. Use the full length of the resistor leads and heatsink the leads while soldering them in place.—*Magnavox Service News Letter*

VERTICAL BUZZ, G-E SF CHASSIS

The buzz comes from laminations in the vertical output transformer. Heat from resistor R404 can soften the transformer wax. This allows the laminations to vibrate, causing the buzz.



To remedy the problem, remove R404 from its bracket. Remove one screw and disassemble the bracket from the transformer and electrolytic capacitor. Bend bracket 90 degrees as shown in the drawing. Reassemble the bracket and R404. Allow the transformer to cool about one hour before applying power. This will allow the wax to harden.

Caution: In SF1600 series receivers, slide R404 down in the clip so there is at least ½ inch between R404 and the bottom cover of the vhf tuner. In SF2200 series receivers, maintain at least 1 inch space between R404 and the antenna terminal.—*G-E Television Service Bulletin* **R-E**

try this

CABLE JACKET REMOVER

There are many occasions when it is necessary to remove the outer vinyl plastic covering from a multi-con-

ductor cable. A fast and easy way of doing this with no risk of damaging the insulation of the conductors is to use a dressmaker's seam ripper, as shown. Simply slip the end of the seam ripper under the outer covering, and push. Zip! It slices the jacket like a knife through soft butter.— *Hugh Gordon*

R-E

DID YOU MISS IT?

The Sansui Variomatrix system for producing 4-channel sound from encoded 4-channel records is presented on page 35. If you're not up-to-date on the latest developments in 4-channel sound you'll want to be sure to read this article.

EQUIPMENT REPORT

(continued from page 61)

curve tracer and a working service-type oscilloscope.

The scope does not have to be a highly accurate type. The *Model A* has built-in calibrating features. The staircase output of the curve tracer is fed to the vertical input, and the vertical gain control set so that each step covers one division of the graticule. The scope is now set at 1.0 volt per division. If the scope has a X1/X10, etc. attenuator, this is handy. Calibrated at 1.0 V/div, then turned to the X10 for 0.1 V/div, the screen will then read 1.0 mA per division, of the transistor's collector current.

Horizontal sweep is calibrated by reading the setting of the SWEEP VOLTAGE dial. You can adjust this for any desired V/div setting. At 10 volts sweep, for example, set for 5 or 10 divisions, and so on.

With this instrument you can not only tell whether a transistor is good or not, but identify its polarity, pnp or npn; and its material, silicon or germanium, by a quick twitch of a switch. Just set the controls to the point where you see a family of curves and read the dials. An open transistor makes a horizontal line; a shorted transistor makes a vertical line. Instant identification.

Dual TO-5 transistor sockets are provided on the top of the case. By flipping the socket selector switch back and forth, you can accurately match any pair of transistors. If the patterns are the same, these two are matched. A third position on this switch selects the probes. These plug into a socket on the front panel.

One of these has three very sharp pins, for in-circuit tests. If you can't get to a transistor with this, another one has three tiny alligator clips. This last one is also very handy for hooking up transistors with odd basing, larger types such as the TO-3 and TO-66 case, and anything that won't fit the sockets.

This instrument *will not damage transistors under test.* Current limiting resistors prevent this, even during the very useful collector-current breakdown test. If the transistor is inserted in the socket incorrectly, the characteristic upside-down L pattern will tell you. The instruction manual gives a fast method for locating the correct connections to unknown transistor types, a very useful thing. Needless to say, while checking out this instrument, I managed to make all of the hook-it-up-wrong tests, *some* of them intentionally, and I came out very well.

In-circuit curve-tracer tests are be-

(turn page)

EQUIPMENT REPORT

(continued from page 99)

coming quite popular with manufacturers. Sylvania in the Jan. 1971 issue of its Service News, published a full set of curves for its D-12 color TV chassis, one for each transistor in it. You can repeat this test for any solid-state set, and either draw or photograph the curves for future reference. In-circuit curves for similar stages tend to look a lot alike; for instance, first and second video i.f. stages, audio amplifiers, and so on.

In-circuit tests are simple, in principle. Since a curve-tracer tests transistors by turning them on, out-of-circuit; it should do the same, in-circuit, and it does. Due to the numerous shunt reactances present, the curves won't look like the out-of-circuit curves, but they *will* show a distinct "family" of curves, indicating that this transistor is capable of working.

This is strictly a GO/NO-GO test, for the transistor and doesn't indicate the quality of other parts in the circuit. However, it will give you the same basic reactions that other in-circuit testers do. If the transistor tests bad in-circuit, but tests good out-of-circuit, this shows that there is a bad part in that stage somewhere.

I gave it my best shots; three-and four-stage direct-coupled audio amplifiers. It showed curves on all four of the transistors. I tried it on a CATV line-amplifier, with very low reactances across most of the transistors. Came up smiling. In fact, we found the bad transistor in a known-bad amplifier. TV antenna booster, same results.

The *Model A* will do quite a few other tricks which we aren't able to cover here. These are all in the manual. This can be a money making instrument, properly used, and a welcome addition to your instrumentation. **R-E**

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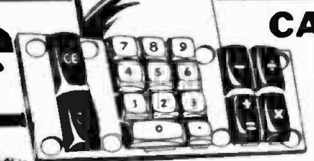

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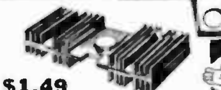

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☐ 2-SPERRY SP332, twin digit, factory rejects, .33" charac. no test. $1.00
☐ 1-OPCOA SLA-11*, like MAN-5, green, 1-or-more segs gone, .33" charac $1.29
☐ 1-OPCOA SLA-13*, 0.7 charac. readout, 1-or-more segs missing $1.29
☐ 5-MONSANTO opto isolators, no test, 1500V $1.00
☐ 10-LED HOBBY SURPRIZE, asst. types, factory rejects, no test $1.00
☐ 1-OPCOA SLA-1*, MAN-1, red, .33" charac. 1-or-more segs gone $1.00
☐ 1-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red $1.00
☐ 3-MONSANTO MAN-3, (the claws) .12" charac, red, some segs gone . . . $1.00
*Reflective bar segments, while Monsanto all LED segments.

POLY PAKS STOCKS "C-MOS" IC CIRCUITS

Type	Sale
☐ 74C00	$.95
☐ 74C02	.75
☐ 74C04	1.15
☐ 74C10	.95
☐ 74C73	1.79
☐ 74C74	1.59
☐ 74C76	1.79
☐ 74C157	2.50
☐ 74C160	3.50
☐ 74C161	3.50
☐ 74C162	3.50
☐ 74C163	3.50
☐ 74C195	4.50

RCA TYPE "C-MOS" IC's

Type	Sale
☐ CD4001AE	$ .71
☐ CD4002AE	.71
☐ CD4009AE	1.69
☐ CD4011AE	.71
☐ CD4012AE	.71
☐ CD4013AE	1.62
☐ CD4016AE	1.62
☐ CD4023AE	.71
☐ CD4035AE	4.16

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☐ **12 for $3.50**

All hermetically sealed. Submini, 1/6, half, and full crystal can types in 6-12-24V in asst contacts up to 4PDT, 1 amp up 10 amps. Such types as BR40, 41, 10, 44, 16, 24, etc. Sorry, no choosing voltages or types. From factory mixtures . . . to you! Good asst, if you are space-minded, at low prices.

SPERRY "ORANGE" TWIN DIGIT ARRAY

☐ **$5.95** 3 for $15.

Type SP332, each digit is individually controlled, operates off 180VDC, 100 ua, 200 mw. Color: ORANGE. 7-digits, glass protection over digits, Character height: 0.33, P.C. mounting. Size: ¾" x ¾", 9-pins per digit. Driver: SN7447.

3 LED DIGITS ON A DIP

☐ **$8.88**

Each digit is 7-segment LED (MAN-3 type) and internally "multiplexed" and driven by one SN7448. Similar to DL-33 by Litronix . . . . . intended for calculators, clocks, test equipment, etc. Encapsulated in red transparent epoxy in 14-pin dip pak. With decimals. High brightness, character size .12 x .077. Requires 5V 10 mils.

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$2.49 3 for $6

Your choice ☐ 115 VAC ☐ 24 VDC

Measures only ¾ x 1 x 1¼". Plastic cased. Like KNP type. For pc board or socket, 14 lugs, 1-8/32 stud too! Both 4PDT. All ceramic construction, 3 amps, contacts. For r-f ant, switching. Wt. 1-oz.

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

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

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* Plastic case
* Red needle Indicators

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☐ VU, side mtg. plus 3 minus 20 db.
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PRV	15 amp	25 amp
50	☐ $.65	☐ $.85
100	☐ .85	☐ 1.05
200	☐ 1.25	☐ 1.45
300	☐ 1.45	☐ 1.65
400	☐ 1.85	☐ 1.95
500	☐ 2.55	☐ 2.25
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Each board properly multiplexed for 6 digits, to hold MAN-1's, MAN-3's, MAN-4's, Litronics 707 (MAN-1) and 704 (MAN-4), and Opcoa's SLA-1 (MAN-1). Board 6⅞" long with spec sheets.

☐ MAN-1 ☐ Litronics 707 (MAN-1*)
☐ MAN-3 ☐ Litronics 704 (MAN-4**)
☐ MAN-4 ☐ Opcoa SLA-1 (MAN-1*)
☐ 6-MAN-3A's for above board. $9.50.

* Elec char. same as Monsanto devices MAN-1 or 4.

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Circle 88 on reader service card

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$39.95

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● (ITEM #738) -- Amazing "up-and-around" switch. Great experimental item. When used with two-wire telephone dial will select any number from 0 to 100. Make intercom or private system. Use to turn on remote lights, start motors, etc. Complete with contact bank. 13" x 6" x 3". (16 lbs.) Cost Over $90.00 **$8.95**

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(1¼ lbs.) Orig. Cost Over $19.00 Each **$1.99** Three For **$4.99**

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● (ITEM #22-063) -- A Four Star Buy! New, leading make. Heavy duty units excellent for use in 12 or 24-volt fast chargers, high current power supply systems, etc. 3½" x 1½" x 1½". ¾"-16 SAE mounting threads. (1 lb.)

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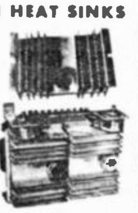

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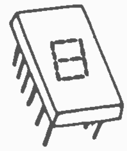

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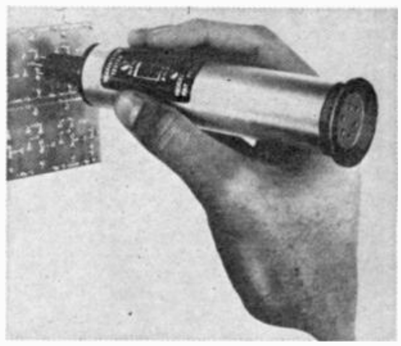

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☐ 4W	Motorola	MFC9000*	DIP	Yes	$2.95
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- ☐ 10 – RCA CA-3000 OP AMPS, TO-5 case* $1.
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*Untested, guaranteed satisfaction

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- ☐ 10 — SLIDE SWITCHES, SPDT, DPST, DPDT, 115/1/60, 3A $1
- ☐ 30 — ALLEN BRADLEY MICRO MINI 1/8 watt resistors, asst. $1
- ☐ 30 – POWER RESISTORS, 3-to-25m, square, vitreous, asst. vals. $1.
- ☐ 10 – MICRO REED SWITCHES, 1" long, transistor work $1.
- ☐ 1 – $25. SURPRISE PAK, resistors, caps, transistors, etc. $1.
- ☐ 50 – TERMINAL STRIPS, 1-to-8 screw & tie lugs $1.
- ☐ 30 – SQUARE DISCS, 85mmf, to 01mf, space-savers $1.
- ☐ 75 – PRE-FORMED DISCS, condensers, printed circuit $1.
- ☐ 60 – TUBE SOCKETS, receptacles, plugs, audio, etc. $1.
- ☐ 100 – PREFORMED RESISTORS, 1/2 watt, printed circuit $1.
- ☐ 50 – COILS & CHOKES, if, rf, ant, peaks, osc, parasitic $1.
- ☐ 60 – PRECISION RESISTORS, 1/8, 1/2, 1 & 2w, 1% asst. vals. $1.
- ☐ 60 – TUBULAR CONDENSERS, to .5mf, to 1kv, molded too $1.
- ☐ 30 – POLYSTYRENE CONDS, finest caps made, asst. values $1.
- ☐ 10 – PANEL SWITCHES, 110VAC, micro, rotary, thermal, slide $1.
- ☐ 10 – VOLUME CONTROLS, to 1 meg, duals too, some w/switch $1.
- ☐ 40 – MICRO MINI RESISTORS, 1/8w, 100 ohm to 1 meg, 5% $1.
- ☐ 40 – MICRO-MICRO-MINI CONDENSERS, to .05mf cerafil $1.
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- ☐ 10 – ELECTROLYTIC COND's, FP's, & tubular, 2 & 3 sect. too $1.
- ☐ 6 – TRIMMER POTS, 100, 500, 2K, 5K, 10K, 25K, 1/8w, snap-in $1.
- ☐ 4 – MICRO POTS w/knob, snap-in, 1/5w, 25k, 50k, 100k, 1 meg $1.
- ☐ 30 – YELLOW PACKET MYLARS, assorted values & sizes $1.
- ☐ 10 – POWER TRANSISTOR SOCKETS, for TO-3, asst. types $1.
- ☐ 64 – PLASTIC TRANSISTORS TO-18, printed circuit $1.

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$47. Any Type Clock less time-base

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Cabinet is compact 6" x 5 1/2" x 6".

CHOOSE YOUR READOUT

Type	LED	Charac.	Sale
KR-101	MAN-3	.12	$47.
KR-102	MAN-1	.27	47.
KR-103	MAN-4	.19	47.
KR-104	Nixie*	.45	47.
KR-105	707†	.33	47.
KR-106	704†	.33	47.
KR-107	SLA-1†	.33	47.
KR-108	Same as SLA-1 but GREEN, add $12.		

† "MAN" LED readouts are "all LEDs" but the Litronix 707 and Opcoa SLA-1, like the MAN-1, are of the reflective bar segment technique, the 704 is the reflective bar version of the MAN-4. *The Nixie tube is a 7-segment device as others.

Scientific Devices introduces the new any LED Kronos digital clock. That's right, you can choose the "ALL-LED" Man-1, Man-3, and Man-4, and the new reflective bar types with the larger digits, at only one price, $47. This is a Scientific Device first! We even hav the GREEN LED readouts at a slightly extra cost. We have more . . . for $19.95 we have available as an (*) extra option to Naval Observatory your clock, or making it an all-purpose all-duty unit. For indoor and outdoor activity. This "TIME BASE" is the simplest on the market today with the help of one of the largest time base manufacturers for the famous digital wrist watches. Therefore, current drain is negligible, not like other cumbersome types. It's easy to construct, easy to slip into the Kronos of your choice and connect with easy instructions. Its overall design is simple and easy to construct. The kit is complete with famous black-and-white TEN-TEC cabinet, plus all accessories with booklets. Features include 3 setting controls, 1-hour per second, 1-minute per second, and hold button. Scientific Device exclusive!

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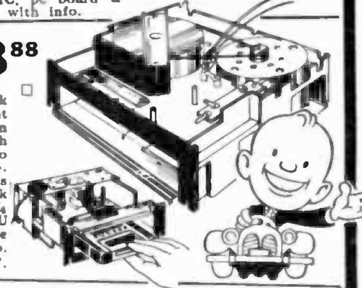

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☐ SN7402	.30	☐ SN7437	.60	☐ SN7473	.52	☐ SN74106	1.25	☐ SN74163	1.95
☐ SN7403	.30	☐ SN7438	.60	☐ SN7474	.52	☐ SN74107	.70	☐ SN74164	3.50
☐ SN7404	.35	☐ SN7440	.30	☐ SN7475	.95	☐ SN74108	1.25	☐ SN74165	3.50
☐ SN7405	.32	☐ SN7441	1.40	☐ SN7476	.55	☐ SN74112	1.25	☐ SN74166	2.05
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☐ LM-320	Minus 5V 1-amp V.R.*	1.95
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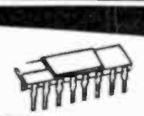

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7407	.53	7453	.32	74145	1.25
7408	.29	7454	.45	74153	1.45
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7410	.25	7460	.30	74155	1.35
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7423	.37	7480	.69	74176	.95
7425	.39	7483	1.25	74177	.95
7427	.39	7485	1.20	74180	1.15
7430	.25	7486	.55	74181	4.50
7432	.30	7489	3.25	74182	1.10
7437	.50	7490	1.25	74192	1.65
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7440	.25	7492	1.05	74195	1.15
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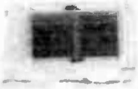

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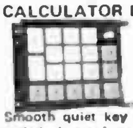
SLA-7 Readouts $2.50

CALCULATOR KEYBOARD



This is a Flex-Key series SK keyboard made for pocket calculators. Only 2.36" x 3.76" x 0.45" thick; Switch matrix for Cal Tex 5001, 5002 or Mostek 5010 or 5012 chips. Smooth quiet key travel, double shot keys, completely sealed, impervious to dust, moisture and even direct liquid spills.

CK . . . $8.00
10 or more . . . $6.00

12 VOLT 0.750 AMPERE HOUR SEALED NICKEL CADMIUM BATTERIES

Brand new, manufactured by Gould National. Size: 1" dia. x 9-3/8" L. Manufacturer's list price is $24.50. Excellent for photo-flash, burglar alarms, etc. Fully guaranteed, available at a fraction of original cost—quantities are limited, won't last long, so order now!

12V 0.75 AHSNCB . . . $9.75

7-SEGMENT DIGITAL DISPLAY — $1.70 each

Bright blue-green display tube, with numerical display characters. Tube exhibits very fast display speed and easy-to-read characters of .57" H x .36" W, with decimal point. Complete with instructions to make a decade counting unit or a 6-digit clock. Tubes are brand new, bulk packed, and manufactured by Tung-Sol, no. 1705. Sh. Wt. 4 oz.

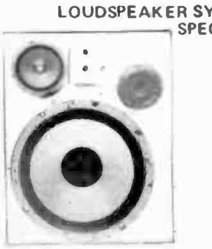
7SDO-1705 . . . $1.70 each; or 6 for $8.50, 10 for $14.00, 100 for $125.00, 1000 for $950.00

COLLINS CRYSTAL FILTERS

Anyone who is familiar with super high quality communications receivers is familiar with the Collins filter. 455 Kc center frequency 300 Hz bandwidth. Part number 526 7073 009, type X455-KF 300. Full technical information provided.

Collins Crystal Filter . . . $14.75

LOUDSPEAKER SYSTEM COMPONENT SPECIAL!



We have made an excellent purchase of an excess inventory of a local manufacturer's speaker systems, although we are not allowed to mention the mfg's. name, the specs should make it self-evident. The woofer is a 12" free-edge (acoustic suspension) unit, with 2" voice coil and a No. 2 magnet. The mid-range is a 5" sealed back speaker and 3-½" flare dome tweeter for best high frequency dispersion. Crossover between woofer & mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided. The level controls provide frequency response to suit room acoustics, with realism that will delight even the most critical listener. Response — 25 to 20K + Hz., Power — 40 watts RMS. Impedance — 8 ohms.

Sh.Wt.12 lbs.

- ☐ LSCS $36.00
- ☐ 2LSCS . . . . 2 for $65.00

TELSA COIL KIT

Here's a truly basic kit for those who like to "roll their own." All the parts for an exciting adventure into high-frequency, high voltage. Add your own metal housing — a small chassis or universal box is ideal.

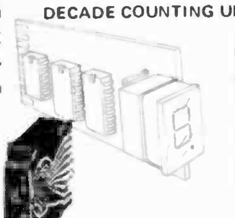
Tesla coils are patterned after the design of Nikola Tesla (1857-1943) an American electrical genius who built versions many feet tall. His dream was to light and power entire cities with energy radiated from such coils — but no luck!

Today's Tesla coils are popular with experimenters and students, and especially for science fair and educational demonstrations. Ours is a high-frequency push-pull oscillator coupled to a television flyback transformer, which steps up an external 12 VDC power supply to many thousand volts.

SPECIAL NOTE: Although current output is relatively low, some hazard is inherent in all high voltage devices. This kit is intended for the experimenter who is mature enough to observe reasonable precaution in its use.

TESLA COIL KIT $7.50

DECADE COUNTING UNITS WITH READOUTS



Always one of B & F's most popular items, now revised to include drilled boards, I.C. sockets, and right-angle socket for readout. Arranged so that units can be stacked side by side and straight pieces of wire bussed through for power, ground and reset. Several different units are available as follows:

7490	Basic 10 MHz counter. Used in frequency counters and events.
74196	Same as 7490 except presettable 50 MHz unit. Used where higher speed and/or presettability is required.
74192	Bi-Directional Counter, 32 MHz operation. Has two input lines, one that makes the unit count up, the other down. Uses include timers, where the counter is preset to a number and counts down to zero, monitoring a sequence of events, i.e., keeping track of people in a room by counting up for entries and down for departures.
7475	Adds latch capability. Used in counter so displays continue displaying frequency while new frequency is being counted for uninterrupted display.
7447	Basic decoder module. Drives basic seven segment display which is included for all modules.

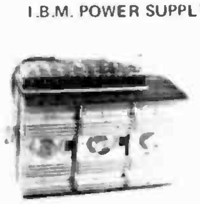
NEWEST DCU!

This DCU combines all of the features of our other counting units, that is, high speed counting, up-down operation, storage, and preset. In addition it includes a comparator (7485) and a thumbwheel switch in order to provide comparison and preset capability. With this combination you can do the following:

1. Count up or down at speeds to 33 MegaHertz.
2. Store previous count during new count.
3. Preset to any number, count down (or up) and generate a logic level when count of zero is reached. Stack several units and generate logic level for any count greater than zero.
4. Preset to zero, count up (or down) and generate a logic level for any number greater or equal to the number preset in the thumbwheel switch. Stack several DCU's and generate a logic level showing whether number is greater than, equal to, or less than numbers preset on switches.

- ☐ 910 K 7490-7447 Counter $8.25
- ☐ 910 LK 7490-7475-7447 Counter $9.25
- ☐ 911 LK 74196-7475-7447 Counter $10.25
- ☐ 912 K 74192-7447 Counter $9.25
- ☐ 913 K 74192-7475-7447-7485 Universal DCU $14.50

I.B.M. POWER SUPPLY REGULATOR PARTS!



Like-new assembly surplus from the I.B.M. Company contains the following: (6) 150-Watt transistors, (6) heat sinks, (6) .1Ω 5W resistors, 12V, 20 Amp circuit breaker, a 16-ohm 10-Watt resistor, 50-Watt resistor, terminal strip, (2) 16-pin P.C. edge connectors for regular cards. An 8000 mfd, 15V computer grade capacitor is also provided. All in a nice mounting — looks as if it could be a neat unit to make a lab-type power supply. Unit is sold as an assembly, or in parts. Quantity is limited.

Sh.Wt. 20 lbs.	IBMPSRA	$7.50
3 for $20.00	IBMPSRA	$20.00/3
8 for $52.00	IBMPSRA	$52.00/8

Heat sinks capable of dissipating 150 watts of power

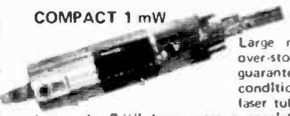
Price . . . . $1.00 ea.
Transistors, 2N441 or 2N442 type, TO-36 case . . . $1.00 ea.
Heat sink with transistor . . . . $1.50 ea.
4 for $5.00 . . . . $5.00/4
Connectors, 2 for $1.50 . . . . $1.50/2
Capacitor, $1.50 . . . . $1.50 ea.

HEWLETT PACKARD SOLID STATE NUMERIC INDICATOR

These fantastic L.E.D. Indicators have built-in decoder/driver with memory. They use a 4 x 7 dot array for much better readability. They are packaged in a standard Dual-In-Line (DIP) package with built-in contrast filter. Completely DTL TTL compatible. HP part number 5082-7300 (right hand decimal)

HP 5082 . . . . $9.75

COMPACT 1 mW LASER TUBE



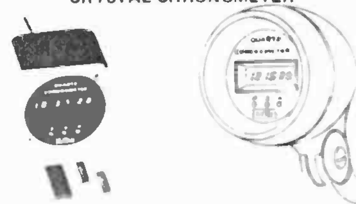
Large manufacturer sells his over-stock tubes to us, all guaranteed to be in perfect condition. Most compact 1mW laser tube (TEM.) on the market, only 8-½" long, uses a special tapered bore design, unique in the industry. Cavity design, internal hemispherical mirror system with co-axial mounting of all elements, maintain beam alignment and power stability under mechanical stress and changes in temperature. SPECIFICATIONS: red laser, 1mW power, TEM., 632.8mm wavelength, 1.10mm beam diameter, 0.85 mrad divergence, linear polarization, size: 8.5 x 1.75" diameter. These can be useful for alignment systems, measurement systems, and for illumination, etc., in equipment such as levels, transits, ranging, inspection displays, holography, etc. Operation life beyond 10,000 hours. This is not a toy tube, but a laser designed to meet rigid industry standards. List price is over $200.00 each.

Sh.Wt. 3 lbs.	C1mWLT	$97.50
2 for $180.00	C1mWLT	$180.00/2
10 for $850.00	C1mWLT	$850.00/10
100 for $7500	C1mWLT	$7500.00/100

Portable supply—operates from 12 vdc input. Useful for field experiments with laser. Available only with purchase of tube.

Price $25.00

AIRCRAFT AUTO BOAT QUARTZ CRYSTAL CHRONOMETER



Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2½" x 2½" x 23/8", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2¼" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e., replacing battery in car). The clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligible power drain. The low price is only possible because of a new one chip MOS clock. Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit 59 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

- ☐ Quartz Chronometer, Kit Form $69.50
- ☐ Quartz Chronometer, Wired $99.50
- ☐ 24 Volt Adapter $10.00

New-Style AUTO/BOAT/PLANE QUARTZ CRYSTAL CHRONOMETER

As you can see from the illustration, we have provided a new enclosure for our most popular kit, the ARIES Model AR-720K Quartz Crystal Chronometer. This enclosure can be mounted in many convenient variations, i.e., over or under the dashboard, over the center drive tunnel, or under the roof above the windshield.

- ☐ Automotive style quartz crystal chronometer $75.00
- ☐ Same assembled, calibrated, tested $99.00

Send in an order and get on our special custom customer Mailing List.

CATALOG: Check reader's card or write.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED) POSTAGE PAID IN THE U.S.A.

CHARGES WELCOME!

Phone in charges to 617 531-5774 or 617 532-2323. BankAmericard — Mastercharge. $10.00 minimum. No C.O.D.'s please.

B.&F. ENTERPRISES Mass. 01960
Phone (617) 531-5774
119 Foster Street
Peabody, Mass. 01960

Circle 91 on reader service card

ADVERTISING INDEX

RADIO ELECTRONICS does not assume responsibility for any errors which may appear in the Index below.

MORE BARGAINS IN SURPLUS ELECTRONICS from B & F ENTERPRISES

Just off the press our Best Catalog yet with 104 Illustrated pages of surplus Electronics, Optics, and Much More...

DIGITAL CLOCK CHIP

These large scale integrated (LSI) chips eliminate 14 to 20 MSI TTL chips in the design of an electronic clock. Features 12 or 24 hour operation, 6 digits, internal multiplexing, operated on 50 or 60 Hz input, or a schematic is provided for crystal control. Logic gates between the counter allow setting at the rate of one hour digit per second, or, one minute digit per second. A "hold" input allows stopping the chain. The multiplexer samples the outputs of the hours, minutes and seconds counters (in the six digit model), routing this data to a programmable read only memory (ROM), which is programmed to provide BCD and seven segment outputs. All outputs are compatible with bipolar devices, necessitating few external components for the display interface. Only one power supply is required for operation.

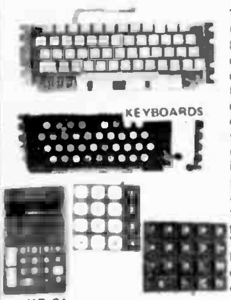
1. 5314 chip (24 pin plastic) used for 7 segment displays such as LED's, numitrons, minitrons and Sperry displays.
   Price $9.95
2. 5311 chip (28 pin ceramic) includes BCD output to above for interface to nixies, computer inputs, etc., in addition to 7 segment outputs.
   Price $14.95

1/4-Watt RESISTOR ASSORTMENT!!

Brand-new 5% tolerance resistors, individually bagged 5 to a bag, each bag marked with values. 70 different values, 10 ohms to 10 megohms in a 1 : 1.5 : 2.2 : 3.3 : 4.7 : 6.8 : 1 sequence. A complete laboratory supply of resistors at less than 5 cents apiece

Sh.Wt. 2lbs.	¼WRA	$15.00
4 bags for $55.00	¼WRA	$55.00/4

KEYBOARDS:



Teletype format ASCII coded keyboard, with parity check line (see fig. A). Coding is by means of a built in diode matrix, which can be modified from ASCII by inserting or removing diodes. Keys are 26 characters, all numbers, plus shift, ctrl, alt, line feed, car return, rept, brk, rub out, here is, and usual typewriter symbols. Mfr controls research and microswitch. Requires +5 volts, uses DTL circuitry, compatible with DTL or TTL. 52 keys, 3 integrated circuits, about 200 diodes. Brand new, guaranteed. 15 pin connector on 10" cable.

KB-01 .... $44.50

Non-decoded alphanumeric keyboard. Figure "C", single form, SPST contact on each key.

KB-3 .... $24.50

Figure "D", calculator keyboard in calculator case, pressure sensitive elastomer contacts, manufactured for Aries.

KB-4 .... $9.50

Touch-tone keyboard, Figure "E", manufactured by Chromerics. No electronics included.

KB-5 .... $9.00

Desk calculator keyboard, Figure "F", manufactured by Controls Research.

KB-6 .... $15.75

RT 270A/GRC TRANSCEIVER

This is a prime government surplus item, until recently in scarce supply and selling for hundreds of dollars. Consists of a double conversion FM superhetrodyne receiver and a FM transmitter linked thru a common antenna circuit. Range is 47 to 58.4 mHz continuous. Size is 7-3/8 x 4-3/16 x 12-15/16. Built-in calibrator and heat oscillators permit fast alignment

RT 270A/GRC
New, including 1 mHz crystal $35.00

RT 2700A/GRC
Used, excellent, less crystal $20.00

***1 mHz crystal only $5.00

TRANSISTORIZED FLUORESCENT CAMPING/EMERGENCY LIGHT KIT!

This transistor inverter powered camping and emergency light will provide a bright portable light from a 12-Volt D.C. battery. A cigarette lighter adapter is provided for automotive operation, or the unit may be run from other 12-Volt lantern batteries. The advantages of this unit over more conventional incandescent lamps is the vastly greater light output for equivalent power input and the superior distribution and color of the light.

The camping/emergency light is enclosed in a weather-tight plexiglas tube, with the electronics built into the tube. Completion time should be less than two hours, making it a nice evening's project, even for the beginner.

Sh.Wt. 3 lbs.	TFCELK	$12.50

CALCULATOR CHIPS

Chip "A" 12 digit, fixed automatic decimal point, no constant, mfg by moster or caltex. 40 pin i.c. $11.75

Chip "B" 8 digit, floating point, 7 segment output, constant, single 40 pin i.c. mfg by nortec and microsystems international

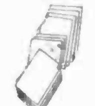
Price $19.75

5-VOLT, 5-AMPERE LOGIC SUPPLY

These high-quality supplies originally cost $118.00 in production quantities. Due to a manufacturer's closeout, we can offer them at less than one-quarter the price. Unit is cooled by a Pamotor fan. Is fully adjustable (±10%) and is rated for continuous duty service at full load in an industrial environment. Brand new in original cartons – can be used as a lab or prototype supply. This is a best value in B&F's extensive line of electronic surplus.

5V5A Supply $34.50

COPPER-CLAD CIRCUIT CARD MATERIAL



Make your own circuits with this card stock. We have fibreglas, epoxy G-10, cloth epoxy, etc., in thicknesses of 1/32", 1/16", and 1/8". Can be used as-is for screen-processed parts, or can be coated with photoresist (available from Kodak and others) for photo process.

G-10, 1/32"-thick or Epoxy-cloth, 1/16"-thick (State choice!!!)

	Single-Copper Clad			Double-Copper Clad		
Size	1-4	5-9	10-25	1-4	5-9	10-25
6x12	1.00	.80	.70	1.20	1.00	.75
12x12	1.60	1.40	1.25	2.00	1.75	1.55
12x18	2.30	2.10	1.80	2.75	2.45	2.00

Note: Prices quoted are PER UNIT price for designated quantity.

6032 INFRA-RED CONVERTER TUBE

With this tube, an appropriate power supply, optics and I.R. light source, one can "see in the dark." Tube converts infra-red radiation imaged on front to visible image on back of tube. With it one can see I.R. emitters such as I.R. light emitting diodes, very hot objects. Or see in the dark by using an incandescent light behind a I.R. filter. Full instructions included. Requires 10-20,000 volts to operate.

- ☐ 6032 tube only, with data $7.50
- ☐ 6032 tube, with solid state voltage converter 12 volts D.C. to 15 KV instructions $27.50
- ☐ 6032 tube, voltage converter and optics instructions
  Price $47.50

GIANT 2½" NUMERAL "NIXIE" CLOCK KIT

New! For factories, offices, and commercial establishments, and those people who like large displays, characters appear as a bright continuous line which can be read from distances as great as 150 feet. All drive circuits are solid state, and unit employs new custom LSI clock chip. Indicates hour, minutes, and seconds. May be wired for 24 hour or 12 hour operation with a simple jumper change. Kit offered complete with or without case for custom installations. Parts include P.C. board, sockets, solid state components, hardware, resistors, caps, viewing filter, etc.

Sh.Wt. 15 lbs.

- ☐ GNNC/C With Case $98.50
- ☐ GNNC Without Case $84.50

ULTRA LOW COST DIGITAL CLOCK (STANDARD TIME CHRONOMETER)

Aries/BF has sold over 12,000 digital clocks, to the best of our knowledge more than the combined output of all other manufacturers. Because of our huge purchasing power, and the engineering background gained, we can offer the features listed below. Compare with any other manufacturer and see if they can offer all these features:

- Decorator solid walnut case. A striking addition to even the most luxurious living room. Our sketches just don't do it justice.
- Superb accuracy, seconds per month.
- Choice of 50 or 60 Hz operation, 12 or 24 hour display in hours, minutes, seconds.
- BCD outputs, for auxiliary readouts etc.
- Excellent beginners kit, elaborate step by step instructions debugged by trial construction by experimenters who have never built a kit before. Only a soldering iron, wire snip and screwdriver needed. Guaranteed success. (maximum repair charge $10.00).

☐ Low-cost Digital Clock Kit $47.50

SUPER QUALITY I.C. SOCKETS

Sockets made by T.I. and Clnch. All are low-profile, compact types.

Now available 24, 28, & 40 Pin sockets Only $1.00 ea.

14 Pin Dip Solder Tale Sockets
3 for $1.25 16 for $5.00
16 Pin Dip Solder Tale Sockets
2 for $1.00 13 for $5.00
14 Pin Dip Gold Wire Wrap Socket
2 for $1.25 10 for $5.00
16 Pin Dip Gold Wire Wrap Socket
2 for $1.50 8 for $5.00
10 Pin to 5 Gold Sockets (Clnch)
2 for $1.00 13 for $5.00

RADIATION SURVEY METER

At this giveaway price, no one should be without one of these. In the event of a reactor explosion or atomic attack it could save your life.

"CD" type Radiation Meter in good condition with carrying straps and instruction manual. Picture is of a typical unit in bright plastic waterproof case. Counter gives readings from 0.01 γ/hr to 50 γ/hr. Batteries required are one (NEDA 13) D cell and one (NEDA 215) 22 ½ v hearing aid battery, not supplied. Will last approx. 400 hrs. of intermittent operation on one set of batteries. Last time we offered these we were sold out in a short time. All units are clean, like new. Untested.

Sh.wt. 3 lbs.	GCCDT	$7.00

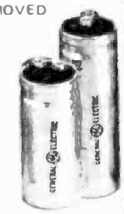
COMPUTER GRADE ELECTROLYTIC CAPACITORS

These brand new capacitors are in great demand for IC logic circuit filters, power supplies and energy storage networks. Some of them are big enough to take out the noise in the most stubborn cases. Capacitance (first number) is given in MFD.

COMPUTER GRADE CAPS – ALL NEW

Wt. (lb)	Cap (mfd)	WVDC	Order No.	Price (ea)
1	1500	50	GE1550	.75
1	1300	50	SP1350	.75
3	3000	250	MA3025	3.50
2	17000	30	GE17030	2.00
2	23900	20	GE23920	2.00
3	60000	20	GE60020	3.50
3	140000	6	SP14006	3.50
1	6000	40	GE6040	2.00
2	21500	40	GI21540	3.00
1	10800	20	GI10820	1.75
1	150	250	SA1525	1.00
3	1000	450	SP10045	2.50
1	6000	10	PA6010	.75
½	75	350	MA753	.60
1.5	3750	75	SA3775	1.50
1	500	200	CA520	1.25
1	7400	10	CA7410	1.25
1	15000	10	CA1510	1.50

COMPUTER GRADE CAPS – REMOVED FROM EQUIPMENT



Cap.	WVDC	Order No.	Price
250	330	CC2533	1.00
300	275	CC3027	1.00
750	165	CC7516	1.00
800	99	CC8099	1.00
900	165	CC9016	1.25
2300	23	CC2323	1.00
3500	52.5	CC3552	1.25
7000	16.5	CC7016	1.25
10000	11	CC1011	1.25

All caps 12 for the price of 10.

NEW – COSMOS INTEGRATED CIRCUIT

Said to be the "New Wave" in integrated circuits of the future. Ultra low power drain (microwatts)

- ☐ 4000AE Dual 3 Input Nor & Inv .... $ .99
- ☐ 4001AE Quad 2 Input Nor .... $ .99
- ☐ 4002AE Dual 4 Input Nor .... $ .99
- ☐ 4006AE 18 Stage Static Shift Register $4.99
- ☐ 4007AE Dual Complementary Pair & Inv .... $ .99
- ☐ 4009AE Hex Buffer, Inverting $2.19
- ☐ 4010AE Hex Buffer, Non Inverting $2.19
- ☐ 4011AE Quad 2 Input Nand .... $ .99
- ☐ 4012AE Dual 4 Input Nand .... $ .99
- ☐ 4014AE 8 Stage Static Shift Register $5.99
- ☐ 4017AE Decade Counter W/Decoder $5.99
- ☐ 4020AE 14 Stage Binary Ripple Counter $5.99

Send in an order and get on our special customer Mailing List.

CATALOG: Check reader's card or write.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED) POSTAGE PAID IN THE U.S.A.

CHARGES WELCOME!

Phone in charges to 617 531-5774 or 617 532-2323. BankAmericard – Mastercharge. $10.00 minimum. No C.O.D.'s please.

B.&F. ENTERPRISES Mass. 01960
Phone (617) 531-5774
119 Foster Street
Peabody, Mass. 01960

Circle 109 on reader service card

LIVE IN THE WORLD OF TOMORROW...TODAY!

A BETTER LIFE STARTS HERE

(And our FREE CATALOG is packed with exciting and unusual ecological & physical science items—plus 4,500 finds for fun, study or profit . . . for every member of the family.) Great for unusual christmas gifts!

3-CHANNEL COLOR ORGAN KIT

Easy to build low-cost kit needs no technical knowledge. Completed unit has 3 bands of audio frequencies to modulate 3 independent strings of colored lamps (i.e. "lows"-reds, "middles"-greens, "highs"-blues. Just connect hi-fi, radio, power lamp etc. & plug ea. lamp string into own channel (max. 300w ea.). Kit features 3 neon indicators, color intensity controls, controlled individ SCR circuits; isolation transformer; custom plastic housing; instr.

Stock No. 41,831EH ....$17.50 Pd.

ELECTRONIC CALCULATOR–$79.95!

Terrific buy, reduced from $199.50! Top quality American made with big machine capabilities. Adds, subtracts, multiplies, divides, does mixed calculations—silently in milliseconds! 8-digit entry, readout; floating decimal; +/— change key; zero suppression; automatic constant; error correction; recall key. Easily operated in home or office. 110-120v AC. 6-1/2X9X2". 3 lb. 6-month guarantee. Instructions.

Stock No. 78,006EH ....$79.95 Ppd.
No. 78,007EH ... (6-oz. PORTABLE) ....$89.95 Ppd.
No. 78,008EH (ECONOMY MODEL—NO MEMORY) ....$59.95 Ppd.

KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, listen to your Alpha-Theta brainwaves. Ultra-sensitive electrode headband slips on/off in seconds—eliminates need for messy creams, etc. Atch'd to amplifier, filters brainwaves, signals beep for ea. Alpha or Theta wave passed. Monitoring button simulates Alpha sound audio & visual (L.E.D.) feedback. Reliable, easy-to-use unit—comparable to costlier models. Completely safe. Comprehen. instr. bklt.

No. 1635EH (8x3x4"; 24 oz.) .. $124.50 Ppd.
Stock No. 71,809EH..(Low Cost "Starter" Unit) ....$49.95 Ppd.

AUTHENTIC ACUPUNCTURE MODEL

Learn first-hand about Asiatic needle probing from exact duplicate of models used in Red China. 10½" free-standing model clearly shows 12 all-important meridian lines and approx 500 specific points an acupuncturist must learn to pierce. Precise enough to serve as teaching aid for doctors, teachers & medical students. Fully illustr instructive 12-page bklt. See why this 5000 yr. old healing & pain removal method has had such impact on Amer. medicine. Polyethylene (rubberized).

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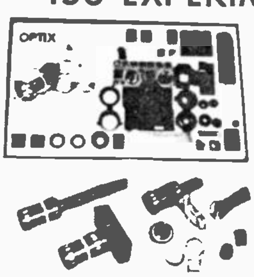

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