60¢ ■ OCT. 1973

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

SPECIAL ISSUE — 4-CHANNEL STEREO

FOUR-CHANNEL FM
9-Ways To Go

DISCRETE 4-CHANNEL RECORDS
Setting Up A System

4-CHANNEL EQUIPMENT
What's Available Now

4-CHANNEL
RECORD
REVUE

R-E Rates
The Effect

IC FM CIRCUITS
How They Work

PLUS

State-Of-Solid-State
Voice Actuation For Phone Sent
R-E's Replacement Transistor G

GERNSBACK PUBLICATIONS

The Timesaver!

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.

A NEW APPROACH to agc system analyzing!

Permits signal injection after the agc controlled stages to simplify testing for agc defects.

- Works with any 40MHz receiver . . . color or black and white . . . solid state, tube or hybrid.
- High level, low impedance output furnishes signal usable at input of final i.f. stage.
- Special output circuit works equally well into first i.f. input of late model, link coupled systems and older, low "C" bandpass coupled systems.
- Antenna input and i.f. output electrically isolated; no "hot" chassis hazards.
- No need to disconnect supply leads from suspected tuner being tested. Substitutes the VHF tuner and tests the UHF tuner.
- Tunes all 12 VHF channels, has preset (memory) fine tuning on all channels.
- Higher overall gain than previous models with wide range gain reduction control of 60db.
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- Use on the bench or in the home . . . anywhere.
- Comes complete with extension cables, batteries and instructions.

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Inputs:	300 ohms balanced VHF antenna terminals, electrically isolated. 75 ohms 40 MHz amplifier (Ch. 01) RCA phono jack, electrically isolated.
Sensitivity:	30 microvolts. Input signal handling capability: over 100,000 microvolts.
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Tuning Range:	All 12 VHF TV channels, plus Ch. 01 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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Gain Control:	Gain reduction 60 dB.
Power supply:	18 volts. Uses two 9v transistor batteries.
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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Circle 1 on reader service card

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Circle 2 on reader service card

SONY PS 2251: a declaration of independence.

Independence of belts, pulleys, idler wheels and all the other paraphernalia that can cause wow, flutter and rumble. Independence from fluctuations in power line voltage that can effect the precise speed of the turntable. And independence of acoustical feedback. The new, direct-drive Sony PS-2251 has declared itself independent of all these potential intruders upon the enjoyment of your records.

Most turntables use belts, pulleys, idler wheels to make their turntables spin at the record's speed, instead of the motor's. Look underneath Sony's new PS-2251 and all you'll see is the motor. We don't need all those extras, because our motor's speed is precisely the same as the record's.

Eliminating all those parts also eliminates the wow and flutter and rumble they can cause. So, our rumble figure is a remarkable —58dB (NAB). And because our motor turns so much slower than conventional ones, the rumble frequency is lowered too, making the rumble even less audible than that —58 dB figure indicates.

To maintain precise speed accuracy at slow speeds, we use an AC servo system (superior to a DC servo system because of its uniform magnetic field strength). Its precise speed is not affected by variations in line voltage or in line frequency. But its speed can be varied ±4% by the built-in pitch control and returned to a precise 33-1/3 or 45 rpm, with the built-in self-illuminated strobe.

Then we matched it with a statically-balanced tonearm that tracks records as precisely and faithfully as our turntable turns them. We added viscous-damped cueing and effective anti-skating. And we mounted the PS-2251 on a handsome wood base using an independent spring suspension system to completely isolate it from externally caused vibrations. At $349.50 (suggested retail) including arm, wood base and hinged dust cover, the PS-2251 is today's most advanced turntable.

We also offer a moderately priced, single-play component turntable with the convenience of automatic operation, the PS-5520. The complete system: turntable, arm, walnut base and hinged dust cover, $159.50 (suggested retail) Sony Corporation of America, 9 West 57th Street, New York, New York 10019.

Circle 3 on reader service card

Radio-Electronics

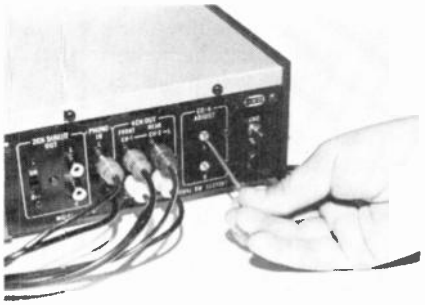
FOR MEN WITH IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

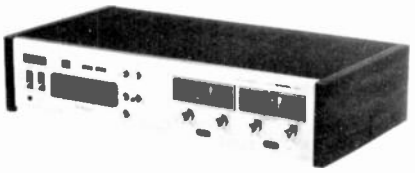
OCTOBER 1973

ON THE COVER

4-channel equipment shown this month includes four AR-3A speaker systems and a Sansui QRX-3500 4-channel receiver. The girl is optional, and each reader will have to supply his own.



4-CHANNEL DISCRETE records are growing in popularity. Learn how to set up the playback decoder. **. . . see page 33**



TYPICAL 4-CHANNEL amplifier. For a rundown of available equipment **. . . see page 29**

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looking ahead

Home TV readout

LONDON—A new home television service, designed to provide written material on demand, is currently undergoing on-the-air tests in Great Britain. Set manufacturers and broadcasting authorities are confident that it will be placed in commercial operation as the next major home electronic product.

Two systems are currently under test, and both operate in a similar method—sending written material for on-screen display during the vertical blanking period of the regular broadcast TV period. The technique developed by British Broadcasting Corporation (BBC) is called "Ceefax," while the Independent Broadcasting Authority (IBA) uses the acronym "Oracle" (standing for "Optional Reception of Announcements by Coded Line Electronics").

In each case, the consumer uses a telephone-type pushbutton array to select the material he wishes to view. The material is sent in "pages"—one "page" being one screenfull of information. The first few pages comprise the index. If, for example, the viewer wishes to see the up-to-the-minute weather forecast, he observes from the index that it is on page 28, then dials "2-8" and the forecast instantly starts to unfold on his screen.

Material suggested for these TV "marginal notes" includes news, stock market reports, TV program logs, theater and concert calendars, police and traffic information, ski reports, programmed-learning quizzes (with answers on another page). Generally, the material would be presented in black on a white screen or vice versa, but several pages would be reserved for a line or two of text to be superimposed on the top or bottom of the screen while the television picture is appearing. Among these would be special services such as subtitles for deaf or foreign-language viewers, and a "news flash" page which would keep the viewer informed of breaking stories of top importance while he's watching TV. For details, he could dial up the "news page." Similarly, the weekend fisherman and small-boat owner might dial-up in-shore weather and the latest dope on what's biting and where.

The transmitting equipment for both systems requires a small computer with storage capacity for the number of pages to be sent. At the receiver end is an integrated-circuit character generator which responds to digital pulses sent by the station during the vertical interval period, and a memory to store the information.

The Ceefax system uses two unoccupied lines in the vertical interval and sends out 32 pages, each with a maximum of 750 letters or numbers. All of these pages are re-scanned (and can be updated) every 15 seconds. Oracle occupies only one line of between-pictures space, accumulates a "book" of 50 pages, each with about the same number of characters as a Ceefax page, updated in a little less than two minutes.

BBC officials estimate that a black-box adaptor to add Ceefax to a standard TV set would cost about the price of a black-and-white TV receiver. If Ceefax were built into new sets, it would add about $50 to the retail price. BBC hopes to get enough digital information into its signal to permit deluxe receivers which will provide upper and lower case letters and letters or lines in different colors for easier reading, while standard receivers would get the same material in all capital black-and-white letters.

An alternative or add-on system is also planned. This is a single "page" which is constantly changing. One page—say Page 32—could be devoted to this high-capacity service, which could provide 1,357 different screensfull of information in a day. The viewer could dial the information he wants by finding out exactly what time it's scheduled to be transmitted. Alternatively, his receiver can incorporate a "dial now—read later" feature. Using this system, he would feed into his pushbutton dial the exact time the page he wishes to see will be transmitted. Then it would be stored for later viewing.

Both Ceefax and Oracle are relatively simple first steps toward a home data terminal. Oracle is already being studied by the British Post-office Department (which operates the telephone system) for use in conjunction with the telephone and a central computer to provide vast amounts of information. Under one proposal, the TV set might eventually eliminate the printed telephone directory, permitting the user to get any phone number quickly and automatically on his home screen.

Shifting to discrete

Although the SQ matrix system is currently dominating the quadriphonic phonograph record and radio scene, audio marketers increasingly are predicting that discrete four-channel systems will end up winning the race. The major discrete system, developed in Japan by Matsushita Electric (Panasonic) and Japan Victor (JVC), is the CD-4 technique, the refinement of which was undertaken by RCA Records under the "Quatradisc" trademark.

One of the early drawbacks of discrete discs was the high cost of cartridges and the precision required in the manufacture of turntables for the system. This threatened to reserve the CD-4 system for the affluent and hobbyists willing to sink plenty of cash into their equipment. Now, a British record-changer manufacturer, Glenburn, says it has come up with a CD-4 record changer to sell at about $60, including ceramic cartridge. An integrated-circuit CD-4 demodulator, developed by Quadracast Systems Inc.—and said to be the largest linear IC ever developed for a consumer application—is being offered to manufacturers.

While well over 100 FM stations are currently broadcasting 4-channel sound using the SQ matrix system—which requires no special studio equipment—the National Quadraphonic Radio Committee (NQRC), organized by the Electronic Industries Association, has been compiling specifications on 10 proposed discrete 4-channel FM broadcasting systems and plans to begin field tests early next year.

Among the discrete broadcast systems are the pioneer Quadracasting system and techniques developed by both GE and Zenith, which are given joint credit for today's FM stereocast system. Although RCA has been pushing CD-4, Zenith gave the first indication it would go along with discrete record-playing equipment when it showed an "audio center of the future" containing a CD-4 player. To avoid the problem of speaker cables, Zenith's system uses wireless rear speakers which pick up their signals via infra-red transmission.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Here's everything you'd expect from a high-priced portable VOM.

Except a high price.

The VOM is one of the most important tools in your kit—but you needn't pay high prices to get the features and quality you want. Like the high-priced units, the B & K model 120P VOM has features like a front-resettable overload protection circuit, preventing damage to the instrument and components should an overload occur.

The 120P is more accurate than you'd expect—20,000 ohms/volt sensitivity on DC, with 2% accuracy. Plus a total of 35 ranges, measuring DC volts and current with 0.25 volt and 50 μA low-range scales; AC RMS volts, output volts, and decibels; and ohms. That makes it one of the most versatile test units ever designed. But it's also one of the most rugged—its meter movement is a taut-band, self-shielding annular type, to withstand damage from shock or vibration.

You'll also appreciate the 120P's easy-access battery and fuse compartment complete with extra fuse; and the handy TRANSIT position on the range switch.

All considered, the B & K 120P VOM gives you more accuracy, reliability, and versatility for your money than any other battery-powered portable VOM. And that's just what you'd expect from B & K.

Contact your distributor for complete information. Or write Dynascan Corporation.

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

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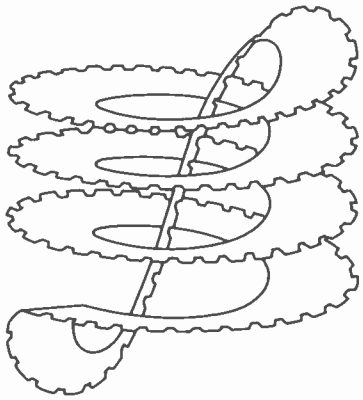
Circle 4 on reader service card

new & timely

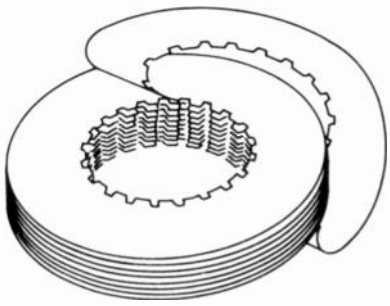
New continuous-loop tape uses no capstan nor reel

A new tape system for applications where endless tapes are used stacks the tape with one layer resting flat on the preceding one. The tape therefore does not need a reel. Notches in the edge of the tape line up to make the stack a sort of gear, which is engaged by a gear on the drive motor. Thus the tape is driven without the help of a capstan.

The new *Helicassette* tape comes in two types. One, called S, is driven by gear notches on the outside of the stack.



S–TYPE



Z–TYPE

The tape is lifted from the top and returned to the bottom of the stack through the center. The Z-type has the notches on the inside edge of the tape, and the tape is returned to the bottom via the outside of the stack.

Claimed advantages of the new tape are simpler drive mechanism, reversibility (not possible with other continuous-loop tapes), no friction and therefore no need for special lubrication. Tape widths can range from ¼ inch to 2 inches. One unit now being demonstrated has a ¾-inch, another a 2-inch tape. Lengths can run to 1200 feet, and a ¾-inch tape can have as many as 25 tracks.

The design comes from France, and is being sold in the United States by Y Square Associates of California.

Survival stretcher saves lives of patients enroute to hospital

Heart disease, America's No. 1 killer, is unique in that the victim of a sudden heart attack may have only seconds to live if effective aid is not immediately at hand. More than half the deaths due to acute heart attacks occur on the way to the hospital. A New York City heart specialist, Dr. Nicholas A. Pace, has designed an "electronic stretcher" to give the patient immediate assistance, when he needs it.

LIFE SUPPORT SYSTEM keeps victims of heart attacks alive on the way to the hospital. The oxygen equipment is seen at the head of the stretcher. The upright cylinder with the straps is the heart-lung resuscitator, which compresses the patient's chest, breathing for him. Further down is the combined electrocardioscope and the Pacemaker, with the defibrillator and its large hand-held electrodes. Batteries and an oxygen tank are also built in. The equipment swings up clear of the patient when the stretcher is used.

Besides electrocardioscope equipment, which makes it possible to monitor the victim's heart condition and apply immediate aid, the unit includes a heart-lung resuscitator that breathes for the patient, a defibrillator that can shock a randomly fluctuating heart back into regular pumping action, and a Pacemaker that can synchronize it and keep it beating regularly. The electrocardioscope also provides a graphic record.

Drawers for necessary drugs and other items are included in the rolling stretcher, as well as batteries and an oxygen supply.

Designed primarily for heart cases, the unit is also useful in cases of electrocution, drowning, wound or other asphyxiation and even drugs. The system is already in production, and a number have been installed in large-city business offices, as well as in the Pentagon.

Virginia State Association supports national unity

Reaffirmed support of the proposed merger of the national electronics associations and of state licensing highlighted the business sessions of the 9th annual convention of the Virginia Electronics Association, held late in June at Tyson's Corner, Va.

John McPherson of Yorktown was reelected president for the 1973-74 term. Wayne Appelman of Richmond was reelected first vice president, Everett Kilby of Manassas, second vice president; Jane Hudson of Lynchburg, recording secretary, and Joe Jackson, Madison Heights, treasurer. Elected to their first terms were J. Cobb Laine, Suffolk, third vice president, and Art Pearsall, Norfolk, secretary general.

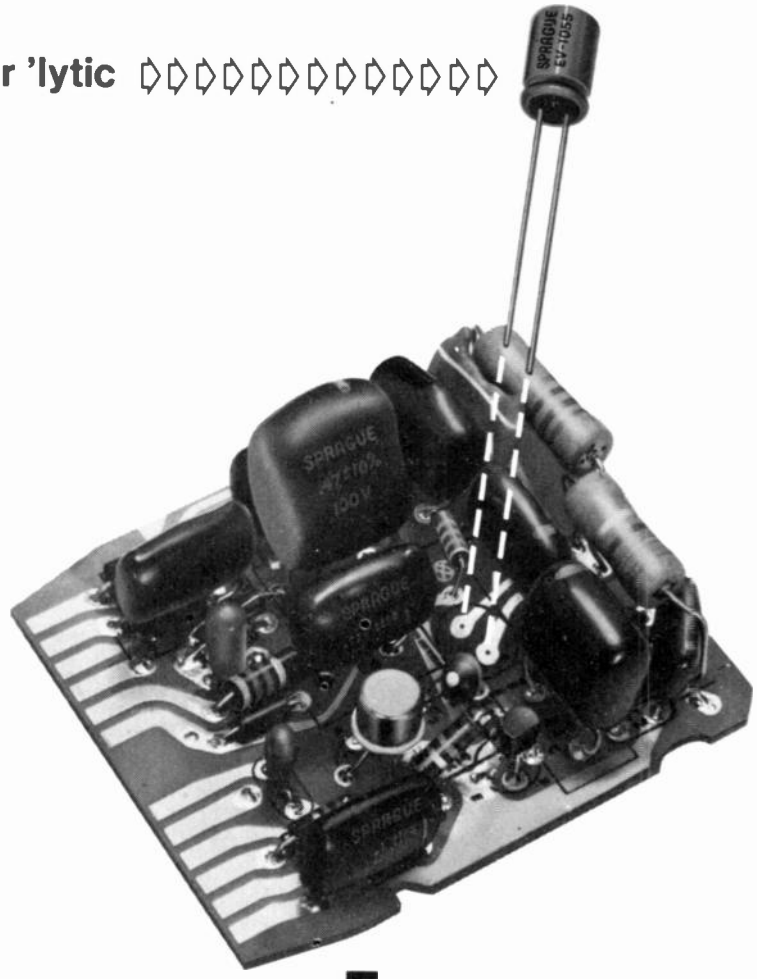
Certified Electronic Technician tests were held throughout the convention. Dick Glass, executive vice president of the National Electronic Associations, addressed a special Saturday luncheon, which honored the state's 74 CET's.

The VEA ladies auxiliary scheduled an enjoyable evening at the Wolftrap Theater before the convention. Anne Mitchell of Hampton was elected president of the auxiliary; Lu Cole, Colonial Heights, vice president; Anita Laine, Suf-

AT THE VEA SPECIAL CET LUNCHEON. Left to right: Larry Steckler, Stan Prentiss, Phil Dahlen, Charles Porter and Jim Teeters, all CET's.

(continued on page 12)

Type EV —
the space-saver 'lytic



board room

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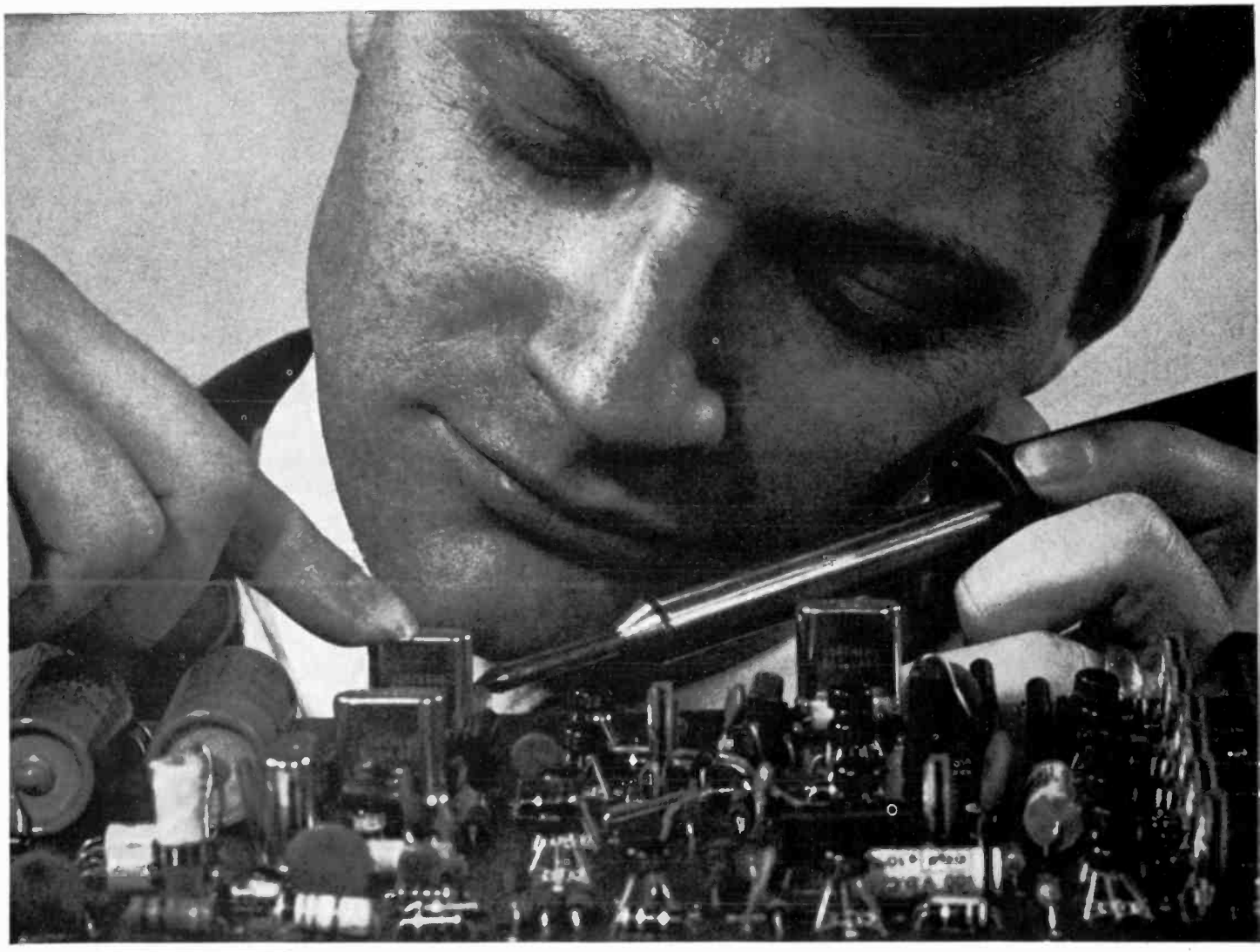

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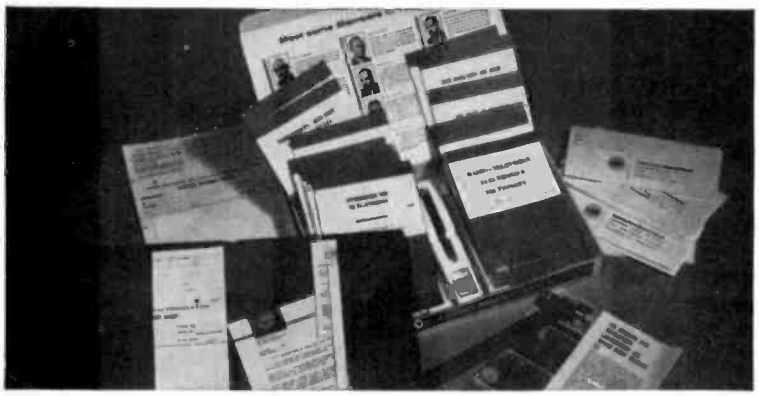
Experience is still your best teacher



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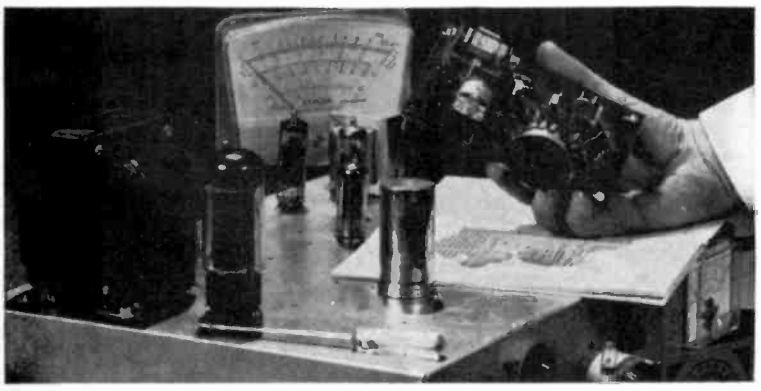

Designed-For-Learning Equipment

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

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

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

Train with the leader—NRI

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

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ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

new & timely *(continued from page 6)*

folk, secretary, and Anne Cooke, Hampton, treasurer.

Phillip Dahlen, Editor of *Electronic Technician/Dealer* magazine and chairman of the International Society of CET's, was the featured banquet speaker. He was awarded an honorary membership in VEA for having "proven his friendship and concern for the profession he serves." Others attending and participating were Stan Prentiss (associate editor, *Tab Books*), Larry Steckler (Editor, **Radio-Electronics**), Mary Anne Schurtz (Virginia Consumer Affairs coordinator), Dutch Meyer (General Electric national service manager), Bud Petzold (Motorola Service Manager), Paul King (Sylvania service representative), Jesse Leach (NEA Region 1 vice president) and Walter Cooke (NEA Region 2 vice president, VEA's past president and recipient of the President's Plaque for outstanding services to VEA).

M. L. Finneburgh, Sr., installed the officers at the Saturday evening banquet and drew a resounding ovation with his Sunday dissertation on the need for industry and association unity.

Nickel-cadmium battery charges in 15 minutes

A newly designed rechargeable battery, the General Electric *PowerUp-15*, reaches 90 per cent of its maximum capacity in 15 minutes of fast charge. At that point the battery may be put into use, or left to charge further. If left on charge, the current immediately drops to a "topping charge" rate, which brings the battery up to full charge in about two hours and can be continued indefinitely without damage to the cells.

The new battery is designed to accept a charge four times the ampere-hour rating (for example, a 4-ampere charge for a 1 ampere-hour battery) and a topping or trickle charge of 0.1 the ampere-hour rate (0.1 A for the same 1 AH battery).

The safe fast charge is made possible by improved design of fast-charge cells, and sensors that monitor independently both the voltage and the temperature rise in a cell. Thus the charger will go into topping charge when the battery either reaches the desired voltage or rises above a predetermined temperature, as signaled by a thermistor or thermostat buried in the battery pack. Maximum charging voltage is 1.5 volts per cell and temperature 120 F (49° C). (The charger is usually set somewhat below these limits for reliability.) The battery comes in all the standard GE sealed cylindrical cell sizes from 100 mAH to 3.5 AH.

The new battery meets the same performance and reliability specifications as the standard GE nickel-cadmium line. The new 15-minute charge feature will, GE spokesmen believe, make it more useful for a wide range of applications, ranging from cordless industrial and garden tools through a wide range of household and hobby devices to portable communications equipment.

Harry Secor 1889-1973

We regret to announce the death on May 17 of the oldest Gernsback editor (both in age and in length of service), Harry Secor. He died shortly before his 85th birthday and had been employed in the Gernsback organization over a span of 54 years.

Old timers may remember the byline H. Winfield Secor which first appeared in *Modern Electrics* around 1910 or 1911. He became an employee of Hugo Gernsback in 1913 when he joined the staff of the *Electrical Experimenter*. In 1915, with S. Gernsback and Austin Lescarboura, he co-authored the pioneer radio text: *Wireless Course in 20 Lessons* which was published by the Electro Importing Company. In the 20's he was on the staff of *Science and Invention* and in the 30's he was the managing editor of *Short Wave Craft* and, for a brief period in 1941, the managing editor of this magazine when it was still called *Radio-Craft*.

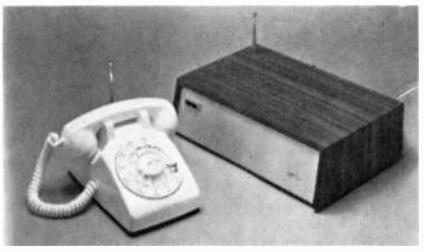
During the post-war years and up until his retirement in 1967 when he reached his 80th birthday, Mr. Secor continued work on various editorial projects in the Gernsback organization.

He will be missed by all his associates.

NEW COLOR SET IS READY FOR CABLE. Late line of RCA receivers (XL-100) is built for vhf and uhf reception off-the-air, as well as cable TV without an external converter. The photo shows RCA's John Meelan holding in his right hand the built-in unit that replaces the former separate 24-channel selector he holds in his left hand. The new receiver features, as well as vhf, uhf and 24-channel cable reception, wireless remote control, automatic fine tuning, instant picture, and Cable Guard shielding, to eliminate interference from local TV signals.

New telephone extension operates without wires

A new slant on the cordless telephone is offered by the *Rovafone*, produced by Fonetron of Milwaukee. Unlike the cordless instrument described in the July issue (pages 7, 12) this device is not connected direct into the telephone system, but is an extension working with the user's telephone installation. Also unlike the one mentioned in July, this instrument is in actual production and available.



It consists of two units, an ordinary telephone fitted up with an FM transmitter and receiver with a range of several hundred feet *(Rovafone)* and a *Tele-*

(continued on page 14)

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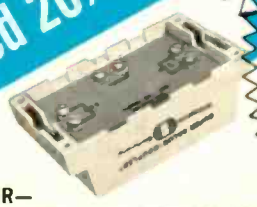

CC-282 82 CH. 2-SET COUPLER—Efficient 300 ohm coupler connects two TV-FM sets to a single 300 ohm downlead. Input and output connections are handy no-strip type for easy installation. Quality circuitry insures perfect color and black and white reception.

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Circle 6 on reader service card

new & timely

(continued from page 12)

tron base unit, connected to the electric and telephone lines, which makes it possible to receive and dial calls in the usual way.

The equipment is especially useful in restaurants, meeting rooms and other "hospitality industry" areas. The home owner will also find it particularly useful in the back yard—he can get involved in gardening or a barbecue without the fear of missing a phone call. And the *Rovafone*, since it has no electrical connection, is one unit that is absolutely safe in the bathtub or swimming pool.

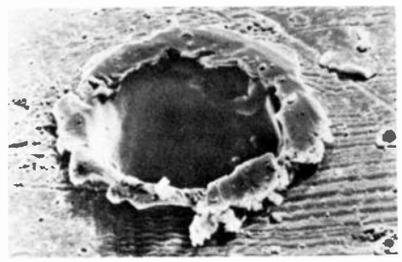
Maine ETA elects officers for 1973

At the Annual Convention of the Maine Electronic Technicians' Association, held June 9 and 10 at Sebasco Estates Lodge, Manley Lane, CET, was elected president for the fiscal year of 1973. Keith Marquis was elected first vice president; Joseph Pomerleau, second vice president; Theodore Stackhouse, CET, treasurer; and Maynard R. Young, Sr., CET, secretary.

The convention was well attended, and attracted a number of outside visitors including Larry Steckler, CET, Editor, **Radio-Electronics.** The members were addressed by Earl Gove, secretary-general of NATESA and State secretary of Vermont, and by Leon Howland, CET, State president of Indiana.

Electron microscope photo shows tiniest moon crater

A crater made on the moon by a micrometeorite, and brought home by the Apollo 16 astronauts, is only three-hundredths of a millimeter in diameter, the



thickness of the finest of human hair. Under the scanning electron microscope of the Siemens laboratory at Karlsruhe (Germany), it shows the raised rim of a true moon crater. **R-E**

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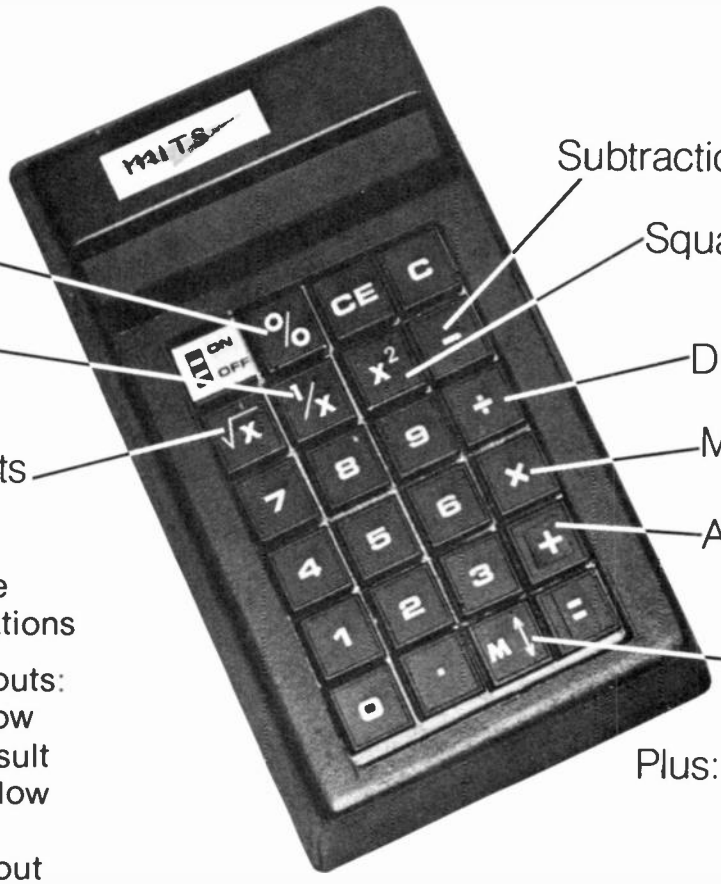

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RE-10

Circle 8 on reader service card

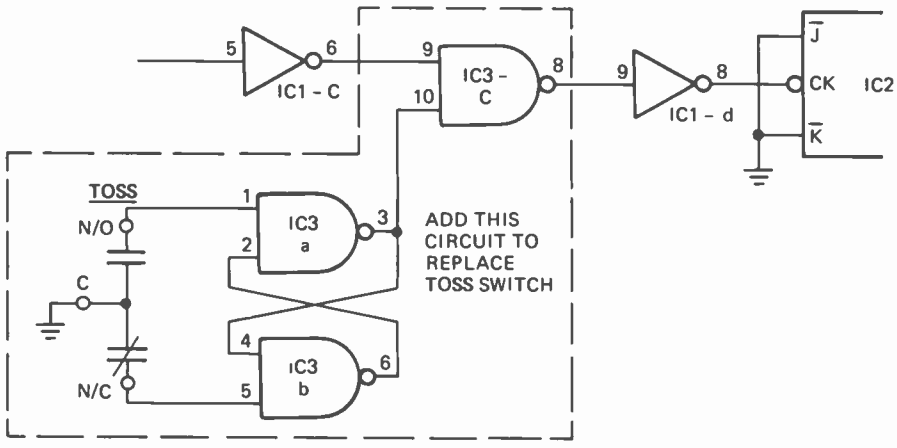
letters

Mr. Goegl ("Circuits", **Radio-Electronics**, July 1973 page 90) is about to be trapped by a very common bug. I was snared by it a few years ago when I began getting my feet wet in the weird and wonderful world of high-speed logic.

If John will use a small clip-lead and ground pin 6 of IC-1 (assuming the TOSS switch is a common garden variety dry switch), he will find the "dice" to come up as randomly as they did before the short. The reason is simple but elusive; the contact bounce of the switch will toggle the J-K flop several times (in some cases, hundreds) and no matter how carefully or quickly the switch is operated it will bounce.

There are two ways to overcome the difficulty.

1. Use a mercury-wetted contact switch. These switches have no bounce, but are position sensitive and therefore must be operated in an upright position.



2. The second solution is cheaper and simpler but requires more logic and a SPDT switch (see attached sketch). The latch formed by IC3-a and IC3-b squares and deglitches the contact closures. IC3-c then gates the output of the oscillator to the input of IC1-d (which isn't required and may be omitted.)

I'm not writing this to be a nitpicker, it is a real problem whenever mechanical switches are interfaced with digital logic. I hope this letter, if printed, will save

(continued on page 22)

Announcing the Panasonic Parts Hot Line.

In 48 hours we can ship you anything we've got.

The New Panasonic Parts Hot Line is a performance promise: 24-hour-a-day, 7-day-a-week service. Now, if you have a problem getting the part you need, just call one central number.

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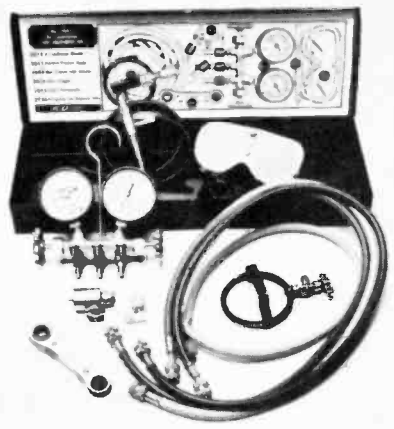

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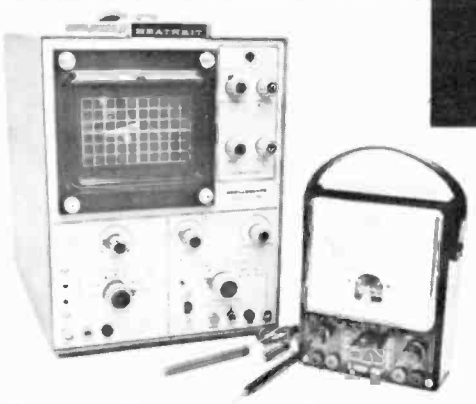

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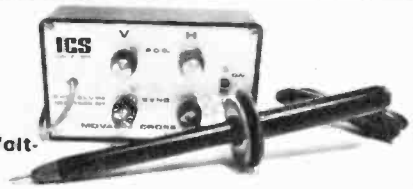

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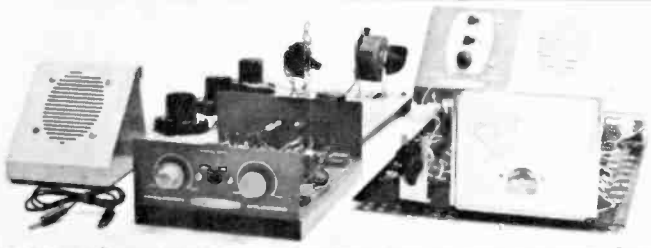

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Circle 10 on reader service card

LETTERS

(continued from page 16)

someone the time that can be wasted looking for this kind of problem.

AL WOODS
Houston, Tex.

ANOTHER TOSSED COIN

I am probably one of many people writing to point out a minor error in the July 1973 Reader Circuits (page 90). The J and K inputs of the electric coin tosser, if grounded, will make the toss rather one sided, as the flip flop will be inhibited from changing states. Possibly your artist erred, and J and K should either be left open or connected to V_{cc}.

STU RASMUSSEN
Beaverton, Oregon

AUTHOR REPLYS

Thank you for allowing me the opportunity to comment on Mr. Rasmussen's letter pertaining to my TTL coin tosser circuit.

My comments: Strictly speaking, pins 5 and 9 of the 7470A (DIP) are "complementary" rather than "true" J and K inputs and should be designated J* and K*. Thus my diagram is correct in showing pins 5 and 9 connected to ground ($-V_{cc}$) as they must if the 7470 is going to toggle.

Additional comments: Connecting these pins to V_{cc}, will, in fact, Inhibit the 7470 and prevent it from toggling. I suggest that readers interested in building a tosser use DIP type IC's. Then they can wire per my diagram pin-for-pin.

These comments don't apply to Mr. Rasmussen's letter so I'm keeping them separate.

I have been questioned as to the probability of the tosser's output. Frankly, I don't have the time to make a detailed analysis, mathematically. My opinion is that for a single "toss", the circuit will give equal heads-tails odds.

Other published tosser circuits (for example, see "Heads 'N' Tails", *Popular Electronics* Jan. 1972, page 35) have relied on the ac line as a toggling source. One author pointed out that with this approach a symmetrical waveform can be derived, whereas a multivibrator-generated waveform is usually at least slightly asymmetrical. This asymmetry, it was argued, causes a built-in bias which results in unequal heads-tails probabilities.

The multivibrator "clock" which I used in my circuit *does* generate an asymmetrical waveform. However, since the 7470 J-K F-F is an edge-triggered type (positive) it will only toggle on the positive-going edges of the clock waveform. Thus in practical circuits the degree of waveform asymmetry has no effect on the probabilities.

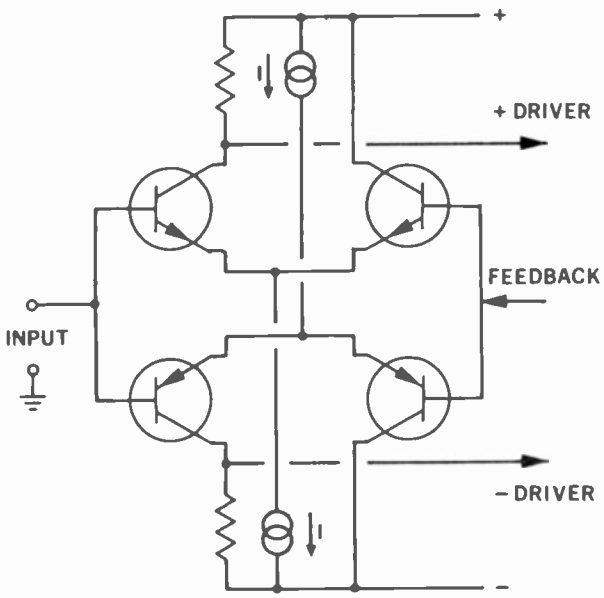
Aside from the fact that my tosser is compact and portable, its freedom from the ac mains is a definite safety advantage. When used by the inquisitive young set or where used in basement rec rooms, on the patio, or near the pool, battery power is on the way to go. Check?

JOHN GOEGL, WA2LJK
Union, New Jersey **R-E**

Am I ever glad this isn't my picture tube!

We think that our new push-pull cross coupled input circuit represents a major advance in amplifier design. Those of you who are familiar with amplifier circuits will recognize this as two complementary differential amplifiers, with the input and feedback points tied together. This elegant little circuit makes possible a completely push-pull amplifier.

Push-pull circuits produce distortion when they amplify just like any other circuit, but with one important difference. The upper and lower halves of a push-pull circuit produce even harmonic distortions that are equal but opposite in phase. They will therefore cancel each other out for the most part when combined at the output. Almost all transistor amplifiers use push-pull output and driver stages, but only our new #198 preamp and #207 amplifiers are push-pull throughout.

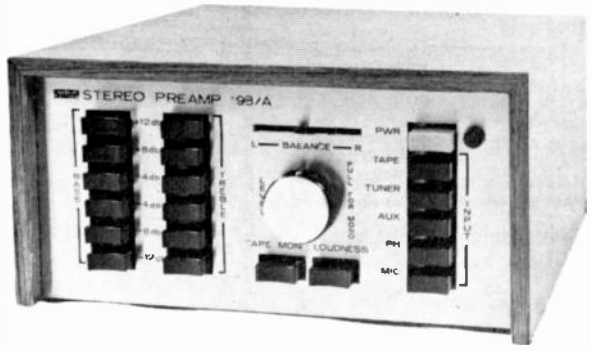


The "Tiger .01" #207/A amplifier using this new circuit is packaged in a neat little quarter rack chassis and is supplied with the perforated cover shown. This allows you to assemble a system with any number of amplifiers you might want and to later expand the system if you wish.

The #198 preamp uses the same basic circuit as the power amplifier and has similar outstanding performance. All inputs and tone control settings on the preamp are push button switch selected. The construction is primarily on two "mother boards" so wiring is kept to an absolute minimum.

#207/A AMPLIFIER KIT...$75.00...14 lbs

How much better is this type circuit? Considerably. The total harmonic distortion of the power amplifier is typically .02% up to full rated output of 60 Watts at 1,000 cycles. The really interesting thing though is the fact that the intermodulation distortion is less than .01% up to rated output. This circuit is therefore anywhere from around ten to a hundred times cleaner than previous designs. Now it is generally recognized that IM distortion correlates much better with listening tests than harmonic distortion. Our ears are much more sensitive to distortions that are not harmonically related to the signal. This performance is obtained with a circuit that has only 65 db open loop gain. To even approach this type performance before this required open loop gains from 80 to 120 db, 60 to 100 db of negative feedback will give you low distortion with almost any kind of circuit, but the resulting stability problems might make you wish for a better way.



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Circle 11 on reader service card

appliance clinic

ELECTRIC CARVING KNIVES

by JACK DARR
SERVICE EDITOR

THE ELECTRIC CARVING KNIFE IS A handy thing. It can even make Pop look good when he carves the Thanksgiving turkey or slices fresh bread smoothly. They're pretty simple things; a little motor, a wee gear-box to change round-and-round to back-and-forth (All right; rotary to reciprocal), a pair of blades, and a plastic box to hold the whole thing together. There are two types, ac-powered and battery run, usually called electric and cordless, although both are, obviously, electric.

Repairing one that won't work is pretty simple. The first thing to do is to take out the *blades*. If you don't, and if it wasn't running, but starts up suddenly, you may get to be known as *Three-Finger* from now on.

The cases are usually easy to open. They're made in two parts; one holds the motor, gearbox, etc. and the other is just a cover. Look for small, recessed screws at each end, usually Phillips.

Remove all visible screws, and then (Gently!) try to pry the cover off. If it won't come off, don't use muscle. There's another screw or fastener that you haven't found yet. Some cases have a small tongue on one end of the cover, which slips into a slot on the other half. If one end comes loose, try pulling on it gently, and it will come out. In certain makes, you'll find screws hidden under nameplates, labels and so on. Keep on looking; they're there somewhere.

In a dead one, first find out if you're getting power to the motor. Check for ac voltage where the line cord goes into the case, or read the battery voltage. If it checks out, test the switch. Most switches are spring-return or pushbutton types so the thing won't keep on running if you drop it. A lot of these are built so that you can take them apart, by removing a couple of little screws. The contacts are then visible, for cleaning and adjustment. (I did tell you to pull the line plug before doing this, didn't I? If I didn't, do it now.)

Most of the ac models, and some of the cordless types, have small brush-type motors. Check the brushes and commutator. Brushes must be long enough and make firm contact with the commutator. Many have flexible leads; check them to make sure they aren't open or shorting to something. Brush holders are usually the open type, so you can see any troubles. The brushes are often held down by small springs.

If the commutator is badly pitted, or dirty, clean it up with fine sandpaper after you get the motor running. If it's smooth and shiny, don't mess with it; it's all right. These motors seldom need lubrication. If the rotor is stiff, or labors, check the gearbox first. If it must be oiled, one drop on each end is *plenty*.

Some cordless models use little sealed dc motors. If you can get the full battery voltage across the motor leads but the motor will not run at all, disconnect one motor lead and check for continuity. If the motor is open, replace it. In fact, if you do get continuity, but it won't run with normal input voltage, replace it. You can't take them apart. (They're like an egg; you *can* take 'em apart, but getting them back together is something else.)

All of the cordless models use rechargeable batteries, usually NiCad. These are permanently connected together with welded straps. The 5-cell 7.5-volt unit seems to be the most common. If the dc voltage is low, measured at the motor with the switch on (full load), check each cell of the battery, holding the switch on. If you read the normal 1.5 volts across four of them, and the meter shows a reverse polarity across one cell, or zero voltage, that cell is dead, and the whole unit must be replaced. All should read practically the same voltage, within about 5% or less.

If all cells show low voltage, the battery could be discharged. Recharge it overnight, then recheck. It would be a good idea to check the charging unit first of all. Plug it in, and read the dc voltage across its terminals, no-load. This should be just a little more than the battery voltage. Say about 8.5 volts for a 7.5-volt battery and so on. To check the charger for current, connect a small pilot light across the terminals; for a 7.5 volt unit use a No. 47 (6-8 volts, 150 mA). If the bulb

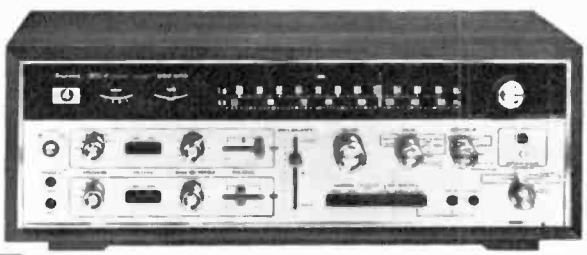
(continued on page 90)

vario matrix: the magic matrix by Sansui

The heart of the new Sansui QRX6500 is a unique electronic circuit called the vario matrix. There are other receivers with matrix decoding circuitry, and there probably will be receivers that claim to handle many different four-channel systems. But the Sansui vario matrix does more than just about any component available. For instance, it:

- decodes records, tapes and broadcasts made with the superior Sansui QS matrix encoding process;
- decodes SQ program material (and does it superbly);
- creates magnificent four-channel sound from regular two-channel sources (instead of offering you two two-channel amplifier sections strapped together for "double stereo" which doesn't sound nearly as good as synthesized four-channel);
- can position sound anywhere you choose, with a "Mode" switch that rotates the sound field 90°, 180° or 270° to create a totally-variable four-channel environment;
- accepts the output of a discrete four-channel demodulator via its "discrete" input position;
- can take auxiliary two- and four-channel inputs, as well as monitor one four-channel and two two-channel tape decks.

The vario matrix, coupled with a low distortion (less than 0.5%) four-section amplifier that delivers a whopping 280 watts (IHF) of power, makes this receiver a standout in its field. See it at your nearest franchised Sansui dealer soon.



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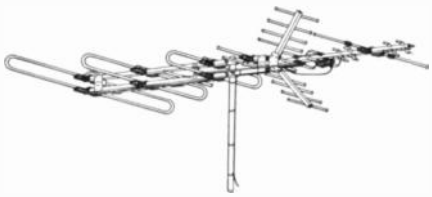
Circle 13 on reader service card

equipment report

Kay-Townes ICA 500 TV antenna



Circle 92 on reader service card

WHAT A SURPRISE! HERE'S A RELAtively small antenna (boom length only 150 inches) intended for deep fringe areas, that weighs a mere seven pounds yet delivers outstanding results. The secret appears to be a matched package of carefully designed antenna plus a built-in high-gain low-noise amplifier.

We put the antenna up at a Long Island, New York location some 35 miles from the transmitters in New York City and about 80 miles from transmitters in Connecticut. The antenna we replaced was an 18-element log-log type that we had been using for the past three years.

The new Kay-Townes antenna, though smaller, is doing a better job than the antenna it replaced. We not only get near perfect reception from New York, but snow-free reception of the more distant Connecticut stations by merely rotating the antenna. This effectively adds two more (extra?) channels of viewing.

The ICA-500 is a vhf-uhf antenna with built-in preamp, designed for 75-ohm coax lead-in. Manufacturer's specifications show vhf gain to be 50 dB, uhf gain, 32 dB. Vhf front-to-back ratio 27 dB; uhf front-to-back, 29 dB. Beam width is a quite narrow 28°.

As you can see in the photo, the antenna uses folded dipoles cut for half-wave operation at low-band vhf. They are mounted on a sturdy twin boom. Since the folded dipole, not too common in modern TV antenna design, is comparatively broadband in normal operation, only three folded dipole elements are needed to give full coverage of the low uhf band. For high-band vhf reception passive elements are staggered along the two booms to assure proper reception. A director element close to the front of the boom aids low-band gain while the corner reflector for uhf also contributes to high-band vhf reception.

The uhf portion of the antenna system also uses folded dipoles. Here two such elements serve as broadband driven elements. These in combination with a corner folded array plus a group of x-type directors assure excellent uhf response.

The gain of the antenna is, however, a combination of its design plus a built-in integrated circuit signal amplifier. This low-noise high-gain wideband IC is specially made for Kay Townes and the specifications claimed for it are 20 dB gain, flat from 50 to 1000 MHz, and a noise figure of less than 4 dB across TV spectrum.

This also leads to one potential problem. When operating this antenna close to strong transmitters it is possible to overload it. When this happens you don't have to add a pad at the antenna terminals. Just turn down the ZOOM CONTROL to reduce gain and avoid overloading. If overload occurs on only one channel plug-in pads are available to eliminate the problem.

The ICA-500 that we tested is a middle-of-the-line antenna. There are two others. One, the ICA-100 is the smallest in the group and has a boom length of only 42 inches. It is recommended for fringe areas. The top-of-the-line unit, which we have not tested (it was not available at the time this report was prepared) is said to be engineered for ultimate television reception in hard to receive locations and ultra fringe areas. Vhf gain is said to be 33 dB, uhf gain, 35 dB and beam width is a narrow 24°.

One extra gained from an antenna of this type is its small size for the performance it offers. This means low wind resistance which in turn means simpler, less costly installation.

Our summary. This is a first rate TV antenna. It has special advantages in difficult locations where physical size, high gain, and narrow reception angle are vital. A worthy competitor in the battle for first-rate fringe area TV reception. **R-E**

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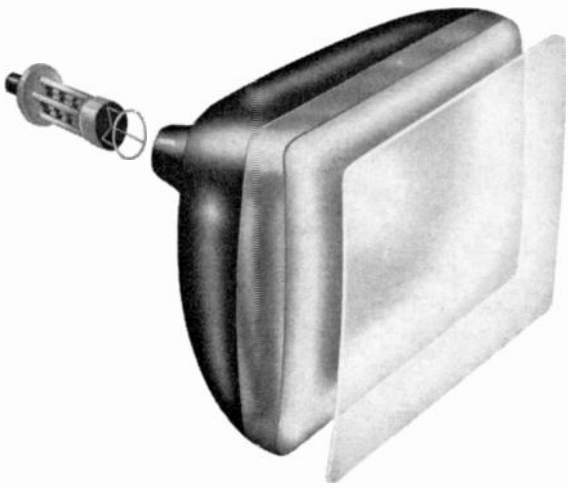
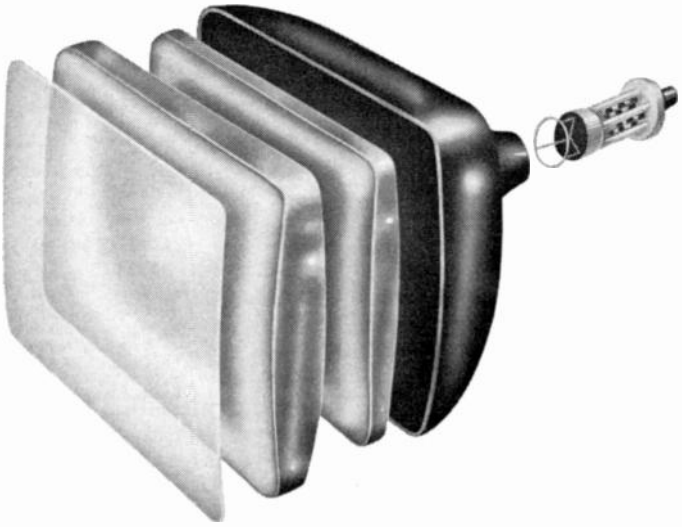
Circle 15 on reader service card



How some tubes are rebuilt.

1. Inspect screen and replace electron gun.
2. Reinstall safety glass.
3. Test tube.



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GTE SYLVANIA

4-CHANNEL TAKES OFF

Ready to take the 4-channel plunge? Before you dive off the deep end, read this article and make sure you're up to date on the latest developments in equipment

by FRANCOIS MARKETTE

At just about the time the *Stereo Mat,* the newsletter of the Hi-Fi Dealers Association of Delaware was knocking 4-channel, the CES show in Chicago was jam-packed with displays of 4-channel hardware and customers looking to order that hardware. The truth of the matter is that quadriphonic sound has taken off like a rocket: the audiophiles are pounding on showroom doors trying to get a listen to 4-channel and the manufacturers are going all out to provide *quality* surround-sound hardware at the first go-around.

Unlike the situation that occurred when stereo was first introduced, where virtually everyone listened to the pundits who claimed stereo was not that much better than mono so why upgrade, the manufacturers are not getting trapped into dipping their toes in to see if the water's warm, nor are they waiting to see if anyone salutes when they run up the flag. They tried this when stereo was introduced and dealers were stuck with "mountains" of add-ons, adaptors and second-rate equipment no one wanted. Virtually every manufacturer of truly hi-fi equipment has introduced an extensive line of *quality* 4-channel hardware—everything from receivers, through pickups to speakers.

As far as amplifier and receivers are concerned nearly everyone is trying to touch all bases by using "strapped" or "bridged" output circuits, which for the purpose of "shorthand" I will refer to as *strapping.* Strapping is an electrical connection of the front and rear power output so that the present stereo-only enthusiast can utilize the available rear channels power output for stereo listening. For example, if the quadrisound amplifier provides four channels of 20 watts each, for stereo listening it becomes two channels of approximately 40 watts each. (Depending on the type of strapping circuit used the combined power output will range from slightly less to slightly more than two times the per channel output. For more details, see "Amplifier Strapping", **Radio-Electronics,** July 1973, by Len Feldman.) Among the many manufacturers who have chosen to follow the strapping idea originally pushed by Harmon-Kardon are Kenwood, Fisher, Pioneer, Toshiba, Sherwood, Pilot, Sanyo, Marantz, Sony, Akai and Onkyo. Though most still retain a line of quality stereo-only equipments the extensive selection of strapped 4-channel receivers and amplifiers allows the consumer with just the faintest thoughts of going 4-channel to upgrade in stereo *now* without fear his purchase will be obsolete in just a few months should he get the quadrisound itch.

The matrix war

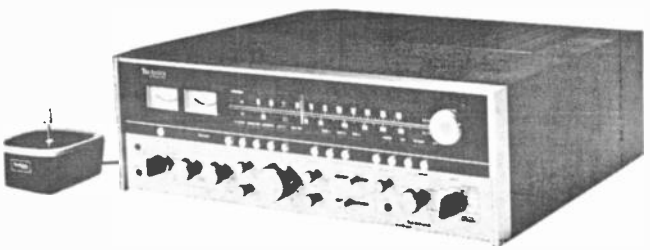
For all practical purpose the so-called "matrix war" (which never really existed for practical purpose) is a dead issue. With few exceptions—and possibly no exceptions by the time you read this—equipment with QS decoding (or RM for *Regular Matrix* as it is termed in Japan) also has SQ decoding. For example, the latest Sansui equipment has a matrix selection termed *phase matrix* which is their description of SQ. More typical examples, on the other hand, are Pioneer and Toshiba who use the standard terms QS and RM on the matrix selector switch.

The primarily American companies such as Lafayette Radio, Radio Shack and Marantz, whose equipment is made essentially for the U.S. market, are going all the way with SQ, for SQ is the "accepted" matrix standard for U.S. matrix records.

On some amplifiers and receivers you will find matrix decoders of the

HEATHKIT AA-2010 (left) is a complete 4-channel integrated amplifier and preamp. It includes front-panel speaker switching.

TECHNICS SA-6800X (below) is a new 4-channel receiver. Note the joystick remote control for setting up the 4-channel balance.



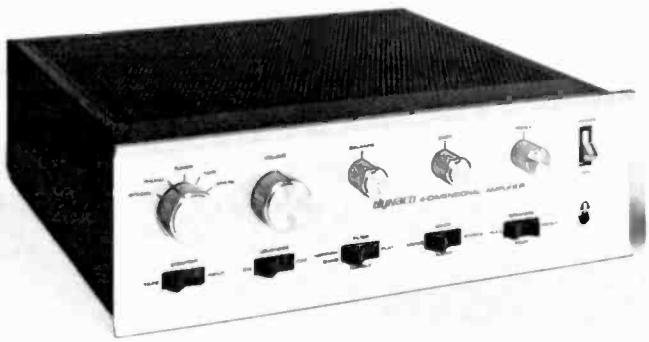
"universal" type, such as used in Heathkit's AA-2010 and some Toshiba models. As proven by Electro-Voice's 4X-44 "universal" decoder, good results are obtained from universal decoders though SQ decoders are rapidly replacing the universal models.

As a general rule basic decoders with rather limited separation are used in lower priced models, with some form of logic-SQ or Vario-Matrix QS (RM) used in the higher priced models; an exception is Harman-Kardon, who has chosen to use an SQ decoder featuring wideband response and phase linearity approaching the specifications of the professional encoding equipment, thereby obtaining a surround-sound without the logic-pumping to which some listeners find objection.

Synthesizers: 2-channel into 4-channel

Many amplifiers and receivers *presently* feature some form of ambience sound extraction from stereo records, often termed *synthesizer*. In many instances this is obtained with a simple, or no, phase shift in the QS or SQ matrix decoder; in others the ambient sound is obtained through a "Dyna" circuit connection (passive) in the rear speakers. The advantage of the Dyna ambient sound extraction is that it provides a form of surround-sound at rock-bottom costs as the equipment is basically stereo, with just two power amplifiers. Teledyne-Olson, Sherwood and, of course, Dynaco are presently equipping their stereo equipments with the Dynaco "synthesized" rear output.

Though the biggest noise is presently being made over matrix decoders, discrete CD-4 is making heavy inroads into the better grades of 4-channel receivers and amplifiers. Pioneer already incorporates a built-in CD-4 demodulator in three receiver



DYNACO SCA-80Q is their 4-Dimensional amplifier combining both preamps and amplifier in one package.

BSR McDONALD TD8QW (below) is a 4-channel 8-track tape player that automatically handles both 2-channel and 4-channel cartridge tapes.

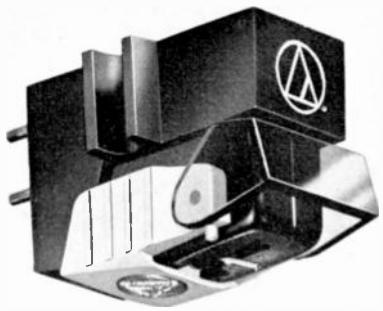
TWO FISHER RECEIVERS, 4020 top and 4060 bottom, are equipped for 4-channel playback.

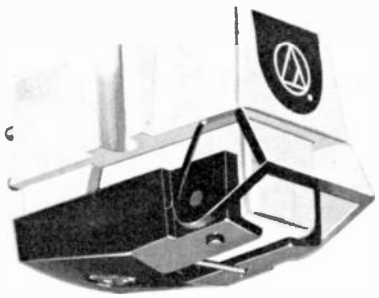
TOSHIBA SA-304 4-channel stereo receiver includes playback selector for regular matrix, SQ, and discrete.

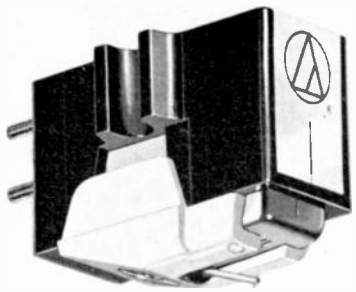
REALISTIC QTA-790 from Radio Shack (left above) is a 4-channel remote/preset stereo receiver. Favorite FM stations can be pretuned.

PILOT 366 (above) four-channel receiver offers matrix, decoder, and discrete modes for 4-channel playback.

LAFAYETTE LR-4000 (left) 4-channel receiver delivers several different 4-channel modes for playback of stereo and matrix discs.







AUDIO-TECHNICA AT14S (above) and AT15S (above center) are two new photo cartridges for playing CD-4 discrete records. Frequency response ranges to beyond 40,000 Hz to permit playback of subcarrier information. Both are dual-magnet stylus assemblies and are available with a variety of stylus types and sizes.

AUDIO TECHNICA AT12S (above) and a closeup of the dual-magnet stylus assembly (left). This unit is lowest-cost CD-4 cartridge in the line. Stylus assembly can be easily replaced when diamond stylus becomes worn. The cartridge will also play regular stereo as well as matrix discs without modification.

models, many other outfits such as Sanyo and Kenwood have at least one receiver model with a built-in CD-4 demodulator. Panasonic (Technics) and JVC, of course, have an extensive selection of equipments with built-in CD-4, while Marantz provides plug-in CD-4 demodulators for several models.

To accommodate quadriphiles who can't decide on CD-4 now, just about every receiver and amplifier manufacturer does what Onkyo does, providing several discrete hi-level and tape recorder connections for add-on CD-4 demodulators.

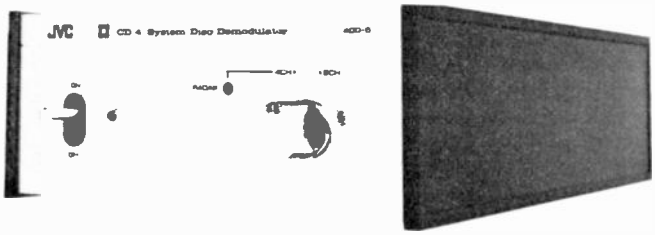
Though CD-4 demodulators were originally available only from Panasonic and JVC, several other manufacturers among them Pioneer and BSR-/Metrotech, have supplied photographs (but no specs) of upcoming add-ons, while Lafayette is firmly committed to a CD-4 add-on in their latest catalog (specs supplied so there's a working model).

Toyo, who virtually stood alone with RCA promoting 4-channel from 8-track cartridges is now being joined by the thundering herd. JVC, Akai and Wollensak are just a few of the big names into 4-channel cartridge players and recorders of high fidelity capacity. For those who like to be surrounded by sound while sitting behind the wheel of their Detroit Special there's an endless assortment of quadraphonic automotive cartridge players from companies such as Hammond, names generally unfamiliar to the hi-fi enthusiast. Even matrix 4-channel is finding its way into the car through a matrix cartridge player by Tenna.

Tape & records

Virtually every manufacturer of hi-fi quality reel-to-reel recorders such as Pioneer, Panasonic, Sony and TEAC already has available or is ready to announce at least one model 4-channel recorder. The few holdouts in the super quality and mass-market lines got burned in the past by coming out with half measures such as stereo record/4-channel play, but with top-of-the-line reel recorders still selling well, most of us expect the holdouts to join in just as soon as they're certain quadrisound isn't another passing fad. (But can you imagine the price of a 4-channel Revox A77?)

Though there is considerable talk about discrete 4-channel FM broadcasts and much interest in 4-channel 8-track cartridges and reel-to-reel tapes, the primary thrust of qua-

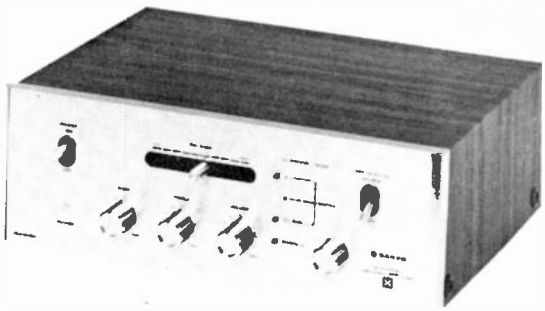


SONY HQR-600 4-CHANNEL stereo receiver (left). JVC 4DD5 CD-4 System Disc Demodulator (above).

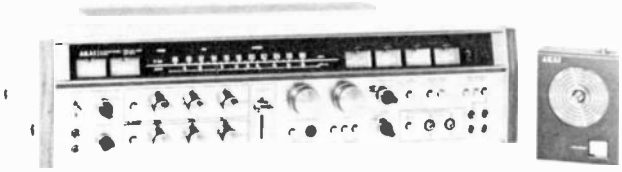
KOSS K/2+2 headphones (above) for silent listening to 4-channel music. 4-channel phones are fun to try. They do work.

SUPEREX QT-48 (left) Quad-tete four-channel headphones. One plug is for the front channels the other for the rear pair.

PIONEER QD-240 is a CD-4 demodulator for playing discrete records. Panel meter shows separation adjustment.



SANYO DCA-1600X 4-channel decoder amplifier is added to existing 2-channel stereo equipment setup.



AKAI AS-980 receiver includes CD-4 demodulator. Accessory remote balance control (right) is optional.

PIONEER QX-747 Quadraphonic Stereo Receiver has built-in CD-4, SQ, and RM (QS) decoders and demodulators.

drisound—both matrix and CD-4—is from records, where final sound quality is sharply determined by the performance level of the turntable, pickup arm and pickup. While the quality equipment from Empire, Thorens, Philips, Panasonic and JVC, among the turntable brands, is, of course, perfectly suitable for 4-channel because it's darn good from any point of view, CD-4 does require the most optimum tracking conditions, and the latest model automatic turntables from Garrard (the new Zero 100), Dual and BSR bring to CD-4 the same optimum "automatic" performance they delivered for stereo and matrix. For those who prefer to assemble their own turntable assemblies the Shure SME and Rabco arms remain among the best you can combine with any quality turntable.

Phono pickups

As far as phono pickups are concerned we are fortunate because the accepted high fidelity models from all the top manufacturers such as ADC, Empire, Shure, Stanton, Pickering, B & O, Elac, etc., do an admirable job when it comes to matrix 4-channel, for the pickup that delivers optimum sound from standard stereo has proven to be as good when it comes to matrix.

CD-4 records, however, require an extended frequency response pickup for optimum results. At the time this article goes to press the selection of quality CD-4 pickups is limited to a handful from Technica (with Shibata stylus), JVC (selected Technica units), Pickering (special Pickering design sylus) and a non-magnetic from Panasonic. In actual fact, most of the highest quality stereo pickups can be used for CD-4 reproduction with but a slight loss in overall performance. On the flip side of the coin, the quality CD-4 pickups are also suitable for high fidelity stereo reproduction.

Speakers & headphone

Finally, we come to loudspeakers and headphones. The question most common in quadriphonic showrooms—after the usual "What is four channel sound?"—is "How do we squeeze two more speakers into the room?" This is the same question asked when stereo came along, only then the problem was to fit two speakers, not four. If quadrisound follows the same pattern as stereo the hi-fi purist will somehow manage to squeeze two more relatively large speakers into his listening room. For the rest of us, who will be sticking the "extra" speakers behind curtains, chairs and tables, the solution will be smaller speakers; just as stereo gave the impetus to the so-called "bookshelf" speaker, we can expect quadrisound to result in a multitude of "vest pocket" models, or some other descriptive term implying a speaker that can be tucked just about anywhere. Anticipating the need for smaller speakers AR and Dynaco introduced mini-models just about when surround-sound got rolling, and ADC, of course, has had a line of smaller high-fidelity speakers for quite a while. Though there are presently no hard facts concerning specific models of other "vest pocket" speakers, several manufacturers or their reps have hinted at new, smaller speakers for the 4-channel market. If previous experience in stereo serves for quadrisound, by the time you're reading this you'll have an almost endless selection of miniature "quadriphonic speakers".

It's a shame to close on "4-channel" headphones because unlike all other aspects of quadrisound, where *quality* appears to be the keyword, much of the 4-channel headphone hardware is a ripoff on the consumer. We have reached the stage in 4-channel headphone design where each earpiece consists of two relatively *large* speakers—supposedly front and rear. Now there is just not enough room around the ear for *two* transducers, so one, at least, radiates its highs into the side of the head where they are absorbed. The end result is "full range" sound from one transducer directly into the ear while the other delivers a muddy, dull sound. In no sense is this *high fidelity*. So far, the true high fidelity 4-channel phones come from those few outfits who chose to design around sound, rather than the *appearance* of front and rear transducers. The 4-channel phones from Koss, Superex and Radio Shack (Realistic) look like ordinary stereo phones, but really deliver four channels.

Summing up

As you can see, though quadriphonics is virtually a brand new idea—if not to "pros" at least to the average audiophile, there is already an extensive assortment of equipments available. **R-E**

Setting-Up for CD-4 Records

Discrete 4-channel records can produce some really fine sounds when your equipment is properly set up. Here is how to install it right the first time.

by HERB FRIEDMAN

THE COMPLETE QUADRIPHONIC SYSTEM includes both matrix and CD-4 (discrete) systems, but unfortunately, at the time this is being written, there is no high-fidelity equipment (in the true sense of the term) which includes both an advanced matrix decoder (such as full-logic SQ) and a CD-4 demodulator. Though virtually every major hi-fi manufacturer now includes some sort of matrix decoder in his quadriphonic amplifiers and tuners (as contrasted to the "synthesized surround-sound" which can be a stereo amplifier with speaker circuit "ambient decoder"), CD-4 record reproduction requires an add-on optional such as the JVC 4DD-5 demodulator, not to forget a suitable Shibata stylus pickup and low-capacitance shielded cables (12 pF per foot) for the pickup to demodulator connections.

In very basic terms, adding CD-4 to an existing quadriphonic system requires only replacement of the phono pickup with the Shibata stylus model, installation of the low-capacitance cables, and finally, connection of the demodulator's four line-level outputs to matching line-level inputs on the quadriphonic amplifier. However, as with all good things, life isn't that simple. While you can make a handful of blunders when installing stereo equipment and still come out with some really fine sound, a few minor blunders with a CD-4 add-on can just about wipe out the surround-sound and leave you with four channels of stereo, or mono.

The first consideration in upgrading to CD-4 is the amplifier line-level inputs. Many of the early quadriphonic amplifiers have little or no provision for "external" accessories; they were intended solely as matrix amplifiers or as something called a *4-channel control center,* the control centers being basic stereo amplifiers with a *master volume control* for future 4-channel equipments (a volume control mounted piggyback or tandem on the regular amplifier volume control had its connections brought out to rear apron jacks, the thought being that a single volume control could serve for two separate front and rear stereo amplifiers). Then there is the "quadrisonic" amplifier which is basically a stereo amplifier with an ambient sound decoder in the speaker circuits. In no instance can any of these so-called quadraphonic, quadrisonic, 4-channel or surround-sound amplifiers be used with a CD-4 add-on.

Whether you have a fully integrated quadrisound amplifier, or are using your stereo amplifier with an amplifier/decoder for the rear output, you must have four separate power amplifiers—for left front, right front, left rear and right rear; and you must have an independent line-level input to each amplifier; in short, four line-level inputs for CD-4.

Many of the latest 4-channel amplifiers, even if they contain matrix decoders, have, at the least, one discrete 4-channel line-level input(s) labeled AUX or auxiliary. Some amplifiers have two discrete 4-channel AUX inputs. When a discrete 4-channel input is not provided for the AUX position of the input selector switch there will probably be a separate discrete 4-channel input—usually labeled DISCRETE or 4-CHANNEL—which is controlled by the stereo/mono mode selector switch. Your CD-4 demodulator can be connected to this connection.

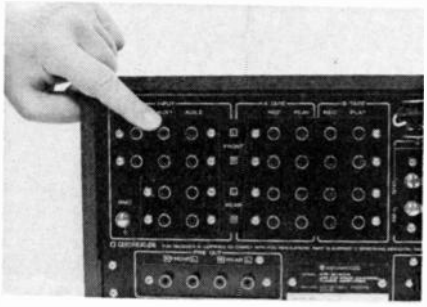
Finally, some quadrisound amplifiers intended primarily for matrix signal processing have no discrete 4-channel inputs. The tape monitor input, however, is discrete 4-channel and can be used for the CD-4 demodula-

tor (though you lose the tape monitor facility).

When you have established that your quadrisound amplifier has a discrete 4-channel line-level input (as we said, some amplifiers don't have this connection), then you are ready to purchase and install a CD-4 demodulator system.

Replace the cables

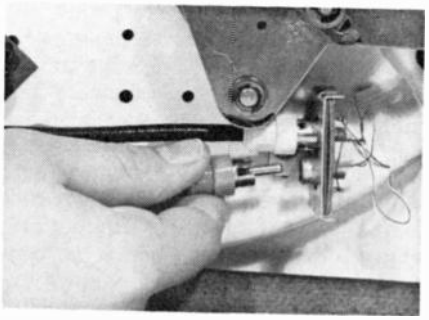
First step in the installation is replacement of the turntable's existing shielded signal patch cords with the low-capacitance patch cords (12 pF per foot) supplied with the CD-4 demodulator. The relatively high capacitance of the normal shielded audio patch cords will "short circuit" a substantial part of a CD-4 record's ultrasonic subcarrier signal, resulting in partial or complete loss of the front-to-rear separation. Actually, you will hear a *stereo* output, for the L - R and R - L signals which are provided by the ultrasonic signal, and which are used to decode the sum stereo signals in 4-channel, will be filtered by normal shielded patch cords before the signal gets to the demodulator.



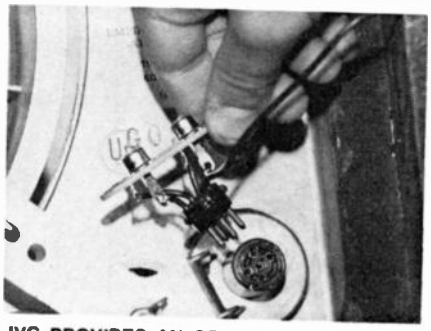
SOME QUADRIPHONIC RECEIVERS and amplifiers are basically stereo equipments, or have no provisions for optional discrete 4-channel hardware. To add a CD-4 demodulator to your system the amplifier must have four independent line-level inputs, such as the AUX 1 and AUX 2 shown above. A discrete 4-channel tape monitor input can also be used.

The low-capacitance cables supplied with the demodulator are shorter than the standard shielded cords supplied with turntables; if they don't reach the amplifier you must use *low-capacitance* extension cords which are available from JVC.

As a general rule the turntable's cables are easily replaced because most quality turntables have twin or duplex phono connectors under the motorboard, generally accessible by removing the bottom cover or the base. Empire turntables use a special multi-terminal connector at the base of the pickup arm pedestal. There is an optional JVC adapter which converts the Empire connector to duplex phono jacks. Some turntables do not have plug-in cables; the connections are soldered. You'll have to cut the connector off one end of each low-capacitance cable and solder to the turntable's connection strip. In many instances you won't be able to tell which turntable wire is the shield, or ground; so before you solder the new cables double check the shield wires with an ohmmeter.



ON BETTER QUALITY TURNTABLES the output patch cords usually connect to phono jacks concealed under the motorboard. Connect the low-capacitance cables provided with the CD-4 demodulator to these jacks. If your turntable has the output cords soldered to a terminal strip make certain you double check the shield connections when installing the low-capacitance cables.



JVC PROVIDES AN OPTIONAL ADAPTER for converting the multi-terminal connector used on Empire turntables to a duplex phono jack.

The pickup installation is the most critical part of the CD-4 upgrading. Whereas a slight misalignment might not have any noticeable affect on stereo records, an improperly installed CD-4 pickup can sharply degrade the demodulator's performance. (It is important to keep in mind that Shibata stylus CD-4 pickups are excellent stereo pickups, so if the pickup is installed for optimum CD-4 it is also optimum for stereo.)

Overhang adjustment is critical

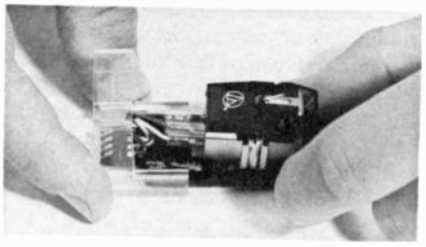
The most critical part of the pickup installation is the "overhang", the distance the stylus extends beyond the platter's spindle. Most quality turntables are provided with some sort of overhang gauge. *Use it.* If the gauge is a plastic assembly with crosshairs that fits on the pickup holder (or shell) make certain the stylus is directly under the cross, with the stylus as close as possible to the crosshair support. Use spacers between the pickup and holder if necessary—just get the stylus raised where indicated by the gauge. If the gauge has a V-notch make certain the stylus is inside the V. If the stylus is centered but under the V-notch use spacers to get the stylus into the notch. If no plastic gauge is provided there is most likely a paper overhang gauge that was supplied with the turntable. Maybe you tucked it away with the warranty—dig it out. Make certain the gauge is positioned precisely as specified on the platter—don't fudge its position. Then check that the stylus falls precisely on the guide line when the tone arm is lowered.

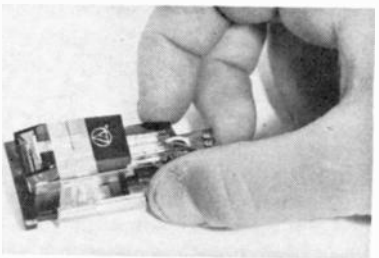
If you have one of those turntables that was supplied without an overhang gauge you are stuck. Better to make your own out of paper than try to slide the pickup across a ruler—even a wood ruler can chip a diamond stylus. Finally, be extra careful when installing the signal connections to the pickup. Crossed or reversed leads will cause some very odd sound distribution. Not all manufacturers use the so-called standard color code, so the best thing is to check each signal wire with an ohmmeter before clipping it to the appropriate pickup terminal.

(Take note that some CD-4 pickups we have tested do not give sufficient overhang adjustment on a few of the finest turntables; it is impossible to get the stylus under the gauge's cross-hair. If you run across this problem with the CD-4 pickup *you* purchase don't fool around with home-brew remedies. There is nothing you can do short of modifying the pickup arm. Take the pickup back to the dealer and try a different model.)

Final checkout and adjustment

Make certain your pickup arm is applying the correct stylus pressure as





CD-4 PICKUP INSTALLATION is critical. If a stylus position or overhang gauge is provided with your turntable be sure to use it. Don't guess. If you don't have an overhang gauge make one.

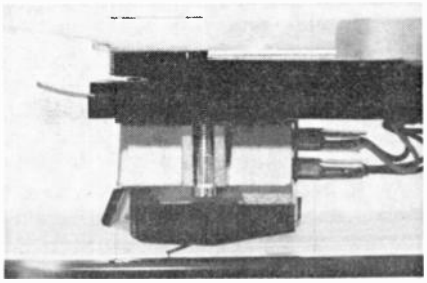
specified by the pickup manufacturer. Don't fudge the value. If 2 grams stylus pressure is suggested use 2 grams, not 1.5 grams. If a range is specified, such as 1.5 to 2 grams, you're better off starting out on the high side at 2 grams. Be sure that the anti-skate is set to the correct *elliptical* stylus value.

When you are certain the pickup is correctly adjusted place the test record supplied with the demodulator on the platter, fire up the amplifier and play the test record, making the demodulator adjustments as specified. If you find that the record specifies a left adjustment and only the right adjustment has an effect, the signal leads from the pickup to demodulator are in error. If the adjustments are made correctly but the positioning announcements are incorrect, such as left front appearing at right rear, the connections between the amplifier and demodulator are incorrect.

A word about speaker phasing

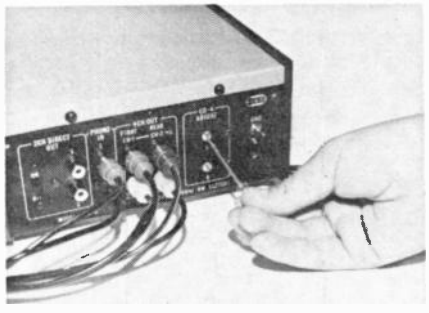
As a general rule all speaker connections should be in the same phase with the positive speaker terminals connected to the positive amplifier output terminals. Actually, it doesn't matter which speaker terminal goes to what amplifier terminal as long as all speakers are connected the same way. Now it is possible for room acoustics to reverse the phase from one or more speakers *at the listening (seating) location*, and the bass—the low frequencies—will sound thin. In fact, it can sound as if one speaker was connected in reverse-phase. Normally, when acoustic reversal of low-frequency phasing occurs the common recommendation is to deliberately reverse the wiring to *one* speaker to compensate for the acoustic phase reversal. While this technique almost always works for stereo, and usually works for CD-4, it can create some really weird effects from matrix surround-sound.

If you run into an acoustic phase-reversal problem first try to determine which speaker is causing the problem by shutting down two speakers at a time. When you have located the problem speaker reverse the connections to that speaker. Then listen to all speakers in CD-4 and matrix. If it sounds OK, leave it be. If it sounds good in CD-4 but appears to have "frequency holes" in matrix, or if both CD-4 and matrix sound good at first but appear to be causing fatigue after 15 or 20 minutes of listening then your best bet is to re-connect the proper speaker wiring phasing and physically move one or more speakers until you eliminate the acoustic phase reversal. And if you still can't eliminate the problem you'll have to select a new listening location.



AFTER THE PICKUP IS INSTALLED in the arm place the stylus on a record and sight-in from the side. The stylus should appear to be almost at right angles to the surface of the record. If the stylus appears to be "digging into" the record place some spacers between the pickup and shell until you obtain almost a right angle. The stylus and its reflection from the surface of the record should form almost a straight line.

ALL SPEAKERS SHOULD START out connected in-phase. If you are not using two-color wire (gold, silver) wrap a small piece of tape around one wire to denote either the positive (+) or negative (–) speaker and amplifier connections.



WHEN PLAYING THE CD-4 adjustment record, the left decoder adjustment should affect only the left test signal. If it affects the right test signal the connections between the pickup and demodulator are reversed.

Experimentation with speaker phasing is particularly important if your basic 4-channel equipment consists of a stereo amplifier or receiver with a *separate* rear-channel amplifier or amplifier/decoder. It is perfectly possible for the rear amplifier to have a 180° phase reversal compared to the front amplifier. For example, if a pulse waveform was applied simultaneously to all four inputs, the speaker cones connected to the front amplifier would move forward while the cones connected to the rear speakers moved backward—an exact 180° phase reversal. The perceived sound will be quite "hairy" under these conditions.

To check, feed a mono sound source through all inputs (mono record with both stereo amplifiers set to the mono mode); then turn off both the left front and left rear speakers. Reverse the wiring to *one* of the *right* speakers. If the bass at the listening location gets "thin", indicating cancellation of the lows, the original speaker wiring was correct. If the bass response is improved by the speaker wiring reversal, reverse the wiring to the matching *left* speaker. Then give it the overall listening test for acoustical phase reversal as previously described. **R-E**

superconductivity breakthrough

The possibility of a breakthrough that may result in making superconductivity practical and useful in commercial applications was presented to the recent American Physical Society meeting in San Diego, CA, by two University of Pennsylvania physicists. Recent experiments conducted by Drs. Anthony Garito and Alan Heeger indicate that superconductivity may be attained at temperatures high enough to make superconductive transmission lines, generators or motors economically possible.

A superconductive transmission line would carry current with practically no losses. It has been estimated that at present 75 per cent of the power generated in the country is lost because of the resistance of the material through which it has to travel.

Up to the present, it has been possible to obtain superconductivity in some metals at temperatures up to 21°K (–252°C). Using an organic salt, Drs. Heeger and Garito have observed fluctuating superconductivity at about 60°K, a temperature that might make superconductive lines and electrical equipment economically practical.

The results may fall far short of the expectations of the scientists at the meeting, or they may exceed them. It is by no means certain that the attempt to stabilize the fluctuations and obtain a consistent superconducting material will be successful. On the other hand, since the scientists are working with a complex organic compound (dimethyltetrathiofulvalene - tetracyanoquinodimethan for any reader who might like to make his own) there is the possibility that organic chemists could build up superconductors with special molecular structures to attain specific electronic characteristics.

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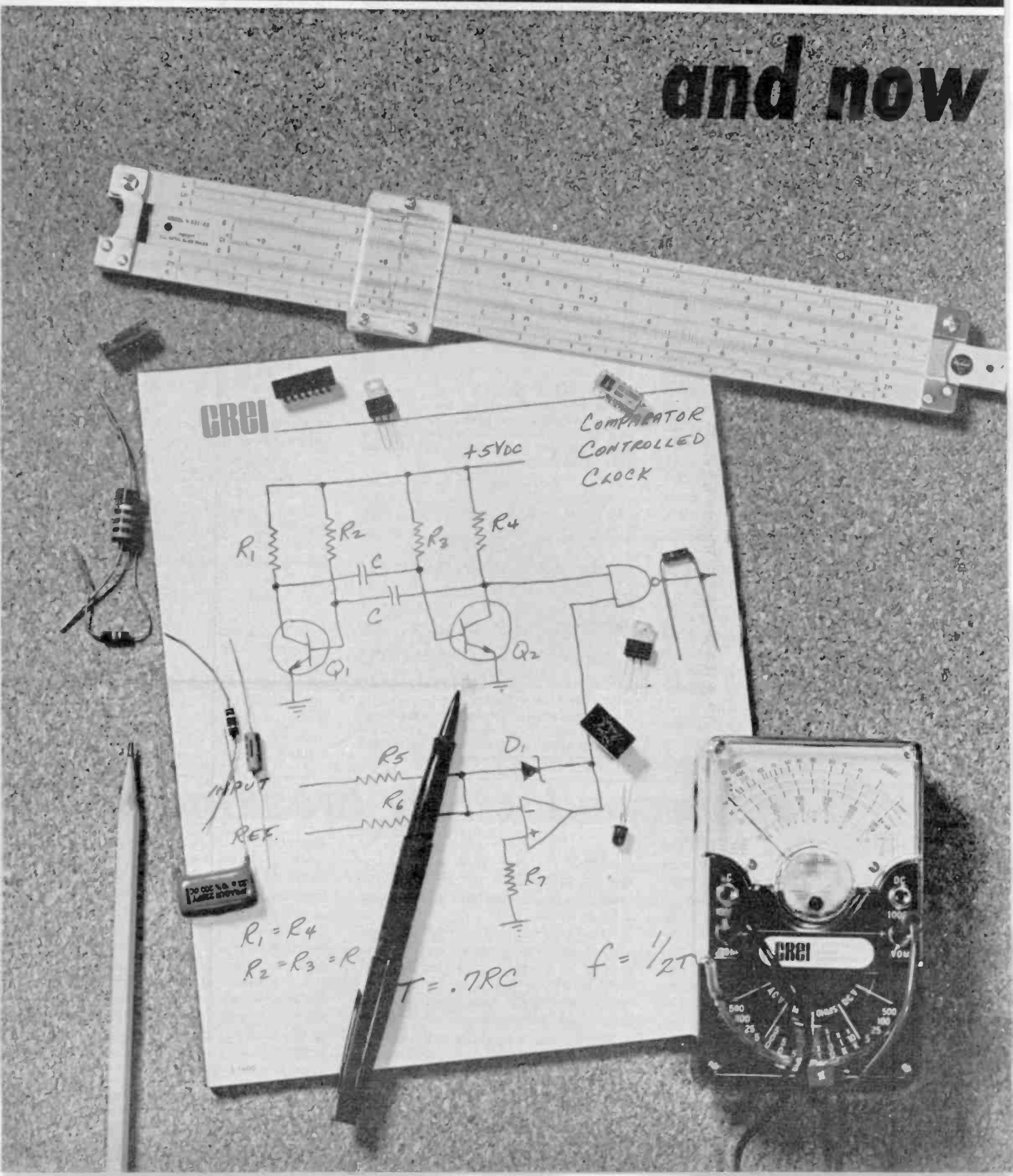

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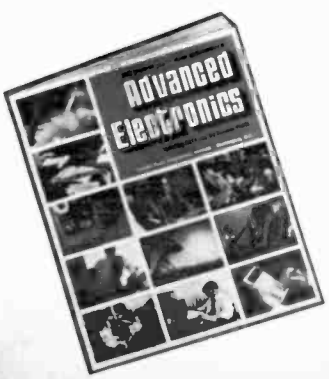

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4-CHANNEL FM
9 ways to go

The 4-channel record has found its groove now let's see what's in store for 4-channel FM

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

FOUR-CHANNEL SOUND, AT LEAST FROM THE PHONOgraph record, has clearly settled into a "two-world" situation. At the moment, matrix discs outnumber discrete discs by a wide margin. CBS continues to champion its SQ matrix system in this country, while in Japan, the Regular Matrix (RM) system of matrixing, akin to Sansui's QS system, is the front-runner. Meanwhile, late-starter RCA has increased its output of discrete Quadradiscs (more often referred to as CD-4 discs—the name given to them by Japan Victor Company which is credited with their initial development).

Many of the high-quality, high-priced component receivers which are now available include facilities for decoding or demodulating one or more types of matrix discs as well as the new discrete four-channel records. Coexistence of "matrix" and discrete discs seems assured, at least for the present, and purchasers of new four-channel receivers seem less concerned about possible obsolescence—at least as far as record playing is concerned.

In the case of four-channel FM broadcasting, the situation is much more complex and unresolved at this time. Many stations throughout the country have been playing matrixed four-channel discs on a regular basis. Because these discs contain *two* audio channels—however complex they may be—present FCC rules need not be modified in any way, since the two encoded matrix channels are simply treated as two conventional stereo channels. Since all matrix discs are compatible with stereo (and, to a greater or lesser degree, with mono), the listener equipped with either a stereo or a mono receiver hears a balanced program, with *all* left information coming from the left-front speaker and *all* right program coming from the right stereo speaker during stereo playback. All four channels are blended together for monophonic listening. The listener equipped with a matrix decoder and a full, four-channel set-up, uses his matrix decoding facilities in much the same way as he would when listening to a matrix quadriphonic disc played over his own phonograph system.

The recently formed NQRC (National Quadraphonic Radio Committee), sponsored by the Electronic Industries Association and recognized by the FCC is now hard at work studying the problems involved in broadcasting four *discrete* signals over a single FM station. There are no less than eleven systems currently being analyzed. Not surprisingly, one of these, proposed by CBS, suggests that no significant rule changes be made by the FCC, since CBS maintains that their SQ matrix system, embellished with sophisticated logic circuits at the receiving end (**Radio-Electronics,** June 1973, page 44) can provide four-channel sound that is as satisfying as that produced from any discrete system. Most of the other proposals submitted to the NQRC, however, involve techniques for actually transmitting a composite signal over an FM station which would be separable into four, fully discrete signals in much the same way that the present stereo composite signal is separated by currently produced stereo FM tuners and receivers.

The earliest four-channel broadcasting system offered for industry and FCC consideration was developed by Louis Dorren, whose Quadracast Inc., in cooperation with San Francisco FM station KIOI, has already demonstrated the feasibility of their system in several months of experimental broadcasting. Many of the other systems currently under consideration (proposed by such companies as RCA, Motorola, G.E., Zenith and Nippon Columbia) are, to a greater or lesser degree "variations on a theme" developed by Dorren, and an understanding of the technical aspects of his proposal will make the other systems equally understandable.

The present stereo composite signal

The make-up of the presently approved stereo composite signal is in Fig. 1. The main channel modulation

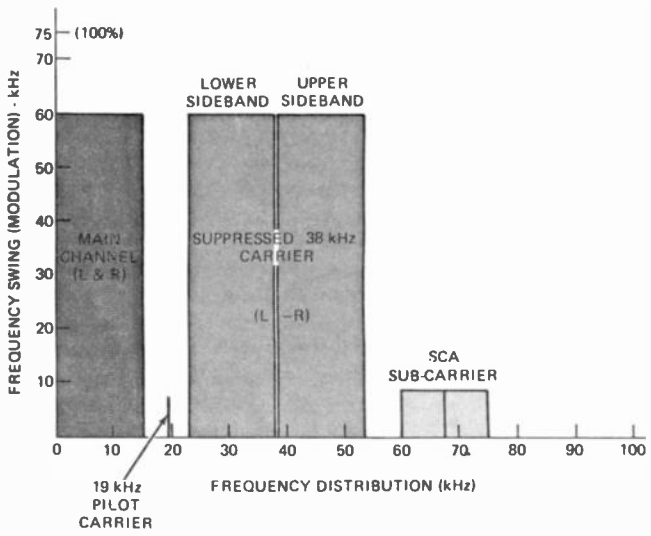


FIG. 1—SIGNAL COMPONENTS in the presently used stereo broadcast system. The 38-kHz subcarrier is suppressed.

consists of left-plus-right audio information in the frequency range from 50 Hz to 15 kHz. Upper and lower AM modulation sidebands, centered about a 38-kHz supressed carrier are used to transmit *difference* information (L-R), while a 19-kHz pilot, modulating the main carrier approximately 10% of total, is sent along so that the 38-kHz subcarrier can be reconstituted in the receiver for proper demodulation of the L-R information.

At the receiver, once the L+R and L-R audio information has been recovered, the simple addition of these two audio signals yields a separated "L" signal [(L+R)+(L-R)=2L], while subtraction results in the recovery of a discrete "R" signal [(L+R)-(L-R)=2R].

Another component shown in Fig. 1, but unrelated to stereo broadcasting, is a 67-kHz SCA subcarrier that contributes 10% to the total modulation of the station carrier. It is this extra subcarrier that is used to transmit "back-

QUADRIPHONIC RECEIVER, Pioneer's QX-747, can handle CD-4, SQ and RM quadriphonic discs.

ground music" to private subscribers such as restaurants, hotels and other public establishments which is not heard by the general public listening to conventional FM sets.

It is this service, too, which poses one of the many problems inherent in the transmission of discrete quadraphonic broadcasts, since the FCC has indicated that provision for such Subsidiary Communications must be maintained in any future quadriphonic broadcast system. More than 600 FM stations now derive extra income by "leasing" this extra facility to companies such Muzak which supply such musical programming and other specialized subscriber services.

The Quadracast composite signal

Figure 2 illustrates the makeup of the composite signal

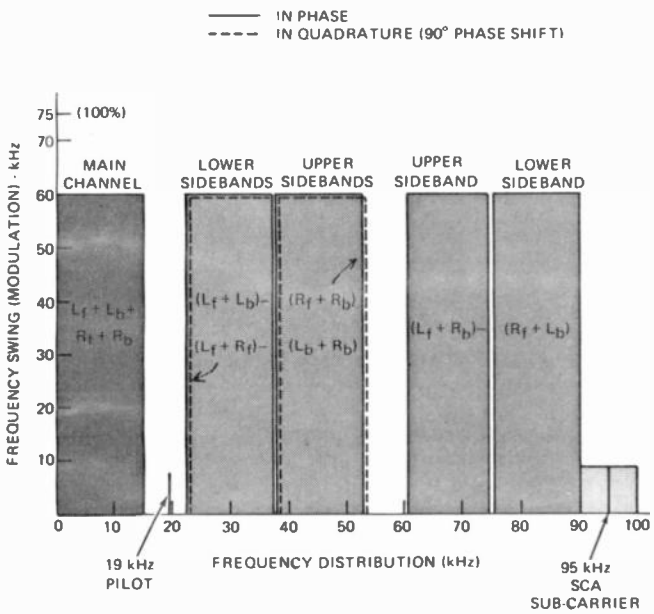


FIG. 2—QUADRACAST 4-CHANNEL FM system distributes its signal components as shown here.

proposed by Dorren for discrete four-channel broadcasting. Again, "main channel" audio extends from 50 Hz to 15 kHz, but in this instance it contains the sum of all four audio program signals (L_f, L_b, R_f and R_b). The subscript "b" stands for "back" signals and this term, rather than "rear", is used to avoid confusion in abbreviations of right and rear. The 19-kHz pilot signal remains exactly the same as for stereo broadcasting.

Two sets of upper and lower sidebands related to the 38-kHz supressed sub-carrier are now used—one similar in phase to that used for stereo, the other leading the first by 90 degrees. Because of this quadrature relationship between the pairs of sidebands, it is possible to detect the audio information modulating each independently by locking the reconstituted 38-kHz sub-carrier in the receiver to the phase of each of the pairs of sidebands.

The first of these pairs of sidebands contains audio modulation corresponding to the difference between the left and right sets of information $(L_f + L_b) - (R_f + R_b)$, while the second, quadrature related sidebands are modulated by the difference between front and back audio for the left side, plus the difference between right-front and right-back audio $(L_f - L_b) + (R_f - R_b)$.

Mathematically, to solve for four "unknowns" (in this case, the four separate audio signals which make up a quadriphonic program), it is necessary to have four separate equations. It is for this reason that *no* matrix four-channel system (working with only two "equations") can ever recover four fully separated signals. Accordingly, Dorren adds still another sub-carrier, whose center frequency is located at 76 kHz (four times the frequency of the 19-kHz pilot reference carrier). Again, the new subcarrier is suppressed and only the upper and lower sidebands are transmitted. Their modulation consists of "diagonal difference" information of the form $(L_f + R_b) - (L_b + R_f)$. Now, with four separate equations of signal entities capable of being recovered by a properly designed receiver, the following mathematical manipulations are used to recover the four separate signals:

$$(L_f + L_b + R_b + R_f) - [(L_f + L_b) - (R_b + R_f)] + [(L_f + R_f) - (L_b + R_b)] - [(L_f + R_b) - (R_f + L_b)] = 4R_f$$

$$(L_f + L_b + R_b + R_f) + [(L_f + L_b) - (R_b + R_f)] + [(L_f + R_f) - (L_b + R_b)] + [(L_f + R_b) - (R_f + L_b)] = 4L_f$$

$$(L_f + L_b + R_b + R_f) + [(L_f + L_b) - (R_b + R_f)] - [(L_f + R_f) - (L_b + R_b)] - [(L_f + R_b) - (R_f + L_b)] = 4L_b$$

$$(L_f + L_b + R_b + R_f) - [(L_f + L_b) - (R_b + R_f)] + [(L_f + R_f) - (L_b + R_b)] + [(L_f + R_b) - (R_f + L_b)] = 4R_b.$$

Quadracast provides for an SCA sub-channel by moving its subcarrier up to 95 kHz, beyond the upper sideband of the 76-kHz subcarrier (required for quadriphonic service) which ends at 91 kHz and also suggests that this extra-service subcarrier be "phase locked" to the 19 kHz, since it would be the fifth harmonic of that frequency.

Extra bandwidth

Those not intimately acquainted with the present FCC spectrum rules will, at first glance, conclude that the presence of program information above 75 kHz in the "baseband" of this proposed composite signal will lead to "out-of-channel" radiation and possible problems with adjacent-channel interference in FM. Actually, many tend to confuse *maximum deviation* of the FM carrier with frequency distribution or content. The fact is that even present stereo transmissions create measurable sidebands well beyond the 75-kHz point, and present rules merely require that any sidebands existing between 120 kHz and 240 kHz removed from carrier "center frequency" be attenuated by at least 25 dB. Dorren has already shown mathematically that his composite system meets these requirements despite its increased bandwidth occupancy.

While FCC regulations in this regard may prove to be no problem, present day receiver design practices may cause problems for those consumers who may someday attempt to convert their existing receiver to this or any other approved system of quadriphonic broadcasting. Better quality stereo tuners and receivers have fairly linear response and phase characteristics up to and beyond the 53-kHz limit which defines the end of the upper sideband in the stereo composite signal. Further increases in bandwidth are often compromised so as to obtain better adjacent-and alternate-channel selectivity—particularly in view of the "crowded" conditions of the FM band brought about by the recent popularity of this radio medium. Just as some monophonic receivers (which had even narrower bandwidth) did not lend themselves to satisfactory stereo conversion in the 1960's, when "multiplex adapters" were sold for this purpose, it is likely that many high quality stereo tuners and receivers will not lend themselves to good conversion to quadraphonic reception, however plentiful good-quality quadraphonic adapters may become when and if a system is approved.

Other quadriphonic broadcasting proposals

Zenith has offered two proposed variations of the basic Dorren proposal which leave the 67-kHz SCA service unaltered in frequency. The first of these, shown in Fig. 3, has a main channel and two quadrature-related 38 kHz sub-

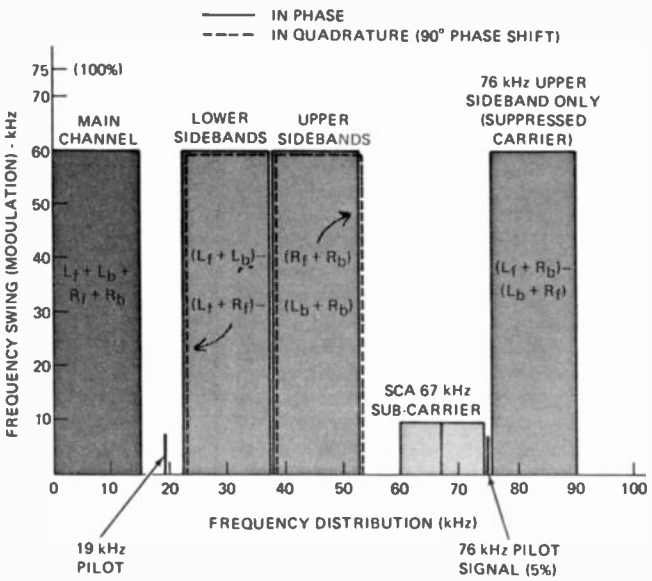


FIG. 3—ONE OF ZENITH'S PROPOSED SYSTEMS permits 67-kHz SCA operation by using only upper sideband of extra 76-kHz subcarrier.

carriers much like the Dorren system. The 76-kHz subcarrier, however, is limited to the transmission of the upper sideband only, thus freeing the frequencies around 67 kHz for continued SCA service. In this system, however, a second pilot carrier at 76 kHz, using 5% of total modulation of the main station carrier is required.

Another Zenith proposal, its spectrum is plotted in Fig. 4, would shift the upper subcarrier to a frequency of 90.25 kHz and would use lower vestigial sideband modulation, thus leaving the frequencies around 67 kHz still available for SCA use.

General Electric's proposal is quite similar to Zenith's second proposal, as can be seen in Fig. 5, except that the upper subcarrier would again be located at 76 kHz and require no separate pilot signal of its own. The upper sideband modulation would be steeply attenuated using vestigial sideband techniques, as shown. SCA service would then be able to occupy the spectrum between 90 kHz and 100 kHz, and if a center frequency of 95 kHz were selected, it could be phase-locked to the 19-kHz pilot signal,

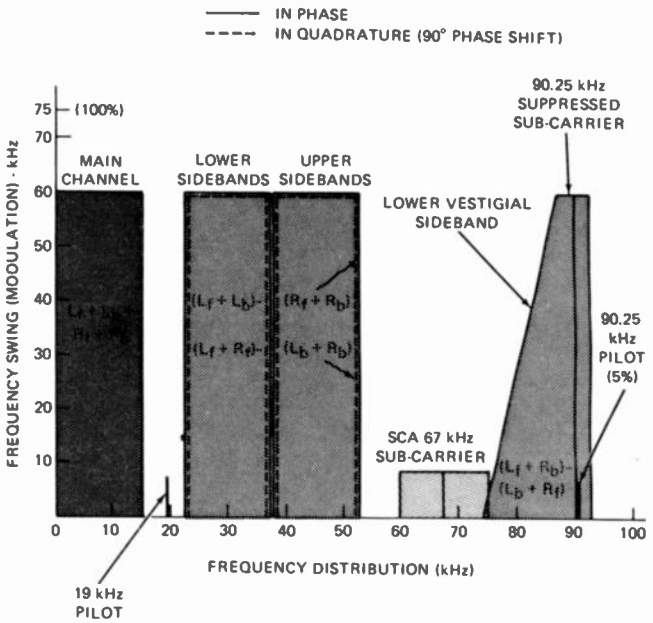


FIG. 4—ALTERNATE ZENITH PROPOSAL uses lower vestigal sideband of 90.25 kHz supressed carrier, still permitting SCA operation at 67 kHz.

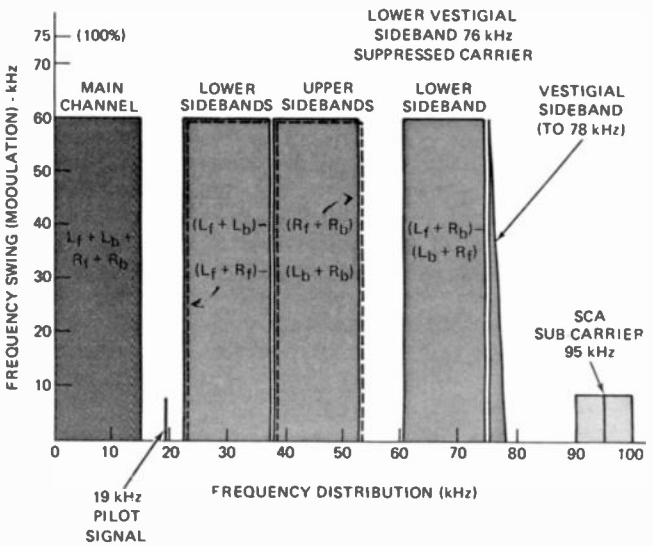


FIG. 5—GENERAL-ELECTRIC'S SYSTEM uses vestigial sideband for upper subcarriers, providing greater isolation between 4-channel and SCA signals.

since its frequency would be the fifth harmonic of 19 kHz.

Both RCA and Motorola have offered "dual-option" proposals which suggest that a three-channel system be used when SCA service is required and that a full, four channel system be used when the station does not engage in SCA service. The two RCA variations are shown in Figs. 6 and 7. In Fig. 6, only the first three types of audio composite signals detailed for the Dorren system are transmitted. Solving for "four unknowns" with only "three audio equations" does not, of course, result in complete isolation of the four original quadraphonic signals but does offer better separation than a simple "matrix" or "two equation" system such as that proposed by CBS. By offering this dual option, the second RCA system shown in Fig. 7 extends frequency spectrum to a maximum of 91 kHz, since in full four channel operation, SCA service is eliminated entirely.

One interesting innovation suggested by CBS in connection with their "matrix" two-channel proposal involves a means of identification for matrixed four-channel broadcasting. At the present time, listeners have no way of

(continued on page 98)

4-channel record review

There are many 4-channel records available now. Here's how we rate the 4-channel effectiveness of these discs

by RADIO-ELECTRONICS EDITORIAL STAFF

DURING THE PAST YEAR THE EDITORS of **Radio-Electronics** have been testing 4-channel matrix recordings and equipment extensively. We have set up a scoring system to evaluate our impression of the effectiveness of these records.

The scoring runs from one to four stars. One star is the lowest and four stars are highest on our scoring system. Note well that we are only evaluating the records from the standpoint of 4-channel technical effectiveness. The ratings shown here have nothing to do with performance or artistic merit.

The equipment

The mechanical and electronic chain of equipment used for playing the records includes the following: Shure V15, Mark III improved cartridge; Shure-SME arm; Thorens TD 124 turntable; Dynaco PAT-4 preamp and Dynaco Stereo 120 amplifiers; a pair of AR-3A speakers for the front channels and a pair of Dynaco A-25 speakers for the rear channels.

A second equipment setup consists of a Shure M91ED cartridge; a Garrard SL95B changer; a Scott model 499 Stereomaster Quadrent stereo amplifier and four Dynaco A-25 speakers.

4-Channel Record Review

Two different SQ decoders were used: The Lafayette SQL and the Sony SQD-2020. The Lafayette unit incorporates logic circuits to improve front-to-back separation. The Sony unit is more sophisticated and includes not only front-to-back logic circuits, but also wave matching circuits which further improve left-right separation.

4-Channel Recording Techniques

When matrix four-channel recordings were first introduced, there were two distinct recording techniques. In Pop music the listener was placed in the middle of the recording group so that the sound would come at him from all directions.

And in some records pan effects were incorporated so that individual instruments and voices would sometimes move around the listening room during a selection.

With Classical music, however, the record makers adopted a more conservative approach and tried to create the illusion of the listener being in an auditorium with the performers in front of him.

The rear speakers picked up the delayed reverberation, giving the listener the effect of the hall ambiance in which the recording took place.

In the past year, four-channel classical record producers became more innovative and in some records, have copied the pop record technique, putting the listener in the middle of a symphony orchestra. This Surround Sound technique has caused controversy among classical music record buyers. Traditionalists rebel at the idea of being surrounded by the music. But many (including some classical musicians) find Surround Sound exciting. A lot depends on the selection and the record producer's style. In the reviews which follow, we have noted those classical records using the Surround technique.

COLUMBIA

CQ-30322—Janis Joplin, Pearl **
CQ-30750—Paul Simon **
CQ-30768—The Raiders, Indian Reservation **
CQ-30797—Andy Williams, You've Got A Friend **
CQ-30800—Percy Faith, Black Magic Woman ***
CQ-30810—Jim Nabors, Help Me Make It Through The Night **
CQ-30961—Johnny Cash At San Quentin ***
CQ-31096—Upendo Ni Pamoja, The Ramsey Lewis Trio **
CQ-31170—Blood, Sweat & Tears Greatest Hits ***
MQ-31193—E. Power Biggs, Music For Organ, Brass and Percussion Recorded in St. George's Church, New York City ****
SQ-31237—Jim Nabors, Man Of La Mancha ***
CQ-31247—Peter Matz Spectacular ****
MQ-31368—Bartok, Miraculous Mandarin—Boulez And The New York Philharmonic Orchestra ****
QX-31403—An Introduction To The World of Quadraphonic Sound ****
MQ-31425—Isaac Stern, Romance **
MQ-31520—Stravinsky, La Sacre Du Printemps—Bernstein And London Symphony Orchestra. Surround Sound ***
CQ-31629—Alone Again (Naturally), Ray Conniff **
CQ-31641—Lynn Anderson's Greatest Hits **
CQ-31748—Lagins And Messina **
CQ-31776—Azteca ***
MQ-31798—Pinchas Zukerman, Conducts English Chamber Orchestra And Plays Vivaldi—The Four Seasons. Surround Sound ***
MQ-31960—Highlights From Leonard Eernstein's Mass ****
MQ-32051—Mozart's Greatest Hits **
MQ-32054—Bach's Greatest Hits **
MQ-32055—Tchaikovsky's Greatest Hits **
MQ-32056—Beethoven's Greatest Hits ***
MQ-32058—Chopin's Greatest Hits **
MQ-32059—Strauss' Greatest Hits **
CQ-32079—The Best Of Mountain Featuring Leslie West And Felix Pappalordi ***

(continued on page 79)

NEW IC's For FM CIRCUITS

THE LITERATURE IS OVERFLOWING with ambitious schemes for improving all phases of communications reception. The profusion of really novel ideas is amazing. Until recently though, the great majority of this wealth of information was kept at a theoretical level for a very simple reason. They were just too complicated for the existing discrete circuit techniques. The IC has completely changed the picture. Circuit complexity is not nearly as costly as it used to be, and looking at the two circuits we are going to explore here, the buyer of these circuits is getting a tremendous bargain. Not only is he getting a bargain in pure number of devices, but he is getting the benefit of many hours of highly skilled innovative development time. The age of the integrated circuit is allowing the many ideas filed away in the various periodicals and journals to be re-explored and is also inspiring new invention and thinking in how to use the new techniques to practical advantage.

We are going to look at FM detection by exploring two very impressive devices. Two reasons prompt us to use FM as an illustration of what can be done. First, the initial appearance of an IC in a television receiver was a sound detector, and second, we will examine two methods of detection which may be unknown to many of you. The devices under question are the RCA **CA3065** i.f. amplifier-limiter, FM detector, electronic attenuator and audio driver and the **CA3089** FM i.f. system. We feel in no way prejudiced by choosing two RCA devices since RCA was the first to implement the detection systems which are now widely copied by other major manufacturers. At first glance, the FM detector portion of the two IC's may seem similar because of the symmetrical differential type circuits. They are in fact completely different in concept, each one chosen for a particular advantage in its specific operating environment. These circuits are all ready and will continue to find their way into all manner of communication equipment, some far afield from their original design intent.

Fig. 1 is the block diagram of the CA3065 television sound system shown in its natural milieu, the TV receiver. With a minimum of external components the circuit does all FM functions between the sound take-off transformer and the audio output transistor. Note that one of the novel features obvious in this diagram is the dc volume control. A bypassed potentiometer controls the audio gain of the system by means of an electronic attenuator. A single wire can be used to control the volume with almost complete disregard as to its length and its route.

With the aid of the schematic of Fig. 2 let us work our way through the maze of some 34 transistors, 9 diodes, 45 resistors and 5 capacitors. The first thing you might notice in a cursory examination is that there are 5 Zener diodes in the schematic. Because of the limited value of capacitors that can be integrated other methods of bypassing must be used. Capacitors of more than a few picofarads consume inordinate amounts of chip area and so are undesirable. When a Zener diode is biased beyond its avalanche breakdown knee its impedance becomes quite low and it becomes an effective bypassing element. (The old gaseous VR tube was used for a similar purpose in early vacuum-tube hi-fi amplifiers.) D3 and D4 in series regulate the power supply bus for the circuit at a specified typical 11.2 volts. D1 in series with R1 and D2 in series with D9 and R2 provides dynamic bypassing for portions of the limiter circuitry that require it.

Q11 through Q19 are three stages of limiter amplifiers to help attain the specified 50 dB typical AM rejection. This is one of the more important FM specifications since it is an indicator of the receiver's ability to reject amplitude modulated noise which is what FM is all about. These three amplifiers are differential types which have always been the backbone of integrated circuit design. The differential amplifier is convenient to bias without using capacitors since the low emitter impedance of the complementary device gives the desirable ac signal bypassing. Another reason for its wide popularity is that it behaves well when overloaded—limiting by cutting off transistors rather than by saturating them. A large positive signal at IC pin 2 pulls up the emitter junction of Q11 and Q12 cutting off Q12 with a resulting positive swing on its collector. A relatively large negative swing at the base of Q11 cuts it off, allowing Q12 to conduct the full current in R25 reducing the collector voltage of Q12. The action of the limiters result in a

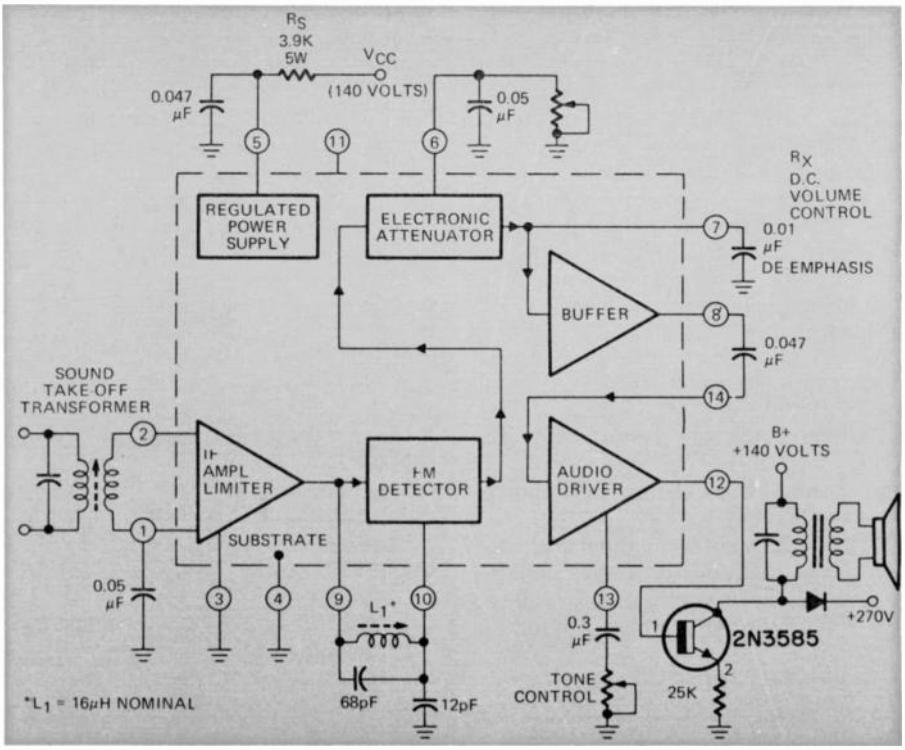


FIG. 1—BLOCK DIAGRAM of the CA3065 IC incorporating an FM i.f. amplifier, discriminator and af amplifier for use in television receiver circuits.

See how old techniques—made practical through new IC's—can improve performance from TV sound and FM receivers.

by **STEVE LECKERTS**

limiting knee of 200 microvolts typical which is the signal level 3 dB below where the amplifier levels off with increasing input.

Transistors Q22 through Q28 are the differential-type FM detector. It detects the difference in two responses of a low-pass filter in such a way as to perform the desired demodulation. Figs. 3 and 4 show how this detector works. The responses of the two inputs to the detector are different since one is taken at its input and one at its output. The nulls in the two responses are at different frequencies. Q23 and C3 peak-detect one response, Q26 and C4 the other and differential amplifier Q24, Q25 subtracts the two detected dc voltages.

If the two curves in Fig. 3 are subtracted point by point as done by the differential amplifier the detector response of Fig. 4 results. This is the familiar S curve essential to all frequency detectors since the straight central portion gives a linear changing dc voltage with frequency. Although we previously said AM rejection is the function of the limiter amplifier a contribution is also made by the detector. Those of you familiar with the ratio detector are aware of this fact.

This differential detector enhances the receiver's AM rejection because the center or zero crossing of the S curve is formed by the difference of two signals. This point can be made virtually independent of input level. We have described how the difference detector produces the demodulated audio current which is the collector current of Q25.

The circuitry of Q6 through Q10 along with Q29 forms the electronic attenuator. The collector current of Q25 feeds the emitter of transistor pair Q7–Q8. The differential dc voltage appearing on the bases of these two transistors determines how the detected audio signal is split between the two transistors. If the base of Q8 is at a higher potential than the base of Q7, Q8 will conduct more than half of the demodulator's output current. The audio output is taken off the collector of Q8 (it's developed across R3) to drive the output follower Q2. By varying the resistance to ground at pin 6, the bias on differential pair Q7–Q8 is adjusted and the output signal level is controlled. If nothing else were added the system would work but there would be an annoying shift in dc level at the output as the attenuation is changed. Transistors Q9 and Q10 fed by dc current source Q29 solve this problem by adding in a dc current equal to the amount subtracted by the audio attenuator portion. As the ac and dc signals in Q8 are reduced the dc current in Q10 increases. Since the two collectors are tied together their currents are added and the net dc current shift is zero keeping the dc out-

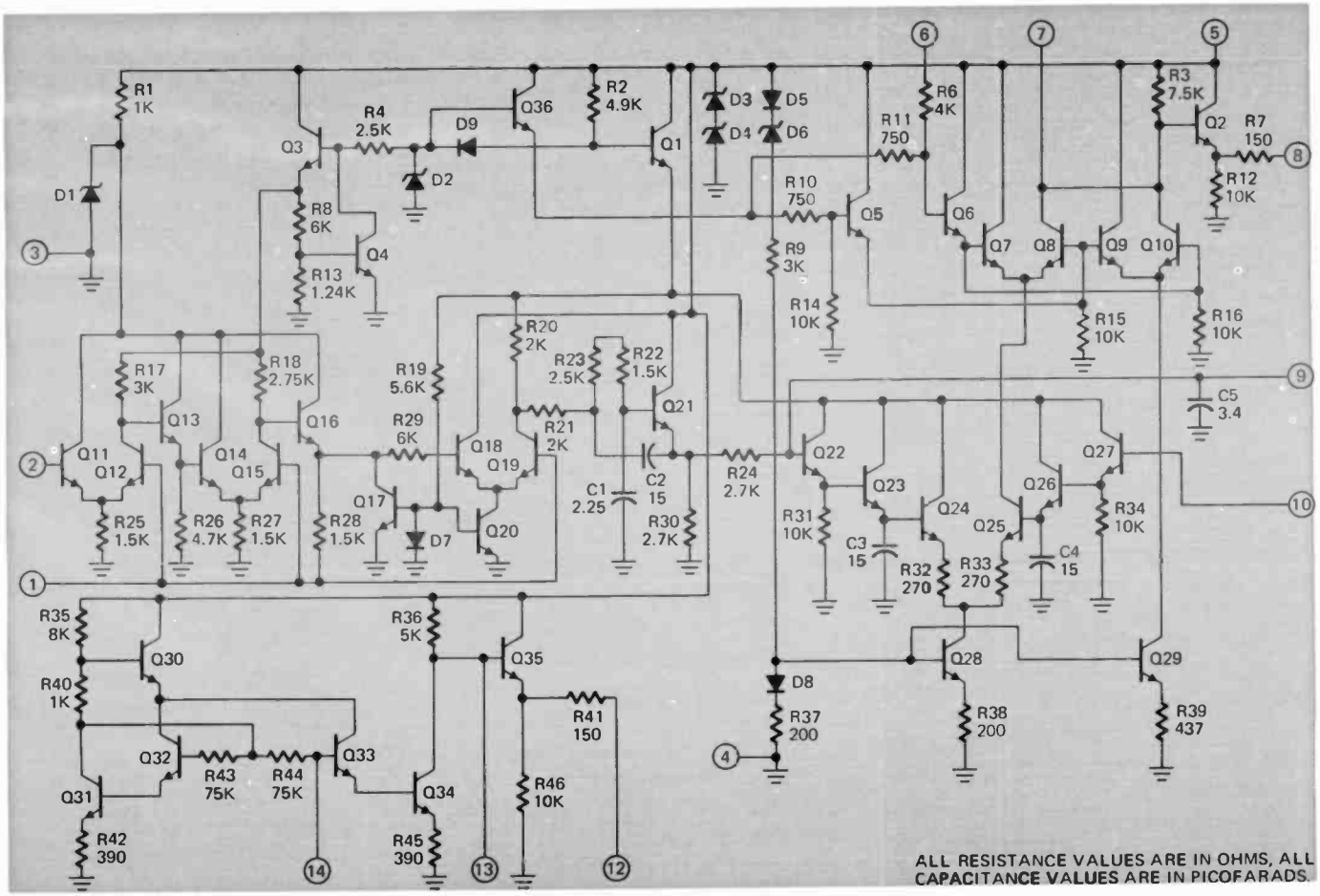


FIG. 2—SCHEMATIC DIAGRAM of the CA3065 IC. Formidable looking with its 34 transistors, 9 diodes and maze of resistors and capacitors; the device is housed in a 14-lead DIP case.

put voltage fixed. This system gives an attenuation range of 60 dB with an output distortion rated at 1.5% typical.

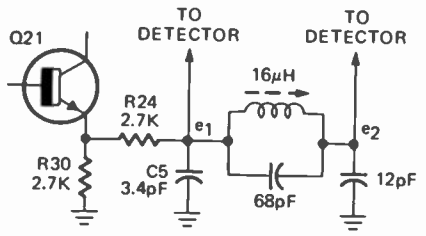
Now for the CA3089

This more complex FM i.f. system was designed for use in the more critical FM receiver where specifications such as capture ratio and distortion are paramount. The CA 3089 can provide exceptionally low distortion (typically 0.1%) using a double-tuned circuit in its detector. With an ideal front-end, a capture ratio as low as 0.5 dB can be achieved. This is the number which tells the difference in two signal levels at the same frequency which results in the smaller one being rejected. The smaller the number the better the performance. While we don't know what receiver capture ratio has been actually achieved combining front-end design with this IC, 0.5 dB is a great place to start. To get these results a quadrature detector is used which pivots around a double-balanced phase detector circuit that has become one of the building blocks of many integrated circuits.

Looking at Fig. 5, the block diagram of the CA3089 FM i.f. system, we see that in addition to the i.f. amplifier-limiter and detector, the circuit contains level detectors used to operate a tuning meter and a squelch circuit to mute the receiver. This IC chip does not have an attentuator as such but an audio muting control amplifier which is used to switch off the audio while tuning between stations. The simplified schematic (Fig. 6) is more complex than the first circuit we discussed. Working at an i.f. of 10.7 MHz it is more difficult to design an integrated limiter, or any limiter for that matter, since the frequency is roughly double that of the 4.5-MHz TV sound i.f. The limiter-amplifier is similar to the previous one using differential amplifiers except that it is completely balanced. Both collectors of the amplifiers are used to couple signal to the next stages. Also phase compensation is included by positive feedback using the small 1- and 0.2-pF capacitors. (The 0.2-pF capacitors are not shown.) Each amplifier has its own level-detector circuit. The detector outputs are combined to operate a signal-strength meter over a large signal range. RCA points out that this is not just an agc metering scheme but a system that gives a true signal-strength indication.

Figure 7 explains the operation of the doubly-balanced phase detector. The diagram shows that as the relative *phase* between the two inputs changes, the detector *output voltage* changes. To convert this voltage change so the FM quadrature detector can process it, the frequency shift of the received signal must be changed into phase shift. An inductor-coupled tank does the job. As the frequency changes the phase shift of the tank circuit feeding Q21 and Q26 (across pins 9 and 10) is compared to the phase of the input signal feeding Q27 and Q28. The circuit is adjusted so that with no frequency modulation there is a 90° phase shift between the two inputs resulting in no demodulated output.

The audio output of this amplifier exists as currents in the collectors of Q23, Q24 and Q22, Q25. These currents feed two identical mute circuits. They appear in duplicate because of the way the audio output is formed by a subtractor circuit. A second subtractor circuit produces an AFC current directly from the chip which can be connected through a resistor circuit to control a varactor-tuned local oscillator. The audio output is squelched while the afc output is not. The muting circuit Q43, Q44, Q47 is controlled by the dc voltage on the base of Q47. When this base is driven positive by the squelch output Q43 is turned on harder, turning off Q44 and reducing



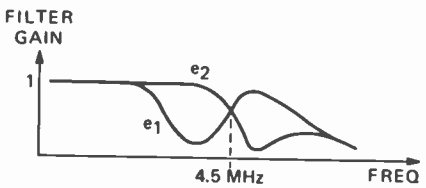


FIG. 3—EXTERNAL LOW-PASS FILTER and the responses of signals sent to detector.

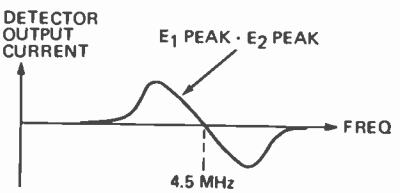


FIG. 4—FAMILIAR S-CURVE shows the response of the differential FM detector.

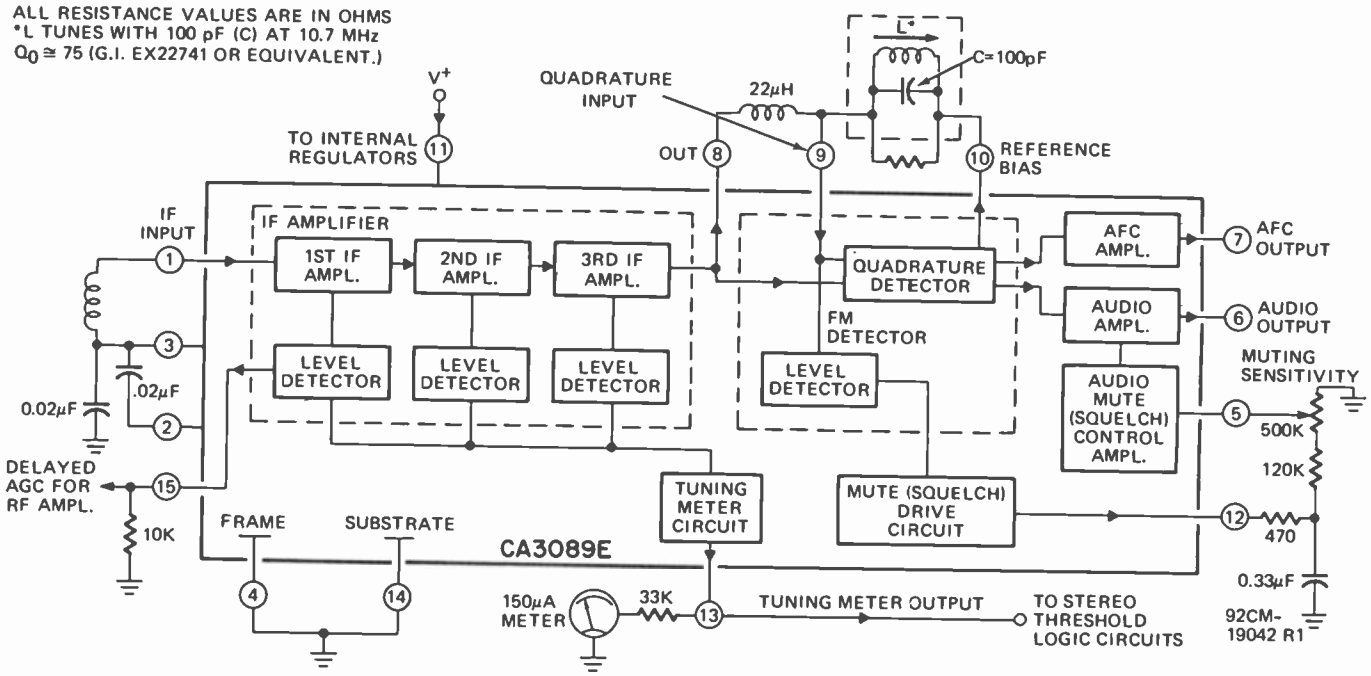


FIG. 5—BLOCK DIAGRAM OF THE CA3089E IC, an elaborate device designed for top-notch FM receivers. The integrated limiter is more complex than the one in the CA3065.

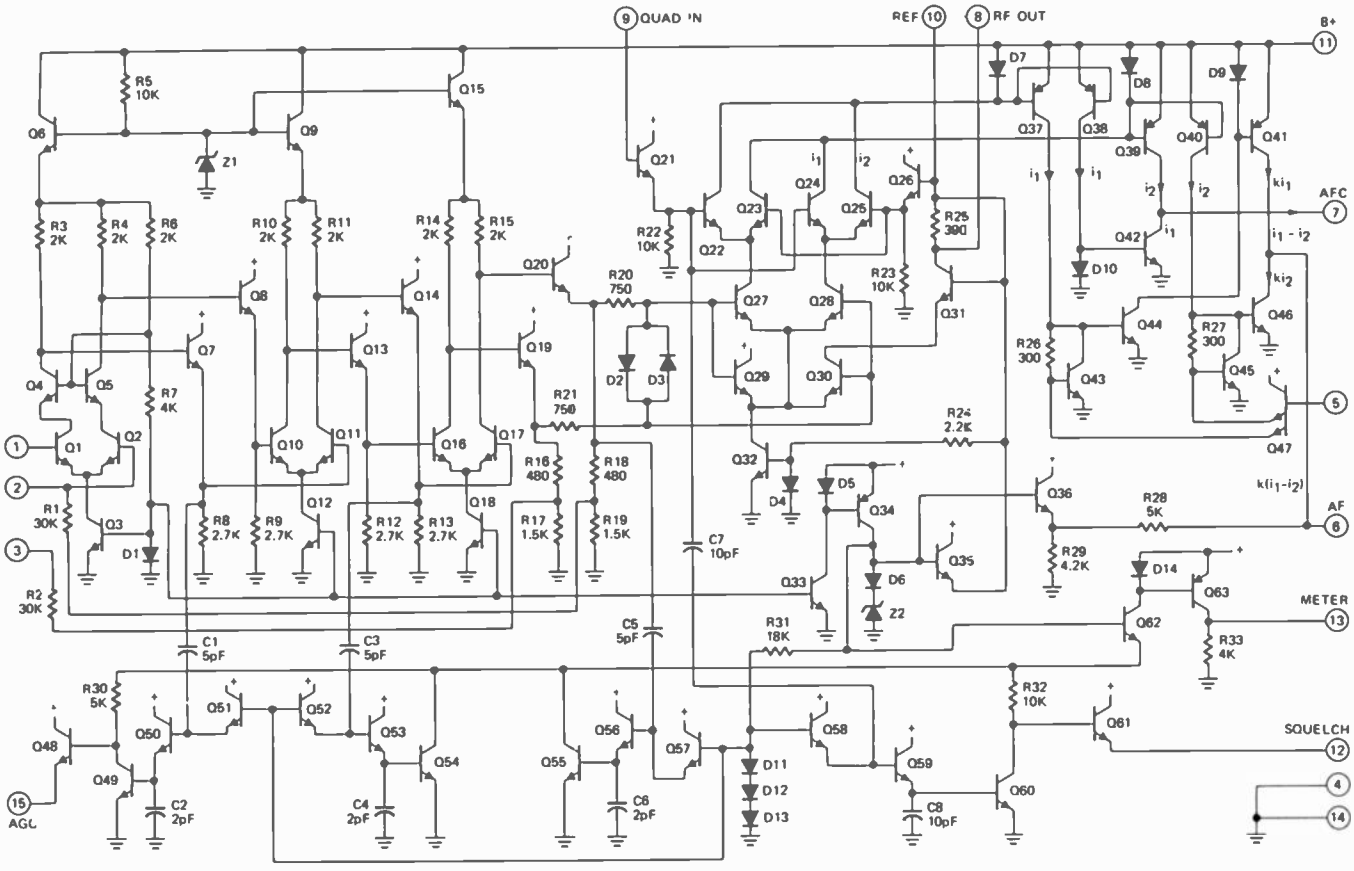


FIG. 6—SIMPLIFIED SCHEMATIC DIAGRAM of the CA3089E. The device features squelch or muting, afc for the tuner, drive for tuning meter and a balanced phase detector.

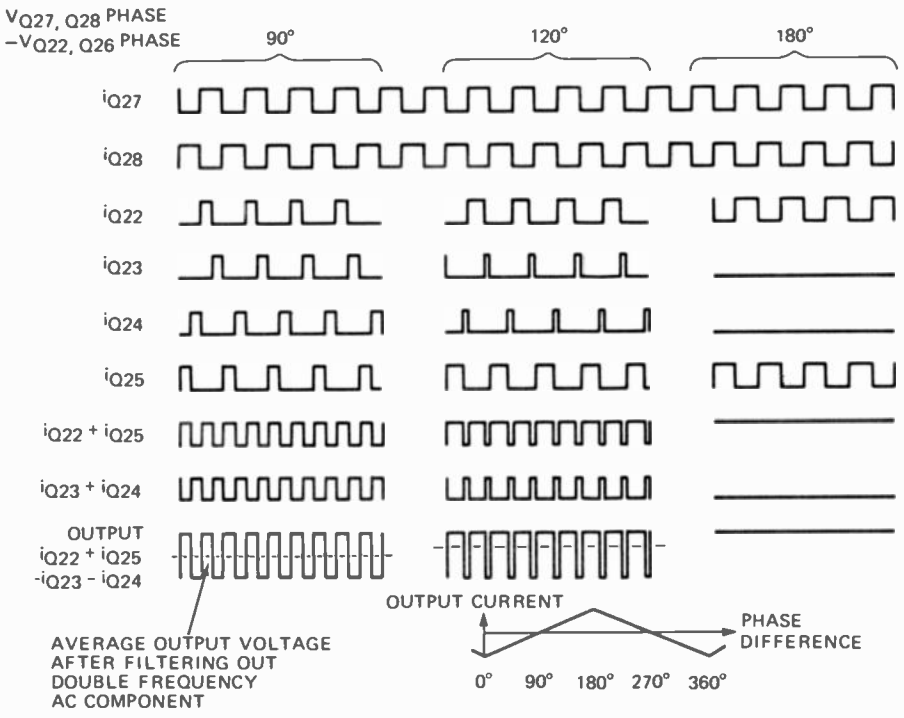


FIG. 7—PULSES SHOW PHASE RELATIONSHIPS of currents in various sections of the phase detector. Phase difference produces a voltage difference that is processed by the detector.

the audio signal flowing through it. The second circuit (Q45 and Q46) stabilizes the dc voltage at the audio output similarly to the way it was done on the CA3065.

Other applications

There are many imaginative applications and variations possible with these two circuits. For example the detector-gain control part of the CA3065 can be used as a variable-gain audio amplifier without using the limiter-detector functions at all. All that has to be done is to feed audio into pin 10 and bias pin 9 at the same dc voltage as pin 10 by using a resistor and bypass capacitor.

An interesting extension of the CA3089 is to use the meter circuit to detect multipath transmission. If we feed filtered afc output at pin 7 to the horizontal input of an oscilloscope and the meter signal into the vertical input we will set up the required display. The horizontal axis now corresponds to frequency and the vertical deflection indicates received signal strength. Deviations from a straight line show multipath reception. The same effect will be seen if the rf and i.f. filter responses are not flat.

We hope we have stirred up some interest in the modern sophisticated integrated circuit and at the same time enlightened you on the operations of two types of now practical FM detectors considerably different from the common diode types. IC manufacturers provide a mass of information in their manuals in the way of detail-packed data sheets and application notes and these are a good investment for learning, or a necessary one to profitably use the devices. For those interested in reading further on the devices we have discussed here we recommend hunting up copies of the CA3065 and CA3089 data sheets. The August 1971 issue of the *IEEE Transactions on Broadcasting and Television Receivers* has a detailed report on the CA3089, "Advances in FM Receiver Design" by Jack Avins of RCA. **R-E**

New Antenna For Fringe-Area Reception

Co-channel and adjacent-channel interference are common problems in fringe areas. Here's an approach to antenna design that minimizes these problems

by JULIUS GREEN
Channel Master

TV ANTENNA INSTALLERS HAVE KNOWN for a long time what antenna manufacturers were a little slow to pick up: that the most widespread reception problem today is not weak signal, but electrical interference. Or, put another way, the principal antenna requirement in most areas is not higher gain, but better interference rejection characteristics.

Ten years ago—even five years ago—antenna engineering centered almost entirely on producing higher gain. There was always a fringe area that needed just another dB or two to pick up a distant channel. Fringe areas still exist, of course, and gain is still an essential antenna characteristic. But another quality has become just as important, if not more so: noise rejection.

The Institute of Electrical and Electronics Engineers defines noise as, "Unwanted disturbances superposed upon a useful signal that tend to obscure its information content."

An installer trying to deal with practical TV reception headaches might more graphically define noise as "interference from trucks, trains, appliances, and unwanted broadcast transmission that throw patterns and streaks across what would otherwise be a fine TV picture."

This article deals with external noise sources only, principally of the man-made variety.

The importance of a noise-free environment to good reception is suggested by the care taken in the siting of radio-telescopes (such as the large parabolic array at Green Bank, West Virginia) and other antennas used in space communications and exploration, to find an area as free as possible from interference.

Interference sources

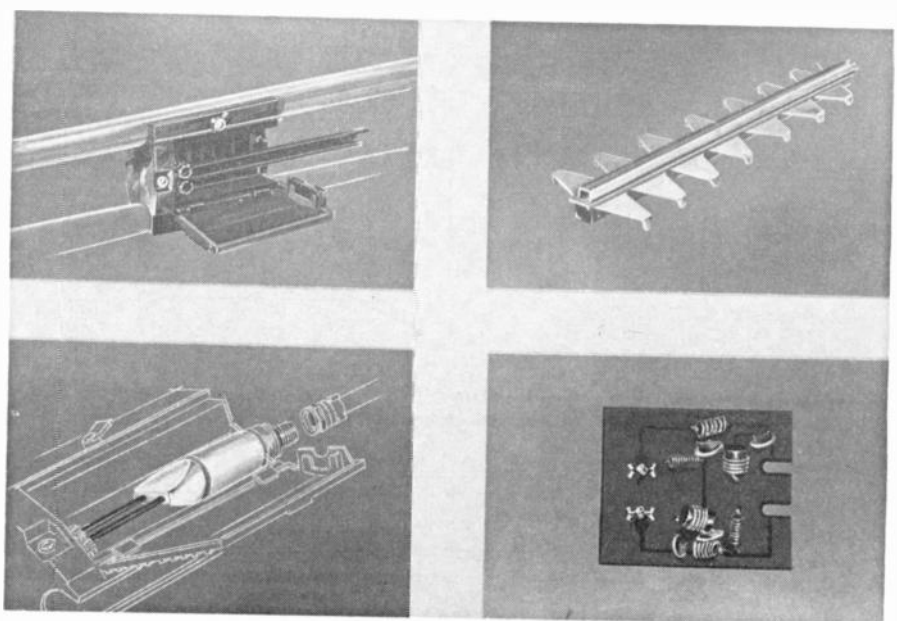
What are the sources of external interference and their significance to TV reception?

Atmospheric noise is caused by lightning, whose low-frequency radiation is trapped between the earth's surface and the ionosphere, affecting reception at global distances. At radio broadcast frequencies below about 20 MHz, it is the limiting factor on reception—many times greater than internal receiver noise. For this reason, the typical broadcast receiver operates fairly well with an extremely short, low-gain ferrite rod antenna: any increase in antenna gain would increase both signal and noise but would not change the signal-to-noise ratio. At TV frequencies, this source of noise is unimportant except on a local basis.

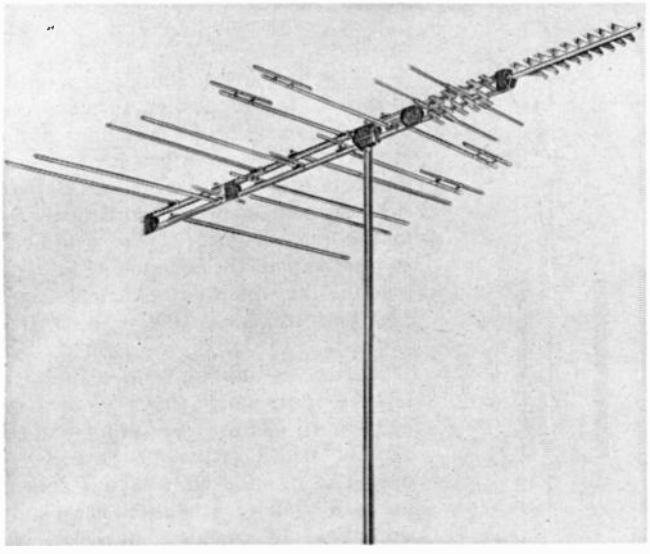
Cosmic noise, first discovered by Jansky in 1932, originates outside the earth's atmosphere, and includes radiation from the sun, from other portions of our galaxy, and from other galaxies. Because of attenuation by the atmosphere, its magnitude decreases with increasing frequency. Furthermore, it does not appear equally from all directions. Location of the particular sources of this noise has attracted great interest and effort, and has given birth to the field of radio astronomy. On the average, this noise is slightly greater than typical internal receiver noise on Channels 2 to 6, less than set noise on Channels 7 to 13, and insignificant at uhf frequences.

Man-made noise, constantly increasing, is the result of our endless proliferation of electrical devices. Consequently, its continued rapid growth is guaranteed. Noise sources include appliance motors, switches, ignition systems (especially busses and trucks), generating stations and power transmission lines, diathermy equipment, amateur radio, FM stations, and TV stations. Ghosts (reflections off natural or man-made structures and topographic features), adjacent-channel interference, and co-channel interference might also be placed in this category. This distressing situation has given the term "air pollution" a new meaning for the TV industry and the unhappy home viewer.

Obviously, the level of man-made noise varies considerably with the particular location, but some generalizations can be made. Like cosmic noise, it decreases with increasing frequency. In metropolitan areas it can be much greater than the internal set



ACCESSORIES FOR THE QUANTUM ANTENNA. Top left is the weatherproof terminal housing, top right is the uhf antenna segment. Lower left and right are coax balun and FM trap.



ONE OF THE CHANNEL MASTER QUANTUM ANTENNAS for deep fringe vhf and uhf TV. An FM trap and balun for coax are useful.

noise. As one moves out into less densely populated areas, it becomes less of a factor.

Experienced technicians are only too painfully familiar with the visual results of such interference, particularly but not entirely on the low band: herringbone and moire patterns, venetian blinds, sync bars, windshield wiper effect, and so on.

Since neither the TV set location nor the noise sources are likely to be moved away, the most effective way—indeed, perhaps the only way—to eliminate interference is to eliminate antenna and transmission line pickup of the offending signals.

High-gain antennas, with extremely narrow forward beams, have been a valuable step in this direction. However, a narrower beam width implies higher gain, and the engineering efforts to achieve higher gain, and thus narrower beams, are approaching the practical limits imposed by size and cost. Therefore, little more can be done to reject interference coming from the same direction as the TV transmitter other than using an array.

However, there is at least a 50-50 chance that much of the interference may come in from the rear or sides of the antenna. When faced with co-channel or adjacent-channel interference, probably 90% of the undesired signals come from the rear because of the FCC's geographical allocation of channels.

Despite this growing problem, high gain has continued to be the principal target of TV antenna engineers. Other characteristics have remained secondary considerations, and often are even sacrificed for additional gain.

This is in contrast to the design of large radar arrays and radio telescopes where control of side and back lobes is the primary design objective to assure the best possible performance.

However, the scope of the interference problem became glaringly apparent following a national field survey of reception conditions by Channel Master engineers in late 1970. This led to a design project which had, as its *principal objective*, the development of a TV antenna with a higher Interference Rejection Factor (IRF) than ever before attained. High gain, of course, remained a major objective, but was not to be achieved by any sacrifice of IRF. The project was completed in the spring of 1972 with the successful development of the Channel Master "Quantum" antenna.

The IRF is defined as the ratio of an antenna's *maximum* sensitivity normally the front) to its *average* sensitivity in the rear 180° sector. The peak IRF of high-gain antennas to date has been 15 to 18 dB. The Quantum antennas (there are eight VHF/UHF/FM models and seven VHF/FM models) have an average IRF of 25 dB, and they go as high as 35 dB. Remember, they are high-gain antennas designed from scratch to eliminate rear and side interference.

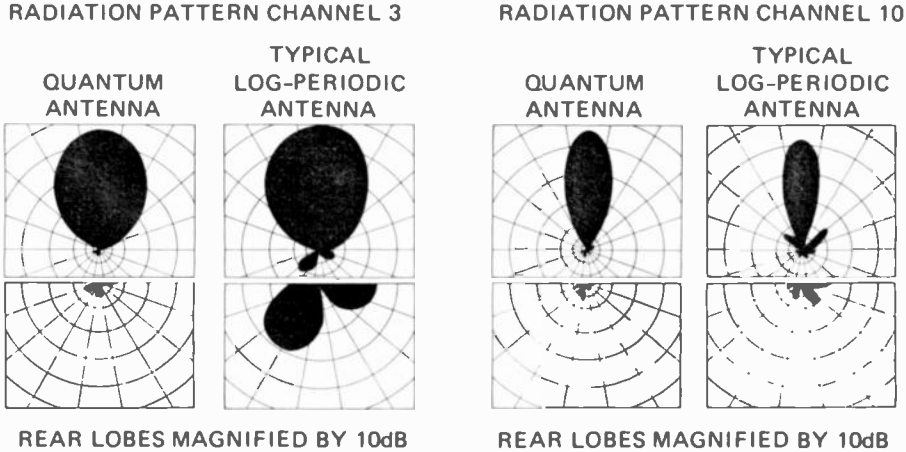
In a reception area where the predominant interference originates at the rear or sides of the antenna, a 10 dB improvement in signal-to-noise ratio occurs: *note that this is equivalent to a 10 dB increase in antenna gain.*

The importance of this concept cannot be over-emphasized. In many deep-fringe reception situations, eliminating interference by an antenna with improved IRF will bring about the same dramatic improvement in picture quality that technicians normally expect only from higher antenna gain. And in near-fringe and suburban areas, where the TV signal is usually ample, but where interference sources are numerous, the use of a high IRF antenna will usually elminate all signs of interference.

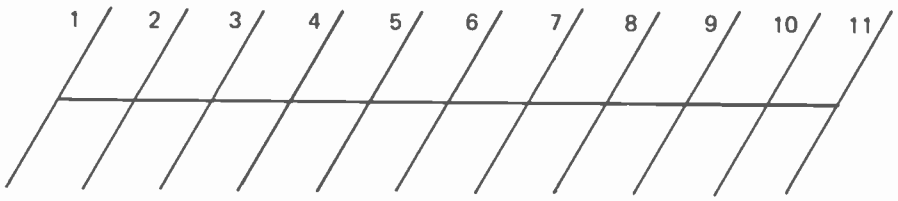
It is generally known that the "orchestration" of current distribution on the elements of an antenna determines its gain, bandwidth, and pickup patterns. Several years ago, Channel Master introduced the principal of Proportional Energy Absorption in its high-gain Crossfire. The impedance of each element was adjusted so that every driven element in the array absorbed approximately the same amount of current, since uniform current distribution was a key to high broadband gain.

However, equal current distribution does not produce the best possible front-to-back ratios. For the next step to occur, the state of the art had to await development of sophisticated new measuring equipment which permitted, for the first time, the application of Fourier Transform Theory to TV antenna design.

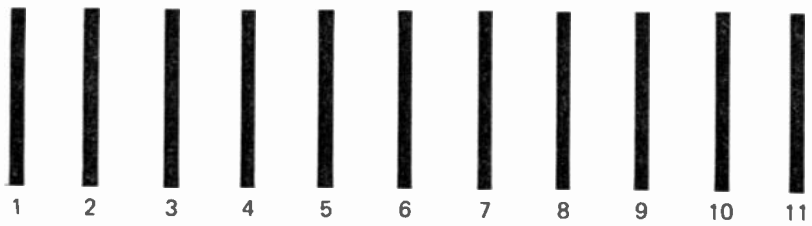
Fourier Transform Theory, widely applied in radio-telescopes and space communications, states that a *tapered*, symmetrical distribution of current over an antenna's elements will yield



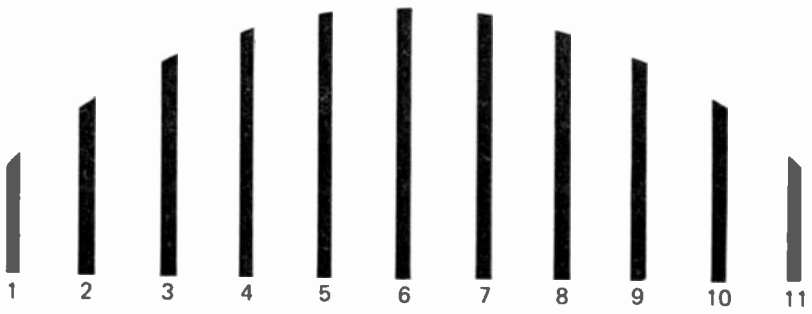
REAR-LOBE RESPONSE OF QUANTUM ANTENNA compared to a typical log-periodic on channels 3 and 10. Quantum has the best front-to-back ratio.



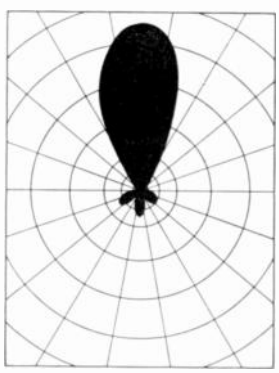
TYPICAL ANTENNA



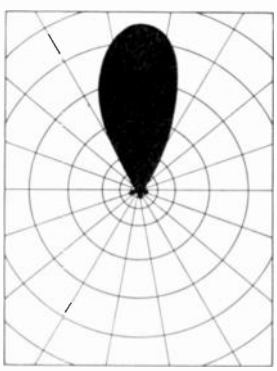
UNIFORM CURRENT DISTRIBUTION



TAPERED CURRENT DISTRIBUTION



Radiation Pattern
UNIFORM CURRENT



Radiation Pattern
TAPERED CURRENT

ANTENNA GAIN AND RADIATION PATTERN is determined largely by the amplitude and phase of the currents in the driven and parasitic elements. The Quantum antenna parasitic elements are designed for tapered current distribution which results in minimum pickup of signals arriving from directly behind and from the right-rear and left-rear sectors.

patterns with the smallest side and rear lobes.

The new instrumentation referred to above provided new insights into the functioning of TV antennas and a greater ability to measure currents precisely in both phase and amplitude. Advanced engineering also contributed to the maintenance of the symmetry and balance of the antenna system. As a result the Quantum antennas reach new performance levels in both IRF and gain.

There is another source of interference problems: transmission line pickup. In theory, the input impedance of the TV receiver is balanced; it does not respond to a signal present on both wires of a twin-lead transmission line. In practice, however, the balance is never perfect. This degrades picture quality, since interference signals induced on the twin lead appear on the picture tube. For this reason, about 10% of installations today use coax with a balun at each end.

There is an optional balun available for the Quantum, specially designed to fit into a terminal housing on the antenna crossarm.

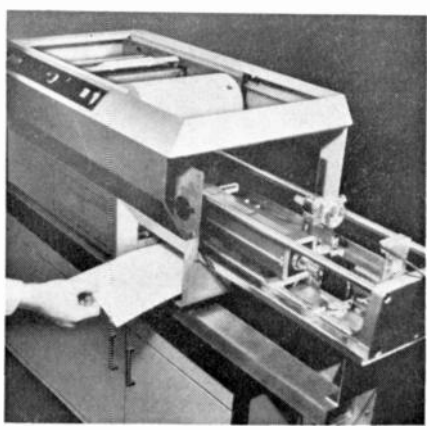
One source of interference is particularly difficult to eliminate—local FM transmission. The growing number of FM stations has made this a problem of major dimensions—especially in areas where the TV signals are weak. The effectiveness of the Quantum can be augmented in such situations with printed circuit FM trap, model 0091, that fits into the Quantum's terminal housing.

The Quantum is engineered to provide excellent FM reception, with the same high IRF as for the TV frequencies. There are 15 models in all, ranging from city-metropolitan to deep fringe. The 82-channel models feature an adjustable high-gain uhf antenna, mounted on the front end, that can be peaked for a range of selected channels in any reception area. The Quantum is a new generation of antenna. It is more signal-selective and sets new standards of color reception in every area. **R-E**

New high-speed laser printer operates with ultrasound

A non-impact experimental high-speed printer recently demonstrated by Zenith prints as fast as most computers can deliver the data. Operating at a rate of 5,000 lines a minute, it turns out four pages (64 lines of 132 characters each) in a second. Most printers work at about one-fourth of that speed, and their inability to keep up with the computer makes the printer a bottleneck in data processing.

The new machine can print on photo-sensitive paper or microfilm, with a resolution of 1,000 spots (almost



double the resolution of a home television receiver).

Information from a computer is converted into ultrasonic frequencies that control the brightness and the scanning of the laser beam. One ultrasonic signal modulates the beam; a second, by varying in frequency, causes it to scan (the higher the frequency, the greater the beam deflection).

The operation is entirely electronic—the only mechanical system in the printer is the transport that carries the paper at 90 feet a minute through the rapid dry-development process and delivers the pages to the operator. **R-E**

STATE-OF-SOLID-STATE

This month's selection of semiconductor devices is diverse and interesting. The more unique of these include a receiver in a 3-lead IC package and a digital alarm clock on a single IC chip.

by LOU GARNER

FROM THE REPORTS RECEIVED, MANY OF YOU were fascinated by the Lithic Systems' LP2000 microtransmitter IC discussed in February. In fact, a number of readers wondered why no manufacturer offered a comparable "receiver IC."

Actually, such a device is available, although designed to operate over a different frequency range than the LP2000. It's Ferranti's ZN414, a 10-transistor trf (tuned radio frequency) receiver IC assembled in a 3-lead TO-18 package and selling, in 1-4 quantities, for $5.00 each plus $0.50 for postage and handling. A detailed applications circuit booklet is offered by the U.S. subsidiary, Ferranti Electric, Inc. (East Bethpage Road, Plainview, N.Y. 11803).

The ZN414 consists of a high-impedance (4 megohm) input stage, several capacitively-coupled rf amplifier stages, and a transistor detector stage, as illustrated in Fig. 1. Requiring but six external components for operation as an AM broadcast band receiver or tuner, the device is suitable for use from 150 kHz to 3 MHz. It can be powered by dc sources from 1.2 to 1.6 volts (a single cell) and draws less than 0.5 mA. With a 1.3-volt dc source and a high-Q coil, the ZN414 has a threshold sensitivity of 50μV and can deliver a typical power gain of 72 dB. Its agc range is 20 dB. Selectivity is quite good for a single-tuned design and, according to the manufacturer, a 4-kHz bandwidth is possible with suitable coils.

Although the ZN414 can drive a sensitive earphone, the manufacturer suggests that the device be used in conjunction with an audio amplifier for greater sensitivity and power output, using an arrangement similar to the circuit shown in Fig. 2. The audio section may be as simple as a single transistor driving an earphone, a multistage complementary push-pull design, or an audio amplifier IC.

OOPS!

Have you ever considered the unemployment situation and economic chaos that could result if people stopped making mistakes? No longer would pencil manufacturers have to include eraser tips on their products. The "CE" key could be eliminated from electronic calculators, reducing the demand for these components. The manufacturers of erasers, correction fluid, and ink eradicators would face economic ruin. Supervisors would be hard pressed to find fault with their underlings and thus encourage them to greater efforts. Psychiatrists' offices would be jammed. Teachers would have to develop completely new grading systems. Editors would be frustrated. The world, in short, would totter on the brink of disaster.

Frankly, I wouldn't want to see all of this happen, so I manage to do my bit in avoiding such a catastrophe by making an occasional misteak (sic). Not deliberately, of course, and I try my best to avoid overdoing it (after all, others are helping), but one does manage to slip in from time to time.

My latest goof occurred in the June issue when I inadvertently described the Signetics ULN2111 FM limiter/detector IC as if it were a completely new device. This rather miffed my (former??) friend Sidney Chertok, Director of Information Services for the Sprague Products Company (North Adams, Mass. 01247), who wasted no time in letting me know that the ULN2111 was first introduced by Sprague some time ago, and, further, that Signetics was but one of several "second-sources" for the interesting and versatile device.

As Napoleon may have said after the battle of Waterloo . . . *c'est la vie!*

In any case, my personal apologies to Sprague, and, most of all, to my readers, for the boo-boo.

Tick-tock-tick-tock . . .

With single-chip calculator circuits a reality and available from several sources, and interest in electronic clocks booming, it was only a matter of time before someone introduced a single-chip digital clock circuit. The latest here is the MM5316, a complete self-contained digital alarm clock circuit capable of directly driving fluorescent tube or liquid crystal displays, announced recently by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, Calif. 95051).

As shown in Fig. 3-a, the MM5316 provides all the logic and decoding needed to assemble several types of clocks and timers, including 12- or 24-hour alarm clocks and desk clocks, clocks for radios and automobiles, stop watches, appliance timers, and industrial timers. The unit is a monolithic integrated circuit that uses both

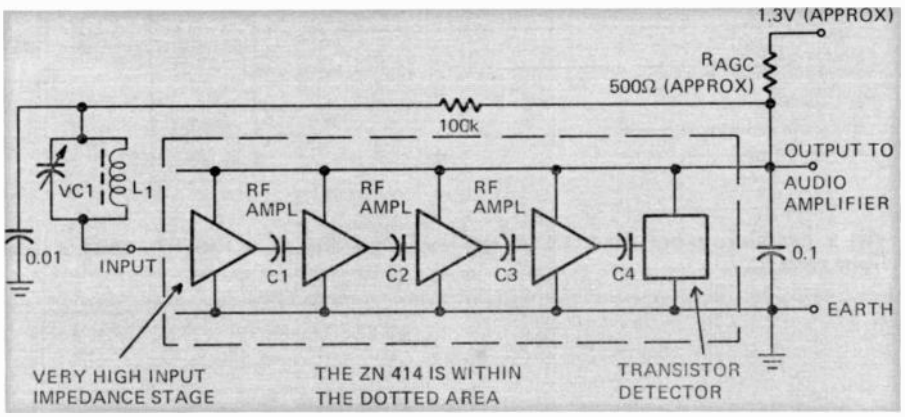


FIG. 1—FERRANTI'S ZN414 RECEIVER IC—Internal block diagram.

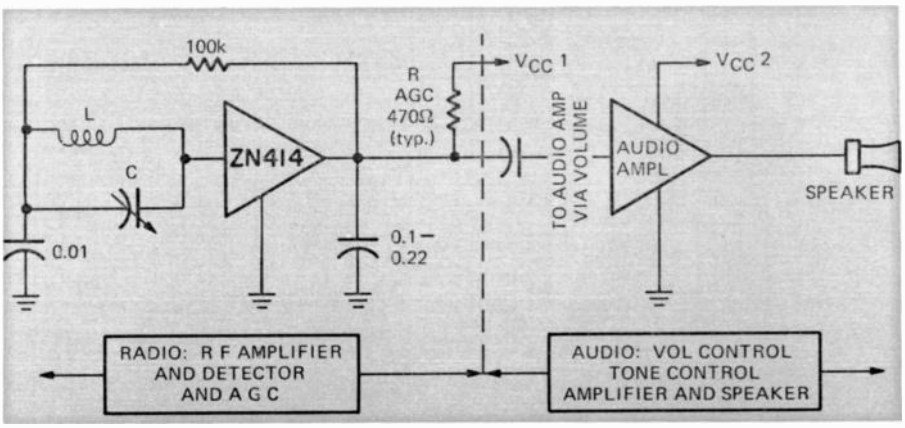


FIG. 2—TYPICAL RECEIVER BLOCK DIAGRAM for the ZN414.

low-threshold P-channel enhancement mode and ion-implanted depletion mode devices. It is supplied in a 40-pin plastic DIP, Fig. 3-b, and is designed to operate from 8- to 29-volt unregulated dc sources.

The MM5316's timekeeping function is triggered by either a 50 or 60-Hz input, with the display format either 12 hours with leading zeros suppressed and an AM/PM indication, or 24 hours. In addition, the device offers the user four possible display modes: 1) time in hours and minutes, 2) time in minutes and seconds, 3) alarm set time, and 4) sleep time. Outputs are provided for display drives, alarm enable, and sleep or timed radio turnoff.

In operation, a Schmitt trigger shaping circuit built into the MM5316 permits the use of a simple filtered sine wave at 50 or 60 Hz as the input signal, providing about 6 volts of hysteresis and driving the counter chain that performs the actual timekeeping function. Either 50 or 60-Hz operation is programmed via a single pin connection, while two other pins are used for fast and slow time and alarm setting.

Alarm operation is controlled by a comparator that senses the coincidence between the alarm counters (i.e., the alarm setting) and the time counters (real time). The comparator output sets a latch which turns on the alarm output driver. The latch remains set for 59 minutes, during which time the alarm sounds unless it is reset with the ALARM OFF input, or the SNOOZE ALARM input which temporarily inhibits the alarm for 9 minutes.

The MM5316 also contains an interval timer which can be set for up to 59 minutes. This may be used in clock radios, for example, to allow the user to fall asleep to music, with the radio shutting off after the preset interval. In desk clocks, the interval timer could be used to sound an alarm after a preset period to remind the user of an event, such as the end of a three minute phone call.

Abstracted from NSC's technical bulletin on the MM5316, a complete schematic diagram for a general purpose digital alarm clock using the device and a standard fluorescent tube display is in Fig. 4. An external alarm sound generator is required, of course, as well as an external control device

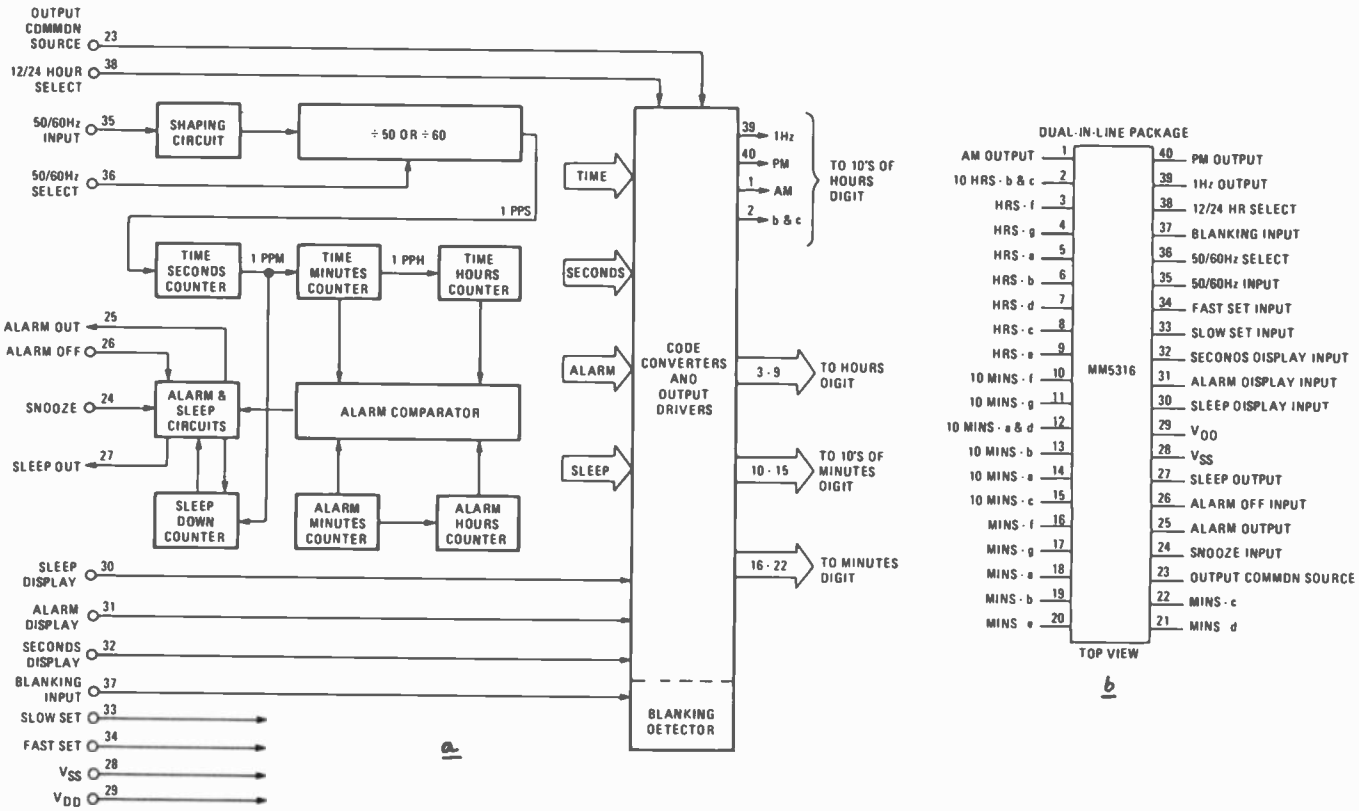


FIG. 3—INTERNAL BLOCK DIAGRAM (A) AND lead connections (B) of National's MM5316 digital alarm clock IC.

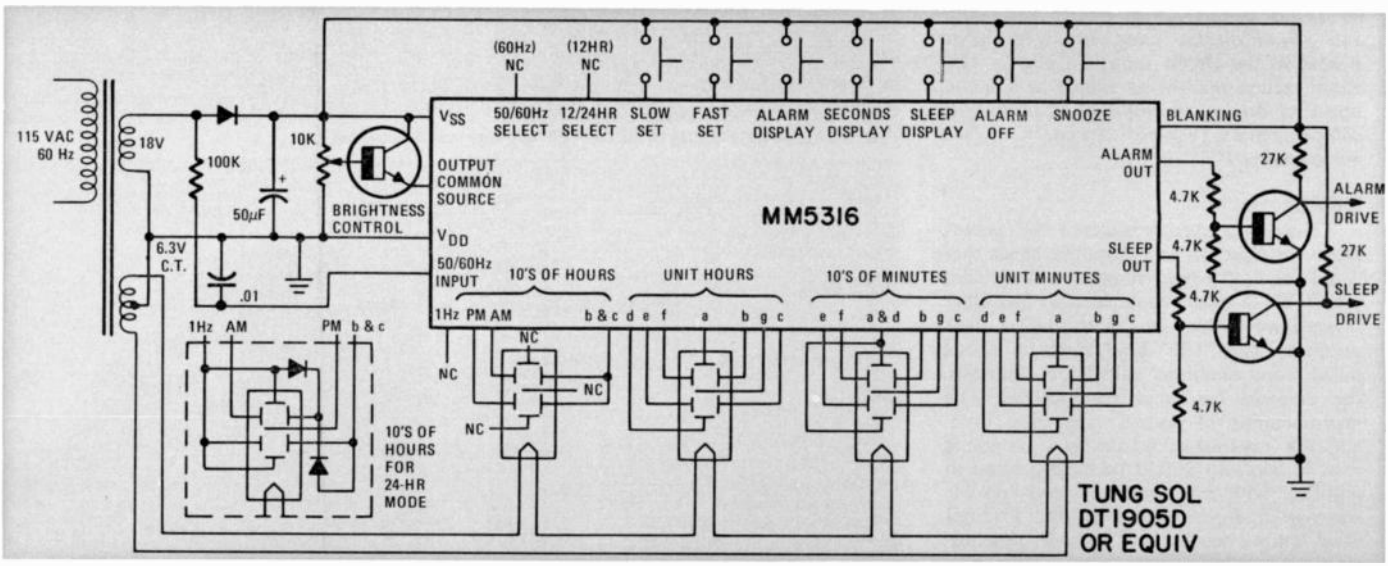


FIG. 4—COMPLETE SCHEMATIC DIAGRAM FOR a digital clock using the MM5316.

for "sleep" switch operation, should these features be desired.

Let there be light

Undismayed by continuing inflationary pressures, both Hewlett-Packard (1501 Page Mill Road, Palo Alto, Calif. 94304) and Motorola (P.O. Box 2953, Phoenix, Ariz. 85036) are doing their bit to hold down the prices of light emitting semiconductor devices. H-P initiated the fight against higher prices with their introduction of a LED priced at only 17 cents each in 100,000 lots, as reported in my May column. Motorola was not far behind with their announcement of a 10-cent LED (in 1,000,000 lot quantities). Now both have announced low-cost digital readouts.

H-P's offering, Fig. 5, is a 0.3-inch

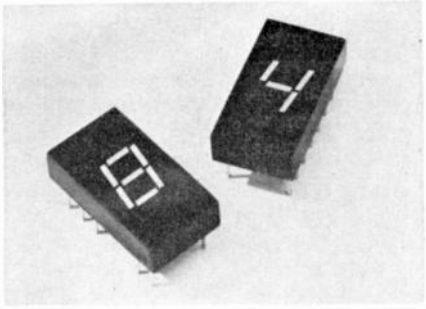


FIG. 5—H-P's NEW LED numeric displays are low cost.

high, seven-segment single-digit device in a DIP package. Their type 5082-7730 contains a left-hand decimal point, while type 5082-7731 features a right-hand decimal. Both displays are IC compatible.

Forward voltage per segment or decimal point is 1.6 volts; luminous intensity is typically 250 microcandelas per segment; typical operating current is 10 mA per segment when strobed. Each display makes use of but one LED per segment (eight in all), with a funnel-shaped "light pipe" used to stretch the light source optically to a bar five times the length of the LED chip.

Suitable for applications in calculators, TV sets, radio receivers, counters, test instruments, and digital clocks, H-P's new displays are priced at only $2.95 each in quantities of 1,000.

Recognizing that hobbyists and experimenters, too, are interested in low-cost digital readouts, Motorola's HEP Semiconductor group has introduced a four-device, seven-segment readout kit at a net price of only $9.98 per kit. This is equivalent to a price of less than $2.50 per readout device.

Designated the HEK-5 kit, the new HEP item includes a valuable booklet that contains basic information about readouts, their characteristics, applications, and capabilities, as well as a number of suggested "thought starter" projects. Complete parts lists and schematic diagrams for each project are featured in the booklet.

Product/device news

In addition to its digital alarm clock IC, described earlier, the National Semiconductor Corporation has introduced a number of other new devices, including a quad comparator, a one-chip calculator IC, and a family of solid state transducers.

Designated type LM359, National's new quad comparator, is the first comparator specifically designed for use with both CMOS and bipolar logic. It can operate over a wide range of power supply voltages . . . from 2 to 36 volts on a single supply, or from ±1 to ±18 volts on dual supplies . . . and requires only about 0.8 mA total current; with a 5 volt supply, the device draws only 1 mW per comparator.

Input offset voltage on all four comparators is typically 2 mV, with a guaranteed maximum of 5 mV at room temperature. Suitable for use as an interface between different logic levels or in interfacing sensors, such as those used in speed control systems and level sensing to logic circuits, the LM359 is offered in both plastic and ceramic 14-lead DIP's.

National's new calculator IC, type MM5725, is a complete 8-digit calculator on one MOS/LSI chip. It uses three registers to provide the four arithmetic functions—addition, subtraction, multiplication, and division—and also contains a 16-place decimal point register and self-contained oscillator and clock driver.

Calculations in the device are handled in floating decimal point for both entry and display, while internal timed key-bounce protection circuits permit the use of low-cost keyboards without affecting calculator performance.

The unit can be used with virtually any type of display, including LED's, Panaplex II neon readouts, and fluorescent display tubes. Designed for operation with a -28-volt and a -35-volt supply, the MM5725 is available in a 28-pin DIP.

Claimed to be the industry's first full family of IC transducers, National's new line is designed for applications in such industries as automotive, medical, altimetry and air data, computer peripherals, communications, air conditioning and refrigeration, heating and ventilation, food and chemical processing, hydraulics, numerical control, and process control.

Each device in the line contains in a single small package all four of the basic transducer elements—diaphragm and vacuum reference, piezoresistive sensor, signal discriminator and conditioner, and signal amplifier and processor. The first three functions are contained on a single die, the fourth provided by standard IC op amps. Various models are offered for measuring absolute, gage, and differential pressures.

Designed for complete rf amplifier or driver applications in uhf land mobile communications systems, two new amplifier modules have been introduced by Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, Ariz. 85036). Designated types MHW709 and MHW710, both hybrid units are intended for operation on 12.5-volt dc sources.

The MHW709 delivers 7.5 watts output with a driving power of approximately 100 mW for a power gain of 18.8 dB, while the MHW710, Fig. 6, supplies a full 13.0 watts with only 150 mW of driving power and a power gain of 19.4 dB.

Two versions of each model are offered, one covering the 400 to 440 MHz range, the second the 440 to 470 MHz band. Harmonic suppression is at least -40 dB down across the frequency range with all spurious outputs more than 70 dB below the desired signal. Input impedance is 50-ohms for both modules, and operation with a 20:1 load mismatch produces no damage to the units.

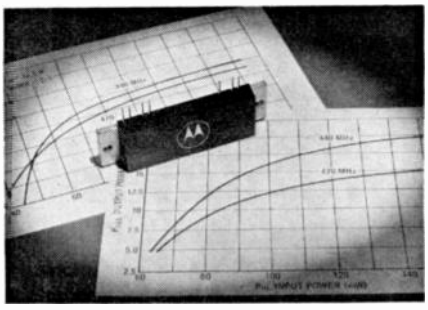


FIG. 6—MOTOROLA'S MODULAR uhf hybrid amplifier, type MHW710.

A new hf power transistor offered by the Amperex Electronic Corporation (Hicksville, N.Y. 11802) produces up to 150 watts in class, A, B, C, CW and SSB service up to 70 MHz with IMD≤-30 dB. Designated type BLX15, this new *npn* silicon planar transistor, is ruggedized against mismatch failures and offers a gain-bandwidth product of 300 MHz at collector currents as high as 10 amps. Intended for use in industrial, military and commercial applications, the BLX15 operates on 28 Vdc.

Meanwhile, back in the great southwest, Texas Instruments, Inc. (P.O. Box 5012, Dallas, Tex. 75222) has introduced a number of new devices, including a family of six optically-coupled isolators and a chopper-stabilized op amp IC.

TI's new opto couplers, identified as types TIL114 through TIL119, are supplied in 6-pin DIP's. Each coupler consists of a gallium-arsenide LED and a high-gain standard or Darlington phototransistor.

The TIL117, for example, has a minimum 50% current transfer ratio at a forward current of 10 mA. The TIL114 has a minimum 12.5% current transfer ratio at a forward current of 16 mA. The TIL115, TIL116, TIL118, and TIL119 are rated at 10 mA forward current with current transfer ratios of 2, 20, 6, and 300 percent.

Electrical isolation for the TIL114-117 is ±2.5 kV, while the TIL118 and 119 are rated at ±1.5 kV. The devices may be used as solid state relays, for circuit isolation, and as interface devices between systems, as well as for line driver/receiver applications.

Designated type SN62/72088, TI's new chopper-stabilized op amp, is believed to be the first of its kind to be integrated and made available in a standard 14-pin plastic DIP. The unit's characteristics include a 35-μV input offset voltage, a 130 dB voltage gain, a slow rate of 25V/μs, a small signal rise time of 65 ns/pe, and a low 0.6 μV/°C. offset voltage drift.

The SN62/-72088 comprises two IC chips encapsulated in a single package. One is a P-channel MOS chip, the other a JFET bipolar chip. Fabricated on the MOS chip are three linear amplifiers, a clock generator, multiple stages of flip flops, associated logic decoding, and MOS analog switches; this chip performs chopper control, synchronous demodulation control, and some sample and hold functions.

The second chip contains two amplifiers, with the main one an internally-compensated high-frequency wideband amplifier and the second an active low-pass filter which provides nulling of the main amplifier's offset voltage.

That concludes our look at the solid state field for now. **R-E**

CIE graduate builds two-way radio service business into $1,000,000 electronics company!

How about YOU? Growth of two-way transmitters creates demand for new servicemen, field and system troubleshooters. Licensed experts can make big money. Be your own boss, build your own company. And you don't need a college education.

Edward J. Dulaney, Scottsbluff, Nebraska, (above and at right) earned his CIE Diploma in 1961, got his FCC License and moved from TV repairman to lab technician to radio station Chief Engineer. He then founded his own two-way radio business. Now, Mr. Dulaney is also President of D & A Manufacturing, Inc., a $1,000,000 company building and distributing two-way radio equipment of his own design. Several of his 25 employees are taking CIE courses. He says: "While studying with CIE, I learned the electronics theories that made my present business possible."

Two-way radio is booming. There are already nearly seven million two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc., and Citizens Band uses. And the number keeps growing by the thousands every month. Who is going to service them? You can – if you've got the know-how!

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he's *licensed* by the FCC (Federal Communications Commission).

Another reason is that when two-way radio men are needed, they're *really* needed! A two-way radio *user* must keep those transmitters operating at all times. And, they *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

As a licensed man, working by the hour, you would usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses.

Or you could set up a regular monthly retainer fee with each customer. Your fixed charge might be $20 a month for the base station and $7.50 for each mobile station. Studies show that one man can easily maintain at least 135 stations – averaging 15 base stations with 120 mobiles! This would add up to at least $12,000 a year.

Be Your Own Boss

There are other advantages, too. You can become your own boss – work entirely by yourself or gradually build your own fully staffed service company. Of course, we can't promise that you will be as successful as Ed Dulaney, or guarantee that you'll establish a successful two-way radio business of your own, but the opportunities for success are available to qualified, licensed men in this expanding field.

How To Get Started

How do you break in? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC exam and get your Commercial FCC License.
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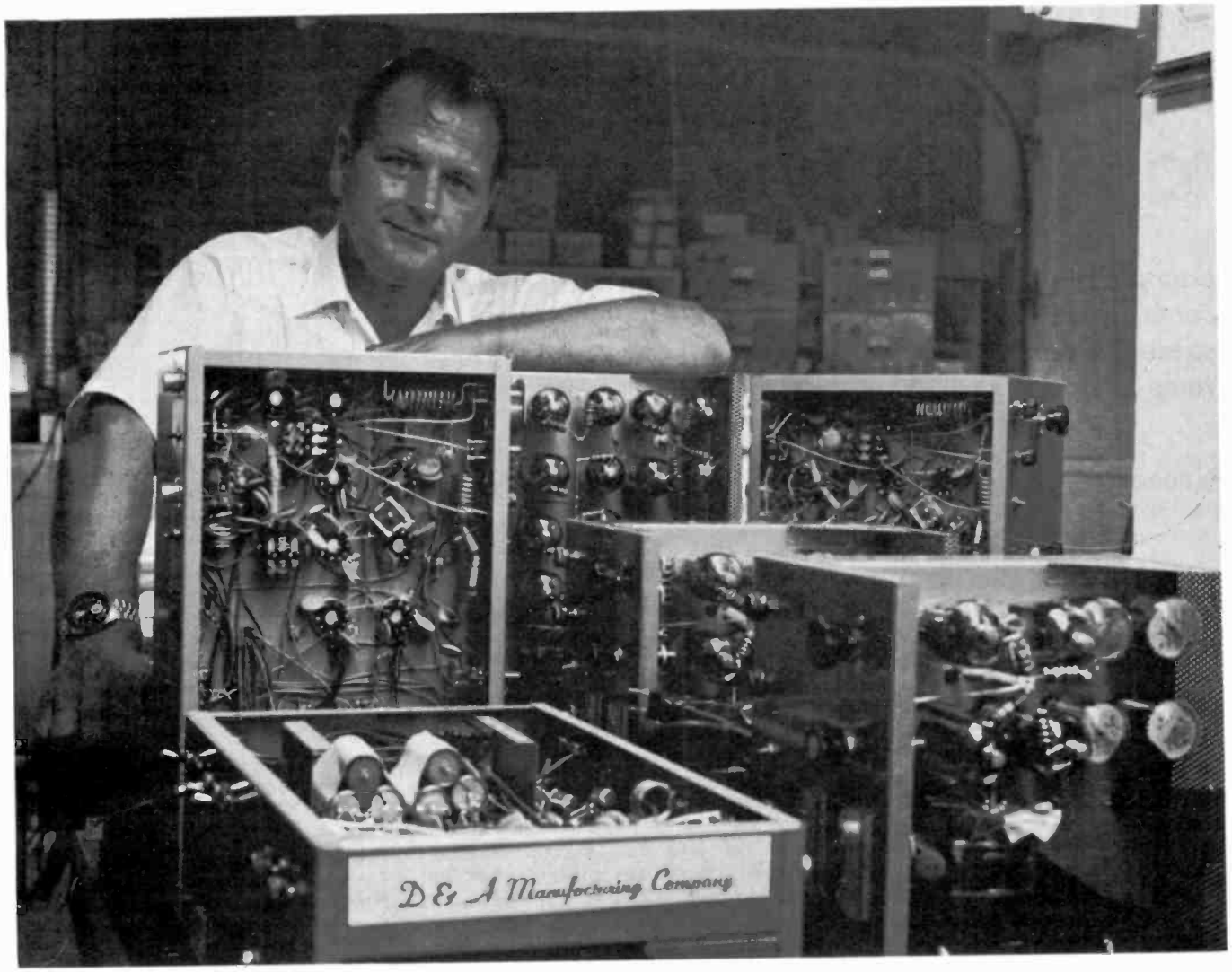

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RE-23

Circle 16 on reader service card

add voice actuation to your phone sentry

A simple and inexpensive adapter described in the June issue contains the control electronics that lets you use two cassette recorders as a phone-answering device. Here is how voice-actuation removes the time limit on the caller.

by ROGER L. SMITH

HERE'S A USEFUL ADDITION TO THE Phone Sentry automatic telephone answering machine (**Radio-Electronics,** June 1973). The original Phone Sentry circuit contains a 30-second monostable that times the recording of the incoming messages. With the addition of this voice-actuated circuit, your incoming message recorder will run for as long as the caller talks.

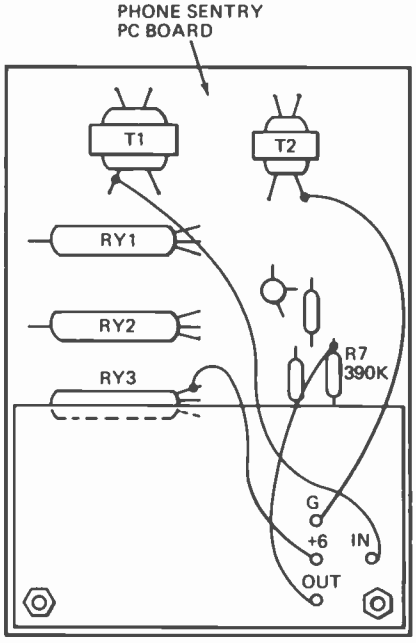
An advantage to adding this circuit (apart from recording long messages) is that it stops your recorder 6 to 8 seconds after the caller hangs up. Thus when you play back the messages, you have a maximum of 8 seconds of dial tone between messages. Since most callers leave only a short message, you will find this a welcome change and also you will be able to record more messages on less tape.

One word of caution. This voice-actuated circuit can't be used on all phone lines. You can quickly tell if your line will accept the circuit by picking up your receiver and listening to the dial tone for 30 to 40 seconds. If you hear nothing but dial tone for this time, or dial tone for 20 seconds and then silence, the circuit *can* be used on your line. On phone lines where a recording is heard after 20 seconds (asking you to dial again), or if an intermittent tone is heard (an out of order signal), then the circuit will *not* work. Also, if there is a high level of noise on your line, you will have difficulty with the circuit.

A feature of this circuit is that by simply disconnecting the output lead, you can restore your answering machine to the original 30-second operation. You could even put a switch in this lead if you expect to change locations in the future and you find you can't use the circuit.

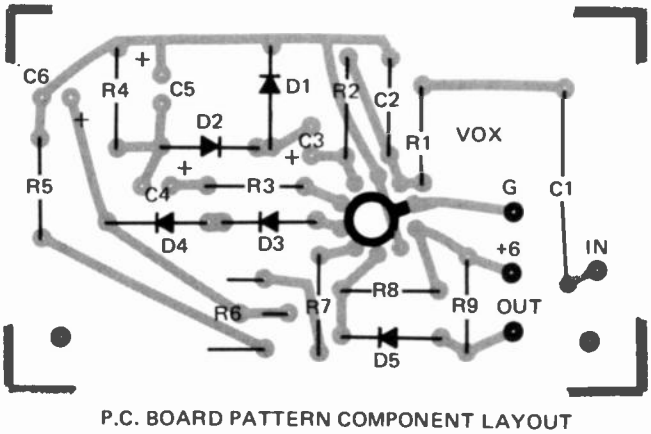
How to build it

Build up the circuit on a 2 x 3¼-inch board. You can use perf-board or



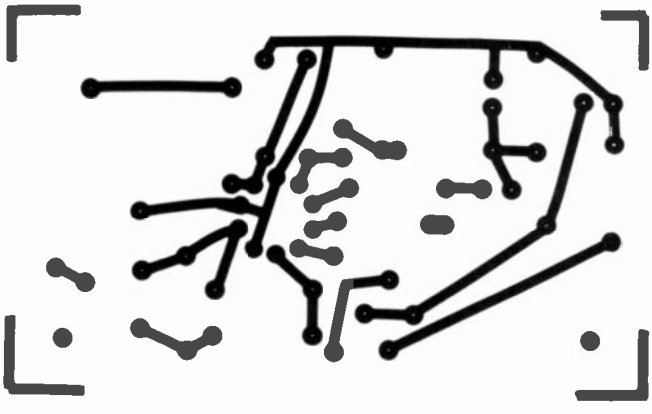
VOICE-ACTUATED BOARD MOUNTED ABOVE PHONE SENTRY BOARD

THERE IS ADEQUATE SPACE inside the Phone Sentry for the VOX circuit PC board.

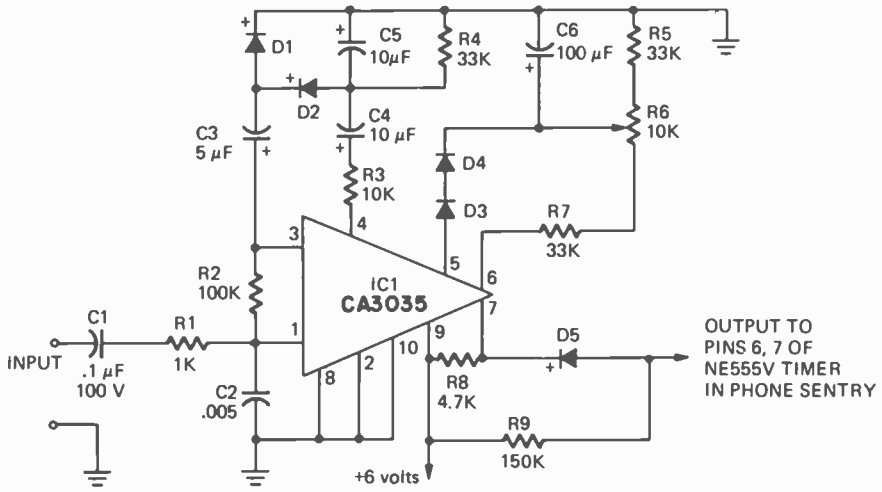


P.C. BOARD PATTERN COMPONENT LAYOUT

LAYOUT OF PARTS on the PC board used to add voice-actuation to the Phone Sentry. Diodes D1-D5 are ordinary 1-amp silicon devices



PC FOIL PATTERN is shown full-size. Trace or photograph it or use it as a model as you design your own board.



THE VOICE-ACTUATED (VOX) CIRCUIT is designed around an IC that contains an array of three ultra-high-gain wide-band amplifiers. Average gain per stage is about 44 dB.

PARTS LIST

All resistors ¼-watt 10% unless noted
R1—1000 ohms
R2—100,000 ohms
R3—10,000 ohms
R4, R5, R7—33,000 ohms
R8—4700 ohms
R9—150,000 ohms
R6—10-ohm trimmer control
C1—0.1μF, 100V
C2—.005μF
C3—5μF, 15V electrolytic
C4, C5—10μF, 15V electrolytic
C6—100μF, 15V electrolytic
D1 thru D5—1A silicon diodes
IC1—CA3035 integrated circuit (RCA)
Circuit board, hook up wire and mounting hardware as required
NOTE: A circuit board is available for $2.25. A kit of all of the above parts can be obtained for $9.95 (plus postage) from Southwest Technical Products Co., 219 W. Rhapsody, San Antonio, Tex. 78215

the foil pattern shown in this article. Watch capacitor and diode polarities and don't overheat leads. Mount the board by two corners with ¾-inch spacers and ¼-inch 6-32 screws directly above the board in the Phone Sentry (over the end nearest IC1). Four 6-inch leads are necessary to connect up the board. Follow the diagram for their connections.

After you have installed the board, you will have to make some final adjustments. Adjust R6 (10,000-ohm trimmer) so the output (pin 7) will go high when there is no input signal. Also, you may have to change the value of R1 to alter the gain of amplifier 1. This would only be necessary if you had a noisy line; so do not make this change unless you have to.

How it works

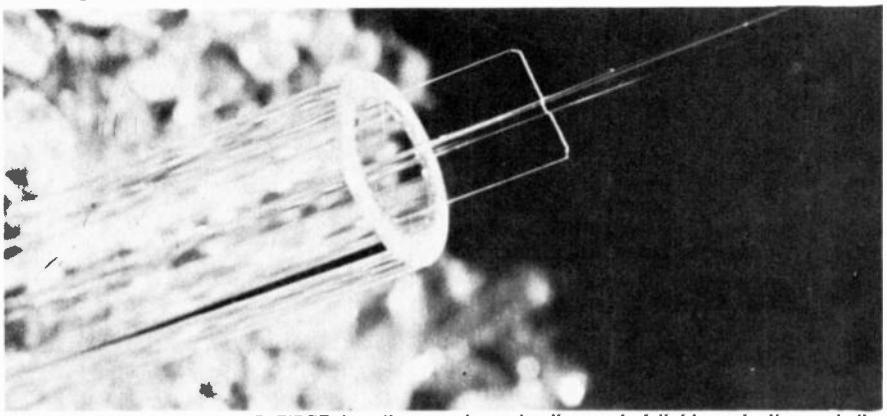
The signal from the phone line is coupled thru a 0.1-μF, 100-volt capacitor to pin 1 of the CA3035 amplifier (do not use a lower voltage capacitor for C1). The CA3035 contains three separate amplifiers. The output of the first amplifier (pin 3) is ac coupled to diodes D1 and D2. The rectified signal appearing across R4 is coupled thru C4 and R3 to amplifier 2 (pin 4). This ac coupling means that a steady tone signal (dial tone) or silence will generate no output from the second amplifier. Only variable signals such as voice signals are amplified. The output of amplifier 2 (pin 5) is rectified by D3 and D4 (two are required to give the proper dc level shift), and filtered by capacitor C6. This final dc signal is then coupled to amplifier 3 which is used as an inverter and as isolation.

When voice signals are present at the input of the circuit, the output (pin 7) is held low. Since this output is coupled to the timing capacitor of the NE555v thru D5, the timing capacitor will not charge up and the NE555v will net "time out." When the input signal is a steady tone signal or silence, the output (pin 7) rises toward +6 volts and the timing capacitor is allowed to charge up. Resistor R9 (150,000 ohms) is in parallel with the 390,000-ohm resistor in the Phone Sentry timing circuit, so this reduces the charging time from 30 seconds to about 8 seconds. **R-E**

electronic news

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.

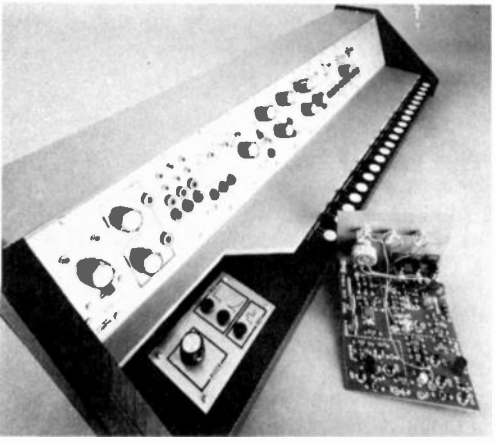
Three Bell scientists, S. E. Miller, E. J. Marcatili and P. Kaiser, selected a glass that showed a very low transmission loss as an unclad fiber. Then they developed a unique configuration that made it possible to form the glass into an optical fiber without any additional materials. One design has three 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, which is the optical conductor.



THE NEW LIGHT-CARRYING FIBER has three main parts: the central light-conducting rod, the flat plate or partition that supports it and the outer glass tube that protects it.

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.

The excellent light conduction (losses of 5 dB per kilometer) would make it possible to space signal amplifiers farther apart than in land cable systems now in use, and scientists are looking ahead to the day when such glass fibers, packed into cables perhaps a quarter inch thick, may carry as many signals as thousands of the present telephone wires.



Now that you have your synthesizer completed you must be ready to start playing it. Here's the instructions you will need to get started

Using the SYNTHESIZER

by JOHN S. SIMONTON, JR.*

IF YOU'VE BEEN FOLLOWING THE development of the **Radio-Electronics,** synthesizer (May, June, July, August, September, 1973) it's a good bet that after the last article you spent a couple of weeks plugging cables and pushing buttons. In the process you probably discovered that you could make some pretty interesting noises with the gear even if you didn't understand exactly why. This month we're going to fill in the why's and try to cover some of the not-so-obvious how's.

Since the greatest part of understanding any new field is learning the vocabulary we'll begin with preliminary definitions of *pitch* as the dominant frequency of a sound, *dynamics* as the time varying intensity changes of a sound and *tibre* as the time varying spectral changes of a sound (how the harmonic content varies with time.)

Notice that *pitch* was defined as the dominant frequency, not the fundamental frequency. The difference is mostly technical but still important from a musical standpoint. To the technician, the fundamental frequency of a waveform is by definition its lowest frequency component. To the musician, the dominant frequency is in all probability not the lowest, but the one that has the greatest impact on the listener. Because of his understanding of sound a musician will consistently refer to the subharmonics of a sound, whereupon the technician will probably begin to twitch and loudly proclaim that there's no such thing as a subharmonic.

The human ear is more sensitive to changes in pitch than any other musical parameter. Tuning is ordinarily expressed in "cents" with one cent being a frequency deviation equal to 1% of the interval between the note being tuned and the next highest note in the chromatic scale. Even an unskilled listener can spot a 3-cent change in pitch.

Finally, kind of a reverse point regarding pitch is that not all musically interesting sounds have it. Unpitched "noise" is composed of all frequencies and is typically generated by such non-resonant mechanical systems as the wind, surf, explosions, etc. When noise is used to excite a resonant system the result is "pink noise", a term that at one time denoted noise composed only of lower frequencies but lately is used to designate any bandwidth limiting. Noise will be covered by examples in a later part of this text.

In Fig. 1 we have drawn a line that represents the change in overall amplitude of a sound as a function of time. Radio engineers are familiar with modulation envelopes of radio frequencies. This is the modulation envelope of an audio frequency. There are an unlimited number of possible envelopes and each has it's own distinctive sound regardless of the pitch of the note involved. This is dynamics.

As it happens, Fig. 1 is an envelope

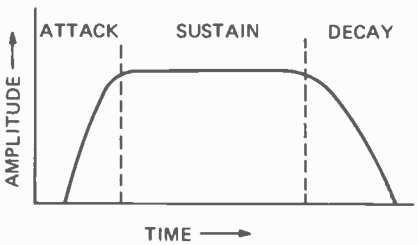


FIG. 1—WOODWIND SOUNDS have rapid attack and decay; sustain period is in between.

that would impart to the listener the feeling that he is hearing an instrument in the wood-wind family. These instruments are characterized by a moderately rapid rise in volume (attack), a steady period (sustain) followed by a moderately rapid return to zero output when the performer stops playing (decay.)

Instruments in the percussion family generally have an envelope similar to Fig. 2, characterized by very sharp attack followed immediately by an exponential decay. If the resonant member is a string as in guitar or piano the decay period can be quite long—on the order of seconds. The decay is relatively shorter if the resonant member is a steel bar as in vibes and very short if the resonant element is a tightly stretched membrane as in drums. In no case will a natural percussion instrument have a sustain period simply because the energy that causes the sound is applied in a single pulse—or possibly rapid succession of pulses.

One of the advantages that a synthesizer offers over conventional instruments is illustrated in Fig. 3. This envelope would be highly improbable in a natural instrument because it has the sharp attack of percussion followed by a sustain period typical of reeds or horns and the long decay found in percussion strings. Considerable skill on the part of the performer would be required to produce this envelope using a conventional instrument but with a synthesizer it's simple.

Function generator at work

In a synthesizer dynamics are handled by the combination of the function generator—which is often called an envelope generator—and the VCA (voltage-controlled amplifer). The attack and decay controls of the function generator are set to produce a time varying voltage that if viewed on the screen of an oscilloscope would look essentially the same as the envelopes shown in Figs. 1, 2 and 3. This voltage is then applied to the control inputs of the VCA. As the control voltage rises so does the gain and consequently the output of the amplifier. While the control voltage is constant the gain of the amplifier is constant and when the control voltage decays the output of the amplifier decays in a similar manner.

As a demonstration, connect the modules as shown in Fig. 4 with the function

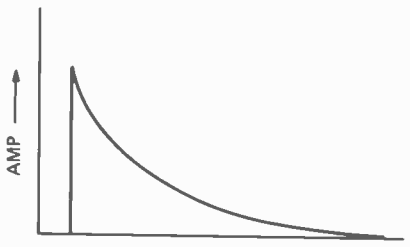


FIG. 2—TYPICAL TONE WAVEFORM produced by the attack and decay controls.

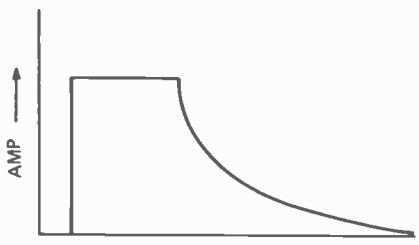


FIG. 3—INSTANT RISE, moderate sustain and logarithmic decay are possible with VCA.

(continued on page 62)

*President, PAIA Electronics, Oklahoma City, Okla.

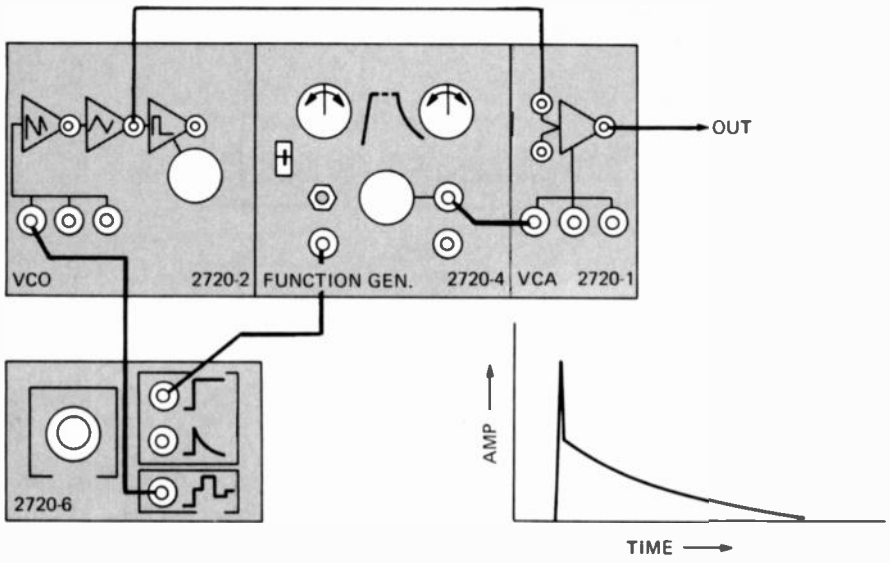


FIG. 4—WITH MODULES CONNECTED AS SHOWN the output of the function generator (see waveform) rises to its sustain level and remains there until the controller key is released.

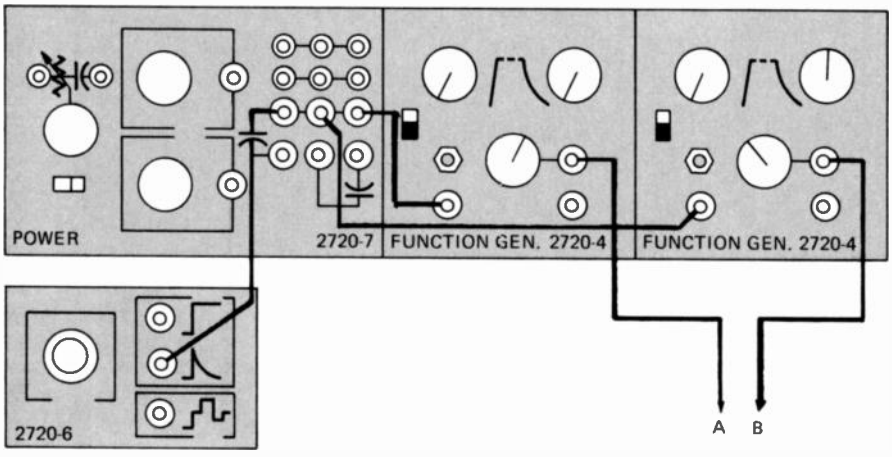


FIG. 5—TWO FUNCTION GENERATORS ARE CONNECTED as shown, to simulate certain percussive sounds. The resulting waveforms are determined by attack and decay settings.

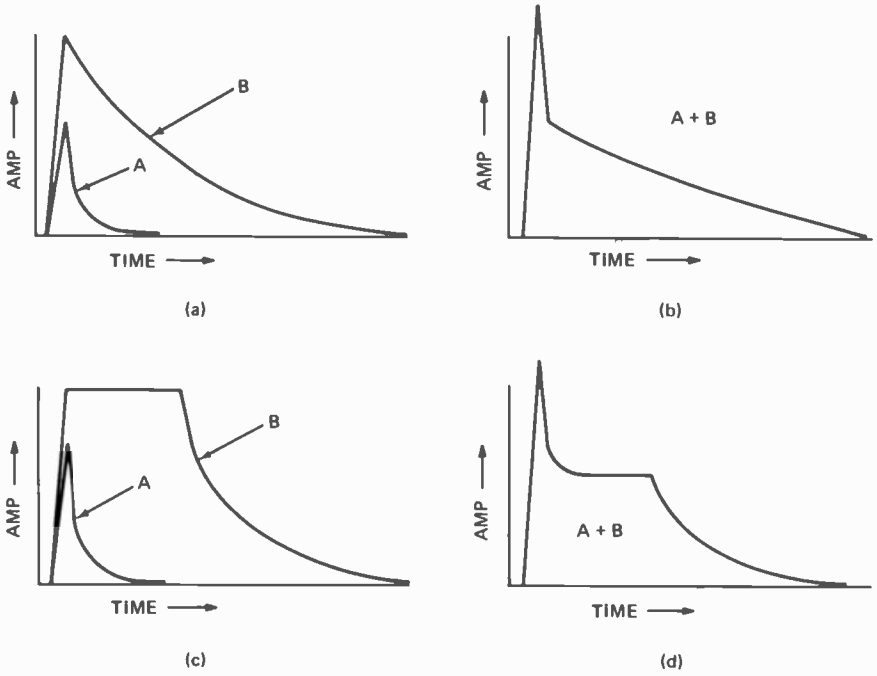


FIG. 6—HOW THE TWO FUNCTION GENERATORS, triggered by the common output of the controller are summed together to form the desired percussive waveform. Diagrams (a) and (c) show how the decay controls can be adjusted to develop various percussive effects.

generator being triggered from the controller's step output. (The operation of the controls for each module were covered in the first parts of this series. In the interest of brevity this information will not be repeated.) In this configuration the output of the function generator will rise to it's sustain voltage at a rate determined by the setting of the attack control, remain at that level as long as any one of the controller keys is held down and then decay at the rate determined by the setting of the decay control.

A little experimentation with the settings of the attack and decay controls will quickly show the importance of these parameters to the total effect that the sound produces. To completely eliminate the sustain portion of the envelope, switch the trigger input of the function generator from the controller's step output to it's pulse output. The short trigger pulse causes the function generator to cycle through the attack and immediately advance to decay.

Remember that we said that the arrangement of Fig. 4 could produce *almost* any imaginable envelope? Here's the exception. Fig. 5 shows a situation that is quite common for percussion instruments, it illustrates a case in which the instrument is played particularly hard. So hard that what can be thought of as an "overload" occurs, a short time during which the instrument is incapable of dissipating in a uniform exponential manner the applied energy.

As is shown by the envelope, the result is a brief time during which a large amount of energy is dissipated followed by the normal exponential decay. The function generator that we assembled doesn't provide for this type of envelope primarily because of cost but also because the envelope can be generated using two function generators with the added advantage of being able to, at other times, use the two modules separately. Our example illustrating this coincidentally makes a good point of the advantages of control voltage summation.

Fig. 6-a shows two function generators being triggered by the pulse output of the controller. Notice that **A** is set for the shortest possible decay while **B** is set for a significantly longer period. The outputs of these modules are routed to two of the control inputs of a single processing module—typically the VCA—where they are summed together to produce the equivalent envelope shown in Fig. 6-b.

If function generator **B** is triggered from the step rather than the pulse output of the controller the result is individual envelopes as shown in Fig. 6-c which sum together to produce another envelope that would be rare to the point of impossibility in a natural instrument.

There is one important point to note regarding multiple function generator arrangements and that is that the peak amplitude of the equivalent envelope is the sum of the amplitudes of the individual waveforms. For most of the equipment we've built this sum should not exceed the 5-volt design limit placed on control voltages. This same consideration also applies to any multiple control voltage situation.

How to add timbre

As important as pitch and dynamics are, they pretty obviously don't account for all the differences between the sounds of

various instruments. For example, the trumpet and French horn are both brass instruments with approximately the same attack, sustain and decay characteristics. They even overlap in pitch range but there would be little danger of mistaking the blaring, brassy sound of the trumpet for the muted, mellow tones of the French horn. The difference between the two is what we ordinarily call timbre and as was stated earlier, differences in timbre are essentially differences in the harmonic structure of the sound the instrument generates.

Since any imaginable waveform can be constructed by summing together sine waves of the proper frequency, amplitude and phase, the most obvious way to impart timbral differences to an electronic musical instrument is to get a bunch of oscillators going and sum their outputs together as needed to produce the desired waveform. This technique is known as frequency synthesis and is most often employed in electronic organs. Fig. 7 shows the result of summing a fundamental with its half amplitude second harmonic to produce the wave form shown by the solid line.

Mother Nature has developed a different method that she uses in what is probably the most versatile of all synthesis systems, the human voice. Most electronic music synthesizers employ the same technique, known as formant synthesis.

In formant synthesis the starting point is not a group of oscillators producing precisely time-related sine waves but a single oscillator that is cranking out a waveform rich in harmonics from the start. Rather than adding in sine waves as needed to produce a given voice, component frequencies are removed from the source as needed.

As an example, Table I gives the harmonic content of the three common waveforms that our VCO produces; ramp, triangle and square wave. Referring back to the wave in Fig. 7 again and comparing it to Table I we quickly see that if we remove all of the harmonics above the second that are present in a ramp the result will be the same as summing together a fundamental and it's second harmonic. Granted, this is a specially chosen, simple example but the basic principle applies to any waveform.

Some people will read that last paragraph and disagree because of the phase differences that cause one waveform to look entirely different from another even though the harmonic contents are identical. The answer to that is that as far as the sound produced is concerned constant phase differences have no effect. As evidence of this we offer the fact that a sawtooth that ramps up as time goes on sounds the same as one that ramps down even though the phase differences between the harmonics are as great as any you'll find. We can further state that phase differences cannot be heard unless they are changing in which case they are perceived as an apparent frequency shift.

Filters on the job

To use formant synthesis there must be some way of eliminating those unwanted harmonics and this is where our filters come in. Probably neither of the filter types we've built needs any explanation but briefly, the band-pass filter allows for attenuation of frequencies outside of a given frequency band while the frequencies within the band are passed without alteration. In our filter the "Q" (how well the filter does it's job of attenuating out-of-band signals) is adjustable with a front panel control while the sum of the input control voltages determines the center frequency of the filter. Likewise, the low-pass filter attenuates all frequencies above the frequency of interest while allowing frequencies below that point to pass unaltered. In our low-pass filter increasing the control voltage simultaneously lowers the cut-off frequency and increases the rate at which higher frequencies are attenuated.

Due to space limitations we will leave the more subtle uses of the filters to the experimental discovery of the user and concentrate instead on some of the more spectacular effects that can be achieved. Fig. 8 shows a module arrangement that for lack of a better name we will call the "automute" connection. The arrangement is such that the control voltage from the keyboard sets the pitch of the oscillator while either of the controller trigger outputs (pulse works better than step) are used to key the function generator. As in the previous example the function generator output controls the VCA to provide appropriate attack and decay times. Unlike the previous example, however, the output of the VCO is routed through the band-pass filter before it passes through the VCA. The filter is also

(continued on page 88)

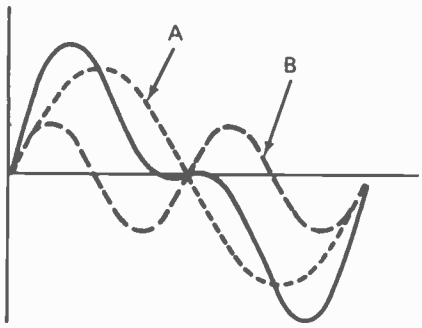


FIG. 7—SUMMING A FUNDAMENTAL with its half-amplitude second harmonic produces the waveform shown by the solid line.

TABLE I

harmonic \ wave	triangle	ramp	square
fundamental	$8/\pi^2$	$2/\pi$	$4/\pi$
2nd	— —	$1/\pi$	— —
3rd	$8/9\pi^2$	$2/3\pi$	$4/3\pi$
4th	— —	$1/2\pi$	— —
5th	$8/25\pi^2$	$2/5\pi$	$4/5\pi$
6th	— —	$1/3\pi$	— —
7th	$8/49\pi^2$	$2/7\pi$	$4/7\pi$
8th	— —	$1/4\pi$	— —
9th	$8/81\pi^2$	$2/9\pi$	$4/9\pi$

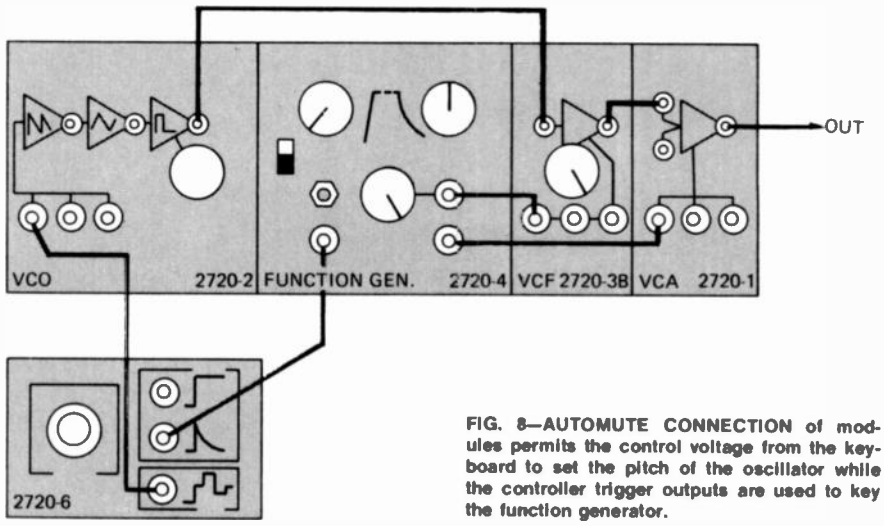


FIG. 8—AUTOMUTE CONNECTION of modules permits the control voltage from the keyboard to set the pitch of the oscillator while the controller trigger outputs are used to key the function generator.

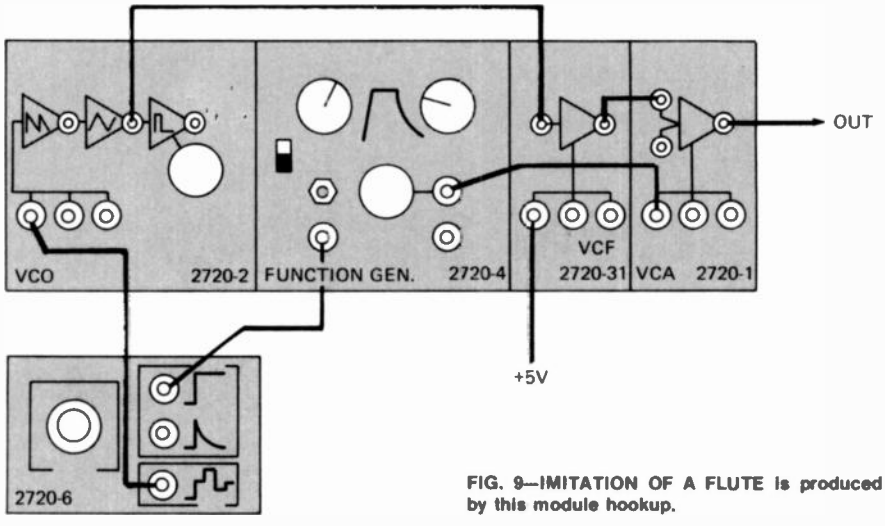


FIG. 9—IMITATION OF A FLUTE is produced by this module hookup.

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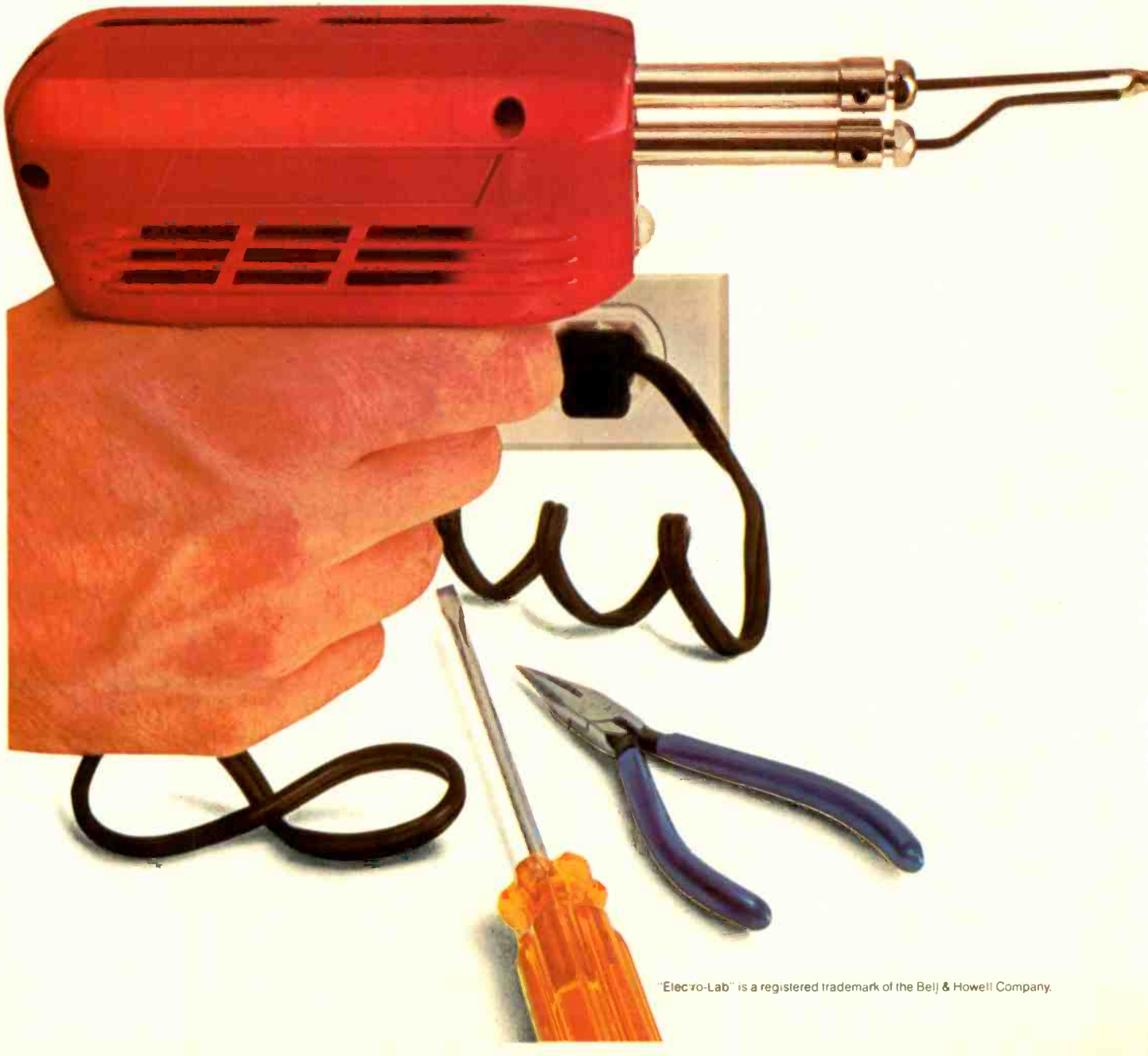

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Your color TV project is probably the best way for you to learn the most advanced "state of the art" concepts of sophisticated electronics circuitry. It's part of a complete at-home learning program prepared by skilled instructors at Bell & Howell Schools. Mail the postage-free card today so that our representative can bring you all the facts at no obligation.

It doesn't matter if you've never had any training in electronics before. Nobody's going to start throwing "diodes" and "capacitors" at you right off. You start with the basics. You take it one step at a time. You walk before you run. And you'll be amazed at how quickly you start to feel comfortable with things that seemed complicated at the beginning.

Attend special "help sessions" if you like

In case you run into a sticky problem—or you want to discuss your project with an instructor—come in and see us. We've scheduled special "help sessions" regularly at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Drop by. Meet an expert instructor in person. Talk over any rough spots with him—and with other students. You'll enjoy the chance to "talk shop."

Master the most up-to-date solid-state circuitry

Solid-state is here to stay. Not just color TV but almost every type of electronic device will eventually move farther and farther in the direction of *total* solid-state circuitry. Get to know the most advanced "trouble-shooting" techniques for these sophisticated circuits. You'll find an almost irresistible demand for your skills.

Why you *should* know electronics

No matter where you look, the amazing technology of electronics is becoming a bigger and bigger part of the picture. More and more automotive parts and diagnostic instruments are electronic. Many large manufacturing plants use sophisticated electronic systems—controlled by a few skilled electronics technicians. The increasing use of two-way radio . . . the huge promise of cable television . . . the astonishing growth of electronic data processing all open doors to exciting new career opportunities for the man with thorough training in electronics. In fact, the day may come when the man who does *not* have electronic skills will be severely handicapped in many industries.

Why you should get your training from Bell & Howell Schools

Skilled instructors at Bell & Howell Schools—carefully selected for their knowledge, experience and teaching ability—plan each program with the utmost care and attention. Each year, they spend over $200,000 improving programs to keep them up-to-date with the latest technology. Many Bell & Howell Schools graduates have used their home study training to get started in exciting new careers or businesses of their own in electronics. You could too!

With your first lesson you get...

. . . the Laboratory Starter Kit! A volt-ohm-meter (VOM) with design panels, modular connectors, experimental parts and battery power source. Gives you *immediate* "hands on" experience with your very first lesson.

You also build and keep the exclusive Bell & Howell Schools Electro-Lab® electronics training system

To make sure you get practical experience with instruments used daily by professionals, you build yourself a Design Console, an Oscilloscope and a Transistorized Meter (see details at right). These are the three instruments you'll work with constantly—both during your program and thereafter.

CONSIDER THESE ADVANTAGES:

Help Sessions We've scheduled special "help sessions" regularly at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Top instructors give you expert advice and you meet other students, too.

National Career Placement Center

When you complete your course, we will help you in your search for a job in a field of electronics that fits your background and interests. Although we cannot guarantee jobs to our graduates, this placement service is available at *any* time after you graduate.

Veterans' Benefits We are approved by the state approval agency for Veterans' Benefits. Check the box for details.

Student Financial Aid We are an eligible institution under the Guaranteed Student Loan Program. Check the box for details.

Detach postage-paid reply card and mail today for Free Information!

25-inch picture (measured diagonally)

■ **Bell & Howell Solid-State 25-inch color TV.** Ultra-rectangular tube . . . 25-inch picture measured diagonally . . . full 315 square inch viewing area. Solid-state modular circuitry . . . 4 advanced IC's . . . 100 transistors . . . 72 diodes . . . individual plug-in circuit boards. Special UHF/VHF tuning features . . . built-in self-service components.

■ **Design Console** Use this to rapidly "breadboard" circuits without soldering. Equipped with built-in power supply . . . test light . . . speaker . . . patented plug-in modular connectors.

■ **Oscilloscope** Portable 5-inch wide-band oscilloscope offers bright, sharp screen images . . . calibrated for peak-to-peak voltage and time measurements . . . 3-way jacks for leads, plugs, wires.

■ **Transistorized Meter** Combines most desired features of vacuum-tube voltmeter and quality multimeter. Registers current, voltage and resistance measurements on a large, easily-read dial. Features sensitive, 4-inch, jewel-bearing d'Arsonval meter movement.

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R-E's Service Clinic

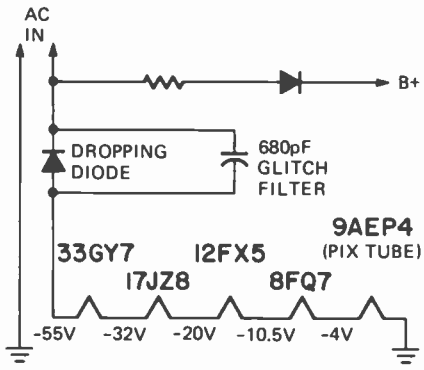
A dropping diode—what is it?

A diode is a cool substitute for a filament resistor

JACK DARR
SERVICE EDITOR

WHAT IN THE WORLD IS A "DROPPING diode"? Just what it says. A diode connected in series with the heater string of a hybrid TV set—the kind with four or five tubes, in the high-power stages. You might say it's a "heater rectifier", and in fact, it's marked FIL RECT in some Sams Photofact schematics. True, in a sense. Actually, it looks to me as if it's used to drop the ac line voltage to about half normal. One case of this is in RCA's KCS-176A portable chassis.

The use of these can lead to some confusion, and some funny voltage readings, if we're expecting them. The heater circuit is in the diagram. Here,



THE DIODE RECTIFIES half of the input sinewave, reducing effective voltage to half.

we're not rectifying ac to get dc. in the regular sense; note that there aren't any filter capacitors on the load-side. What is happening here is that the rectifier is cutting off one half of each sinewave. (Doesn't matter which half; happens to be the positive halves.) So, we get approximately "half-power." The *heating effect* of the current is reduced, referred to full-wave ac.

This gives us some unusual readings if we use our regular rms-reading ac voltmeters. Note the voltages shown along the heater string. The 33GY7 for example shows 55 volts on one side and 32 volts on the other; total (55-32) = 23 volts! Yet, the tube works. Note that these voltages are read with a *dc voltmeter;* it shows -55 volts, etc. The normal ac drop across the heater string adds up to 76 volts, but we see only -55 volts at the input. The "heating-effect" of the half-wave rectified ac is enough to get the cathode up to the correct operating temperature.

We set up an experiment, using a 33GY7 tube, in a tube-tester, on an adapter. Setting the heater at the rated voltage we got the readings shown in the table. We used a standard vom, a FET vom and a digital vom. On ac volts, the readings were correct. Then, one side of the heater was opened, and a standard silicon rectifier diode was connected in series. The heater voltage was not changed.

TABLE OF MEASUREMENTS
33GY7 tube, in test adapter, in tube-tester. Heater set to 33 volts ac.

METER	Set on ac volts.
VOM	33V
FETVOM	33V
DVM	34.1V
With diode in series, one side of heater.	
METER	Set on ac volts
VOM	15V
FETVOM	18V
DVM	18.6V
METER	Set on dc volts.
VOM	15V
FETVOM	18V
DVM	14.88V

(Polarity of reading depends on how diode is connected; unimportant)

Now look at the readings! On ac volts, we get roughly half the applied voltage, which makes sense. Setting them on dc volts, we got about the same readings. (Oddly enough, the *emission* of the tube didn't seem to go down too much. Perhaps I didn't wait long enough for the cathode to cool down; tests took only about 3 minutes.)

(continued on page 71)

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.

R-E's Transistor Substitution Guide

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N1729	NA	NA	GE-53	NA	TR-05	PTC 102	HEP-629	SK 3005	RT-118	ECG 100	NA
2N1730	RS276-2002	T-641	GE-54	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1731	RS276-2004	T-353	GE-53	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	ZEN 304
2N1732	RS276-2001	T-641	GE-54	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1742	RS276-2003	T-3	GE-9	ICC-3	NA	PTC 102	HEP-3	NA	NA	ECG 160	ZEN 301
2N1743	RS276-2004	T-253	GE-9	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	ZEN 304
2N1744	RS276-2004	T-253	GE-9	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	ZEN 304
2N1745	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	ZEN 301
2N1746	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	SK 3006	NA	ECG 160	ZEN 301
2N1747	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	SK 3006	NA	ECG 160	ZEN 301
2N1748	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1749	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1750	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	SK 3007	NA	ECG 160	ZEN 301
2N1751	NA	NA	NA	NA	NA	NA	NA	NA	RT-147	ECG 179	NA
2N1752	NA	T-2	GE-51	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N1753	NA	T-2	GE-1	ICC-2	TR-17	PTC 109	HEP-2	NA	NA	ECG 160	ZEN 300
2N1754	NA	T-2	GE-9	ICC-2	NA	PTC 107	HEP-2	SK 3005	NA	ECG 160	ZEN 300
2N1755	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1756	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1757	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1758	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1759	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1760	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1761	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1762	NA	NA	GE-3	NA	NA	PTC 105	NA	SK 3009	RT-124	ECG 104	NA
2N1763	RS276-2009	T-53	GE-18	ICC-53	NA	PTC 123	HEP-53	SK 3124	RT-100	ECG 123	ZEN 102
2N1764	RS276-2009	T-50	GE-20	ICC-50	TR-22	PTC 136	HEP-50	SK 3024	RT-114	ECG 128	ZEN 100
2N1765	NA	NA	NA	NA	NA	NA	HEP-R1307	NA	NA	NA	NA
2N1768	NA	NA	GE-66	NA	NA	NA	HEP-S5003	NA	NA	NA	NA
2N1769	NA	NA	GE-66	NA	NA	NA	HEP-S5000	NA	NA	NA	NA
2N1770	NA	S-300	NA	ICC-300	NA	NA	HEP-R1241	NA	NA	NA	NA
2N1771	NA	S-300	NA	ICC-300	IR-1771	NA	HEP-R1241	NA	NA	NA	NA
2N1772	NA	S-302	NA	ICC-302	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1773	NA	S-302	NA	ICC-302	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1774	NA	S-302	NA	ICC-302	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1775	NA	NA	NA	NA	NA	NA	HEP-R1306	NA	NA	NA	NA
2N1776	NA	NA	NA	NA	IR-1776	NA	HEP-R1306	NA	NA	NA	NA
2N1777	NA	NA	NA	NA	IR-1777	NA	HEP-R1307	NA	NA	NA	NA
2N1778	NA	NA	NA	NA	IR-1778	NA	NA	NA	NA	NA	NA
2N1779	RS276-2002	T-641	GE-6	ICC-641	TR-10	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1780	RS276-2002	T-641	GE-5	ICC-641	TR-10	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1781	RS276-2002	T-641	GE-5	ICC-641	TR-10	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1782	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 109	HEP-3	SK 3005	NA	ECG 160	ZEN 301
2N1783	RS276-2003	T-641	GE-1	ICC-641	TR-10	PTC 109	HEP-641	SK 3005	RT-119	ECG 101	ZEN 315
2N1784	RS276-2003	T-3	GE-1	ICC-3	TR-17	PTC 107	HEP-3	SK 3005	NA	ECG 160	ZEN 301
2N1785	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1786	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	S 3006	NA	ECG 160	ZEN 300
2N1787	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1788	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1789	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3006	NA	ECG 160	ZEN 300
2N1790	NA	T-2	GE-9	ICC-2	TR-17	NA	HEP-2	NA	NA	ECG 160	ZEN 300
2N1800	NA	NA	GE-53	NA	NA	NA	NA	NA	NA	NA	NA
2N1808	RS276-2001	T-641	GE-8	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1837	NA	NA	GE-18	NA	TR-87	PTC 144	HEP-S3011	NA	NA	NA	NA
2N1838	RS276-2009	T-53	GE-63	ICC-53	IRTR-21	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1839	RS276-2009	T-53	GE-27	ICC-53	IRTR-78	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1840	RS276-2009	T-53	GE-27	ICC-53	IRTR-78	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1841	NA	NA	NA	NA	NA	NA	HEP-S3010	NA	NA	NA	NA
2N1842	NA	S-304	GEMR-3	ICC-304	NA	NA	HEP-R1301	SK 3505	NA	NA	NA
2N1843	NA	S-304	GEMR-3	ICC-304	IR-1843A	NA	HEP-R1301	SK 3505	NA	NA	NA
2N1844	NA	S-306	GEMR-3	ICC-306	IR-1844A	NA	HEP-R1304	SK 3505	NA	NA	NA
2N1845	NA	S-306	GEMR-3	ICC-306	NA	NA	HEP-R1304	SK 3505	NA	NA	NA
2N1846	NA	S-306	GEMR-3	ICC-306	IR-1846A	NA	HEP-R1304	SK 3505	NA	NA	NA
2N1847	NA	NA	GEMR-3	NA	NA	NA	HEP-R1306	SK 3505	NA	NA	NA
2N1848	NA	NA	GEMR-3	NA	IR-1848A	NA	HEP-R1306	SK 3505	NA	NA	NA
2N1849	NA	NA	GEMR-3	NA	IR-1849A	NA	HEP-R1307	SK 3505	NA	NA	NA
2N1850	NA	NA	NA	NA	IR-1850A	NA	NA	SK 3505	NA	NA	NA
2N1853	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	ZEN 304
2N1854	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3004	RT-120	ECG 102	ZEN 304
2N1858	NA	NA	GE-20	NA	TR-08	PTC 108	NA	SK 3010	RT-122	ECG 103	NA
2N1864	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3008	NA	ECG 160	ZEN 300
2N1865	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	SK 3008	NA	ECG 160	ZEN 301
2N1866	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3008	NA	ECG 160	ZEN 300
2N1867	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	SK 3008	NA	ECG 160	ZEN 300
2N1868	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300

NA = NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N1869	NA	NA	NA	NA	NA	NA	HEP-R1215	NA	NA	NA	NA
2N1870	NA	NA	NA	NA	NA	NA	HEP-R1215	NA	NA	NA	NA
2N1871	NA	NA	NA	NA	NA	PTC 107	HEP-R1216	NA	NA	NA	NA
2N1872	NA	NA	GE-50	NA	TR-17	PTC 107	HEP-R1217	NA	NA	NA	NA
2N1873	NA	NA	GE-50	NA	TR-17	PTC 107	HEP-R1218	NA	NA	NA	NA
2N1874	NA	NA	GE-50	NA	TR-17	PTC 107	HEP-R1218	NA	NA	NA	NA
2N1871	NA	NA	GE-50	NA	TR-17	PTC 107	NA	NA	NA	NA	NA
2N1881	NA	NA	NA	NA	NA	NA	HEP-R1101	NA	NA	NA	NA
2N1882	NA	NA	NA	NA	NA	NA	HEP-R1101	NA	NA	NA	NA
2N1883	NA	NA	NA	NA	NA	NA	HEP-R1102	NA	NA	NA	NA
2N1884	NA	NA	NA	NA	NA	NA	HEP-R1103	NA	NA	NA	NA
2N1885	NA	NA	NA	NA	NA	NA	HEP-R1103	NA	NA	NA	NA
2N1886	NA	NA	GE-66	NA	NA	NA	HEP-S5003	NA	NA	NA	NA
2N1889	NA	NA	GE-18	NA	NA	PTC 125	HEP-714	NA	NA	NA	NA
2N1890	NA	NA	GE-18	NA	NA	PTC 125	HEP-714	NA	NA	NA	NA
2N1891	RS276-2002	T-641	GE-5	ICC-641	TR-08	PTC 102	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1892	RS276-2002	T-641	GE-54	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101	ZEN 315
2N1893	RS276-2009	T-714	GE-27	ICC-714	TR-87	PTC 125	HEP-714	SK 3024	RT-114	ECG 128	NA
2N1894	NA	NA	NA	NA	NA	NA	HEP-S5003	NA	NA	NA	NA
2N1895	NA	NA	NA	NA	NA	NA	HEP-S5003	NA	NA	NA	NA
2N1896	NA	NA	NA	NA	NA	NA	HEP-S5003	NA	NA	NA	NA
2N1897	NA	NA	NA	NA	NA	NA	HEP-S5000	NA	NA	NA	NA
2N1898	NA	NA	NA	NA	NA	NA	HEP-S5000	NA	NA	NA	NA
2N1905	RS276-2006	T-232	GE-16	ICC-232	IRTR-88	PTC 105	HEP-232	SK 3014	RT-115	ECG 129	ZEN 326
2N1906	NA	T-626	GE-25	ICC-626	TR-27	PTC 138	HEP-626	SK 3014	RT-147	ECG 179	NA
2N1907	RS276-2006	T-232	GE-25	ICC-232	TR-27	PTC 105	HEP-232	SK 3014	RT-147	ECG 179	ZEN 326
2N1908	RS276-2006	T-232	GE-25	ICC-232	TR-27	PTC 105	HEP-232	SK 3014	RT-147	ECG 179	ZEN 326
2N1917	RS276-2021	T-51	GE-22	ICC-51	TR-88	PTC-103	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1918	RS276-2021	T-51	GE-22	ICC-51	TR-88	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1919	RS276-2021	T-51	GE-21	ICC-51	TR-88	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1920	RS276-2021	T-51	GE-21	ICC-51	TR-80	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1921	RS276-2021	T-51	GE-21	ICC-51	TR-88	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N1922	NA	NA	GE-21	NA	IRTR-88	PTC 103	NA	NA	RT-115	ECG 129	NA
2N1924	RS276-2007	T-629	GE-2	ICC-629	IRTR-85	PTC 102	HEP-629	SK 3004	RT-121	ECG 102A	NA
2N1925	RS276-2005	T-254	GE-2	ICC-254	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A	ZEN 305
2N1926	RS276-2005	T-254	GE-2	ICC-254	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A	ZEN 305
2N1929	NA	SR-1241	NA	ICC-R1241	NA	NA	HEP-R1241	NA	NA	ECG 5400	NA
2N1930	NA	SR-1241	NA	ICC-R1241	NA	NA	HEP-R1241	NA	NA	NA	NA
2N1931	NA	SR-1243	NA	ICC-R1243	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1932	NA	SR-1243	NA	ICC-R1243	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1933	NA	SR-1243	NA	ICC-R1243	SCR-04	NA	HEP-R1243	NA	NA	ECG 122	NA
2N1934	NA	SR-1005	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N1935	NA	SR-1005	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N1936	NA	T-247	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N1937	NA	T-247	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N1940	NA	T-250	GE-2	NA	TR-05	PTC 102	NA	SK 3005	RT-118	ECG 100	NA
2N1941	NA	NA	NA	HEP-S3011	NA	NA	HEP-S3011	NA	NA	NA	NA
2N1942	NA	NA	NA	HEP-629	NA	NA	HEP-629	NA	NA	NA	NA
2N1943	NA	T-714	GE-18	HEP-S3020	TR-87	PTC 125	HEP-S3020	NA	NA	NA	NA
2N1944	RS276-2009	T-53	GE-63	ICC-53	TR-86	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1945	RS276-2009	T-53	GE-63	ICC-53	TR-86	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1946	RS276-2009	T-53	GE-63	ICC-53	TR-25	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1947	RS276-2009	T-53	GE-17	ICC-53	TR-87	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1948	RS276-2009	T-53	GE-17	ICC-53	TR-86	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1949	RS276-2009	T-53	GE-17	ICC-53	TR-25	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1950	RS276-2009	T-53	GE-17	ICC-53	TR-87	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1951	RS276-2009	T-53	GE-17	ICC-53	TR-86	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1952	RS276-2009	T-53	GE-17	ICC-53	TR-25	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1953	RS276-2009	T-53	GE-18	ICC-53	TR-65	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1954	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A	ZEN 305
2N1955	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A	ZEN 305
2N1956	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A	ZEN 305
2N1957	RS276-2005	T-254	GE-2	ICC-254	IRTR-85	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A	ZEN 305
2N1958	RS276-2009	T-53	GE-63	ICC-53	TR-25	PTC 123	HEP-53	NA	RT-102	ECG 123A	ZEN 102
2N1959	RS276-2009	T-53	GE-63	ICC-53	TR-25	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1960	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 102	HEP-3	SK 3123	NA	ECG 160	ZEN 301
2N1961	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 102	HEP-3	SK 3123	NA	ECG 160	ZEN 301
2N1962	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N1963	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N1964	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N1965	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N1969	RS276-2005	T-254	GE-1	ICC-254	IRTR-85	PTC 135	HEP-254	NA	RT-121	ECG 102A	ZEN 305
2N1970	NA	T-233	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N1971	RS276-2006	T-232	GE-25	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N1972	RS276-2009	T-53	GE-63	ICC-53	TR-21	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1973	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 123	HEP-53	SK 3124	RT-102	ECG 123A	ZEN 102
2N1974	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1975	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N1980	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327
2N1981	NA	T-231	GE-4	ICC-231/233	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105	ZEN 327

NA = NOT AVAILABLE

(continued next month)

substitution guide
PART VIII

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.

SERVICE CLINIC

(continued from page 68)

This type of circuit can lead to some unexpected problems, if you don't know it's being used. In one, although the customer's complaint was "poor focus", the tubes suddenly started glowing very brightly, then the fusable resistor in the B+ supply popped out. Checks showed that the diode in the heater string had shorted. This applied the full 120-volt line voltage to the heaters.

The diode was replaced, and the B+ checked. A heavy short was still there. This turned out to be the audio tube, a 12FX5, with a big fat short. It's possible that the heater overload had caused this. Although the other tubes had been overloaded too, they weren't damaged. Note: this diode seems to be used *only* in the "A" series of the KCS-176 chassis. In later runs, higher-voltage tubes were used, and a small dropping resistor (15 ohms) was added.

In other sets, you'll find other things used as droppers. In fact, anything having either resistance or reactance can be used. Small chokes can be used, but these are much more expensive than diodes; so are big resistors, nowadays. In some imported TV sets, a special non-polarized *electrolytic capacitor* was the dropping "resister"! Needless to say, this was a very odd value, and practically impossible to get. We finally began replacing these with stock resistors, which worked beautifully.

If you run into a set with some kind of unusual dropper, and you can't find a replacement, good old-fashioned resistors will solve the problem. You can find the value needed with Ohm's Law. Don't forget to figure the wattage too. Some of these will get pretty warm. Most can be mounted in some place on the chassis where they'll stay cool enough.

Suspect the use of some odd thing whenever you see that the heater voltages of the tubes do not add up to the line voltage. As in the RCA mentioned, where they add up to only 76 volts. Here's how to get the right value; add up the heater voltages of all tubes in the string. Now, subtract this value from the line voltage at 120 volts. In the example above, this would be 120–76 = 44 volts drop, across the dropper. The current will be the same in all tubes, so you need only look up one type. Here, it's 450 mA. So, Mr. Ohm says that R = E/I, or 100 ohms. If you come out with an

oddball resistance value, use the next *higher* stock value; this will give you a little "cushion" in case of line-surges, and the tubes will never know the difference. You can run them at least 5% below rating, with full output.

The dropping resistor must have an ample wattage rating. Here, we'd have $P = I^2R$, or $.45^2$ times 100; comes out around 20 watts. Use a 25-watt type, for safety-factor. You can mount this on a couple of small metal brackets, so that it will be held away from the chassis, for best air-circulation.

So, there you are. With good ol' fundamentals, and some scratch paper, it's not too hard to cope with some of the more unusual things you run into. Just keep your eyes (and your mind) open. **R-E**

reader questions

REGULATED SUPPLY LOW

The 20-volt regulated supply on a Sylvania D-12 color chassis reads only 10 volts. I have no raster or sound. Higher dc voltages OK.—T.D., Bellevue, Ohio

One of two things: either you have a high leakage or short in some of the many circuits fed by that 20-volt source, or the regulator transistor itself is bad.

Check: disconnect the output of the 20-volt supply. Turn the set on. If this reads exactly 20 volts, it's OK. If it reads 10 volts no-load, try a new regulator transistor. Should hold the dc output constant at 20 volts, with line voltage all the way from 105 to 120 volts.

Loss of video and raster could be due to low supply voltage on the first and second video amplifier transistors, biasing the pix tube off

INTERMITTENT CONVERGENCE

We've got an odd case of intermittent convergence in a Magnavox 938. The customer complains bitterly, but we had an awful time making it show up in the shop. When we did, it looked like a sudden displacement of the three colors, by about ½ inch each.—T.D., Bellevue, Ohio.

Check the Molex plug on the convergence yoke for intermittent contacts or loose wires to the male pins. Possibility 2, check the 50-μF electrolytic in the vertical output tube

cathode circuit. If it is opening intermittently, it can cause some strange and wonderful symptoms. While you're at it, hit the diode unit on the convergence board a couple of smart raps with a screwdriver. These can "loosen up" and cause just this type of trouble. If it's loose, replace it.

REDUCE FULL-SCALE READING OF VTVM?

I've got an old, but good vtvm, with a 5-volt full-scale as the lowest range. Do you know how I could modify this to get something like a 0.5 or 1.0-volt full-scale?—A.K. Elmhurst, Ill.

Frankly, no. This uses a standard vtvm bridge circuit. In these, the maximum voltage for full-scale deflection is applied to the "hot grid" of the dual-triode, through the multiplier resistors. In your instrument, the lowest voltage seems to be 5 volts, since there are no resistors in circuit on that scale. (In other words, no matter what voltage range you're on, you get 5 volts on the grid of the tube for full-scale; the multiplier does this.)

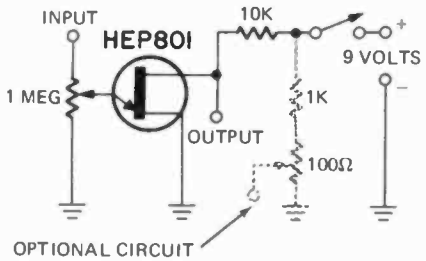
I don't think you could modify this without a complete redesign. However, you might build up a little "preamp", with the circuit for a "dc amplifier" (see diagram) that comes from Motorola's HMA-33 Fet folder! This could be used ahead of the vtvm for a lower range. Adjust its gain so that you get a 5V. output for say 0.5V input, and away you go.

POOR HORIZONTAL SYNC

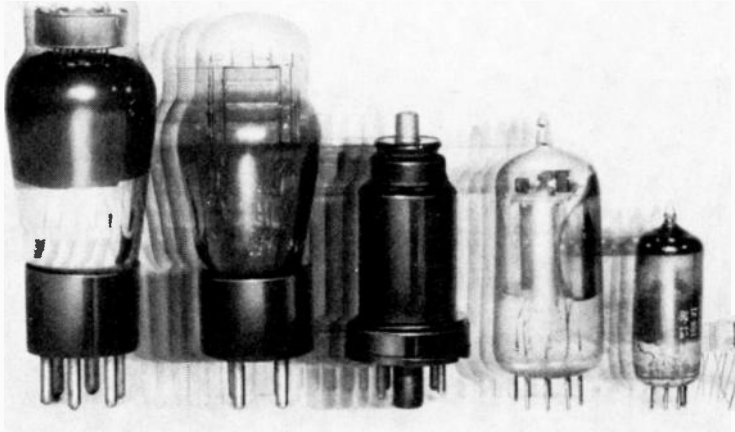
I've checked and replaced every part in the horizontal afc in this RCA KCS-144—diodes, capacitors, resistors, etc. Still won't work. It will hold pretty well, until anything disturbs it; change of camera, commercial, etc, then out it goes. I'm at my wit's end.—R.S.G., Provo, Utah.

Last resort, on this type of problem. If it will hold *fairly well*, or hold at all, apparently without any sync, the oscillator is working, and the afc

(continued on page 78)



Changes come fast in electronics.

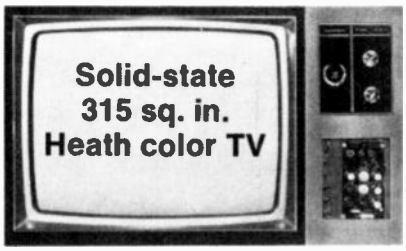


From tube to LSI

Take a look at the race in circuit technology. In the 1960's the tubes at the left made way for the transistors at the right. Today, transistors are surpassed by the large scale integrated circuit (LSI) at the far right. This circuit, less than a quarter inch square, replaces over 6000 transistors!

There's big money to be made by the men who stay ahead of this technology race. Put yourself ahead with NTS Home Training! You get the latest, most advanced equipment (at no extra cost). More solid-state units, and more advanced technology. Plenty of training with integrated circuits, too! As an NTS graduate, you enter a world of electronics you're familiar with. You have a thorough working knowledge of solid-state circuitry. You're ready to tackle bigger jobs at higher pay!

NTS COLOR AND B&W TV SERVICING



Build and keep the largest, most advanced color TV made! Over-all solid-state design, ultra-rectangular screen, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state, 24-channel detent UHF/VHF power tuning, and much more! Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, hi-fi, stereo, multiplex systems, radio, color and B&W TV servicing.

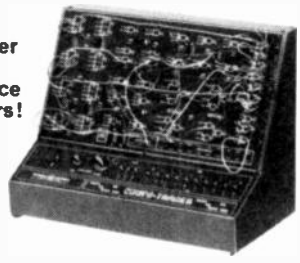
Learn sophisticated solid-state circuitry as you build this B&W TV receiver. Lo-Silho "Superhet" Radio, FET Volt-Ohmmeter, Solid-State Radio, Electronic Tube Checker, and Signal Generator. TV and all other equipment are yours to keep.

Solid-state B & W TV, 74 sq. in. picture (cabinet included)

NTS ELECTRONICS & COMPUTER TECHNOLOGY

Build and keep this exclusive NTS Compu-Trainer. It teaches you the same principles used in million-dollar systems. Contains 14 integrated circuits! All Solid-State! You perform all wiring and patchcording. No shortcuts. No pre-wired circuit boards. Your training is complete! Also receive an FET Volt-Ohmmeter and a 5" wide-band Solid-State Oscilloscope.

Solid-state Compu-Trainer 14 integrated circuits replace 198 transistors!



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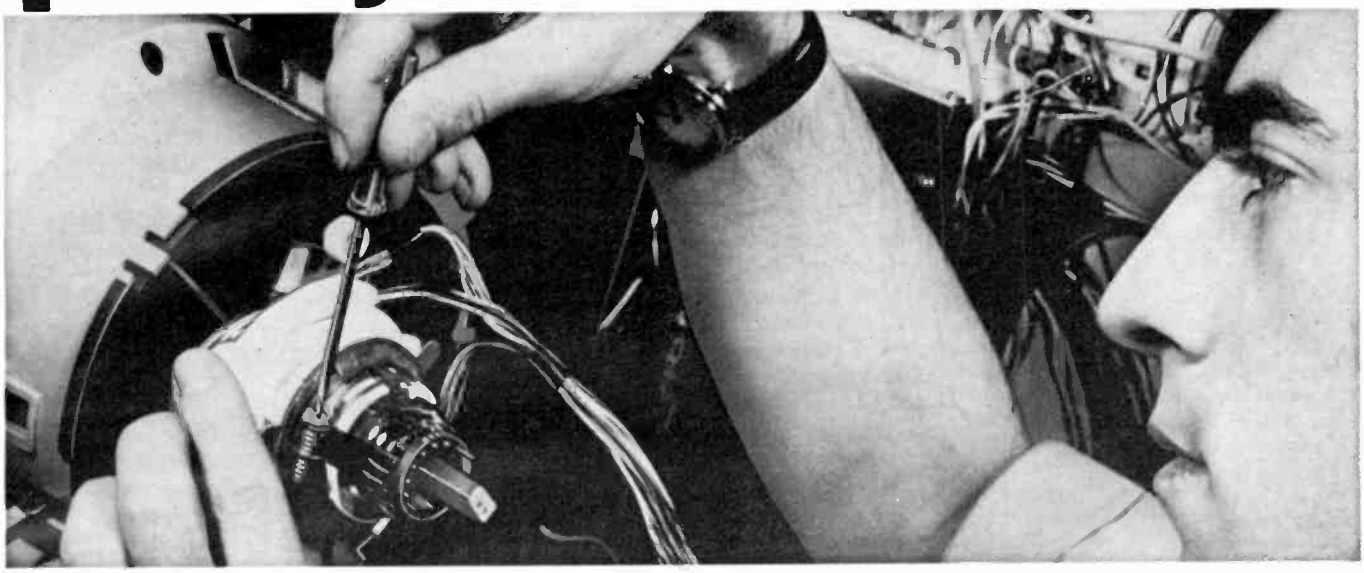
Gain the prestige and earning power of owning an F.C.C. First Class Radio-Telephone License. Two comprehensive NTS courses cover the big opportunity field of transmitting and receiving.

You build and keep 14 kits, including this amateur phone 6-meter VHF Transceiver, NTS's exclusive 6-transistor Solid-State Radio, and a fully transistorized Volt-Ohmmeter. Also, learn 2-way radio, Citizens Band microwaves, and radar.

5-watt AM transmitter/ receiver

NTS Home Training puts you in the lead.



NTS INDUSTRIAL & AUTOMATION ELECTRONICS

Automation is the future of industry and you can play an important part! Learn industrial controls by training on the NTS Electro-Lab (a complete workshop). You also build and operate this 5" Solid-State oscilloscope. And you perform experiments that involve regulating motor speeds, temperature, pressure, liquid level, and much more. All equipment is yours to keep.

NTS AUDIO ELECTRONICS SERVICING

Learn basic sound theory—how it works in home radio, car tape decks, stereo multiplex component systems, and more! Set up a spectacular music system. Learn about sound distortion, amplification and control, loud-speaker baffles, problems of system installation, etc. Included is Volt-Ohmmeter, In-Circuit Transistor Tester, and Solid-State Radio. Prepare yourself for great opportunities in the Home Entertainment Industry!

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- ☐ Check if interested in Veterans Training under new G.I. Bill.
- ☐ Check if interested ONLY in Classroom Training at Los Angeles

READER QUESTIONS

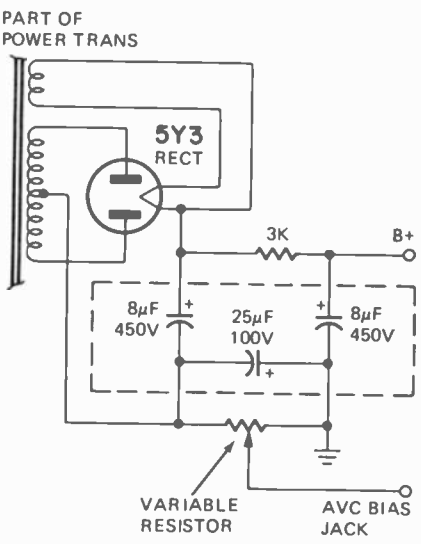
(continued from page 73)

circuit itself is probably OK. One thing that has caused exactly this problem, in this and many others, is broken PC-board conductors. These will be in the conductors which feed the horizontal sync from the sync-separator into the afc. I found one with a ¼-inch break in it, where a screwdriver had slipped at some time in the past. (Under a metal brace, so I couldn't see it, naturally.) Check all of these with an *ohmmeter*.

FILTER CAPACITORS

My old Precision E-200 signal generator has a shorted filter capacitor. I can't find the value of these on the can, and I don't have a service manual. What are they?–J.P., Louisville, Ky.

The main filters in this generator are 8-μF at 450 volts. There is also a 25-μF at 100 volts in the same can. Watch out for the connections on any replacements. There are actually four terminals; see the diagram.



You'll probably be better off using three separate capacitors; you might have a hard time finding a single unit type with this exact hookup.

BURNED OUT FLYBACK

The flyback has burnt out in this Admiral 4G13 color chassis. There are two horizontal output tubes, in parallel. I'd like to protect the new flyback against tube-shorts. No fuses used, that I can see. How would I do this?–C.G., Mountain Top, Pa.

Open the cathodes, tie them together, and add about a ⅜A fast-blow fuse to ground. Don't use slow-blow fuses; they have enough resistance to cause degeneration. Beside that, you want that circuit to open as quickly as possible if anything happens! **R-E**

CQ-32114—Johnny Mathis, Me And Mrs. Jones **
MQ-32132—Bartok, Concerto For Orchestra—Boulez And The New York Philharmonic Orchestra. Surround Sound ****
CQ-32149—Liza Minnelli, The Singer **
MQ-32196—Haydn, Mass In Time Of War—Bernstein And Orchestra With Soloists, Recorded At Washington National Cathedral ***

PROJECT THREE

PR-5067QD (QS encoded)—The Brass Ring Featuring Phil Bodner ***
PR-5068QD (SQ encoded)—4-Channel Dynamite ****
PR-5068QD (QS encoded)—4-Channel Dynamite ****

EPIC

EQ-30209—Poco Deliverin' ****
EQ-30325—Sly & The Family Stone Greatest Hits **
EQ-30472—Chase ***
EQ-30658—Tammy Wynette, We Can Sure Love Each Other **
EQ-31584—They Only Come Out At Night, The Edgar Winter Group ***

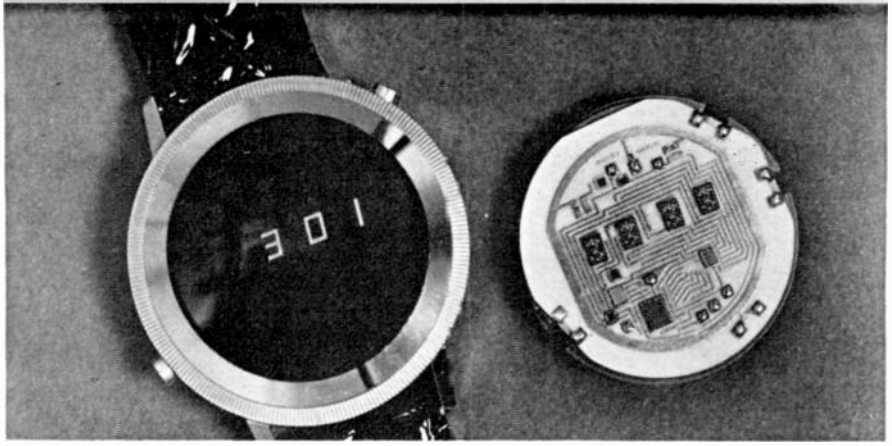
OVATION

OVQD/14-27—Laura, Comin' Apart **

VANGUARD

VSQ-30012—Martin Berinbaum Trumpet And English Chamber Orchestra, Music By Hayden, Albinoni, Torelli And Hummel ****
VSQ-30021—Stravinsky, Petrushka, Mackerras And London Symphony Orchestra. Surround Sound ****
VSQ-30025/7—Rossini, La Pietra Del Paragone (Opera Buffa)—Jenkins And Clarion Concerts Orchestra, Chorus And Soloists ****
VSQ-30008/9—Mahler, Third Symphony—Abravenel And Utah Symphony Orchestra (Fifth Movement is especially effective) ****
VSQ-30013/4/5—Handl, Judas Maccabeus ****
VSQ-30020—Handl, Royal Fireworks Music, The Water Music ***

That's our list, complete as of now. As we receive and listen to more new 4-channel records, we'll report on them too. We think you'll find this report useful and would appreciate comments. **R-E**



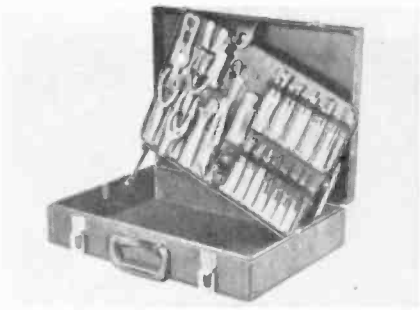
MICROELECTRONICS MAKE WATCHES RUN accurate to 3 minutes per year. Using quartz crystal and a CMOS (complementary metal oxide semiconductor) chip, the accuracy is five times that of the "tuning fork" watch. The module, one eighth inch square, is made by Hughes Aircraft Co. for watch manufacturers, and contains the equivalent of 1,500 transistors. Other IC's drive the displays. With average use, the watch will run a year on a single change of batteries.

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.

TOOL CASE, *model TC-200ST* contains assortment of screwdrivers, nutdrivers, pliers, cutters, stripper/cutter, etc., all mounted in see-thru plastic pockets on a removable pallet of heavy-gauge vinyl located in the lid of the case. Bottom of case is empty to allow ample space for individualized selection of additional tools, test instruments, parts boxes, soldering gun, etc. Lid contains a full-width pocket for literature, manuals or other printed matter. Case alone, without tools, is available as model TC-200/MT. 18" x 13½" x 4¾".—**Xcelite Inc.,** Orchard Park, N.Y. 14127.

Circle 31 on reader service card



HI-FI RECEIVER, *SA-8000X* is an FM/AM 4-channel/2-channel receiver with a built-in CD-4 demodulator plus matrix circuitry for direct demodulating or decording 4-channel source material without external accessories. Includes 64 watts of total continuous rms power, all 4-channels driven at 8 ohms in the 4-channel mode; 84 watts total continuous rms power, both channels driven at 8 ohms in the 2-channel mode. Total IHF power is 160 watts.

Can accommodate all auxiliary 4-channel sources, including discrete 4-channel tape equipment, reel-to-reel and cartridge. Has separate level control for each channel, 4-channel/2-channel speaker outputs and multiple tape-monitor and dubbing facilities. $499.95.—**Technics by Panasonic,** 200 Park Avenue, New York, N.Y. 10017.

Circle 32 on reader service card

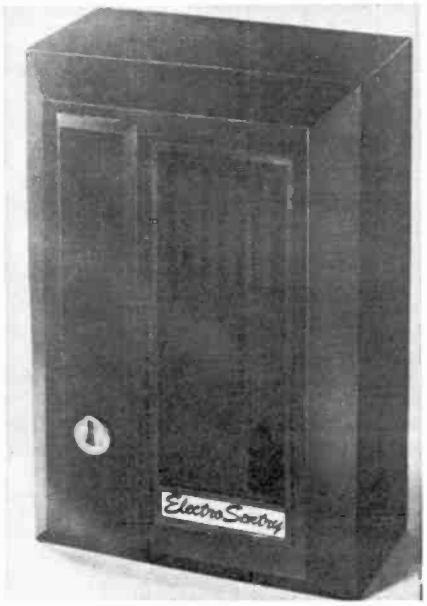
VOM MULTITESTER, *model VM-100K* features ±1% temperature stabilized carbon film resistors. Long mirrored scale to eliminate parallax in reading. Polarity changeover switch; 23 ranges. Dc volts; 7 ranges, from 0-0.6, 3, 12, 60, 300, 600,

1,200. Ac volts; 5 ranges, from 0-6, 30, 120, 300, 1,200. Dc current; 6 ranges, 0-12 μA, 300 μA, 6 mA, 60 mA, 600 mA, 12 A. Ac current; 0-12 A. Ohms; 4 ranges, 0-20 K, 200 K, 2 meg, 20 meg. Db; 6 ranges, –20 to +17, 31, 43, 51, 63. Sensitivity: 100,000 ohms/volt dc, 10,000 ohms/volt ac. Accuracy: ±3% dc, ±4% ac (of full scale). 180 x 135 x 65 mm; 2 lbs., 4 oz.; $65.95.—**Finney Company,** 34 West Interstate, Bedford, Ohio 44146.

Circle 33 on reader service card

SECURITY SYSTEMS. *Ultransonic-Sentry, model 30-9030,* detects anyone within 25 feet. Needs no installation. Features a delayed-action electronic timing circuit, automatic shutoff, adjustable sensitivity control and comes complete with power supply/battery charger to extend battery life.

Electro-Sentry, model 30-9020, protects any door or window against intrusion. Features built-in electronic timer and a piercing 100-dB horn that sounds until silenced with a special key. Battery operated.



Magna-Sentry, model 30-9010, is a versatile alarm that is installed by self-adhesive backing. Battery operated unit has built-in fire alarm that sounds any time temperature reaches 135°F—even when burglar alarm is turned off. All models are do-it-yourself and solid-state.—**GC Electronics,** Div. of Hydrometals, Inc., 400 South Wyman Street, Rockford, Ill.

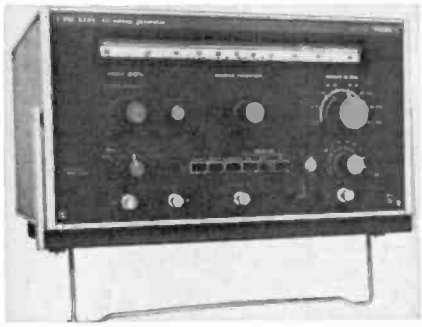
Circle 34 on reader service card

AUTOMOBILE SPEAKER SYSTEMS feature instant-mount, hardware-less installation, air-suspension cones, high-temperature voice coils and aluminum tweeters. May be used indoors as well as outdoors—for patio, poolside, camper and boat. Prices range from $14.95 for a pair of 5" speakers in black and chrome-trimmed, recess-mount enclosures to $39.95 for top-of-the-line *model SA1000,* a 30-watt rms, 2-way stereo system that uses 4" x 6" air-suspension woofers, 2¼" supertweeters and crossover networks in black leather-finished and chrome-trimmed enclosures.—**Amperex Electronic Corp.,** 230 Duffy Avenue, Hicksville, N.Y. 11802.

Circle 35 on reader service card

HF SWEEP GENERATOR, *PM5334.* Frequency range from 3 MHz to 860 MHz in eight panel-selected sweep ranges. Setting accuracy is better than 1%. Sweep frequency is continuously adjustable from 8 to 50 Hz on any band. Fixed frequency markers at 5.5, 10.7 and 38.9 MHz—each with 0.1% stability. Variable frequency marker is also available.

Output is electronically stabilized and is continuously adjustable down to 80 dB below the maximum output level of 200 mV. A 1-KHz internal amplitude modulating signal may be superimposed on the output. Front panel controls are color coded by specific function. A 0 to 30 V floating bias output voltage eliminates the need for a separate power supply for radio and TV alignment work. $575.00.—**Test & Measuring Instruments Inc.,** 224 Duffy Avenue, Hicksville, N.Y. 11802.



Circle 36 on reader service card

SSB & AM MOBILE CB TRANSCEIVER, *Spartan SSB* has selectivity of ±3.5 KHz at 6 dB and sensitivity of 0.4μV for 10 dB S/N. Up front controls include PA/CB

switch, noise blanker, local/distance RF control and AM/upper sideband/lower sideband selector switch. Features illuminated channel indicator and S/RF and power indicator. Has ±600 Hz clarifier.

Uses a lattice crystal filter on SSB and mechanical ceramic filter in AM operation. Detachable mike comes with the unit and all mounting hardware as well as crystals for all channels. Power output is full 15 watts peak envelope power, 5 watts rms. 7½" x 2-5/16" x 9½"; 6 lbs.—**Fannon/Courier Corp.,** 990 South Fair Oaks Avenue, Pasadena, Calif. 91005.

Circle 37 on reader service card

COLOR PICTURE TUBES, *Speed Fit* are fitted with pre-assembled and premounted straps and hardware. These units replace tubes in Motorola chassis 908, 914 and 914A; all RCA 25" (23v) chassis; and nine Zenith chassis from 20" to 25". CRT's for Zenith chassis

have a premounted one-piece shield, built-in degaussing coil, premounted pads for repositioning the yoke and preassembled strap and corner brackets.—**Channel Master,** Ellenville, New York.

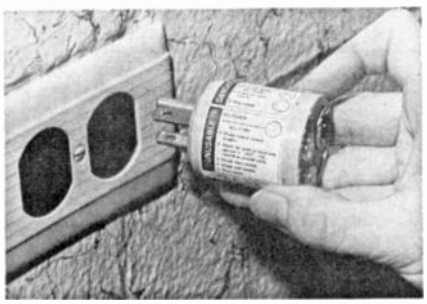
Circle 38 on reader service card

SPEAKER SYSTEM, *MP-2000.* 3-way tuned-port system. Bass octaves are reproduced within ±2.5 dB by a 12" high-compliance woofer that features a long-throw, 4-layer high temperature voice coil (wound on a 1½" aluminum form re-

inforced with asbestos), a 4-lb ceramic magnet drive assembly and viscous-damped fabric suspension. Acoustically isolated 5" midrange unit with chemically treated cloth rolls and a 1" horn-loaded phenolic dome radiator for smooth response to 20,000 Hz. Variable control permits adjusting the response to match room acoustics. Can take 60-watt power peaks. 15¼" x 24" x 12"D; $139.95.—**Utah Electronics,** 1124 East Franklin Street, Huntington, Ind.

Circle 39 on reader service card

GROUNDED OUTLET TESTER, *GT-20* checks for faulty wiring circuits. Simply plug the tester into any wall outlet and observe the indicator lights. Amber lights



show presence or absence of power. Reverse polarity, faulty connections or missing grounds are immediately evident. $6.95.—**Alco Electronic Products Inc.,** 1551 Osgood Street, North Andover, Mass. 01845.

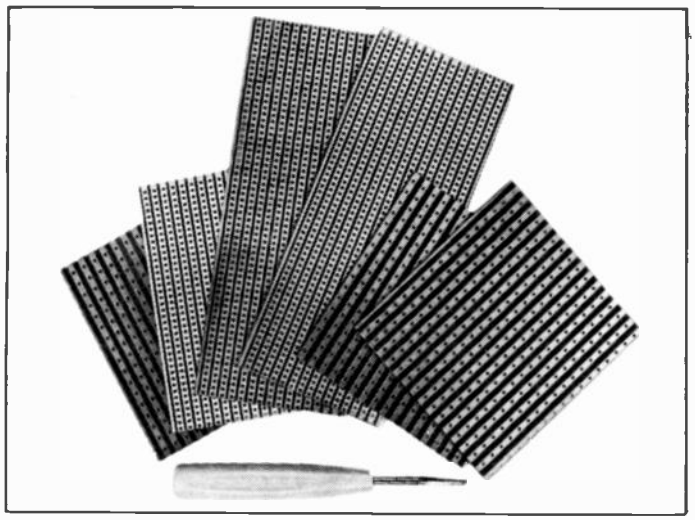
Circle 40 on reader service card

STEREO MODULATION/FREQUENCY MONITOR, *TBM2200A.* In addition to simultaneous metering of left and right channel modulation, this model features continuous monitoring of the 19-KHz pilot frequency deviation. The modulation meters also measure channel separation, crosstalk, 38 KHz suppression and individual channel stereo signal-to-noise ratios. Internal calibration of pilot injection level and frequency is featured as well as full remote metering plug-in options and rear access to all critical circuits

that appear on individual plug-in cards. 7" rack height; $1,350.00.—**McMartin Industries, Inc.,** 605 North 13th Street, Omaha, Neb. 68102.

Circle 41 on reader service card

SPEAKER SYSTEM KITS. *CK10-2* is a two-way system. 6½" woofer and 2" tweeter. Response 35 to 18,000 Hz. Maximum power input 20 W, 8 ohms. 13"H x 8"W x 8"D; 12 lbs.; $34.95 each, $59.95 pair. *Model CK20-2* is a two-way system. 8" woofer and 2¼" tweeter. Response 40 to 20,000 Hz. Maximum power input 60 W, 8 ohms. 20"H x 10¼"W x 9½"D; 22 lbs.; $59.95 each, $99.95 pair. *Model CK20-3* is a three-way system. 8" woofer, 5" mid-range and 2½" tweeter.



THE VERO BK-6 KIT LETS YOU BUILD ANY CIRCUIT IN 3 STEPS

Here, in kit form is the fastest, simplest method of circuit building. Veroboard eliminates the need for etching, wires or terminals — you can now build any circuit in 3 easy steps. The BK-6 Veroboard kit contains six assorted veroboards, a spot face cutter and instruction sheet. Try it and you'll never want to go back to the old method again.

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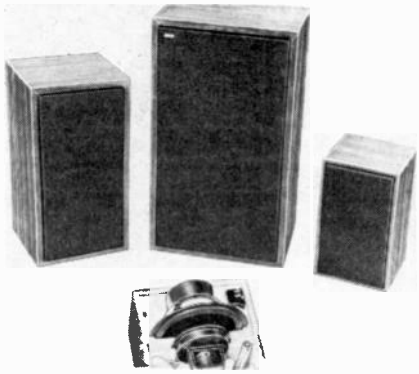


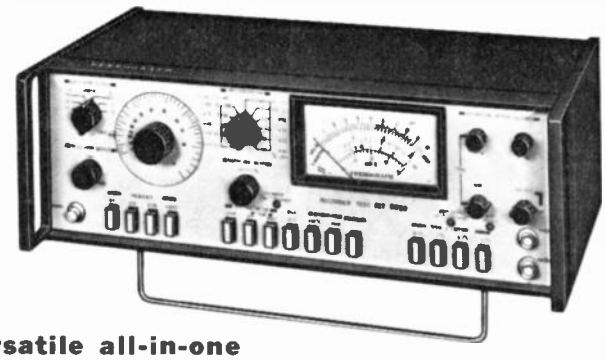
Response 40 to 20,000 Hz. Maximum power input ohms. 20"H x 10¼"W x 9½"D; 23 lbs.; $69.95 each, $119.95 pair. *Model CK50-4* is a four-way system. 10" woofer, 5" x 7" mid-range and two 2½" tweeters. Response 30 to 18,000 Hz. Maximum power input ohms. 26½"H x 15"W x 10½"D; 30 lbs.; $99.95 each, $179.95 pair.—**National Tel Tronics,** 98 Cutter Mill Road, Great Neck, N.Y. 11021.

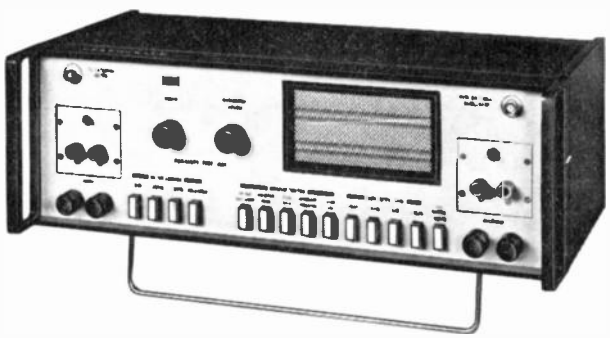
Circle 42 on reader service card

4-CHANNEL CONVERSION SYSTEM, *Quasi Quad* is a passive matrix enhancer packaged with two rear-channel speakers. Designed to be connected to the speaker terminals of any stereo system, this adapter has controls to adjust matrix blend and rear speaker loudness and to select four different sonic effects to suit different kinds of music and personal taste.

System will play any 4-channel matrix sound source and enhance normal

Everything you need for complete audio testing. Ferrograph RTS-2 with Auxiliary Unit



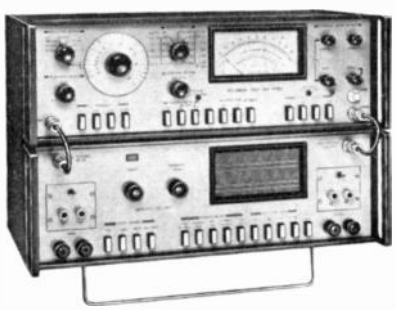


Versatile all-in-one precision test system

It's a Sine Wave generator . . . Millivoltmeter . . . Wow & Flutter bridge . . . Harmonic Distortion analyzer that you can learn to use in minutes. Requiring only two leads, setup time is minimal. Pushbutton controls provide rapid, precise operation. Compact and lightweight, it's ideal for recording and broadcast studios, testing labs and service shops.

Vastly expanded operation

By combining the RTS-2 with the ATU Auxiliary Unit, you're ready for the most sophisticated audio testing. • Monitors pre-recorded test alignment tape with built-in speaker unit • Balanced and unbalanced input/output. Switches between left/right input/output channels. Provides matching impedances for 8Ω, 200Ω, 600Ω impedances, or unloaded. • Compares input/output signals • NAB weighted noise filter network for S/N measurements • Oscillator output may be set in 10dB increments over 40dB range by pushbuttons • Designed for use with virtually any test equipment.



RTS-2 Test Set — $1450
ATU Auxiliary Unit — $560
Carrying cases optional

New, Convenient Leasing Plan!

Try this unique, complete test system Free for 30 days. Write for details.

ELPA MARKETING INDUSTRIES, INC., New Hyde Park, N.Y. 11040

stereo records, tapes and FM broadcasts by synthesizing a 4-channel effect. $59.95.—**BSR (USA) Ltd.**, Blauvelt, N.Y. 10913.

Circle 43 on reader service card

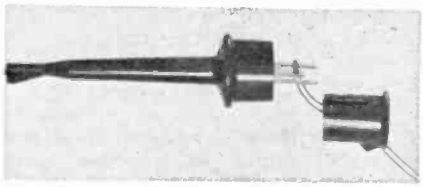
STEREOPHONES, *Traveler* transforms from a full-size set into a compact, palm-size unit for storage or traveling. It features a 1½" Mylar diaphragm and a lightweight, stiff material that is resistant to moisture and temperature changes. Elliptically shaped, the ear-cups include PVC foam cushions for complete seal against outside noises as well as wearing comfort. Delivers a frequency response range of 10-18,000 Hz; 8-foot

---

cord; 9 oz.; $29.95.—**Koss Corp.,** 4129 North Port Washington Avenue, Milwaukee, Wisc. 53212.

Circle 44 on reader service card

MINI TEST CLIPS, *model 3925* permits user to assemble his own test leads for specific testing requirements. Will accept any wire up to .090" in diameter. Features a plunger-action contact hook that connects with and holds component leads or terminals without damage. Specially constructed probe tip slips down over a .025 square Wire-Wrap pin to make positive connection.—**Pomona Electronics Co. Inc.,** 1500 East Ninth Street, Pomona, Calif. 91766.



Circle 45 on reader service card

PTS Electronics, Inc. has announced three more service centers. They are at: P.O. Box 5794, 5111 University Avenue, San Diego, Calif. 92105, phone (714)-280-7070; 5682 State Road, Cleveland, Ohio 44134, phone (216)-845-4480; and P.O. Box 16855, 1921 South 70th Street, Philadelphia, Pa. 19142, phone (215)-724-0999. **R-E**

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.

ELECTRONIC PARTS *1973 Annual Catalog* presents AM and AM/FM radios, tape recorders, speaker systems, turntables, stereo amplifiers and receivers, headsets, rf connectors, silicon-controlled rectifiers and diodes and semiconductors, relays, power supplies, wire cords and cable, transformers, fuses and holders, capacitors, switches, sockets and security equipment. Also included is a section on test equipment and tools and service aids.—**Electronic Distributors Inc.,** 4900 North Elston Avenue, Chicago, Ill. 60630.

Circle 46 on reader service card

PARTS CATALOG 16-page booklet includes silicon rectifiers, circuit breakers, antenna replacements, soldering iron, service kits and sets, hi-fi speakers, microphones, diamond needles, solid-state tubes and TV tuner subber. An order form is included.—**Fordham Radio Supply Co.,** 558 Morris Avenue, Bronx, N.Y. 10451.

Circle 47 on reader service card

SOLDER SELECTOR GUIDE is a 6-page booklet that describes and illustrates soldering problems and the company's full line of solders, fluxes and chemicals. Problems include: icicling, bridging, dewetting and excess solder. Products include: 5-core solders of standard and special alloys and gauges, rosin base, organic acid and inorganic acid fluxes, cleaning solutions, solder creams and tapes and conformal coatings.—**Multicore Solders,** Westbury, N.Y. 11590.

Circle 48 on reader service card

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

SERVICING QUASAR COLOR TV is a 15-page booklet of suggestions to help cut troubleshooting time and present procedures for those sets where the solution is not readily apparent and the problem has not been solved by logical analysis-replacement of panels. Information is arranged according to symptom and by chassis number. Categories included are: audio, high voltage, brightness, raster, Insta-Matic, sync, signal path/picture, sweep, power supply, remote control sets only, and service adjustments. **$1.00, from local Motorola distributors.**

ANTENNA PRODUCTS, *catalog CP-2.* 24 pages illustrate and describe more than 230 products that include TV and FM antennas, preamplifiers, couplers, band separators and wire.—**Winegard Company,** 3000 Kirkwood Street, Burlington, Iowa 52601. **R-E**

Circle 66 on reader service card

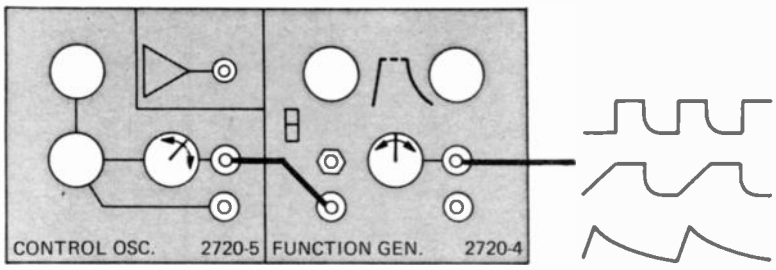


FIG. 10—FOR A LOW-FREQUENCY REPEATING WAVEFORM for percussion repeat effects, use this wiring arrangement. The sinewave output of the control oscillator can't do the job by itself.

under the control of the function generator. A pulse waveform of minimum duration has been chosen as the signal source in this example because of the evenly balanced, harmonic rich spectrum.

When any note is played with the above connection the function generator attacks rapidly and causes the VCF (voltage-controlled filler) to be resonant at some high frequency. During the decay portion of the note the center frequency of the filter slowly slides down through the frequency spectrum of the VCO's output pulses. The result is something like a performer muting a harmonica with his cupped hands but since the spike is a better source of harmonics than the predominantly square wave output of a harmonica and the filter is a more effective resonator than cupped hands the effect is quite naturally more spectacular.

A more standard sound can be achieved by increasing the pulse duration and backing off on pulse filter's Q control. You might also try using the function generator's output attenuator to lower the control voltage to the filter thereby lowering the upper limit of the resonant frequency. Also try summing a constant voltage from the power supply's bias sources into the control inputs of the VCF.

In Fig. 9 we have a simple arrangement that gives a convincing imitation of a flute. The connections are straight-forward; controller to VCO, step trigger to function generator, function generator to VCA. The triangle VCO output goes through the low-pass filter and then to the VCA for envelope shaping. In this example the filter is simply turned on by one of the bias supplies on our power supply module so that it attenuates the higher frequency content of the triangle. In it's fully "on" condition the filter rolls off at the rate of about 12 dB/octave and since there is no second harmonic in a triangle and the third harmonic is already 19 db down from the fundamental there is a total attenuation of the third harmonic of 43 dB. The output of the low pass filter is for all practical purposes a sine wave, the classic flute-like voice. Attack and decay times are adjusted to correspond to those typical of a flute.

Control oscillator/noise source

There is one remaining module that we've treated as an orphan child so far, the Control Oscillator/Noise source. This module is peculiar to the R-E synthesizer because in most other equipment the VCO is flexible enough to be used at very low frequencies. Our cost objectives were best met with a separate low-frequency oscillator. Among the effects produced using a low-frequency control voltage source are vibrato—a slow, rhythmic pitch variation—and tremolo, a slow variation in amplitude. These effects are produced by using the output of the control oscillator as one of the control-voltage sources for the VCO and VCA respectively.

There are times when you need a low-frequency repeating waveform with a shape other than a sine wave. For example, percussion repeat effects similar to staccato banjo picking require that the VCA be driven by a waveform such as the one shown in Fig. 10. The sine wave output of the control oscillator won't hack it by itself but it can be used as a repeating trigger

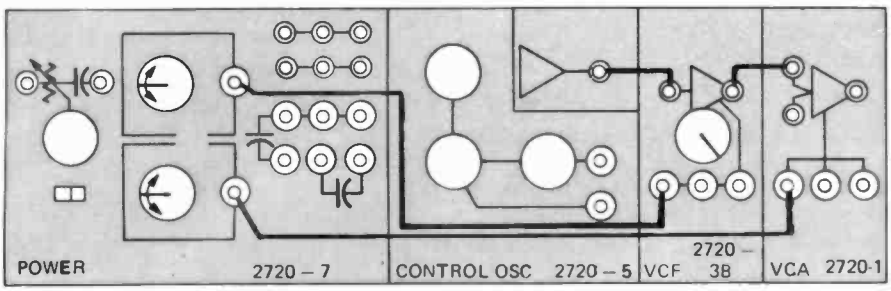


FIG. 11—NOISE IS USEFUL IN MUSIC SYNTHESIS. This hook-up generates wind sounds.

source for the function generator as shown. With this arrangement the attack and decay controls of the function generator control the attack and decay of the final output while the sustain is a function of the point on the sine wave at which the generator triggers and consequently of the settings of the control oscillator's output attenuator.

When Harry Oslon first started work on the old RCA Mark I and Mark II synthesizers back in the 1040's he was pioneering in a number of areas and not the least of these was the first use of noise in an electronic musical instrument. Up until that time the Ondiolines, Martinots, Theremins, etc. had without exception used only pitched sound sources. Because of that they produce less than natural sounds.

There are a number of stock phrases that accurately describe noise, phrases like "white noise is an equal probability distribution of all frequencies" or "pink noise is a Gaussian frequency distribution". While these are answers that display great erudition on the part of the explainer they don't do a lot for the 'splainee. Simply put, if you tune an FM radio to a spot between stations what you hear is noise in the technical sense. If you then play with the tone controls you are "coloring" the noise.

Noise as sound

It's easy to see why the first artisans of electronic music missed the signicance of noise. As you listen to it on the radio it doesn't appear to be the sort of thing that would be musically useful. But to illustrate it's use Fig. 11 shows an arrangement for producing the sound of the wind.

In other words, try everything. We've done a fair job of covering the basics involved but you have at your disposal a complete synthesis system. A few hours constructive play with the machinery will teach you more than a hundred written pages. **R-E**

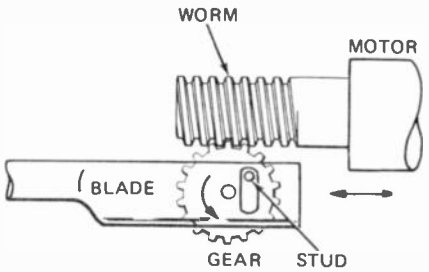
APPLIANCE CLINIC

(continued from page 24)

lights to a fairly good brightness, the charger can supply normal current. Most of these are trickle chargers, at about 150 to 200 mA maximum.

If the charger is dead, check its line cord; it could be broken at the point where it goes into the housing. Some of these go inside the housing and connect to the rectifier unit with flexible leads. If the ac voltage is present, but no dc output, replace the charging unit. This is literally a Black Box, sealed so you can't get into it.

The gear-boxes are about as simple as you can get. Most of them have only a worm cut into the end of the motor shaft, which drives a gear, usually made of plastic so that it will take the wear. This gear has two small studs, one on each side. These slip into slots in the ends of the knife blades, as shown below. This causes



WORM GEAR CONVERTS rotary motion to reciprocating. One blade shown; other on other side of gear.

the reciprocating motion of the blades. Replacement gears are available, and easy to install. If one blade moves but the other doesn't, one of the studs is broken off.

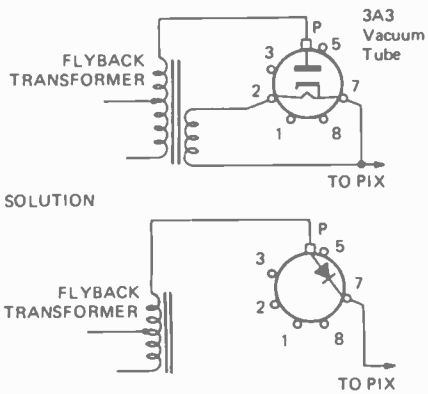
The gear box is usually just a cavity molded in one half of the case. A thin metal cover holds the grease inside. If you find grease-leaks, check for missing screws in the cover, or a broken gasket. In emergencies, you can cut new gaskets out of paper or even plastic.

The blade-mountings and slides are usually made out of nylon or Teflon, or something like that. They are not lubricated. Make sure that they can slide freely. The blades are specially ground, and are normally "self-sharpening" as they rub against each other. If they need sharpening, take them apart, and find the flat side. Use a very smooth oil-stone, fine-grained, and hold the blade with the flat side perfectly flat on the stone. Only a few strokes back and forth on the stone will bring back the cutting edge. Most of them are serrated for easier cutting. Do not try to sharpen from the serrated side. That's a job for the manufacturer or a pro. **R-E**

technotes

HV RECTIFIER FILAMENT ARCING

When the filament winding on the flyback transformer arcs, there is no need to replace the winding or the transformer. Simply remove the filament leads from the set and replace the vacuum-tube rectifier with a solid-state equivalent such as the R-3A3, R-3AT2 and R-DB3 Solid-Tubes by Electronic Devices, Inc.



Do not cut the leads to the picture tube. Completely remove the winding from the transformer core and clean the socket and plate cap. The solder joint on the socket pin to the picture tube should be smooth with no points so that arcing across the unused pins is avoided. Greater protection can be had by putting a drop of RTV silicone rubber such as DOW or GE Silicone Tube Sealer on the connection.—*News From EDI*

MAGNAVOX T979

An intermittent bright horizontal line that moves vertically through the bottom third of the screen may be accompanied by vertical jitter. In some cases, the condition appears to be corrected by tapping or moving certain components on the "D" panel. This may be caused by a contaminate, such as solder flux, in the "D" panel plug-in socket at pins 5, 6 and 7.

If you encounter this condition, clean both male pins on the chassis and female connectors on the "D" panel with an approved cleaner, such as General Cement's Chloro-Kleen or Dry-Kleen, that will not react with the PC board or adjacent components. The female connector should be cleaned using an applicator such as a toothpick, and then thoroughly dried.—*Magnavox Service News Letter*

MAGNAVOX T936/956/957

Snivets on the left side of the screen on uhf channels may be caused by a leaky diode D102. This diode is located in the horizontal output section and is in series with the center arm of the high-voltage adjustment control. Replace with diode part No. 530088-1004.—*Magnavox Service News* **R-E**

There are more low-cost Heathkit projects than ever....

starting for as little as $5

These low-cost Heathkit projects represent great values on electronic items you could pay up to twice as much for in assembled form. But they are also great kits for the first-time Heathkit builder, or the youngster who has been wanting to try a sophisticated electronics project. All the kits shown can be assembled in one or two evenings' time with conventional hand tools and a soldering iron. The assembly instructions begin with a quick course in soldering, then take the builder into the famous Heathkit check-by-step assembly manual. After the kit is completed and working, the builder can go on to the circuit description sections which tell him how and why his kit works.

And finally, only Heath gives its customers this unique pledge: "We won't let you fail". If a Heathkit builder has any problem before, during or after assembly, he has a nation-wide technical consultant staff backing him up. These technicians, at the Benton Harbor plant and Heathkit Electronic Centers in major metropolitan areas are the "big brothers" of the Heathkit fraternity. They are always pleased to lend a helping hand.... free.

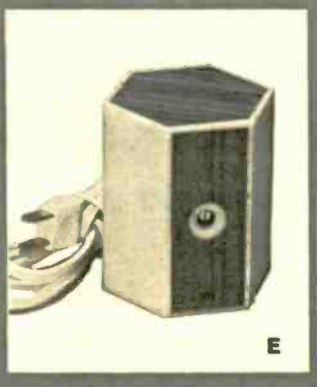
For as little as $5, a Heathkit product could be the most worthwhile investment you'll ever make.


A


B


C


D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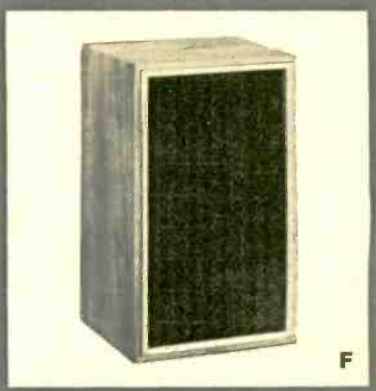
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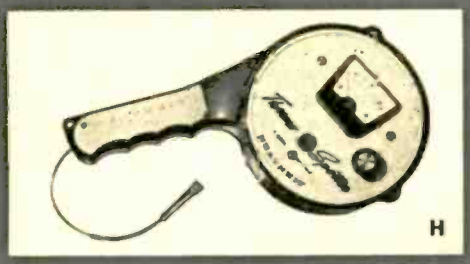


H

A. Heathkit Lamp Dimmer — lets you adjust brightness of table or floor lamps smoothly from full on to complete invisibility. A simple, useful kit, and an interesting introduction to Triac and Diac phase-controlled switches. Handles up to 300 watts.
Kit GD-1018, 2 lbs. 7.95*

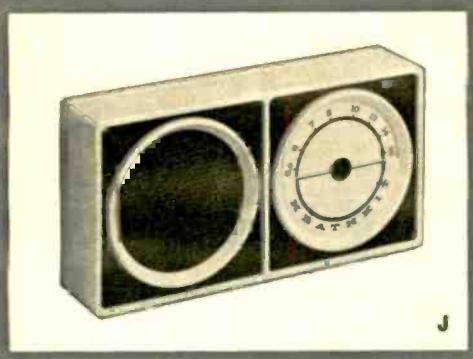
B. Heathkit Tune-up Meter — a 3-in-1 diagnostic instrument for 4-cycle, 3, 4, 6 and 8-cylinder engines having conventional (Kettering) ignition systems. Includes two-range tachometer to 4500 rpm, dwell meter, and voltmeter reading 0-15 volts. Completely portable
Kit ID-29, 5 lbs. 29.95*

I

C. Heathkit Electronic Metronome — provides professional accuracy in tempos from 40 to 210 beats per minute. Has adjustable volume control and includes chart relating tempos in time signatures to beats per minute. Uses two 9-volt batteries (not supplied).
Kit TD-17, 2 lbs. 9.95*

D. Heathkit Cab-to-Camper Intercom — gives instant two-way communication between truck cab and cab-over camper or shell. Great for boats, too. Camper unit has switch position for listening to cab radio. Includes mounting brackets and 15' cable. 12-volt automotive system provides power.
Kit GD-160, 5 lbs. 25.95*

E. Heathkit Photoelectric Lamp Switch — turns on a lamp when you're away. Adjustable sensitivity control lets you set unit to operate at various levels of darkness. No timers to set — electronic circuitry is fully automatic to compensate for changes in daylight hours during the year. Operates on 120 VAC household current.
Kit GD-690, 1 lb. 5.00*



J

F. Heathkit Bookshelf Speaker System — excellent reproduction with any audio system having 4 watts or more per channel. Has 4½" high-compliance cloth-suspension speaker with sealed acoustic suspension cabinet. Measures 12" H x 7" W x 6" D. Useful frequency response extends from 70 Hz to 16 kHz. Order a pair for stereo!
Kit AS-105, 10 lbs. 19.95*

G. Heathkit Code Practice Oscillator — great for beginning and novice amateur radio operators. Has tone and volume controls, built-in speaker, headphone jack, blinker light. Includes key, phone plug, cord. Uses two 9-volt and one "C" battery (not supplied).
Kit HD-16, 3 lbs. 9.95*

H. Heathkit Thermo Fish Spotter — an all-solid-state thermometer with self-contained reel and 100' cable so you can find the depth where your gamefish are likely to be feeding. Kit includes fish temperature preference charts, calibrating thermometer and line depth marking material. Uses one 9-volt battery (not supplied).
Kit MI-104, 3 lbs. 24.95*

K

I. Heathkit 4-Watt Monophonic Amplifier — all solid-state. Excellent frequency response and low distortion. Has inputs for ceramic phono cartridge, mono AM or FM tuner or tape recorder, plus front-panel headphone jack. Drives 4 to 16 ohm speakers.
Kit AA-18, 4 lbs. 19.95*

J. Heathkit Portable AM Radio — tuned-in to today's look, turns on to the sounds of AM. Has big 3½" speaker, RF amplifier stage, automatic gain control — quality features not usually found on portables. Uses one 9-volt battery (not supplied).
Kit GR-1008, 2 lbs. 14.95*

K. Heathkit Telephone Amplifier — lets you carry on conference calls or cook dinner while using the phone. And the special acoustic-coupled design means you can use it with virtually any telephone hand set. Amplifies incoming signal only. Includes speaker and 8' extension cord. Uses one 9-volt battery (not supplied).
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VIDEOPLAYER PROGRESS

Video discs and tape systems for the home continue to be glamour bables of the future in electronics. RCA has lifted the curtain just a little on its plans for its Selecta-Vision videocassette player-recorder. Pilot production will start late this year, but the first units probably won't be on the retail market until early 1975, RCA says. RCA still plans to price the recorder-player attachment with built-in TV tuner at $795. An optional monochrome TV camera will be $300, and blank recording cartridges will be available in 15-, 30- and 60-minute lengths, costing a maximum of $30. RCA will offer a catalog of 100 recorded tapes at the start, available primarily through rental. A feature film will rent for about $10.

MCA Disco-Vision, which demonstrated its laser-scanned video disc for the first time last December, presented a "progress report" demonstration which showed snarply improved pictures and longer playing time. Featured was a 12-inch record which provided 18 minutes of color programming, as compared with seven minutes in the earlier demonstration. The goal is a 40-minute video LP, to go on the market in 1975.

Cassette Sciences also demonstrated a videoplayer—this one designed to play back Super-8 film through home TV sets and to interact with a home computer terminal. Production of the player and the terminal, each costing about $500, is slated to begin late this year or early next. Among the uses cited for the unit are programmed visual instruction and games in which the viewer can compete with the computer. The computer alone, without the videoplayer, can help with such household tasks as checkbook-balancing and homework, will be available to homes at one dollar per hour of actual use. **R-E**

next month

NOVEMBER 1973

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  Make your own hand-held digital electronic timer. Can be built with a 3, 4, 5 or 6-digit readout. The 6-digit version does double duty as a digital clock.

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November issue on sale October 18

(continued from page 42)

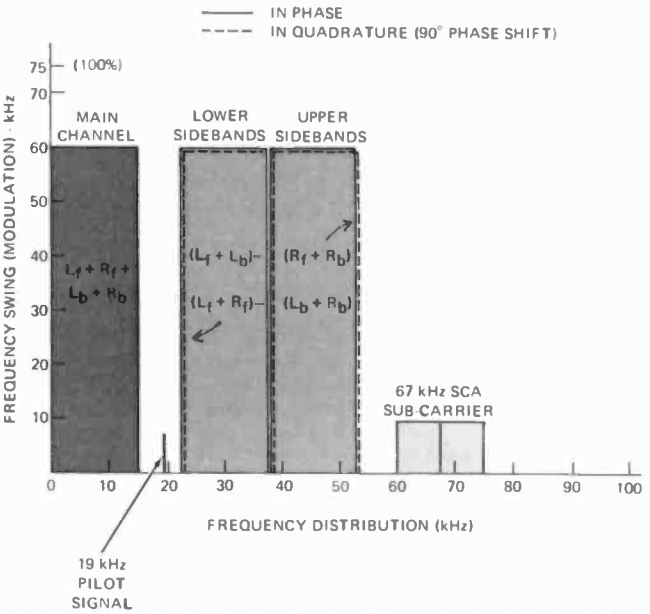

FIG. 6—RCA'S "3 SIGNAL" SYSTEM requires no increased bandwidth, but does not provide total separation between all four channels. SCA remains at 67 kHz.

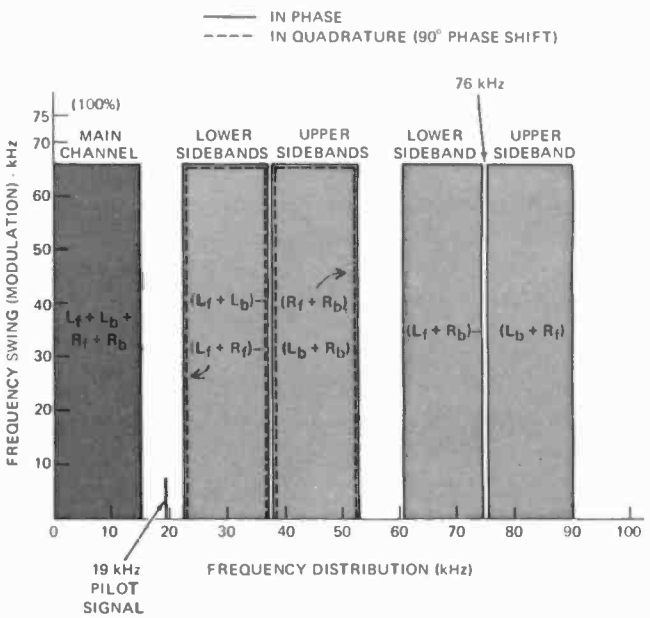

FIG. 7—IN RCA'S ALTERNATE SYSTEM, SCA service is not used. Second subcarrier upper and lower sidebands are transmitted and modulation levels can be somewhat greater.

knowing that a station is broadcasting a matrix disc, unless an announcer indicates that fact.

CBS feels that it would be nice if some sort of indicator light could be activated on a home receiver every time a matrix disc was played. Towards that end, they have proposed that while no major changes need be approved by the FCC for continued transmission of SQ programs, the present unmodulated 19-kHz signal be amplitude modulated by a frequency of 593.75 Hz and that this modulation cause the peak amplitude of the pilot signal to vary by a maximum of 10%.

Since present rules regarding pilot amplitude permit a range from 8% to 10% of total modulation anyway, such amplitude modulation of the pilot signal would not fall

(continued on page 100)

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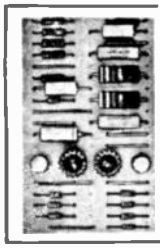
7"	2400' 1.79	5" TAPE REEL ..... .14	
7"	3600' 2.95	7" TAPE REEL ..... .15	



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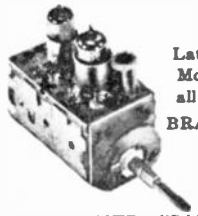

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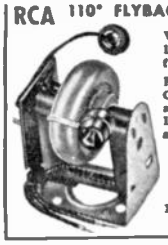

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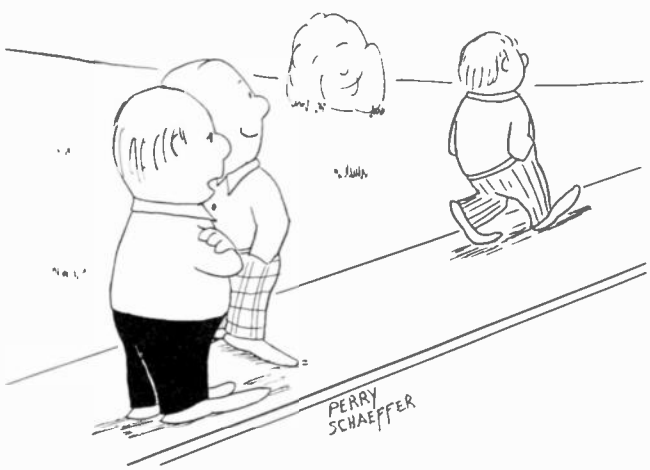
(continued from page 98)

outside these tolerances, and the 593.75 Hz could be detected at the receiver and used to trigger a light or some other indicator every time "matrixed" material were played. In case you're wondering why they chose 593.75 Hz for this modulating frequency—it's because it happens to be the 32nd sub-harmonic of 19 kHz—which was obvious as soon as it was explained!

Tests, timetables and other considerations

At the present time, it would appear that field testing of all of the proposed systems will take place in early 1974—most likely over the facilities of FM station KIOI in San Francisco. Much analytical work remains to be done by the NQRC before that time, and even after the comprehensive field tests are completed, conclusions will have to be reached, data submitted to the FCC, and formal requests for new rule-making will have to be made. If past history is any criterion, the FCC will examine this work very carefully before reaching a decision. Compared to a monophonic broadcast, stereo FM offers approximately 23 dB poorer signal to noise ratios. In strong-signal areas, this has been relatively unimportant, but at greater distances from the transmitter this degradation of S/N often makes stereo listening unacceptable in areas where mono reception is quite satisfactory.

All of the new quadriphonic broadcast proposals, with the exception of CBS (which really involves no new changes) and the RCA three-channel proposal will introduce still further degradation in signal-to-noise ratios. The calculated figures (compared to a monophonic reference) range from 26.2 dB to 30.8 dB, depending upon which system is used. That means a further decrease in signal-to-noise ratio ranging from 3.2 dB to 7.8 dB which can prove to be quite significant. The FCC will not be satisfied with calculated adjacent and co-channel interference figures, but will want to insure proper protection ratios based upon present frequency allocations to FM stations around the country. In short, the job of selecting and approving new standards for quadraphonic FM broadcasting is a complex one—and one not likely to be finished for the next couple of years. While the presence of a new "four-channel decoder jack" on the back panels of some of the latest tuners and receivers seems like a good act of consumer protection, it does not guarantee that the system ultimately chosen will necessarily lend itself to "adapter" packages implied by the presence of this extra jack. While we're waiting, we can all enjoy good stereo FM as well as "matrix" four-channel broadcasts right now. **R-E**



"Ya know, he talks alot of carrier modulation but with very little intelligence."

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Circle 83 on reader service card

Circle 84 on reader service card

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Opto Electronics Sale

LIGHT EMITTING DIODE GaAs INDICATORS

- ☐ 2-MV1*, Amber, visible jumbo epoxy lens upright $1.00
- ☐ 1-MV2*, TO-18, Dome, green, visible 1.00
- ☐ 1-MV-2*, green small dome, green diff. lite 1.00
- ☐ 1-MV-2*, clear small plastic dome, green diff. lite 1.00
- ☐ 1-MV-3*, micro-mini 'pin head' dome, TO18, green lite 1.00
- ☐ 3-MV3*, visible, "coax pin pak", red, mini dome lens 1.00
- ☐ 1-MV4*, stud, high power, red, 2-watts 3.95
- ☐ 1-MV4H*, stud, high power, hi-dome, red, 2-watts 3.95
- ☐ 3-MV10B, visible, red, clear, dome lens, TO-18 ..... 1.00
- ☐ 3-MV10C visible, red, diffused, dome lens, TO-18 ..... 1.00
- ☐ 3-MV50*, axial leads, micro-mini dome, clear, red 1.00
- ☐ 3-MV5012*, visible, red, small dome lens 1.00
- ☐ 3-MV5022*, jumbo red dome, TO-18, visible 1.00
- ☐ 3-MV5020*, jumbo clear dome, TO-18, visible, red 1.00
- ☐ 1-MV5040*, 4-LED red array, with 5-lead pak 1.49
- ☐ 3-MV5054*, visible, red, jumbo dome lens, upright 1.00
- ☐ 2-MV5080*, TO-18, micro-mini, clear dome, red 1.00
- ☐ 4-MV5082, visible, red, clear flat lens, TO-18 ..... 1.00
- ☐ 1-MV5222*, green hi plastic dome, diffused green lite 1.00
- ☐ 1-MV5222*, clear hi dome, diff. green lite 1.00
- ☐ 1-MV5222*, jumbo dome, green, panel snap-in 1.49
- ☐ 1-MV5322*, jumbo dome, GaAsp, panel snap-in Yellow 1.98
- ☐ 1-MV9000*, cartridge panel lamp, sealed, red, clear lens 1.49
- ☐ 2-MT-2*, Photo Transistor, light sensor, TO-18 ..... 1.00
- ☐ 2-ME-1*, infra-red, parabolic lens, pin type 1.00
- ☐ 3-ME-4*, infra-red, "invisible", TO-18, diff. dome 1.00
- ☐ 3-ME60*, infra-red, "invisible", axial, micro-mini 1.00

OPTO-COUPLERS *Monsanto Equivalent

- ☐ MCA2-30* 1500V Photo Darlington Relay $1.00
- ☐ MCD1* 4000V Isolation Photo Transistor 3.95
- ☐ MCD2* 1500V Isolation Photo Diode 1.00
- ☐ MCT1* 4000V Isolation Photo Transistor 4.95
- ☐ MCT2* 1500V Isolation Photo Transistor 1.00
- ☐ MCT2-D* 1500V Isolation Twin Photo Transistor 1.49
- ☐ MCT5-10* 10,000V Isolation Photo Transistor 3.95
- ☐ MCT5-25* 25,000V Isolation Photo Transistor 4.95

1¢ SALE SCHOTTKY TTL IC

	REG.	1¢ MORE
☐ SN74S00	$0.98	2 for .99
☐ SN74S01	.98	2 for .99
☐ SN74S02	.98	2 for .99
☐ SN74S03	.98	2 for .99
☐ SN74S04	.98	2 for .99
☐ SN74S05	.98	2 for .99
☐ SN74S08	.98	2 for .99
☐ SN74S09	.98	2 for .99
☐ SN74S10	.98	2 for .99
☐ SN74S11	.98	2 for .99
☐ SN74S15	.98	2 for .99
☐ SN74S20	.98	2 for .99
☐ SN74S22	.98	2 for .99
☐ SN74S40	.98	2 for .99
☐ SN74S50	.98	2 for .99
☐ SN74S51	.98	2 for .99
☐ SN74S60	.98	2 for .99
☐ SN74S64	.98	2 for .99
☐ SN74S73	1.98	2 for 1.99
☐ SN74S74	1.98	2 for 1.99
☐ SN74S78	1.98	2 for 1.99
☐ SN74S82	1.98	2 for 1.99
☐ SN74S106	1.98	2 for 1.99
☐ SN74S107	1.98	2 for 1.99
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☐ SN74S139	1.98	2 for 1.99
☐ SN74S140	1.98	2 for 1.99
☐ SN74S151	2.50	2 for 2.51
☐ SN74S153	3.98	2 for 3.99
☐ SN74S157	3.50	2 for 3.51
☐ SN74S158	3.00	2 for 3.01
☐ SN74S182	2.50	2 for 2.51

CALCULATOR KEYBOARD

☐ **9.95** 3 for $27

☐ Etched calculator board with holes, as above, less switches ..... $2.50 Board

Properly etched, drilled, "MULTIPLEXED," with proper diodes. Ready to go! Used with our own CAL TECH's 5001 chip advertised at $12.95 or equal to Cal Tech or Mostek chip. Keyboard uses the new manufactured by OAK, printed-circuit low-profile FEATHER TOUCH switches. 0-to-9 in white with black letters. Decimal white with black dot. CE, CL and the 4 function switches are in blue with white characters. Designed by top maker. Size: 6½ x 4½ x ½". All etched connections link to take a 12-pin edge connector.

- ☐ Cal Tech 5001 12-digit calculator 28-pin DIP for $ 9.95
- ☐ Keyboard, 5001 "chip", and 12 MAN-3's, specs $35.00
- ☐ Twelve MAN-3's for above $17.50
- ☐ Twelve MAN-4's for above $32.00
- ☐ Twelve MAN-1's for above $42.00

OAK FEATHER-TOUCH CALCULATOR KEYBOARD SWITCHES

*For RTTY
*Printed Circuits
*For Unique Panel Switches

Mfd. by OAK (Ham's note, RTTY, too) data systems, same as used in Keyboard Calculator, SPST, Normally Open, 24V 1 amp contacts. Characters and letters easily changed, ⅜" high. Printed circuit.

No.	Sale						
☐ 0*	$.49	☐ 5*	.49	☐ CE†	.49	☐ +†	.49
☐ 1*	.49	☐ 6*	.49	☐ CL†	.49	☐ ×†	.49
☐ 2*	.49	☐ 7*	.49	☐ −†	.49	☐ ••	.49
☐ 3*	.49	☐ 8*	.49	☐ + = †	.49		
☐ 4*	.49	☐ 9*	.49				

*White top, black numbers.
†Blue top, white characters.

☐ Kit of 17 above switches for keyboard $7.50

LITRONICS-MONSANTO-OPCOA LED Readouts

All fit 14-pin IC sockets, 5V 10 to 20 mils, 0-to-9 numerals, plus letters & decimal. With spec sheets.
*Monsanto Equal. **MAN-1 Specs. †35-Diode Array.

MAN-1 MAN-2 MAN-3 MAN-4 MAN-5 MAN-8 704 707 SLA-1 SLA-2 SLA-3 SLA-3H

MONSANTO "ALL LED" Type	Size:	Color Display	Decimal	Driver	Each	Special
☐ MONSANTO MAN-1*	.27	Red	Yes	SN7447	4.50	3 for $12.
☐ MONSANTO MAN-2*	.32†	Red	Yes	2513	6.50	3 for $18.
☐ MONSANTO MAN-3*	.115	Red	Yes	SN7448	2.25	3 for $6.
☐ MONSANTO MAN-3*	.115	Red	No	SN7448	1.49	3 for $3.
☐ MONSANTO MAN-4*	.190	Red	Yes	SN7448	2.95	3 for $8.
☐ MONSANTO MAN-4*	.190	Red	No	SN7448	1.79	3 for $5.
☐ MONSANTO MAN-5*	.27	Green	Yes	SN7447	6.50	3 for $18.
☐ MONSANTO MAN-8*	.27	Yellow	Yes	SN7447	6.50	3 for $18.
"REFLECTIVE LITE BAR" (SEGMENT) LED READOUTS! **** Decimal right or left						
☐ LITRONIX 707** (MAN-1)	.33	Red	Yes	SN7447	3.50	3 for $9.
☐ LITRONIX 704*** (MAN-4)	.33	Red	Yes	SN7448	3.50	3 for $9.
☐ OPCOA SLA-1** (MAN-1)	.33	Red	Yes	SN7447	3.50	3 for $9.
☐ OPCOA SLA-1** (MAN-1)	.33	Red	No	SN7447	1.95	3 for $5.
☐ OPCOA SLA-3H Giant Digit	.70	Red	Yes	SN7447	8.60	3 for $24.
☐ OPCOA SLA-2 Plus/Minus/1	.33	Red	No	SN7447	3.50	3 for $9.
☐ OPCOA SLA-11C (MAN-5)	.33	Green	****	SN7447	4.95	3 for $13.
☐ OPCOA SLA-12 Plus/Minus/1	.33	Green	—	SN7447	4.95	3 for $12.

ALLEN BRADLEY 'TRANSISTOR' POTS

Type F. Screwdriver adjust. **Any 4 for $1**

Ohms			
☐ 75	☐ 7.5K	☐ 75K	
☐ 100	☐ 10.0K	☐ 100K	
☐ 200	☐ 20.0K	☐ 200K	
☐ 250	☐ 25.K	☐ 250K	
☐ 500	☐ 50.K	☐ 500K	
☐ 750	☐ 75.K	☐ 750K	
☐ 1.0K	☐ 100K	☐ 1 Meg	
☐ 2.5K	☐ 250K	☐ 2 Meg	
☐ 5.0K	☐ 5 Meg		

ALLEN BRADLEY 'MICRO-POTS'

Type G. 1/2" dia. x 1/2" high. Mounts 1/4" hole, with shaft, linear immersion-proof high freq. **2 for $1**

Ohms			
☐ 75	☐ 2.5K	☐ 25.K	
☐ 100	☐ 5.0K	☐ 75.K	
☐ 500	☐ 7.K	☐ 100.K	
☐ 2.0K	☐ 10.K	☐ 5 Meg	
	☐ 20.K		

We stock Locknut Bushing & Screwdriver types at same low prices.

12-DIGIT "CALCULATOR CHIP"

☐ CT5001 Chip ☐ **9.95** 3 for $27.

Similar to Mostek 5001. Outperforms Texas 8-digit TMS1802. A 40-pin DIP. Adds, multiplies, subtracts, and divides. Use with 7-segment readouts, Nixies, and LED's. We include schematics, instructions to build calculator.

- ☐ CT5002-9 Volt version of above — $9.95
- ☐ CT5005-Same as above with MEMORY — $14.95

NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Any "Chip" ☐ **$12.88**

*Money Back Guarantee!

Mfrs #	Description	Sale	
☐ 5311	28-pin, ceramic, any readout, 6-digits: A-B-D	$12.88	*With
☐ 5312	24-pin, ceramic, any readout, 4-digits: C-D	$12.88	Spec
☐ 5313	28-pin, ceramic, any readout, 6-digits: A-C	$12.88	Sheet!
☐ 5314	24-pin, plastic, LED and incandescent readouts, 6-digits: A-B	$12.88	Save!

Code: A—Hold Count. C—1 PPS Output. B—Output Strobe. D—BCD

NATIONAL MM5316 EQUAL "ALARM CLOCK ON A CHIP"

☐ Only **$14.95**

MOS 40-pin dip IC. Four display modes time, seconds, alarm and sleep, for a variety of digital clocks. Interfaces directly with 7-segment flourescent and liquid crystal displays. Requires single power supply. 12 or 24 alarm setting, featuring 9-minute SNOOZE ALARM and pre-settable 59-minute sleep timer. Low power dissipation only 32mw @ 8V. Operates from 8 to 29 volts. NO REGULATION REQUIRED! Only needs 4-digits. Has seconds provisions, with instant press of button. Has many, many features. The only ALARM CHIP on the market today at this low Poly Pak price. With 5 pages of tech. info, plus applications.

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Over 50,000 pieces purchased from SPRAGUE ULX2137. Designed for superhet AM radio applications Contains two amplifiers, a mixer oscillator, agc detector, and voltage regulator on a single chip. It's inflation-fighting, economy priced because we can't test 'em! With spec sheets and diagrams. 14-pin dip pak. Supply Vcc 14. Money back guarantee.

HOBBY EXPERIMENTAL "LED" KORNER

- ☐ 3-MAN-3* "The claw", some segments missing, hobby use, readout $1.00
- ☐ 1-MAN-*4 some segments missing, hobby use, readout 1.00
- ☐ 1-SLA-7 Opcoa's MAN-1, 1-segment missing 1.49
- ☐ 1-SLA-7 Opcoa's MAN-1, hobby, some segments missing 1.00
- ☐ 10-LED HOBBY SURPRIZE! asst. types, no-test 1.00
- ☐ 5-MONSANTO's Opto Coupler surprise, asst. no-test 1.00
- ☐ 3-PC. KIT, MAN-1, MAN-3, MAN-4, some segments missing 1.49
- ☐ 1-SLA-13H Opcoa, giant 0.7 character readout, some seg missing 1.49
- ☐ 1-SLA-11 Opcoa, like MAN-1, green, some seg missing, readout 1.49
- ☐ 2-SPERRY SP332, twin-digit, factory fallouts, no test 1.00

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.

Each digit is 7-segment LED (MAN-3 type) and internally "multiplexed" and driven by one SN7448. Made by OPTORAY, ONDC-13, 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.

3 LED DIGITS ON A DIP ☐ **$8.88**

LED MITY DIGIT "DCM'S"

*Your choice of 5 red LED readouts!

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Scientific Devices "Digital Counting Modules" outperform any other DCM on the market today. More features than ever before! Not gaseous, not incandescents, not nixie but the modern LED. Choose from such famous manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes 3x2" p.c board with fingers for a FREE edge connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's), and booklet. INCLUDES P.C. EDGE CONNECTOR — FREE!

READOUT	Char.	Maker
☐ 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

POLY PAKS STOCKS "C-MOS" IC CIRCUITS

Type	Sale
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☐ 74C04	1.15
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☐ 74C76	1.79
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☐ 74C161	3.50
☐ 74C162	3.50
☐ 74C163	3.50
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RCA TYPE "C-MOS" IC's

Type	Sale
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☐ CD4009AE	1.69
☐ CD4011AE	.71
☐ CD4012AE	.71
☐ CD4013AE	1.62
☐ CD4016AE	1.62
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PRV	15 amp	25 amp
50	☐ $.65	☐ $.85
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200	☐ 1.25	☐ 1.45
300	☐ 1.45	☐ 1.65
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600	—	☐ 2.65

9 DIGI-METER READOUT FOR PANEL INDICATION

☐ Only **$18**

Imagine! Nine 7-segment MAN-3's mounted in a red plastic molded 2½" x 1" x ½" meter like case. Each group of MAN-3's are multiplexed internally on dip substrate red epoxied then mounted on a multiplexed substrate that holds 3 dips, each consisting of 3 MAN-3's. Then connected to 19 fingers and 19 external connecting pins. Attractive panel-like construction lends itself to 1000's of panel mounting DIGI-METER READOUT applications. Complete with instructions. Mounts easily in Molex sockets, with spec sheets.

MUX'D DIGITAL CLOCK PC BOARD

Your choice **$2.50**

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*)

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

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7403	.25	7446	1.45	7496	1.05
7404	.29	7447	1.45	74121	.55
7405	.27	7448	1.50	74123	1.15
7406	.55	7450	.29	74145	1.25
7408	.29	7451	.32	74151	1.05
7409	.29	7453	.32	74153	1.45
7410	.25	7460	.30	74154	1.75
7411	.35	7470	.50	74155	1.35
7413	.95	7473	.55	74157	1.50
7420	.25	7474	.55	74161	1.65
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LM304	T05	1.25	LM320 -15	T05	1.95
LM305	T05	1.25	LM380	Dip	1.75
LM307	T05	.45	LM3900	Dip	.50
LM308	T05	1.25	LM709	T05-Dip	.29
LM309K	T03	1.95	LM723	Dip	.75
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MV50 type red emitting .25 ea 5/$1.00
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ME4 Infra red T018 .69 ea
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MAN 3 type 1.95 ea 3 or more 1.49 ea
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Test them yourselves and save

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15 Assorted DTL or TTL dip package
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Satisfaction guaranteed. All items except as noted are fully tested. Minimum order $5.00 prepaid in U.S. and Canada. Calif. residents add sales tax. Orders filled within 3 days after receipt. Please add $.50 per spec sheet for items priced at less than $1.00 ea.

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Circle 87 on reader service card

BUILD IC designs quickly and economically. Illustrated manual describes breadboard system: Layout, construction, solderless wiring, making changes. No specialized "breadboard" components required. Permanent results. $4.95 Postpaid. **MP PUBLISHING CO.,** 16 Channing Road, Belmont, Mass. 01278

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115 VAC input. Output 70 VCT at 3 amps. Makes a mignificent power amp.
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LM 309K $2.00
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PA264 5 watt up to 25 volt regulator 1.25
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709 OP AMP TO-5 3/$1.00
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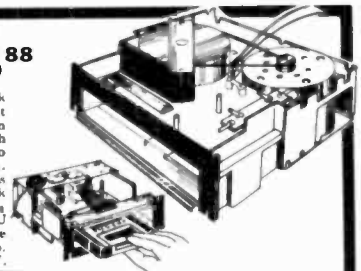

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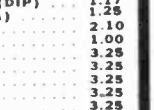

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800	☐ .15	☐ .15	☐ .39
1000	☐ .18	☐ .18	☐ .45

EPOXY FULL WAVE SILICON BRIDGE RECTIFIERS

PIV	2 Amp	6 Amp
50	☐ $.69	☐ $.88
100	☐ .79	☐ .99
200	☐ .95	☐ 1.25
400	☐ 1.19	☐ 1.50
600	☐ 1.35	☐ 1.75
800	☐ 1.59	☐ 1.95
1000	☐ 1.79	☐ 2.25

Code: 2 amp TO-5 case
6 Amp ½ x ½ x 3/16 sq

Terms: add postage Rated: net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

POLY PAKS

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MAN 3

- 0.127" HIGH LED 7-SEGMENT
- DISPLAYS ALL NUMBERS AND NINE LETTERS
- COMPACT SPACING - 5 PER INCH
- BRIGHT RED 400FT-L AT 10 MA PER SEGMENT

EACH.....$2.50
TEN OR MORE FOR .. 2.00

METAL CASE TRANSISTORS-ALL ARE MARKED (MOST ARE HOUSE NUMBERED) ALL ARE GOOD UNITS AND HAVE GOLD PLATED LEADS. PRIME CONDITION ..... SATISFACTION GUARANTEED

1 OUNCE- **$1.50** (40+) TRANSISTORS

RCA 2010

NUMITRON DIGITAL DISPLAY TUBE, INCANDESCENT FIVE VOLT SEVEN SEGMENT

- .6" HIGH NUMERAL VISIBLE FROM 30 FEET
- STANDARD NINE PIN BASE (SOLDERABLE)
- LEFT HAND DECIMAL POINT

EACH $ 5.00
5 FOR $20.00

CT5005

A SINGLE MOS CHIP WITH ALL THE LOGIC NECESSARY FOR A - TWELVE DIGIT - FOUR FUNCTION CALCULATOR WITH AN EXTRA STORAGE REGISTER FOR CONSTANT OR MEMORY APPLICATION
..28 LEAD DIL PACKAGE..

- CAPABILITIES(+,-,X,÷)
- CHAIN CALCULATIONS
- TRUE CREDIT BALANCE SIGN DISPLAY
- AUTOMATIC KEYBOARD DEBOUNCE
- SINGLE VOLTAGE SUPPLY IS POSSIBLE

COMPLETE WITH DATA $14.95
DATA ONLY..... 1.00
(REFUNDABLE WITH PURCHASE OF CHIP)

CT5001 40-PIN

- ADD, SUBTRACT, MULTIPLY, AND DIVIDE
- 12 DIGIT DISPLAY AND CALCULATE
- CHAIN CALCULATIONS
- TRUE CREDIT BALANCE SIGN OUTPUT
- AUTOMATIC OVERFLOW INDICATION
- FIXED DECIMAL POINT AT 0, 2, 3, OR 4
- LEADING ZERO SUPPRESSION

DATA ONLY.....1.00
(REFUNDABLE WITH PURCHASE OF CHIP)
COMPLETE WITH DATA .....$ 9.95

General Telephone KEYBOARD

TOUCH-TONE ENCODING PROGRAMMING DEVICES.10 PUSH BUTTONS 0-9

SIZE: 3X2½X1"

ONLY $5.95

NATIONAL/MOS

DYNAMIC SHIFT REGISTERS TO-5

MM502	DUAL 50	BIT	1.25
MM506	DUAL 100	BIT	1.75
MM5006	DUAL 100	BIT	1.50
MM5013	1024	BIT	2.25
MM5016	512	DIL	1.50

STATIC SHIFT REGISTERS

MM504	DUAL 16	BIT	1.50
MM505	DUAL 32	BIT	1.75
MM550	DUAL DIFFERENTIAL ANALOG SWITCH		2.50

7400 TTL DIP

7400	.35
74H00	.50
7401	.35
74H01	.50
7403	.35
7404	.35
74H04	.50
7405	.35
74H05	.50
7412I	1.60
7413	1.15
7410	.35
7420	.35
74L20	.50
74H20	.50
74H22	.50
7430	.35
74L30	.50
7440	.35
74H40	.50
7441	1.60
7442	1.30
7446	1.75
7447	1.75
7448	1.15
7450	.35
7451	.35
74H51	.50
7453	.35
74H53	.50
7454	.35
74L54	.50
7460	.35
74L71	.30
7472	.50
74L72	.60
7473	.65
74L73	.90
7474	.65
74L74	.90
74154	2.50
7476	.70
7480	.65
74192	2.50
7491	1.15
7492	1.15
7493	1.15
7495	1.25
74L95	2.00
74107	.70
74H30	2.00
74123	2.00
74193	1.50
74195	1.10
7483	1.30

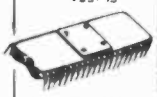
ERIE CER. DISC. CAP.

.05 25V 10/1.00
.01 200V 15/1.00

CT5002

BATTERY POWERED VERSION OF THE CT5001 LOW POWER. COMPLETE WITH DATA.

$13.95



LINEAR SPECIAL

TEN 741 FULLY COMPENSATED OP AMPS WITH DATA SHEETS
8-PIN DIP ONLY
TEN FOR $3.75
EACH .45

TRIAC

2N6344 600V 8A
TO-220 $1.00

ZENER DIODES 1W

IN4651	3.9V
IN4735	6.2V
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EACH	$ .50

SEND FOR FREE FLYER

ALL IC'S-NEW AND FULLY TESTED, LEADS PLATED WITH GOLD OR SOLDER. ORDERS FOR $5.00 OR MORE ARE SHIPPED PREPAID, SMALLER ORDERS---ADD 35¢. CALIFORNIA RESIDENTS ADD SALES TAX...IC'S SHIPPED WITHIN 24 HOURS

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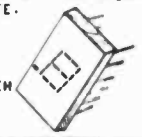
MAN 4

SEVEN SEGMENT, 0-9 PLUS LETTERS. RIGHT HAND DECIMAL POINT. SNAPS IN 14-PIN DIP SOCKET OR MOLEX. IC VOLTAGE REQUIREMENTS. IDEAL FOR DESK OR POCKET CALCULATORS!

EACH.....$ 3.00
TEN OR MORE..$25.00

MAN 1

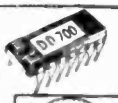
SEVEN SEGMENT, 0-9 PLUS LETTERS. SNAPS IN 14-PIN DIP SOCKET OR MOLEX. OPERATES WITH IC VOLTAGE REQUIREMENTS. LONG OPERATING LIFE.



$4.00 EACH

GIANT "NIXIE"

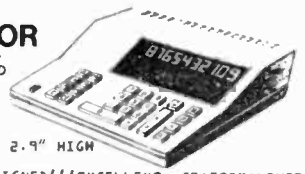
COMES COMPLETE WITH SOCKET AND DD700 202 NUMERIC DRIVER. READABILITY IN HIGH AMBIENT LIGHT...200 FOOTLAMBERTS BRIGHTNESS!! ALL DC OPERATION. LONG LIFE WITH NO LOSS OF BRIGHTNESS. COMPATIBLE WITH CONVENTIONAL SOLID STATE CIRCUITRY.



ONLY $2.25

THESE WERE USED IN THE NEW YORK STOCK EXCHANGE

TABLE TOP CALCULATOR CASE + KEYBOARD



11" WIDE X 10.5"X 2.9" HIGH

ATTRACTIVELY DESIGNED!!!EXCELLENT CRAFTSMANSHIP. CASE AND KEYBOARD (DESIGNED AS ONE UNIT). CABINET IS MADE OF HIGH-IMPACT PLASTIC BEIGE COLOR WITH BLACK BEZEL AND AMBER WINDOW. KEYBOARD CONSISTS OF A 3 POSITION SLIDE SWITCH AND 25 KEYS, 5 OF WHICH ARE USED FOR MEMORY FUNCTION. 20 KEYS GRAY, 5 KEYS ORANGE. ALL KEYS MOUNTED ON ONE PRINTED CIRCUIT BOARD.....

THIS MODULAR UNIT IS WELL SUITED FOR OUR CALCULATOR CHIPS. IDEAL FOR THE CT5005

CASE AND KEYBOARD COMPLETE ONLY $29.95

MEMORY SALE!!

256X1 BIT RANDOM ACCESS MEMORY FULLY DECODED - TTL COMPATIBLE INPUT AND OUTPUT. NO CLOCK OR REFRESH REQUIRED.

INTEL 1101 MOS

16 PIN DIP EACH $ 2.56
1¢ PER BIT 10 FOR 22.56

POWER SUPPLY

723 T (TO-5) VARIABLE REGULATOR CHIP 1-40V.+ OR - OUTPUT @150MA 10A WITH EXTERNAL PASS TRANSISTOR WITH DIAGRAMS FOR MANY APPLICATIONS.

EACH .75
10 FOR $5.95

RECTIFIERS

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VS647 2A	600V		1.10
35A STUD	400V		1.10
MR810	50V	1A	.10
IN4997	50V	1A	.10
IN4001		1A	.10
IN4002		1A	.11
IN4003		1A	.12
IN4004		1A	.13
IN4007		1A	.17

SCR's

IR122	100V	6AMP	.50
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IR122	300V	6AMP	.80
IR122	400V	6AMP	1.00

LINEARS

NE531	OP AMP TO-5	$2.00
NE555b	OP AMP DIP	1.00
NE560	PHASE LOCK LOOP DIP	3.25
NE561	PHASE LOCK LOOP DIP	3.25
NE565	PHASE LOCK LOOP TO-5	3.25
NE566	FUNCTION GENERATOR TO-5	4.00
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LM309K	5V-1A POWER SUPPLY MODULE TO-3	2.00
LM311	COMPARATOR TO-5	1.75
LM380	2W AUDIO AMP DIP	1.75
LM703	RF-IF AMP EPOXY TO-5	1.00
709	POPULAR OP AMP DIP	.45
710	VOLTAGE COMPARATOR DIP	.75
711	DUAL COMPARATOR DIP	.40
723	PRECISION VOLTAGE REGULATOR DIP	1.00
747	DUAL 741 OP AMP DIP	1.00
748	OP AMP TO-5	1.00

LED's

		EACH	TEN FOR
ME3	INFRA-RED	.40	
ME4	INFRA-RED TO-46 DOME	.30	10/2.50
ME5	INFRA-RED	2.95	
ME5040	5 LEAD EPOXY-RED ARRAY	1.25	
ME 60	INFRA RED MICROMINI DOME	.25	5/1.00
MV1	AMBER TO-18 DOME 70MA 2V	1.00	
MV2	GREEN TO-18 DOME	1.00	
MV4	HIGH POWER RED	2.95	
MV108	RED TO-18 DOME	.30	10/2.50
MV50	RED MICROMINI	.25	5/1.00
MV5024	RED TO-18 HIGH DOME	.75	10/6.50
MV5080	RED TO-18 MICROMINI DOME	.40	10/3.50
CLEAR LENS .2" HORIZONTAL RED BAR		1.25	

Circle 89 on reader service card

JAPANESE transistors, wholesale prices, free catalog. **WEST PACIFIC ELECTRONICS,** Box 25837, W. Los Angeles, Calif. 90025

NAME brand digital test equipment, discount prices. Free catalog and price list. **SALEN ELECTRONICS,** Box 82, Skokie, Ill. 60076

WHOLESALE prices on electronic parts. Large discounts. Free catalog. **DONLYN ELECTRONICS,** 2217 North 24th Street, Phoenix, Arizona 85008

TUNERS repaired realigned and neutralized by specialists. UHF or VHF $9.75, combo $15.00. Major parts extra. Ship to: **RAINBOW TUNER LABS,** 4158 Greeby St., Phila., Pa. 19135.

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AUDIO components, TV's, calculators, test equipment. **List of wholesalers** $3. **AUDIO-SALES,** Box 39R, Bluepoint, N.Y. 11715

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MULTIMETER repair and calibration. Repair and some calibration on all other types of electronic equipment. For more information write: **OMEGA ELECTRONICS, INC.** 714 15th Street, Bedford, Ind. 47421

VOM's and VTVM's repaired and calibrated-reasonable rates, expert service, Free estimates before repair. Ship to: **R & R ELECTRONICS,** 4330 Washington Ave., Houston, Tex. 77007

F.C.C. EXAM MANUAL

PASS FCC EXAMS! Memorize, study—"1973 Tests-Answers" for FCC First and Second class Radiotelephone licenses. Newly revised multiple-choice questions and diagrams cover all areas tested in FCC exams.—plus—"Self-Study Ability Test." $9.95 postpaid.

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RADIO ENGINEERING DIVISION • SAN FRANCISCO, CALIF. 94126

MORE BARGAINS IN SURPLUS ELECTRO-OPTICS from B & F ENTERPRISES

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

NICKEL CADMIUM BATTERIES

- ☐ 0.5 ampere hour 1.25 volt sealed button cell ..... 2 for $1.00
- ☐ Vented 4.0 ampere hour cell, plastic case $2.75
- ☐ 24 volt pack, sealed cells, mfg sonotone, size 12" x 1¼" x 1¼" capacity 0.6 ampere hours $11.75

MOLEX SOLDERCON CONNECTIONS

Molex soldercon connections for I.C's. With these you can build low cost I.C. sockets by just cutting off the number of connections required, i.e., two strips of seven for 14 pin socket.

- ☐ 500 Molex soldercon $4.75
- ☐ 1000, Molex Soldercon $7.50

LED READOUTS

Popular OPCOA SLA-7, without decimal point. 0.27" numeral height, we formerly sold these at $4.25, and they sold extremely well. Because of a fortunate purchase we can offer them at a super-low price. Use for clocks, counters, calculators

SLA-7 Readouts $2.50

GIANT NIXIE TUBES ALPHANUMERIC

Burroughs B7971 alphanumeric nixie tube. Giant 2½" character height. Forms all letters of the alphabet, and numerals 0 thru 9. Consists of 15 segments in "star" matrix. When used as numeric display only, it is wired as a seven segment display, requires 170 volts D.C. This is the same unit we use in our Giant Clock.

B7971 tube, brand new with used socket $7.50
B7971 tube, removed from equipment $2.50
Socket for above (only with tube) ..... $.50
4 for $7.50

LOW COST/HIGH QUALITY COPY LENSES

We have two new lenses available, both in production quantities. Excellent for opaque projectors, copy cameras, and inexpensive enough to have around the lab for all kinds of optical breadboarding.

Copy Lens 1, 1¾" dia. mount, 4½" focal length, speed F 5.6. Covers 5" x 5", 9 x 9 at 1:1 conjugates. Manufactured by Ednalite.

LCEO 1 ..... $6.00

Copy Lens 2, 2-1/16" dia. mount, 9½" focal length, speed F 5.6. Covers 9 x 9 inches at infinity, 14 x 14 at 1:1 conjugates. Manufactured by Ednallte.

LCEO 2 ..... $9.00

Both lenses for $13.50
Two(2) of each type for $25.00

POWER RESISTOR ASSORTMENT

We are always getting requests for power resistors to use in testing amplifiers, power supplies, etc. This is an assortment of resistors of various values ranging in power from 5 watts to 100 watts. If you use just one, it is easily worth twice the cost of the entire assortment.

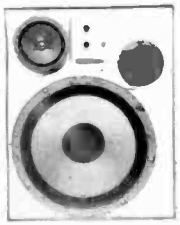
Sh.Wt. 2 lbs.	PRA (10)	$1.00
6 bags of 10	6PRA (10)	$5.00/6

2.25 AMPERE VARIAC

This is a useful item to have for variable power supplies, testing, heater control, etc. 0-115 vac in, 0-130 volts out. Removed from equipment ... $6.00

Add $1.00 for postage and handling.

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.

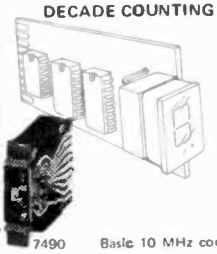
Tesla coils are patterned after the design of Nikola Tesla (1857-1943) an American electrical genius who built versions many feet tall. His dream was to light and power entire cities with energy radiated from such coils – but no luck!

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!

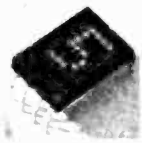
Like-new assembly surplus from the I.B.M. Company contains the following: (6) 150-Watt transistors, (6) heat sinks, (6) 1Ω 5W resistors, 12V, 20 Amp circuit breaker, a 16-ohm 10-Watt resistor, 50-Watt resistor, terminal strip, (2) 16-pin P.C. edge connectors for regular cards. An 8000 mfd, 15V computer 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.

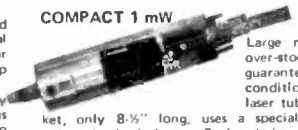
HEWLETT PACKARD SOLID STATE NUMERIC INDICATOR



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



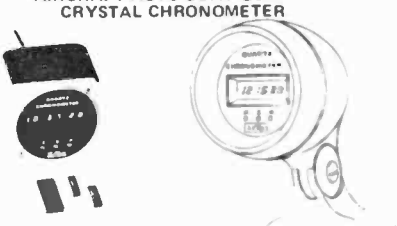
Large manufacturer sells his over-stock tubes to us, all guaranteed to be in perfect condition. Most compact 1mW laser tube (TEM.) on the market, only 8-½" long, uses a special tapered bore design, unique in the industry. Cavity design, internal hemispherical mirror system with co-axial mounting of all 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 to 9 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.

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Phone (617) 531-5774
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Circle 90 on reader service card

ADVERTISING INDEX

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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.

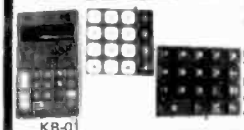
1. 5314 chip (24 pin plastic) used for 7 segment displays such as LED's, numitrons, minitrons and Sperry displays. Price $9.95
2. 5311 chip (28 pin ceramic) includes BCD output to above for interface to nixies, computer inputs, etc., in addition to 7 segment outputs. Price $14.95

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 callbrator and heat oscillators permit fast alignment.

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

RT 270A/GRC
Used, excellent, less crystal $20.00
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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

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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
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Arles/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:

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- 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

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

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

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 (Cinch)
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) 22½ 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.

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

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- ☐ 4002AE Dual 4 Input Nor $ .99
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- ☐ 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

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

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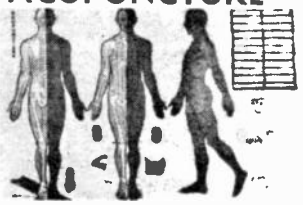

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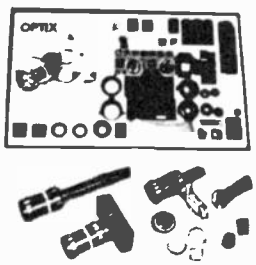

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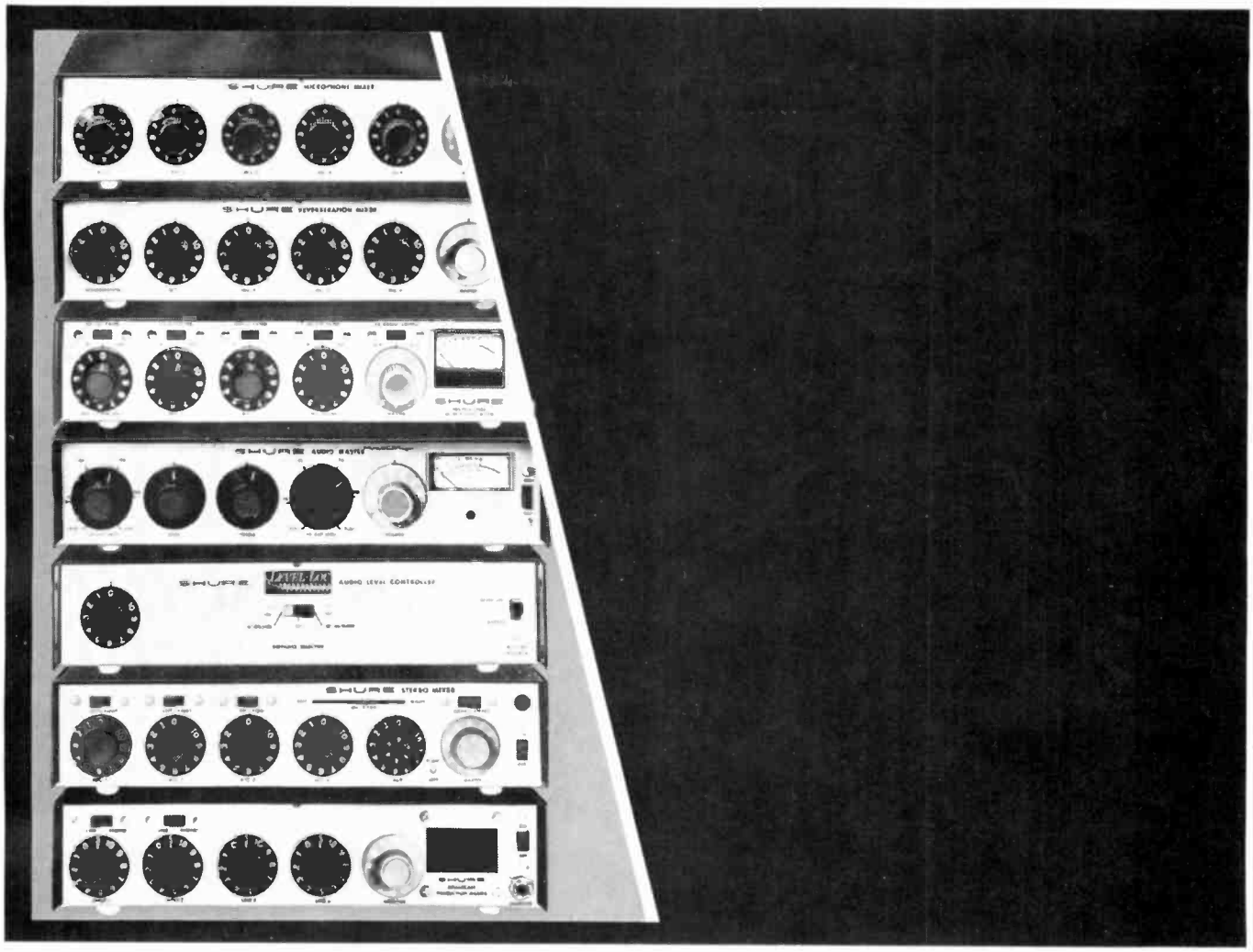

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