SPECIAL ISSUE: STEREO-4-CHANNEL-HI-FI

75¢ ■ OCT. 1974

Radio-Electronics

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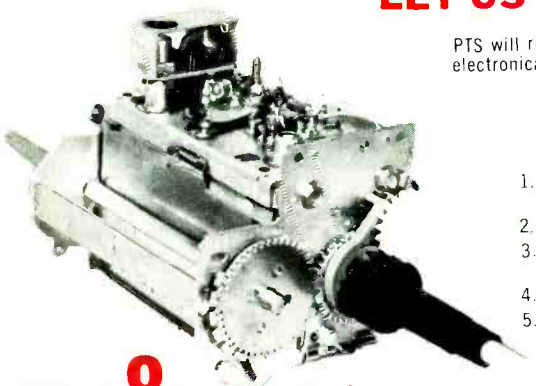

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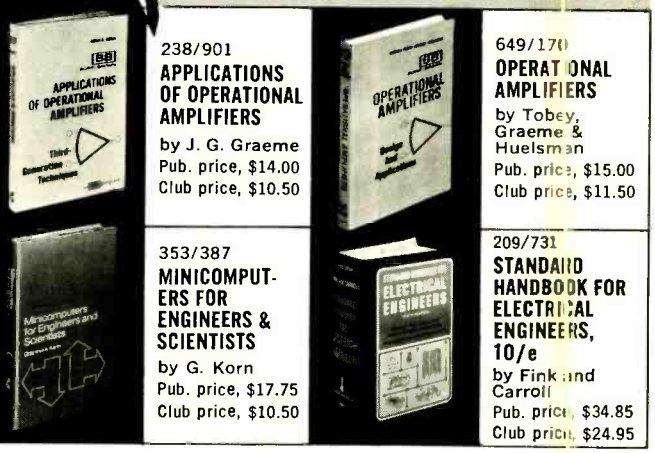

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Circle 2 on reader service card

In the beginning there was foldedhornbassreflexacousticsuspension.

And now BIC VENTURI

For about 40 years, speaker designers have been juggling the characteristics they wanted from speakers: Compact size, high efficiency, high power-handling, and deep ranging, pure, clean, gut-reaction bass.

They tried folded horns: efficient, clean, good power-handling, but too large for most homes, quite expensive. They tried the bass reflex: Efficient, compact, but limited by uneven, one-note bass. Ditto the labyrinth, but far less efficient.

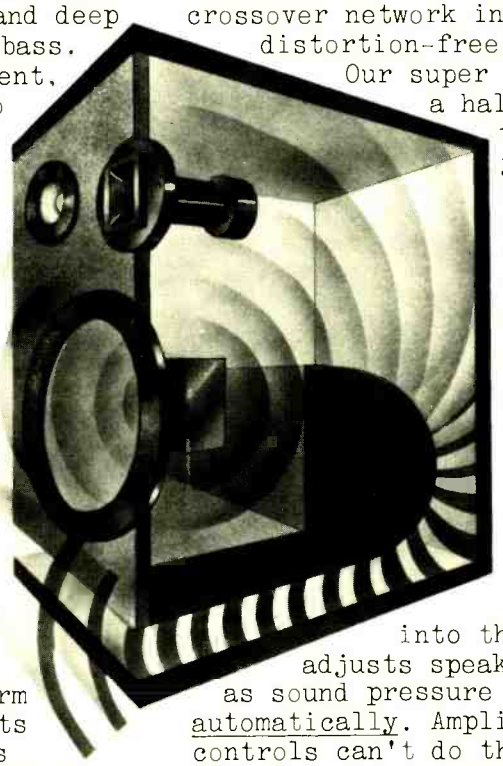
Today's favorite, the acoustic suspension: Compact, smooth, deep-ranging bass. But inefficient (requiring costly, high-powered amplifiers) and limited dynamic range.

A virtue here, a virtue there -- but all with corresponding compromises.

Ironically, the principle that combines these objectives into one compact cabinet has been around for some 180 years: The VENTURI principle of fluid motion transformation, reapplied in a form better suited to acoustics (patents pend). Our simplified diagram shows how the scientifically formulated VENTURI coupled path functions as a step-up transformer. Up to 140 times more bass energy comes from the duct than comes directly from the woofer. And bass is reinforced broadly over the low frequency spectrum, not at a single "tuned" frequency.

The BIC VENTURI coupled path also operates as a low pass acoustic filter, cleansing harmonics and distortion components from the bass waves. So, the bass not only goes down further and is louder, it's cleaner and more natural. And requires a fraction of amplifier power of other speakers of comparable size and performance. Yet, even though BIC VENTURIS need less amplifier power, they can handle more. This new principle eliminates compromises in cone, suspension and magnetic design to "match" cabinet characteristics.

Above the woofer, you can see our midrange. To match the exceptional high efficiency of the bass section, we had to invent a new horn, combining two different types of flare, conical and exponential, BICONEX™ (pats pend). It provides wide, smooth dispersion in both horizontal and vertical planes, so placement in the home won't be critical. BICONEX covers the full midrange to well beyond 15,000 Hz without crossover network interruptions, for distortion-free, smooth response.



Our super tweeter handles just a half octave from 15,000 to over 23,000 Hz. While you can't hear single frequency tones in that range, the accuracy of musical "timbre" depends upon those frequencies being added in proper proportion to the complex tones you do hear. An important subtlety.

Because you hear less bass and treble at low and moderate levels, we built a DYNAMIC TONAL COMPENSATION circuit (patents pending) into the speaker. It adjusts speaker frequency response as sound pressure output changes, automatically. Amplifier "loudness contour" controls can't do that. Result: aurally "flat" musical reproduction always, regardless of volume control settings.

Our Formula 2 is the most efficient speaker system of its size, yet can be used with amplifiers rated up to 75 watts per channel! Formula 4 has deeper bass and can be used with amplifiers up to 100 watts. Formula 6, the most efficient, will handle 125 watts. The Formula 1, newest and smallest model, handles up to 50 watts and needs only a few watts input for clean, high level sound. Hear them at franchised BIC VENTURI dealers. Or write for brochure: BRITISH INDUSTRIES CO., Westbury, N.Y. 11590, Div. of Avnet, Inc. Canada: C. W. Pointon, Ont.

B·I·C VENTURI

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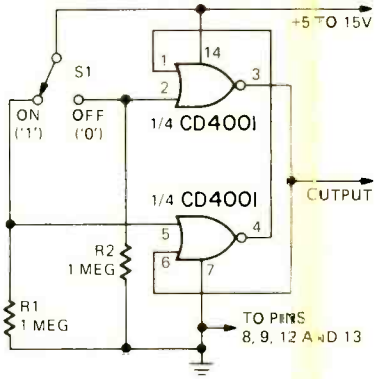
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

OCTOBER 1974 Vol. 45 No. 10

ON THE COVER

This tiny PC board is an advanced SQ decoder you can build for less than $40.00. Circuits and all you need are in the article beginning on page 33.



EXPERIMENT WITH COSMOS IC's. You'll learn how to use this "bounce-less" switch in Part II of Marston's "40 COSMOS IC Projects." For retails on this and other useful and interesting circuits

. . . turn to page 51

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looking ahead

Projection TV boom?

Big-as-life and bigger-than-life color TV pictures may become the next major trend in top-of-the-line receivers. Advent Corporation's giant-screen VideoBeam home color projection system (**R-E**, May 1974) was warmly received by dealers attending the Consumer Electronics Show in Chicago, despite its $2495 retail price tag, and 750 retailers have applied for franchises to sell it.

But Video Beam (see "Video-Beam Projection Color Receiver," **Radio-Electronics**, May 1974) may be only the first in a family of mammoth-screen home TV sets. At least three others are in the works, one of them scheduled for introduction by next spring. Meanwhile, Advent's three-projection-tube set is in production, and about 200 have already been delivered. By year's end Advent says it will be producing at a 10,000-a-year rate at its Cambridge, Mass. plant.

A new projection TV system, which can provide pictures as large as VideoBeam's 4¼-by-5⅔ feet was unveiled at the Consumer Electronics Show. Developed by three New York inventors who call themselves Shannon Communications, its heart is a computer-designed system of five plastic lenses designed to be coupled to the screen of a portable color set. As demonstrated, using a 12-inch Sony as the light source, the picture wasn't as bright as Advent's, but satisfactory for viewing in a darkened room.

Shannon Communications says its color TV projection system could easily be retailed at less than $900, including the TV set and the curved, reflective screen. Shannon says the projection set could be "convertible"—that is, the portable could be used as a direct-view conventional set, or, with the lens system attached, as a projector. The set must be equipped with a switch to invert the picture for projection. Shannon also suggests that the brightness of its projected picture could be stepped up through the use of higher voltage and a picture tube modified for projection.

There currently are no plans for production of the Shannon system, but several American, Japanese and European television manufacturers are said to be interested.

The next home TV projector on the market could be a consumer version of Sony's industrial-educational system now sold as an adjunct to its videocassette recorder. Unlike Sony's existing projector, the consumer version is expected to be a single furniture unit, combining screen and projector, the latter swinging outwards to provide the proper throw distance. Sony's home unit is expected to have a smaller screen than the Advent and Shannon systems—somewhere between 30 and 40 inches in diagonal measurement. Like Shannon, Sony uses a color set as light and picture source.

General Electric, too, is exploring home projection color systems. The basis of its development is its super-bright Light-Valve projector, already on the market for non-consumer uses. It uses an electron gun to modulate a layer of oil, an external light source (Xenon bulb) supplying the beam which is refracted by the oil ripples. GE's projector currently sells for $44,000, and obviously there must be a lot of cost-cutting before it can come within the range of the family pocketbook.

One factor in the new wave of projection TV fever is the widespread anticipation of the home videotape recorder and videodisc player. What better way to see your electronic home movies or recorded feature films than on the giant screen?

How "new" is projection TV? About as old as television itself. During the first three years of post-World War II TV receiver sales, the American public bought 40,000 black-and-white television projection sets.

Counting the quads

The library of four-channel records is gradually building, and by mid-1974 it had reached the total of 771 different LP's—unfortunately recorded in three different quadriphonic systems. The leader, in number of titles, is the QS or "regular matrix" system, with 341 discs available. A close second is the SQ matrix system with about 300, followed by the CD-4 or "Quadradisc" discrete system with 130 records. However, there's a scarcity of top pop albums in quad. Of Billboard's July 20 listing of the 200 biggest-selling LP's, only 19 are shown as being available in any quad format. Eleven of the 200 albums have been recorded in SQ, seven in CD-4, one in QS.

Quick-on

Exit instant-on, enter quick-on. Most TV manufacturers having given up picture tube pre-heating systems as a contribution toward alleviating the energy crisis, they're now in a race to employ new picture tubes which accomplish much of the same results without the power consumption. Philips of the Netherlands developed the first such tube, and tube makers Sylvania, Westinghouse, Sony, Matsushita, Hitachi and Toshiba have all announced development of new cathode and heater systems which bring in the picture four to six seconds after the set is turned on. The systems differ, but most of them invoke new faster-heating cathode materials and smaller cathodes. Because the new cathodes are easier to heat, some of them require less power, adding to the energy savings. The first sets with quick-on probably will show up before the end of this year.

A few television manufacturers, however, cite the fact that pre-heating systems for solid-state sets consume less power than a Christmas tree bulb and pooh-pooh the amount of energy-saving involved in discontinuing the valuable instant-warmup system—so even among the new TV models you'll find some sets with instant-on.

Who's who in TV

Zenith is the biggest-selling brand in both color and monochrome television, according to a survey by the trade publication *Television Digest with Consumer Electronics*. Covering the 1974 model year (July 1, 1973-June 30, 1974), the survey gave these estimates of each major brand's share of the color TV market: Zenith 23.75%, RCA 20.5%, Sears 7.5%, Magnavox and Quasar (formerly Motorola) 6.75% each, General Electric 6%, Sylvania and Sony 5% each, Admiral 3.5%.

In monochrome, Zenith was on top with 17.75%, followed by RCA with 12%, General Electric 11.9%, Sears 8.8%, Panasonic 7.75%, Quasar-Motorola 6%, Admiral 5%, Philco-Ford 4.3%, Sony 3.15%. *Television Digest* emphasizes that the figures may not be exact, since they're based on estimates made by television manufacturers who are asked to appraise their competitors'—not their own—market shares. Most TV manufacturers keep their own sales figures a very dark secret.

Admiral is sold

One of the oldest names in television, Admiral Corporation, has been sold to Rockwell International Corp., a multifaceted firm in such diverse businesses as space science, tools and semiconductors. The Admiral brand name will be retained, with increased emphasis on both technology and marketing.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The new Mallory CA3 Intrusion Alarm.

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This area-and-perimeter device creates and transmits an ultrasonic wavelength field for detection up to a distance of 20 feet. And because of its modern design and walnut-grain finish, the CA3 is attractive and inconspicuous enough to pass as a radio or stereo tuner.

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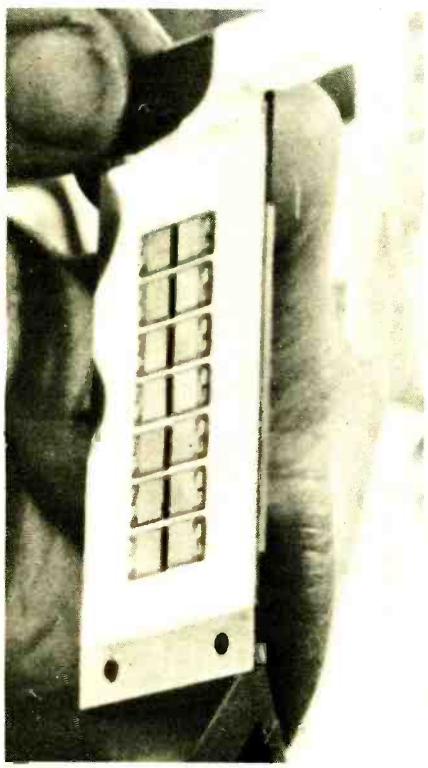
new & timely

Largest magnetic bubble memory devised by Bell Laboratories

A new bubble memory has been developed by Bell Lab scientists. The new memory measures only 3.75 inches long, 1.75 inches wide and 0.2 inch thick and can store a half million bits of information. The memory has an average access rate of 2.7 μs, a data rate of 700,000 bits-per-second and a read-error rate of less than one error in 630 billion read operations.



Magnetic bubbles are minute magnetized areas only one-sixteenth the diameter of a human hair, located in thin films of crystalline magnetic material. These "bubbles" can be created, erased and moved about electronically to perform the same functions that are performed by magnetic core or semiconductor memories. The new magnetic bubble technology may be able to reduce the size and power requirements of computer mass memories while increasing their reliability.

Super-capacity waveguide system started in northern New Jersey

The first link of what will be an entirely new type of super-capacity transmission system is now under construction in Morris County, New Jersey. The new system is capable of handling a minimum of a quarter million telephone calls simultaneously or its equivalent in data transmission or television programming. It will extend 8½ miles from the AT&T Long Lines office at Roxbury Township to Washington Township and will be used to evaluate construction techniques and transmission characteristics.

The new system uses a 2.5-inch hollow waveguide tube with a frequency range of 40 to 110 gigahertz. This is a greater bandwidth than all the combined radio frequencies now authorized for common carrier use. The wavelengths at these frequencies are so short—7.5 mm at 40 gHz and 2.7 mm at 110 gHz —that they are more conveniently and commonly referred to as millimeter waves.

The new 8-mile stretch, which will be extended to 20 miles in 1975, is the first step in a program that envisions tripling the capacity of the Bell interstate network in the next ten years. Since telephone calls alone are increasing 12% annually, this capacity will be necessary.

The new waveguide is being manufactured by Western Electric to standards of accuracy far beyond any previously used in waveguide construction. It is expected that amplification will be required only every 25 miles along the line.

Improved FM broadcasts permitted

The FCC has informed Dolby Labs that FM stations are free to use a combination of Dolby B-Type noise reduction and reduced pre-emphasis—25-μs instead of 75-μs. It will not be necessary for the station to inform the FCC of the changeover to 25-μs.

Broadcast engineers have favored a reduced pre-emphasis of the high frequencies as one means of reducing the danger of overmodulation. But the 75-μs de-emphasis of present FM receivers would cut the high frequencies too much when 25-μs pre-emphasis transmissions were received.

The Dolby B-Type noise reduction compensates for this high-frequency loss. Dolby B-Type transmissions are received on receivers with 75-μs de-emphasis with somewhat more high frequency content than conventional signals. Thus, the reduction in pre-emphasis due to the 25-μs time constant brings the program into normal frequency balance on such receivers, with the possible additional advantages of a decrease in high-frequency distortion and an increase in program level.

Listeners with receivers equipped with the 25-μs de-emphasis and B-Type noise reduction obtain four benefits; an improved signal-to-noise ratio, full dynamic program range—even at high frequencies, better reception in weak-signal areas and reduced likelihood of interference.

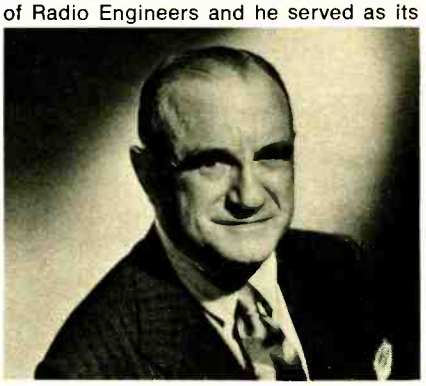
Dr. Alfred N. Goldsmith is dead at age 86

World-renowned scientist, engineer and inventor Alfred N. Goldsmith died July 1 at St. Petersburg, FL. He was a pioneer and prolific inventor in the fields of radio and television, medical electronics, sound motion pictures and other areas of electronics.

Dr. Goldsmith received his B.S. degree from City College of New York in 1907 and his Ph.D from Columbia in 1911. Starting as an instructor at CCNY in 1907, he became a consulting engineer for General Electric in 1915 and director of research for Marconi in 1917. In 1919, when Marconi merged with RCA, he became the first director of research of RCA. At the time of his death, he was senior technical advisor and honorary vice president of RCA.

In 1920, his work made possible the first radio with a built-in speaker and two-knob control as well as the first commercial radio-phonograph. In television, he proposed a picture tube with colored phosphor dots and a perforated plate. This was the basic idea of the present, almost universal shadow-mask tube.

Dr. Goldsmith was a co-founder director and life member of the Institute of Radio Engineers and he served as its



president in 1928. He was editor, editor emeritus and director of the IRE since its founding in 1912. He was a Fellow of the AIEE till its merger with the IRE and became a fellow, editor emeritus and director of the IEEE.

Dr. Goldsmith was also a fellow of the American Physical Society, the American Association for the Advancement of Science, the Acoustical Society of America, the Optical Society of America and the International College of Surgeons, and

(continued on page 12)

THE 3-letter word for television antenna systems:

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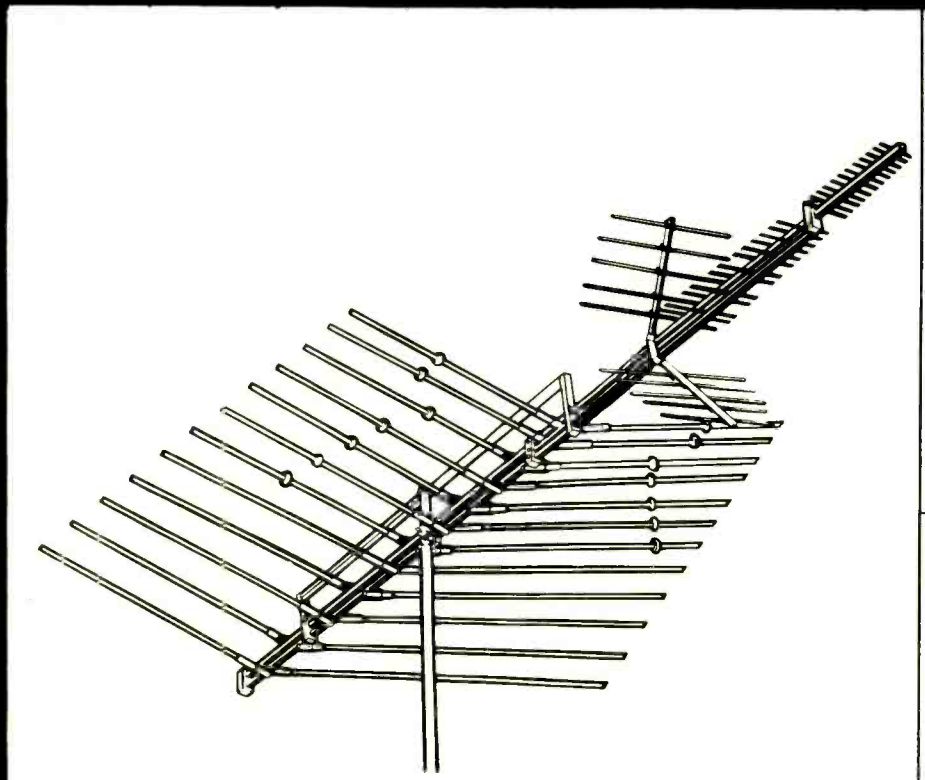
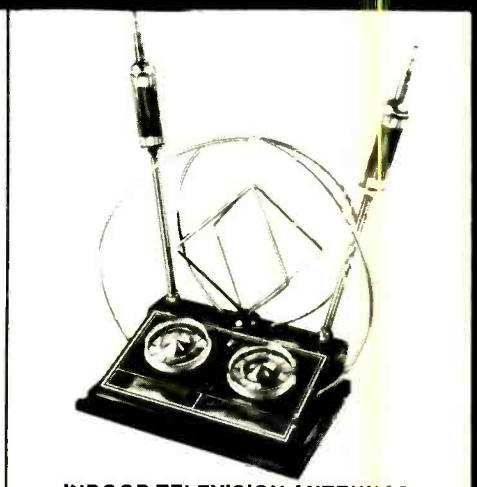


OUTDOOR TELEVISION ANTENNAS



INDOOR TELEVISION ANTENNAS

TELEVISION ACCESSORIES

JFD is the way more dealers, installers, and distributors are spelling television antennas these days.

For good reason.

OUTDOOR TV ANTENNAS

They know that JFD antennas assure best possible performance—in color and black-and-white—on all channels (2 to 83). Because only JFD combines the super-sensitive log periodic concept with capacitor coupled dipole design. *All* of the elements (not just some as in other antennas) work together for laser sharp picture brilliance.

And you can select from a *complete* line of models to suit every reception (and budget) need.

INDOOR TV ANTENNAS

You can also look to JFD for the broadest selection of indoor antennas: Top-of-the-set, behind-the-set, in-the-set, O.E.M. . . . we got them. Made right, packaged right, priced right.

TV ACCESSORIES

To deliver picture-perfect reception to the set, team up your JFD antenna with any of the many JFD accessories: amplifiers, splitters, couplers, transformers, mounts, masts, standoffs, hardware or wire—for superior results.

THE LINE OF PROFIT-ABILITY

Only JFD can hand you a line like this—the line of proved performance and profit-ability.

Take our word for it.

The *Best* Reception Starts with A *JFD* Antenna.

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Ever wonder why no other TV/Audio home study school puts its prices in its ads?

Maybe it's because they can't match this value!

No other school gives you complete TV/Audio service training with a big screen 25″ diagonal color set and all the electronic instruments you need for under $1000. Or gives you a choice of five ways to learn, starting as low as $312 . . . with convenient, inexpensive time payment plans. (Check the difference in interest rates alone!) NRI quotes its prices because we believe you get the top educational value from NRI.

You pay less because NRI passes its savings on to its students.

NRI pays no salesmen. We buy no outside "hobby kits" for our experiments or training kits. NRI designs its own instruments and TV sets . . . to give you great performance plus real training that you can put to practical use. The result is lower tuition rates and exclusive extras, like including a console TV cabinet (a $140 extra from other schools).

Nearly 1 million students have come to NRI for home training.

Home study isn't a sideline with NRI. We've been its innovating leader for 60 years. Nearly one million students have enrolled in our many career courses. NRI is one of the few home study schools with a full-time staff of engineers, authors and editors to help you with any problem. NRI graduates will tell you: you can pay more, but you can't buy better training.

15 Electronic courses available... including digital computer training and complete communications.

Send for the free NRI electronics catalog and check out the full spectrum of courses available, including Color TV, FCC Licensing, Complete Communications Electronics, Computer Electronics, Marine and Aircraft Electronics, Mobile Communications, etc.

Mail the card for your Free NRI catalog. No salesman will call.

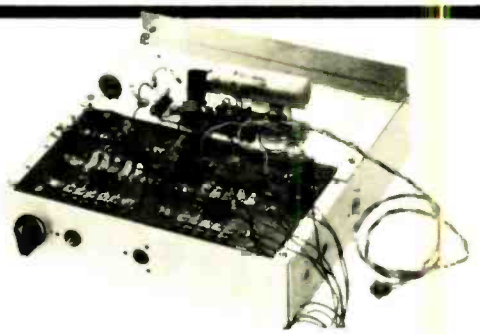
AVAILABLE UNDER GI BILL
Check the GI Bill Box on the card for information.

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue,
Washington, D.C. 20016

good with 7 kits . . . $312

Or low monthly terms

A basic TV/Audio Servicing Course including 7 training kits for your experiments. You build your own solid-state radio, solid-state volt-ohmmeter, and experimental electronics lab. Includes 65 bite-size lessons (16 on color TV), 15 special reference texts with hundreds of servicing short cuts, tips on setting up your own business, etc. This completely up-to-date course covers black & white and color TV, FM multiplex receivers, public address systems, antennas, radios, tube, transistor and solid-state circuits.



better . . . with 11 kits and B/W TV . . . $425

Or low monthly terms

A complete course in B&W and Color TV Servicing, including 65 lessons (16 on color TV), 15 special reference texts and 11 training kits. Kits you build include your own solid-state radio, solid-state volt-ohmmeter, experimental electronics lab, plus a 12" diagonal solid-state black & white portable TV . . . to build and use. At each assembly stage, you learn the theory and the application of that theory in the trouble-shooting of typical solid-state TV sets.

better yet with 12 kits and 19" diag. Color TV . . . $695

Or low monthly terms

The same basic 65 lessons and reference texts as before, plus kits and experiments to build a superb solid-state 19" diagonal color TV receiver . . . complete with rich woodgrain cabinet, and engineered specifically for training by NRI's own engineers and instructors. This handsome set was designed from the chassis up to give you a thorough understanding of circuitry and professional trouble-shooting techniques. You build your own solid-state radio, solid-state volt-ohmmeter, and experimental electronics lab.

best . . . with 14 kits and 25" diagonal Color TV . . . $995

Or low monthly terms

The ultimate home training in Color TV/Audio servicing with 65 bite-sized lessons, 15 reference texts, and 14 training kits . . . including kits to build a 25" diagonal Color TV, complete with handsome woodgrain console cabinet; a wide band, solid-state, triggered sweep, service type 5" oscilloscope; TV pattern generator; digital multimeter, solid-state radio, and experimental electronics lab.

This Master course combines theory with practice in fascinating laboratory units. Unlike "hobby kits", the NRI color TV was designed with exclusive "discovery" stages for experimentation and learning. Building the set will give you the confidence and ability to service any color TV set on the market. And you'll have a magnificent set for years of trouble free performance.

Plus Advanced Pro Color . . . $535

Or low monthly terms

An advanced Color TV Servicing Course for experienced technicians. 18 color lessons, 5 new "Shop Manuals", and the NRI 19" diagonal solid-state Color TV set are included.

new & timely

(continued from page 6)

was president of the Society of Motion Picture Engineers in 1932.

He was an honorary member of the Radio Club of America, the Radio Society of Great Britain, the Royal Society of Arts, the International Committee of Radio Telegraphy (France), the Academy of Motion Picture Arts and Sciences, the Society of Motion Picture and Television Engineers and the Institution of Radio Engineers (Australia).

He was the recipient of numerous awards and honors, including three from the IRE alone.

Sister Mary Benita Carey, WN2UQI is Hugo Gernsback Award winner

Winner of the third 1974 Hugo Gernsback Scholarship Award—a $125 grant made annually to an outstanding student in each of eight leading electronics home-study schools—is Sister Mary Benita Carey, enrolled as a student at NRI. Born in Brooklyn, NY, she lost both her parents within 13 months of each other, before her 17th birthday. She then worked as a private secretary and did some semi-executive work for an insurance company.

In 1950, she entered the Community of Parish Visitors of Mary Immaculate, a group of contemplative-missionary sisters who visit homes, give religious counsel and work with families, individuals and groups. She has been engaged in the Bedford-Stuyvesant section of Brooklyn and helped supervise a program for underprivileged children.

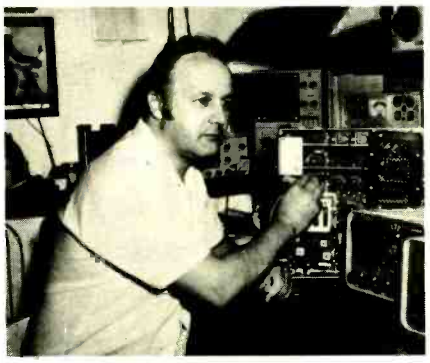
Sister Mary Benita

Sister Mary had long been interested in radio and thought of studying it as early as the crystal-set days. Other needs and activities intervened and it was 1973 before she was able to take it up seriously, studying on her own from available books. She had difficulty working alone — particularly in code practise — and dropped a note to the ARRL with one of her orders for books, asking if there were any nearby amateurs. The League sent her a list of Brooklyn radio clubs and she soon learned that classes were being held in the Hall of Science in Flushing, nearby.

After two semesters, she passed the amateur examination and is now WN2UQI. Meanwhile she had registered for the Amateur Radio Operating course with the National Radio Institute (NRI.)

Sister Mary intends to continue her study of electronics and hopes shortly to become a member in the International Missionary Radio Association (IMRA) network, as an extension of her missionary apostolate and to be of service to the broad community.

A second prize in the third 1974, Hugo Gernsback Scholarship Award—a volt-ohm-milliammeter offered by RCA



Allen T. Poland, Jr.

to the runner-up in the contest—is being awarded to NRI student Allen T. Poland, Jr. A Virginian, he graduated from Piedmont High School in 1953 and enlisted in the United States Army, serving 26 months in southern Germany. Becoming interested in electronics, he obtained his Conditional Class amateur license K8AXW and its German equivalent DL4TPO.

Now married, with two children, he lives in Keyser, WV. Soon after marrying, Allen decided to study electronics systematically to improve his knowledge and skills. He completed a two-year course in Electronics Fundamentals, a one-year course in Communications Electronics and a one-year course in Solid-State Electronics from RCA Institutes. Studying specialized material on communications and broadcast engineering. including a course from the Grantham School of Electronics, he obtained his Amateur Extra Class and the First Class Radiotelephone licenses. In addition, he completed a three-year course in advanced electronics at the Mineral County Vocational Center and is at present enrolled with NRI, taking the NRI Master Course in Electronics Technology.

Now employed with the Westvaco Corp. as a power-house operator, Allen plans to take the NRI course in radar and take the Certified Electronic Technician (CET) examinations.

Satellites to unify Earth?

A "quantum jump" in the use of the telephone and related instruments due to the increasing number of communications satellites and the lower cost of communication resulting from this may initiate a revolution in our way of life as great as or greater than that resulting from the invention of printing. This is the opinion of Robert Jastrow, director of NASA's Institute of Space Studies.

He looks back to the middle '60s when overseas telephone costs dropped with the beginning of satellite operation. This caused a jump in overseas calls from less than 10 million in 1965 to more than 60 million in 1973. He notes that 1974 and 1975 will see five more satellites in operation than at the beginning of 1974. This suggests, he says, that the curve of overseas calls, already rising sharply and is likely to become almost vertical, and that by 1980 the United States may place a billion overseas calls per year, with the cost of a call to Tokyo "by color TV," within every businessman's budget.

Among the results: People will be able to live where they please and "go to work" by Picturephone (color, at that!). School can also come to the home: "... every house can be transformed into an office, a theater or a classroom by pressing a few buttons."

Jastrow quotes Arthur C. Clarke, science fictionist, scientist and originator of the idea of a communications satellite network (in a paper published in 1945). Clarke sees a "slow but irresistible decentralization of mankind" and suggests that "Megalopolis may soon go the way of the dinosaur."

With the sharp increase in international communication, another irresistible consequence may be the development of a common world language (Chinese, with 800 million adherents and English, with 330 million, are mentioned as competitors). Even

(continued on page 14)

THIS IS A PROGRAM PANEL. WITH IT YOU CAN MAKE B·I·C™ PROGRAMMED TURNTABLES DO THINGS NO TURNTABLE HAS EVER DONE BEFORE.

The B·I·C 980 and 960, like many fine turntables, use a belt drive system.

What's unusual, however, is that B·I·C turntables can be programmed to play a single side as many as 6 times... or to play as many as 6 records in series. 'Til now, no belt-drive turntable has been able to do that.

How it works

The program lever (second from the bottom in the picture at left) gives you 22 possible ways to play your records in manual and automatic modes.

By moving the lever to "MAN", the turntable is turned on and can be operated as a manual unit.

By moving the lever to "1", and tapping the cycle button lightly, one record can be played fully automatically.

By moving the lever to 2, 3, 4, 5 or 6, you can play a single record 2, 3, 4, 5 or 6 times.

And this same program lever controls multiple play. If, for example, you want to play 2 records, simply put them on the spindle and move the lever to "2". Or move the lever to "3" and the second record will repeat once. Or move it to "4" and the second record will repeat twice. And so on, and so forth.

Must be seen to be appreciated

This program system is news all by itself. But it's far from the whole story.

The B·I·C tone arm has features found on no other tone arm.

The B·I·C motor is a major improvement over motors in other belt and idler drive turntables.

But features aside, what's truly worth close scrutiny is how all these new ideas are welded into a perfectly balanced system which performs impeccably.

We'll send you more information about the 980 and 960 if you write to:

Andrew Stephens, Dept. 10D
British Industries Co., Westbury, L.I. 11590.

But you really must examine them, touch them and compare them, to appreciate their fundamental excellence. After you've looked them over at your B·I·C dealer's (the leading audio specialist in your area) we think you'll be impressed.

B I C™

This is the 980 with solid state speed control and strobe. About $200.
The 960 is identical except for these two features. About $150.

Circle 5 on reader service card

new & timely

(continued from page 12)

more drastic developments such as a single global society are envisioned for the far future.

Police and taxi communications cooperate in New York crime alert

A New York taxi driver, Ashton L. Smith, was recently honored by the New York City Police Department for the part he played in bringing police aid quickly to a shoot-out. As a Minuteman, he was instrumental in turning in an alarm that may have saved a life. The Minutemen are made up of more than 300 taxi drivers from several fleets who have joined together for radio dispatching and street crime reporting.

NEW YORK CABBY, Mr. Ashton L. Smith. at the wheel of his radio-equipped taxi.

Mr. Smith, returning to his cab from a lunch break about midnight last May 9th, heard shots and saw two Housing Authority patrolmen pursuing a man with a gun. He reported to his dispatcher that a man had been wounded and that help was needed. Squad cars were on the scene in less than five minutes.

The cabs are equipped with a special two-way radio, the RCA Voice-PLUS, which besides transmitting and receiving conventional voice conversations, can send a message in digital code at the touch of a hidden switch. The coded alarm, with the cab's identifying number, is received by the dispatcher. He can then determine the cab's general location from the log of its previous calls and send help. Besides reaching the police, according to a Minuteman spokesman, a "cab driver in trouble" radio report is heard by other drivers and may bring several cabs to the trouble scene. **R-E**

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MARK TEN B, THE GAS SAVING, PLUG SAVING, TUNE-UP SAVING, ELECTRONIC IGNITION FROM DELTA. NOW AS LOW AS $49.95.

Years of testing and use by race car drivers in all categories have proven Delta's Mark Ten B the most advanced ignition system on the market today.

Prove it to yourself. Give you car vroooom! With a Mark Ten B Capacitive Discharge Ignition System under the hood of your car great things will happen... like reducing costly tune-ups by as much as 75%. Further, you get better all-weather starts, quicker acceleration and better mileage.

Many operational problems caused by emission control devices, poor manifolding or improper fuel mixtures disappear. Delta's Mark Ten B even improves the performance of brand-new factory installed electronic ignitions (Chrysler and Ford). Factory systems merely eliminate points and condenser, but the Delta Mark Ten B combines the advantages of capacitive discharge with solid state electronics to give real performance and increased energy.

Are you a do-it-yourselfer? Build your own Mark Ten B.. it's available in low-cost kit form. Or, if you prefer, get the complete ready-to-install unit. Either way, you can install it yourself in minutes with no rewiring, even over Chrysler and Ford systems.

Mail the coupon today and discover how to enjoy happy motoring with Delta's Mark Ten B. The do-it-yourselfer's dream that really pays off.

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Enclosed is $_____ ☐ Ship ppd. ☐ Ship C.O.D. Please send: _____ Mark Ten B assembled @ $64.95 ppd. _____ Mark Ten B Kit @ $49.95 ppd. (12 volt negative ground only) _____ Standard Mark Ten assembled, @ $49.95 ppd. _____ 6 Volt: Neg. Ground Only _____ 12 Volt: Specify _____ Pos. Ground _____ Neg. Ground _____ Standard Mark Ten Deltakit® @ $34.95 ppd. (12 Volt Positive or Negative Ground Only)

Car Year _____ Make _____

Name _____

Address _____

City/State _____ Zip _____

Circle 10 on reader service card

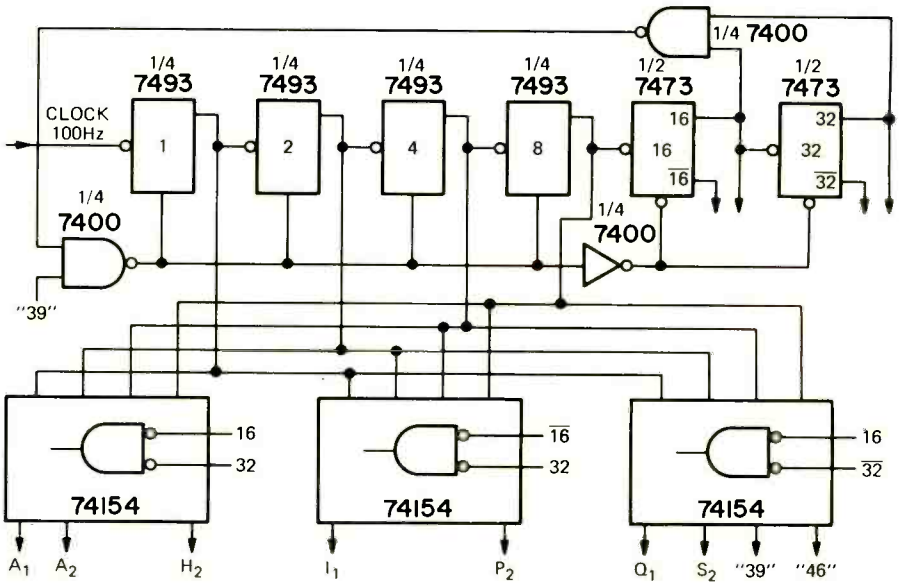
letters

CAUGHT YOU

In reference to Waller Scott's article (Electronic Casino, **Radio-Electronics,** March 1974).

In the case of the roulette wheel, use a counter, a 7493 4-bit binary counter and a 7473 Dual JK flip flop instead of the shift register, along with three 4-to 16-line decoders (74154). This reduces package count from 20 to 6 and eliminates the need for preset and recycle components. The first four flip flops are used to select one of 16 outputs per decoder, while the last two are gated (inside the decoders) to select one of three decoders. The number "39" output line is then returned to reset the counter to "00." Provisions are made so that in the event of a disallowed count ("40" through "46"), the counter will be reset as soon as the last two flip flops go high. Thus the counter can lose at most 7 counts (about 70 ms at 100 Hz) and will begin again at "00." Since in this case an active output is low rather than high, a non-inverting buffer-driver should be used, such as a 7417.

ROULETTE WHEEL



(continued on page 22)

Now you can get "XR" glass tubes in our economy line.

You know the EIA guidelines. Replace like with like.

That used to mean that all you could offer in "XR" glass tubes were the all-new, more expensive types.

Now, Sylvania has changed all that.

We've added 19 of the "XR" glass types to our Color Screen 85 economy line, and another 5 types to our medium price Color Bright 85® RE line. You can tell them by the "V" designation in the type number. For example 23 VANP22. And of course, you've got all types in our Color Bright 85® "XR" new tube replacement line.

Three lines to offer. Three prices to offer.

That should eliminate a lot of your customer's inhibitions.

Electronic Components Group, GTE Sylvania, *100 First Avenue, Waltham, Mass. 02154.*

Another first from the leader

GTE SYLVANIA

You can gain new skills as an electronics troubleshooter in a fascinating learn-at-home program from Bell & Howell Schools that includes building and experimenting with a new generation color TV.

go ex

ploring.

If you're like most men, deep down inside there's still a bit of the boy who loved to go exploring . . . and who'd love to go again. Well, now you can.

Only this time you'll explore the expanding world of electronics . . . a world more fascinating than any you ever dreamed of as a boy.

Learn by exploring . . . Bell & Howell Schools offers an exciting way for you to gain new occupational skills in electronics.

Everybody enjoys learning something new, but why learn it the old way? Classes to go to. Lectures to sit through. Teachers looking over your shoulder. And only a bunch of books to keep you interested.

Bell & Howell Schools' adventure in learning is a far cry from all that.

First of all, you'll be able to probe into electronics and learn exciting new skills right in your own home, in your spare time. On whatever days and whatever hours you choose. That means there'll be no conflicts with your other interests and, more importantly, no need to give up your present job and paycheck just because you'd like to learn new occupational skills. Secondly, we believe that when you're exploring a field as fascinating as electronics, reading about it is just not enough. That's why throughout this program you'll get lots of "hands on" experience with some of todays latest electronic training tools. And we, for one, think the best tools make the best 'teachers'.

You'll be stimulated for hours on end as you build, experiment and learn while using the latest ideas and techniques in this fascinating field.

As part of the program you'll actually learn to build and work with your own electronics laboratory. Then you'll use the lab to put many of today's most dynamic electronic theories to the test.

You'll delve into the applications of electronic miniaturization, discovering how the development of tiny integrated circuits has made possible innovations such as an electronic calculator small enough to fit into a shirt pocket! Or digital display wristwatches where you press a button and the time flashes on in digits.

You'll investigate the concept of "logic circuits". An idea that has been with us for centuries but only in recent years put to use as the "brain" behind all the new digital consumer appliances we see today.

But there's one discovery you'll make that is even more important than all the others: the new occupational skills you'll develop all along the way. Skills in electronics troubleshooting that could lead you in exciting new directions:

1. Use your training to seek out a job in the electronics industry.
2. Use your training to upgrade your current job.
3. Use your training as a foundation for advanced programs in electronics.
4. Use your training in a business of your own—a few of our graduates are even doing this now!

You build and perform many exciting experiments with Bell & Howell's Electro-Lab®. An exclusive electronics training system.

Using our successful step-by-step method, you'll build the following:

1. A **design console,** for setting up and examining circuits.
2. A **digital multimeter** for measuring voltage, resistance and current (it displays its findings in big, clear numbers like on a digital clock).
3. A **solid-state "triggered sweep" oscilloscope**—similar in principle to the kind used in hospital operating rooms to monitor heartbeats. You'll use it to monitor the "heartbeats" of tiny integrated circuits. The "triggered sweep" feature locks in signals for easier observation.

Step-by-step you'll build and work with Bell & Howell's new generation color TV—investigating digital features you've probably never seen before!

Here is one of the outstanding contributions of digital electronics to home entertainment. You'll build, experiment and learn from it.

This 25" diagonal color TV has digital features that are likely to appear on all TV's of the future. Features made possible by recent applications of digital electronics.

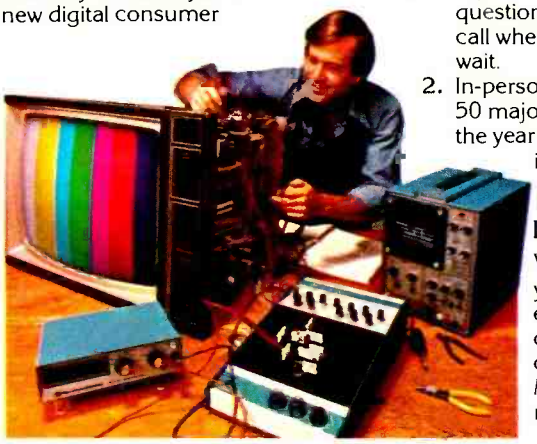
You'll probe into the technology behind all-electronic tuning and into the digital circuitry of channel numbers that appear big and clear, right on the screen! You'll also build-in a remarkable on-the-screen digital clock, that will flash the time in hours, minutes and seconds. Your new skills will also enable you to program a special automatic channel selector to skip over "dead" channels and go directly to the channels of your choice.

You'll also gain a better understanding of the exceptional color clarity of the Black Matrix picture tube, as well as a working knowledge of "state of the art" integrated circuitry and the 100% solid-state chassis.

And having actually built and experimented with this TV, you'll come away equipped with the kinds of skills that could put you ahead of the field in electronics know-how.

We try to give more personal attention than any other learn-at-home program

1. Toll-free phone-in assistance. The program is designed so that you can proceed through it smoothly, step-by-step. However, should you ever run into a rough spot, we'll be there to help. Many schools make you mail in all your questions. We have a toll-free line you can call when you have a question that can't wait.
2. In-person "help sessions". These are held in 50 major cities at various times throughout the year where you can talk shop with your instructors and fellow students.



Simulated TV picture/test pattern.

No electronics background needed.

What you really need is the thing you've never lost. A boy's love for exploring. Now you can go again, only this time learning new occupational skills all along the way. Mail the postage-paid card today for more details, free.

"Electro-Lab" is a registered trademark of the Bell & Howell Company.

This program is approved by the state approval agency for Veterans' Benefits.

An Electronics Home Study School
DeVRY INSTITUTE OF TECHNOLOGY
ONE OF THE
BELL & HOWELL SCHOOLS
4141 Belmont, Chicago, Illinois 606

692

LETTERS

(continued from page 16)

There may be some people who would rather not use the 74154 because it is a 24-pin package and slightly more difficult to handle. In that case, I would suggest that if they prefer Mr. Scott's logic to mine, they could still save space by using 7496 5-bit shift registers instead of the 7473 Dual JK flip flop. They can be more readily preset, already have the required K-input inversion in the package and do not have Q-not outputs which aren't used anyway.

In closing, I would like to say that I am looking forward to future articles of this nature and of other logic uses. I have found that they are good practice both in space and cost reduction. There has rarely been an issue from which I did not profit in some way.

JAMES D. TUCKER
Knob Noster, Mo.

COMPUTER CLEARING HOUSE

Many thanks to **Radio-Electronics** for publishing a natural follow-up article to the TV Typewriter, the Micro-8 minicomputer. Micro-8 components will soon become as difficult to obtain as those in the TV Typewriter.

Builders of Micro-8 will need a forum for exchanging ideas on software and peripherals. Students and staff of the Cabrillo High Computer Center would be delighted to handle distribution of a user group newsletter.

To ease clerical work and minimize cost, we ask that each participant send five self-addressed stamped envelopes for five issues to: Micro-8 User Group, Cabrillo High Computer Center, 4350 Constellation, Lompoc, CA 93436.

The first issue will contain a list of builders, a discussion of software sources, listings of utility software routines and a discussion of possible peripherals and standardization of I/O device numbers.

A user group newsletter will be valuable only if users contribute. Tell us what you intend to do with your Micro-8, what peripherals you want to use, share software, etc. Let's hope that the Micro-8 article creates a large and enthusiastic group of users.

HAL SINGER
Lompoc, CA

NATESA ON WARRANTEES

In this consumerism era, we are certain that all producer/marketers of home electronics products will have to face up to realities.

Governmental consumerism agencies at all levels are taking a continuously closer inspection of plans that affect the public.

It is no longer enough for a company to claim they warranty their products. How they fulfill their warranty is another thing.

As an example, those companies that do not pay a service's legitimate cost of doing business at the going rate, are not in fact really fulfilling their warranties. Obviously no service agency can do good warranty service at below cost and still survive. Acceptance of these cut-rate deals eats up their assets and sincere servicers sooner or later must decide whether to cut corners or go out of business. To jeopardize continuity of an ethical professional caliber service company is unthinkable, especially today with a shortage of facilities. If the servicer is forced to pay below American standard wages and deprive technicians of normal benefits, he and the industry will lose him. The alternative (and some producer/marketers close their eyes to this when it involves servicers working for dealers who sell substantial volume of sets) is to double bill and make all jobs "majors." This is unfair because it makes the servicer a cheater. Clearly it is unfair also to other warranty services not connected with mass-volume dealers.

Another very unbusiness-like attitude, is failure to provide a fair markup on all replacement parts used during warranty. It is one thing depriving the servicer of profit on parts which historically has always been part of needed gross income. It is another thing to deny servicers repayment for costs obtaining, stocking and exchanging, especially since required red tape increases costs.

Probably the most unthinking part of

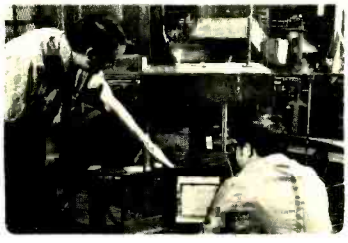
(continued on page 24)

No mere TV set will torture a tube like we do!

By the time we get through building an Opti-Vue, it's ready for anything. Some call it quality control. We call it "torture testing." Because while we were making it, our engineers never left it alone for a minute--constantly testing, checking, probing, measuring---making the Opti-Vue the best replacement tube money can buy.

They tested the components that go into the electron guns we make, down to 1/1000 of an inch. Then **they examined** every finished gun.

They tested for glass quality and neck annealing.



They checked the blistering temperatures in the exhaust ovens, way up to 420°C.

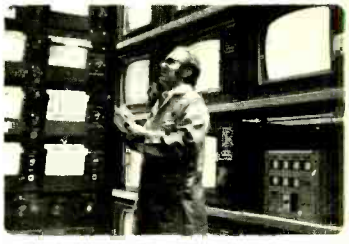
They tested vacuum pressures.

They tested for correct timing of cathode activation (too soon leaves harmful gas and oxygen; too late doesn't permit proper conversion and activation of the cathode coating).

They tested for proper gun sealing.

They tested for gun alignment and optical accuracy, to make sure every gun would produce perfectly round dots on the screen.

They tested shadow masks and screens for spots, pinholes, and other blemishes (our standards are higher than OEM).



They life-tested production samples to determine field performance.

They tested every tube for beam cutoff, color purity, focus convergence, emission and gas ratio, high voltage leakage, inter-electrode leakage, and peak cathode emission. Not just once, but many times. They even took the tubes for a bumpy ride to test for highway shock.

By the time an Opti-Vue finally gets installed into a TV chassis, you can almost hear it breathe a sigh of relief.

We think it's worth the trouble. Channel Master guarantees this tube for a long time. And we aren't taking any chances.

Channel Master
OPTI-VUE PLUS
LIFETIME PROTECTION*

*** 3 Year Warranty Plus Guaranteed Discount for Life of Set**

Circle 12 on reader service card

LETTERS

(continued from page 22)

warranty procedures works directly against the warranty purveyor. One of the main reasons for red tape in processing warranty claims and parts forms is accumulation of facts on breakdowns and performance. If a warranty servicer must "play games" on reports to survive, then the feedback is useless. Computer people have an adage, namely, "Put garbage in and you get garbage out."

This then will indicate that set quality suffers and this costs the public more because of errors encouraged by the producer/marketer.

It is clear then that not only is the servicer unfairly deprived of earned compensation, but so also is the buyer of the product. In the first case, they destroy short-in-supply service agencies. In the second, they destroy the acceptance of set purchasers. Paying substandard in-warranty rates with implied loss recovery by overcharging on out of warranty is fraudulent. Neither policy is smart or honest and soon aggressive consumerism will ask for an accounting. In speaking to a high level law enforcement official, he called many current warranty policies fraudulent.

NATESA urges that all warranty purveyors (1) pay the legitimate going rate for service and we suggest that the rate they themselves ask when they service sets is more nearly honest; (2) that a markup of 40% be paid on all components used; (3) that they scrupulously weed out double billers and other cheaters after sound and legitimate compensation policies are adopted.

Ethical professional servicers refuse to cheat their employees, their customers, their families and others they deal with by continued acceptance of unbusiness-like offers. At the same time, they refuse to be deprived of the right to compete. They are being pushed to seek help from law enforcement agencies at various levels.

There is NO alternative and independent servicers hope showdowns are not forced.

FRANK J. MOCH
Executive Director
NATESA
Chicago, IL

ENLARGE CITIZENS BAND

To cope with the congestion on the Citizens band, the FCC has proposed to approximatey double the spectrum space available to Class D stations in the Citizens Radio Service and eventually switch all such transmitters to single-side-band operation. Under the proposal, the band would be enlarged from the current 26.960—27.230 MHz to 26.960—27.540 MHz. The frequencies 27.310—27.505 MHz would be restricted to SSB with 5-kHz channels. The remaining channels remaining at 10 kHz for five years, after which, all channels would become 5 kHz and only SSB transmission would be permitted, providing a total of 100 channels. **R-E**

new breadboard test equipment

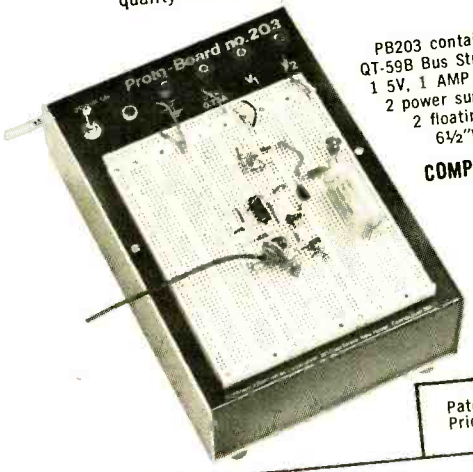
...with power for the professional...with economy for the hobbyist!

Fresh, from the laboratories of Continental Specialties, whose QT Sockets and Proto-Boards have taken the electronics market by storm... here are exciting NEW ideas to make your circuit design and testing faster, safer, easier and less expensive!

NOW...PROTO POWER!

NEW PROTO BOARD-203

New Proto Board 203 with built-in regulated short-proof 5V, 1AMP power supply. Ready-to-use. Just plug-in and start building! 2 extra floating 5-way binding posts for external signals. Completely self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. All metal construction... no chipping or cracking like plastic cases. Two-tone gold/black quality case makes PB203 asthetically, as well as technically, pleasing.



PB203 contains: 3 QT-59S Sockets; 4 QT-59B Bus Strips; 1 QT-47B Bus Strip; 1 5V, 1 AMP regulated power supply; 2 power supply 5-way binding posts; 2 floating binding posts; 9¾"L x 6½"W x 2¾"H. Weight: 5 lbs.

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Patents Pending • Made in U.S.A.
Prices subject to change

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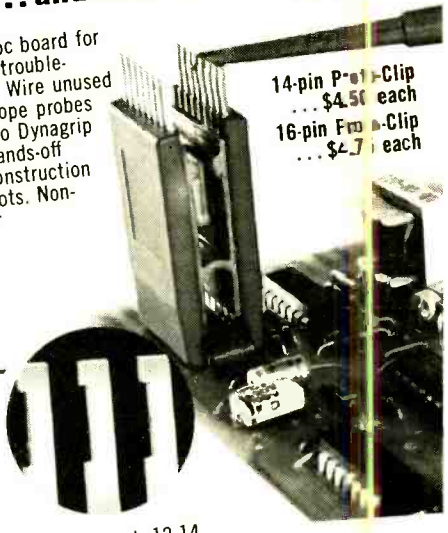
NEW PROTO BOARD-100

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto-Board series... complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets; 1 QT-35B Bus Strip; 2 5-way binding posts; 4 rubber feet; screws, nuts, bolts; and easy assembly instructions.

COMPLETE KIT... **$19.95** ORDER YOURS TODAY!

NEW! PROTO-CLIP for power-on, hands-off signal tracing. Eliminates shorting leads... and costs under $5!

Bring IC leads up from pc board for fast signal tracing and trouble-shooting. Inject signals. Wire unused circuits into boards. Scope probes and test leads lock onto Dynagrip (see circle) inset for hands-off testing. New plastic construction eliminates springs, pivots. Non-corrosive nickel/silver contacts for simultaneous low resistance connections. Narrow throat for high density pc boards.



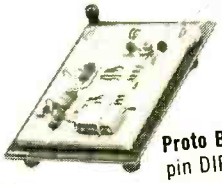
14-pin Proto-Clip ...$4.50 each
16-pin Proto-Clip ...$4.75 each

Build and test circuits as fast as you can think without soldering or patch cords with NEW

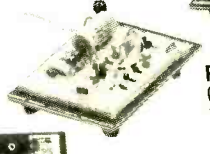
Proto Board

Breadboard Assemblies

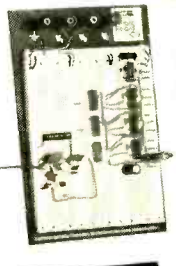
Here are four versatile new Continental Specialties' Proto Boards, made from convenient combinations of QT Sockets and Bus Strips, that let you make all circuit and power interconnections with common solid #22 wire, while power distribution busses make wiring a snap. Aluminum base plates offer solid work surfaces and perfect ground plane. Rubber feet prevent scratching. Each Proto Board features one or more 5-way binding posts to tie into system or power supply ground. And all are compatible with digital and linear ICs, in TO5s, DIP packs and discrete components. Each is assembled and ready-to-use.



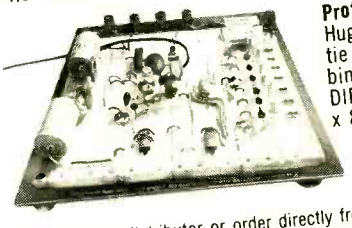
Proto Board 102. Compact. 12-14 pin DIP capacity. 7", 4½". **39.95**



Proto Board 101. Compact. Inexpensive. 10-14 pin DIP capacity. 5.8" long x 4.5" wide. **29.95**



Proto Board 103. 2,250 solderless tie points. (4) 5-way binding posts. 24-14 pin DIP capacity. 9" x 6". **59.95**



Proto Board 104. Huge. 3,060 solderless tie points. (4) 5-way binding posts. 32-14 pin DIP capacity. 9½" long x 8" wide. **79.95**

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Circle 13 on reader service card

appliance clinic

GETTING REPLACEMENT PARTS

by JACK DARR
SERVICE EDITOR

GETTING REPLACEMENT PARTS TO REpair electrical appliances can be quite a headache, if you go at it in the wrong way. With a few simple precautions, it's a lot easier. Luckily for us tinkers, most of the troubles are in the parts that are universal; line cords, heating elements, and the like. These standard replacement parts are obtainable everywhere.

There will be times when you need a special part; something that's used only in this particular make and model. There is really only one source for this, and this is the manufacturer. In the majority of cases, you can get this through the dealer from whom you bought it. If he doesn't have it in stock, he can get it.

There's one thing that's absolutely essential if you want to get the part quickly. You *must* have a complete description of the part. This takes in several items. First is the make and *model number* of the appliance. Watch out; *don't* send the *serial number*. This is completely useless! Appliances are listed by model numbers. In some cases, you'll find two of these. Send them both.

Next is a description of the part. You'll be able to use a stock description in most cases; for example, "Switch, on-off" or "Switch, speed selector", etc. For best results use the name given in the parts list. To get this, you will need a copy of the service manual for the appliance. Here again, your dealer will be a big help. If you didn't get a copy of this with the appliance, he will have one in his files and you can look up the part number, etc.

Here's a good example of a typical order:

Name Item: Blender JC2232.
Model Number: Factory BL3WIZ
Part Name: Switch assembly
Part number: OBL1 118.

This one is taken from a service data folder for a Western Auto blender. If the dealer doesn't have it in stock, with these names and numbers he can file the order with the nearest parts depot. With this company and many others, you can order directly from the nearest Service Center without going through the dealer, if he happens to be a good ways off. Here again, you must have the proper part identification, or the "parts pickers" and service technicians at the depot won't be able to identify the part you want. They have millions of items on the shelves, and without correct identification, they can't find the right one. So, when you get a new appliance, get a copy of the service manual with it. File this with the manuals for all your other appliances.

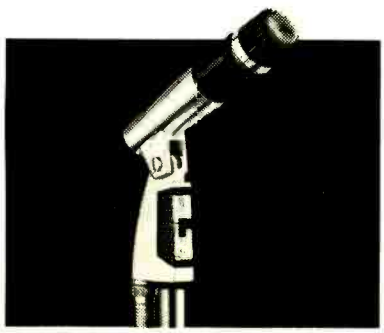
If you can't locate the factory parts depot, there's still a little hope. There are many Appliance Parts Wholesale houses around the country. These places carry large stocks of the most frequently needed parts for the standard appliances. They will all send you catalogues on request. These can be very useful as reference books. In a surprising number of jobs, you can look through the catalogue and identify the part you need.

If you still can't identify the part, write them and ask about it. Give them the complete description, with all of the data you can get. Look at the old part and see if there is any kind of a number stamped or printed on it. If it would help, draw them a rough sketch of the part.

The parts catalogue can be very useful in another way. For example, you can use it to find substitute parts. One catalogue shows a replacement heating element for the oven of an electric range. This one element will fit three different makes, and quite a few different models! You'll find quite a few examples of similar interchangeable parts, all the way from oven heating elements, which are probably the easiest, to replacement motors for washers and dryers. Heating elements for dryers can also be interchangeable. If no direct interchange is on hand, the appliance supply house can probably give you a Universal replacement, with instructions for installing it safely.

Your parts supply house can also be a source for a great many special tools, chemicals, and other items which are essential if you're going to do any amount of appliance work. Get catalogues from all of the places nearest to you. They're handy! **R-E**

Microphones matter most.



Never have so few words said so much about sound system installations. The truth is that a carefully chosen, top-quality microphone makes a measurable difference in sound system quality—regardless of the other components in the system. It is false economy at its worst to be a microphone miser. Install *Shure Unidyne or Unisphere* microphones—for installations with a marked superiority in voice intelligibility (and fewer service calls due to microphone problems).

Shure Brothers Inc.
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In Canada: A. C. Simmonds & Sons Ltd.

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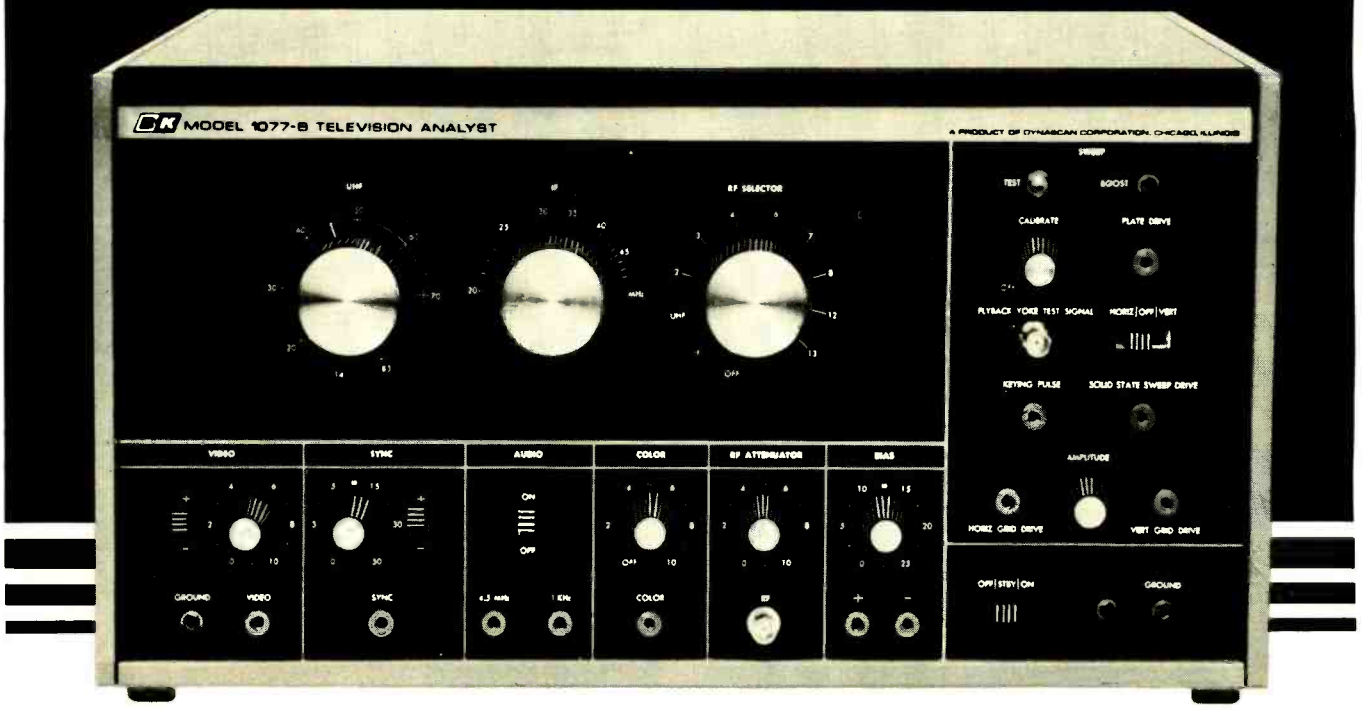
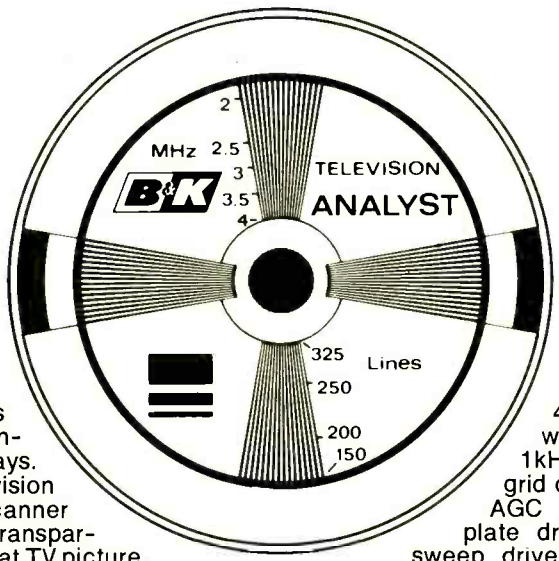


Model 1077B
$454



Remember the test pattern? Here's how to use that old standby to cut your troubleshooting time in half.

Broadcast test patterns are available only at very inconvenient times these days. So our Model 1077B Television Analyst has a flying-spot scanner that transforms any 3"x4" transparency into a broadcast-format TV picture. We even supply you with a test pattern slide.

A test pattern provides valuable information about picture size, linearity, focus, resolution, ringing (overshoot), low-frequency phase shift (smear) and frequency response. Unless the TV receiver isn't working, of course.

That's why the 1077B provides signal-substitution outputs to let you inject the test pattern anywhere in the chain from the flyback all the way back to the antenna terminals. You can pinpoint the problem in minutes instead of hours, checking the quality of each stage as you go.

Outputs include: IF, 8 VHF channels, all UHF channels, video, sync, 4.5MHz sound subcarrier with 1kHz FM modulation, 1kHz audio, chroma, vertical grid drive, horizontal grid drive, AGC keying pulse, horizontal plate drive, horizontal solid-state sweep drive, vertical plate drive and vertical solid state sweep drive.

There's also a built-in dot/bar/crosshatch generator for color TV chroma and convergence adjustments. Plus positive or negative bias supply and B+ boost indication. All level controls are conveniently located on the front panel.

There's nothing else like it.

Ask your distributor for Model 1077B, the latest in over 20 years of television analysts—in stock now or write Dynascan.

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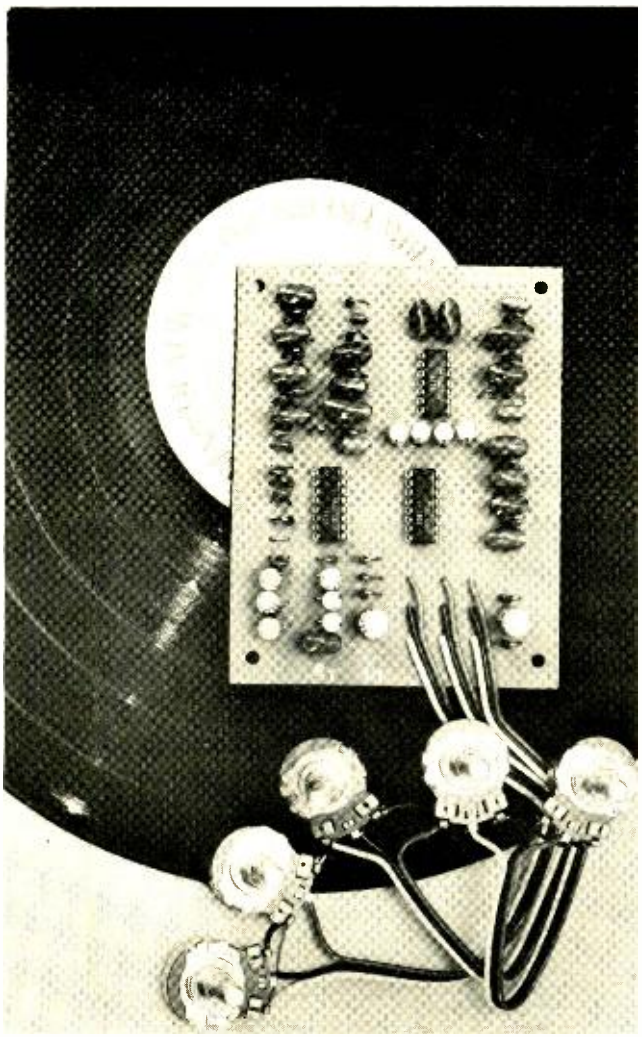


Exclusive!

BUILD THIS 3-IC SQ DECODER

with full logic and wavematching

Whether you decide to build it from scratch or purchase it in kit form, this SQ decoder with full logic and wavematching will provide excellent seperation and low distortion.

by ARNOLD NICHOLS

AFTER SEVERAL YEARS OF FOUR-CHANnel sound and the continuing development of SQ decoders, it is now possible to build, for the first time, at home, an SQ decoder that incorporates both full logic and wavematching. The result is an SQ decoder on a small circuit board that can easily be added to existing hi-fi systems when expanding them to 4-channel sound.

Channel separation provided by this circuit is excellent. Figure 1 shows the details. Note also that the decoder adds little in the way of distortion as its rated THD is only 0.5% over an audio range from 50 to 20,000 Hz.

Three new IC's from Motorola make it all possible. Developed under a CBS patent and made available under a CBS licensing arrangement, these new units—the MC1312, MC1314 and MC1315—do all the work. Once you have built up this project, all you need is a simple source of power (20 volts at 75 mA) and a way to install it between the output of a 2-channel stereo preamp and the inputs of four power amplifiers.

Use a 0.3 μF coupling capacitor at the output of the decoder to match amplifiers with a 100,000-ohm input (see full schematic in Fig. 2). If your amplifier has a 50,000-ohm input, change the capacitor value to 0.5 μF.

A complete set of balance and volume controls makes it easy to set up the decoder for your listening room. Once the controls are set, you should not have to readjust them again. Therefore, when you mount your decoder in a case, you may not want to use knobs on the controls.

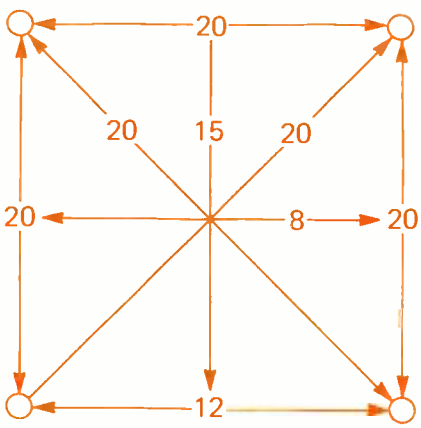


FIG. 1—VECTOR DIAGRAM SHOWS channel separation the full-logic decoder delivers. Units are in decibels.

We have made arrangements to make this decoder available to our readers as a kit (not including case or power supply) or as a kit of three IC's and the circuit board. (Full size circuit board pattern is in Fig. 3. Parts layout is in Fig. 4.) The license fee is included in the price of the kit and is paid by the kit supplier.

By using this decoder with four sound sources and four speakers placed around the listening area, music of startling realism is reproduced. The encoded SQ material makes it possible for the listener to position himself wherever he would like to sit—on stage, on the conductor's podium, anywhere in the orchestra or even at the rear of the concert hall.

Making full use of the capabilities of SQ decoding and encoding, sound can be mixed so that when an SQ record is played, the music is positioned in the front of, or to, either side of or even behind the listener, or it can be dynamically whirled around the

listener, wherever he is seated.

Four-channel matrix sound produces four separate sound signals—Lf (left front), Rf right front, Lr (left rear) and Rr (right rear). In an SQ matrix encoded record, these four channels are combined into Lt and Rt (left total and right total). Through a proper decoder (like the one described in this article), these two combined signals are taken apart and reassembled on playback to recreate the original four channels of recorded material.

SQ encoded music is fully compatible with 2-channel stereo broadcasting and an SQ record to be broadcast is played just like a standard 2-channel record on any 2-channel playback system. When played back on a mono system, it plays like a mono record.

SQ encoded records can also be broadcast by conventional stereo FM stations because only the two encoded channels are broadcast and the decoding is done is the listener home. In fact, the station doesn't need any 4-channel gear at all except for live 4-channel programs. Their regular 2-channel playback system works just fine.

For the same reason, it is possible to record 4-channel matrix material on a 2-channel tape recorder. It sounds like regular 2-channel stereo until it is fed through a decoder to be broken down into four channels of sound.

The first matrix decoders did not completely isolate the individual chan-

PARTS LIST

All resistors ¼ watt, 5% except pots
R1, R5, R7, R16, R28—3900 ohms
R2, R4, R6, R8—4700 ohms
R3—potentiometer, 10,000 ohms, linear
R9, R21—20,000 ohms
R10, R11, R12—130,000 ohms
R13, R14, R15—5100 ohms
R17—30 ohms
R18—50 ohms
R19—910 ohms
R20—560 ohms
R22—8200 ohms
R23—750 ohms
R24—potentiometer, 5000 ohms, semi log
R25, R26, R27—potentiometer, 5000 ohms, linear

Capacitors marked with an asterisk must be 5%. All capacitors Mylar film, except electrolytics. All electrolytics 25 volts or higher.
*C1, *C2—.05 μF
*C3, *C10—.062 μF
*C4, *C9—.012 μF
*C5, *C8—.36 μF
*C6, *C7—.068 μF
*C11—.0039 μF
*C12, *C14, *C16—.1 μF
*C13, *C15, *C17—.0039 μF
*C18, *C19, *C20—.001 μF
C21, C22, C23, C24, C31, C32—1 μF electrolytic
C25, C26—6.8 μF electrolytic
C27, C28—20 μF electrolytic
C29—3.9 μF electrolytic
C30—.15 μF
C33, C34, C35, C36—value depends on load of following circuit
IC1—MC1312
IC2—MC1314
IC3—MC1315

The following parts are available from Photolume Corp., 118 East 28th Street, New York, N.Y. 10016.
Kit SQ-1 (all parts except power supply and case) . . . $37.50. Kit SQ-2 (three IC's and the circuit board) . . . $20.00. Prices include insured shipping and CBS royalty fee. New York State residents must include sales tax.

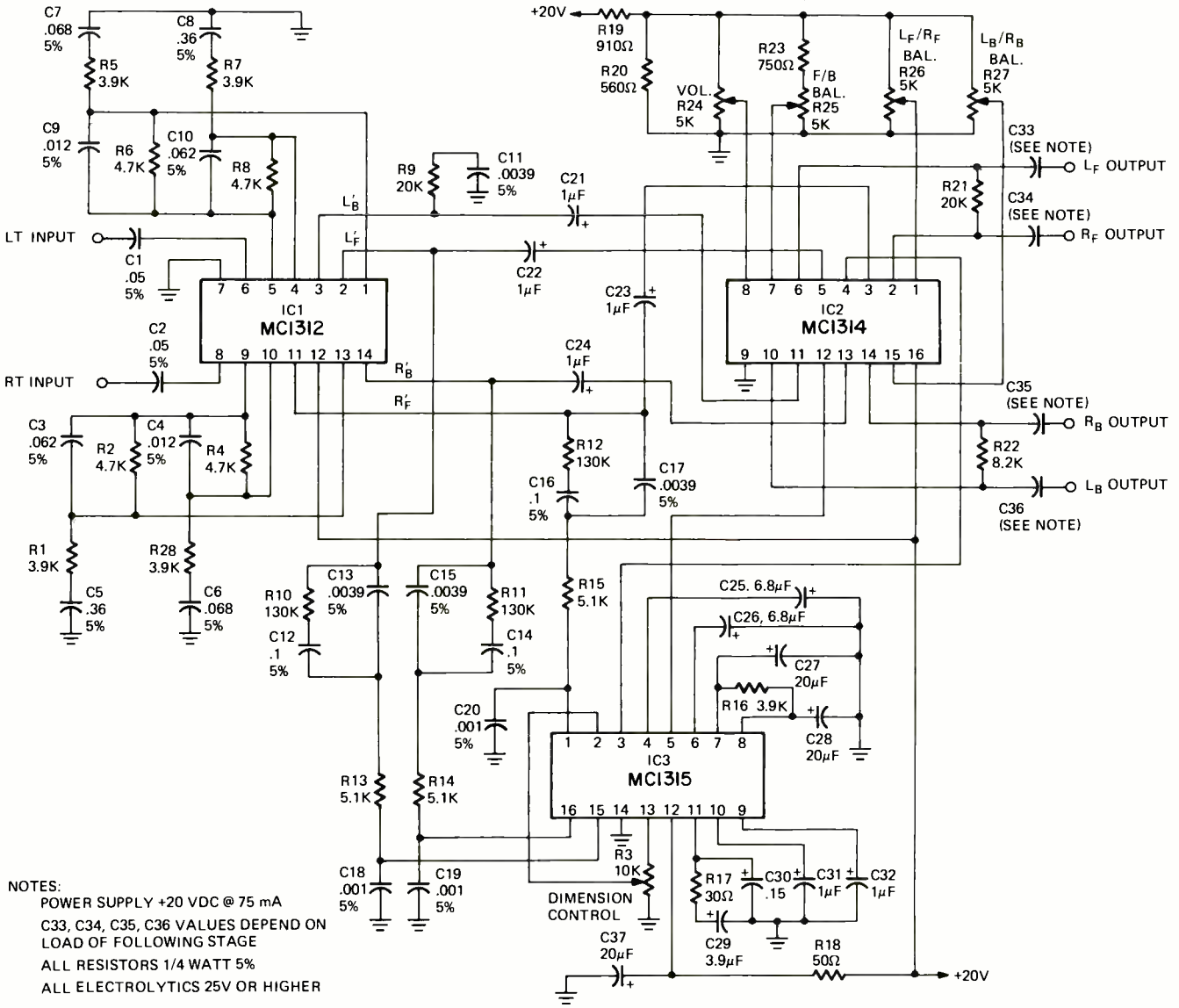


FIG. 2—FULL SCHEMATIC OF THE DECODER. The use of three IC's makes it easy to build.

nels and provided in some instances only minimal channel separation, especially between front and rear. As a result, out-of-phase and unwanted signals often appeared at the rear speakers when a signal was intended to reach the left front speaker.

Similarly, out-of-phase signals would appear at the front speakers when they were intended for the left rear speaker. These out-of-phase signals are 0.707 of the intended signal level and destroy the intended separation. Blend resistors added to front and rear signal pairs cancel some of the unwanted signals with a reduction of rear separation. The ideal fixed blend is a 10-40 blend —10% in the front and 40% in the rear.

About this decoder

The system described here is made up of three integrated circuits and associated discrete parts. The first IC, an MC1312, is the "SQ" matrix decoder. This circuit, with the prescribed phase shift networks but without the fixed blend resistors used in the 10-40 CBS "SQ" matrix, is the basic decoder.

The second IC, an MC1314, is a four-channel voltage-controlled amplifier that accepts the logic commands and translates them into enhanced quadriphonic action.

The third IC, an MC1315, develops the logic voltages that control the voltage-controlled amplifiers of the MC1314. This IC (the MC1315) contains both corner-signal logic (often called and better known as wave-matching logic) and center-signal logic (called front/back logic). Of course, should it be desired, fixed blend can be introduced in the MC1314 output.

The MC1312 consists of two preamplifiers that are fed with Lt (left total) and Rt (right total) signals respectively. Each preamplifier, in turn, feeds an all-pass network that generates two Lt signals in quadrature and two Rt signals in quadrature. These four signals are then matrixed to yield the four separate channels of musical information that was originally encoded when the record was made.

The MC1314 voltage-controlled attenuator IC has four amplifier channels, each of which is controlled by an external dc voltage. In addition the relative gain between channels can be set by three external dc voltages. This IC also provides master volume adjustment and front/rear balance.

The MC1315, logic IC, provides the basic logic required to enhance the front/rear separation and also provides variable dc logic enhancement control signals to extend the "basic" SQ encoder performance.

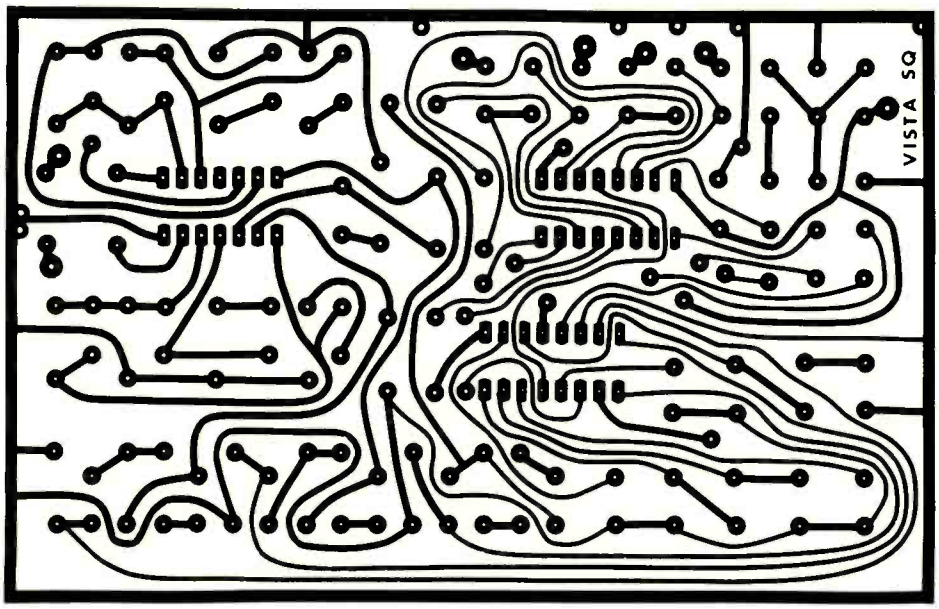


FIG. 3—FOIL PATTERN of the decoder shown full size. This is the improved updated version, while the photograph on the front cover shows the original prototype.

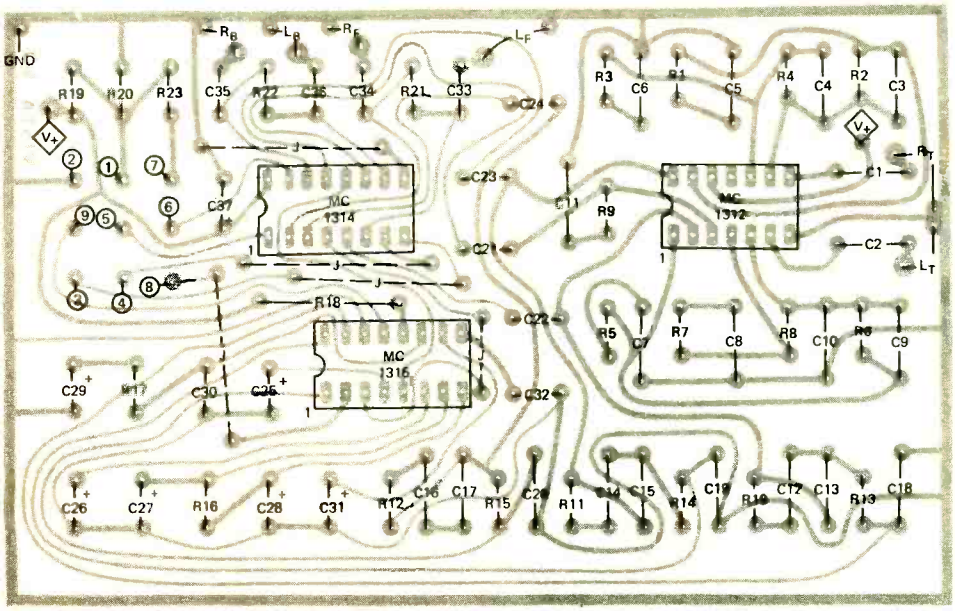


FIG. 4—PARTS PLACEMENT for the circuit board. Circled numbers in diagram show the connections to the external pots as follows: 1—CW terminal of R24, R26, R27. 2—CCW terminal of R24, R25, R26, R27, R3. 3—arm of R24. 4—arm of R25. 5—arm of R26. 6—arm of R27. 7—CW terminal R25. 8—arm R23. 9—CW terminal of R3.

Building your decoder

Thanks to the simple circuit board and the three IC's, construction is not at all difficult. Start by inserting all the resistors into the board. Next the capacitors. Watch the polarity of the electrolytics. The only capacitors to check are the ones at the outputs, select a value that matches the input impedance of your amplifier.

Now's a good time to install the IC socket. The kit comes with the now familiar strip of Molex connectors. However, if you wish you can use a standard low-profile IC socket in their place.

If you do use the connectors solder each complete strip into place before breaking off the connecting strap across their tops. Now, making certain the IC's are turned the right way you can insert the three IC's. Be sure to get the right ones into the right sockets.

Use shielded cables for both inputs and all four outputs (these are not

(continued on page 45)

HOW IT WORKS

Discrete 4-Channel with CD-4 Discs

Standing for compatibility and discreteness, the JVC 4-channel disc system's name contains its two essential concepts. This article tells you how it's done.

by KARL SAVON

THE CD-4 SYSTEM WAS INTRODUCED IN October 1970 at the Audio Engineering Society Convention in New York. It has remained almost unchanged since its inception.

Compatability

Introducing a new system to the public presents the problem of how to merge the new system and the old system with a minimum of inconvenience to the consumer to assure its success. The Victor Company of Japan realized that compatibility with existing stereophonic equipment was a must, and in fact their system is fully compatible. This means that stereo records can be played on a 4-channel disc player and CD-4 discs can be played on stereo equipment. Compatibility is achieved by retaining the two tracks used in conventional stereo equipment.

Some care is needed, however, when playing the CD-4 disc to prevent excessive wear by using an incorrect stylus. Similar precautions were emphasized when stereo records became available, and were being played on monophonic equipment. A stylus such as the Shibata must be used when playing the CD-4 record on either two- or four-channel equipment. The Shibata stylus can also be used to play the stereo discs and actually improves stereo performance. More about this later. In contrast with the CD-4 disc, 4-channel magnetic tape is not compatible with stereo tape since a different number of tracks are used.

Discreteness

In the 4-channel medium, four corner located loudspeakers are used to generate a 3-dimensional sound field in which source images can be located front to back, as well as from side to side within a large portion of the listening area. Technically we call this a 2-dimensional sound field with the 3-dimensional description reserved for the future when possibly sound images will be located at selective heights in addition. While it is possible to produce 4-channel effects with the contemporary CBS/Sony SQ and Sansui QS matrix systems, it is impossible (at this point in time) to reproduce 4 channels of sound to create a 3-dimensional ambience exactly as it originated from two unmultiplexed channels.

Until recently the CD-4 system had been implemented with a number of expensive decoders—expensive because of the intricacies of decoding the complex format. An integrated circuit design for the CD-4 decoders should cause an increase in popularity and public acceptance. Signetics has recently announced their QSI 5022 IC, which was developed jointly with Quadracast Systems (See "The Newest CD-4 Demodulator," Len Feldman, **Radio-Electronics,** June 1974).

The four-channel record is cut with the familiar stereo format. Each of the two groove walls are cut at a 45° angle with the disc surface and at a 90° angle with respect to each other. Conventionally, the inner wall closest to the record center is recorded with the left channel information. The modulation of the walls is perpendicular to their surfaces, and because of their 90° relationship can be traced by a pickup to produce independent electrical outputs that correspond to the mechanical undulations of the walls.

Frequency multiplexing

CD-4 is a frequency multiplexed

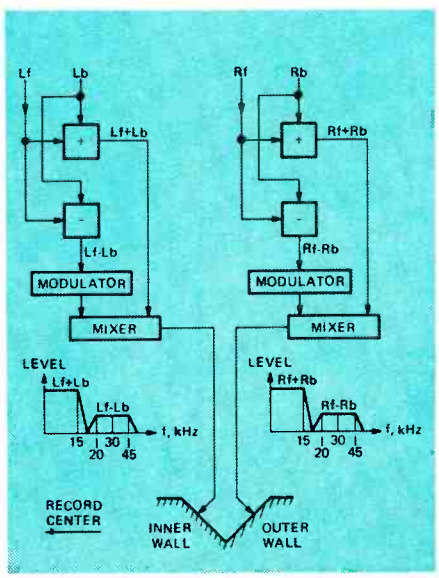


FIG. 1—SUM AND DIFFERENCE recording scheme.

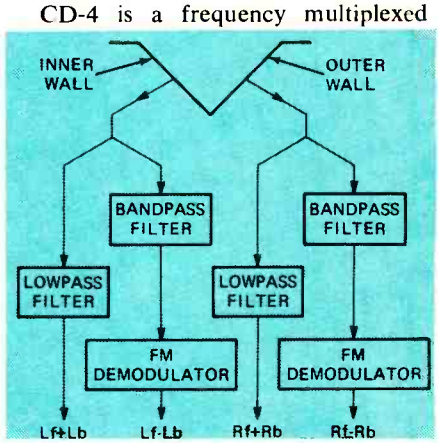


FIG. 2—SUM AND DIFFERENCE channel detection.

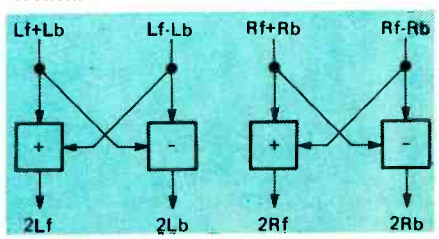
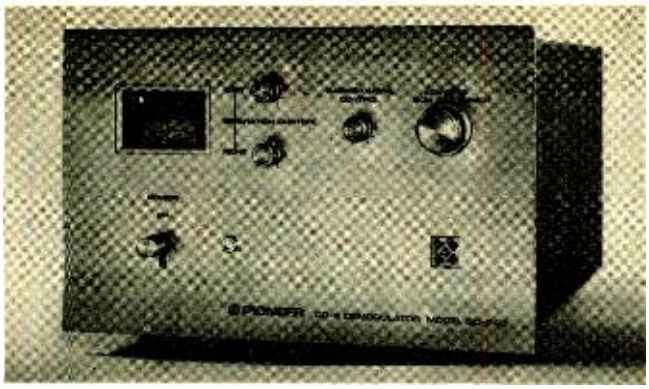


FIG. 3—FOUR CHANNEL recovery matrix.



PIONEER QD-240 is typical of CD-4 demodulators available today.

system. To add the two new channels it was decided to superimpose a frequency modulated signal above the conventional 15-kHz stereo spectrum. The new ultrasonic frequency band has been added to both the left and right channels to give a total of 4 discrete channels. To be compatible with stereo, these four channels are not recorded with a one to one correspondence to the four speaker outputs as might at first seem natural, but are converted to sum and difference channels. Amplitude modulation was rejected for the ultrasonic spectrum because of its poor signal to noise performance, particularly significant because the information to be stored on the 4-channel disc is substantially increased. Just as there is a degradation in S/N in the transition from monophonic to stereo, there is an additional lowering of the S/N ratio when continuing on to 4-channel. Frequency modulation is also relatively immune to surface imperfections such as scratches.

Sum and difference channels

Adopting L, R, f, and b for left, right, front, and back, the four channels—Lf, Lb, Rf, and Rb—are arranged at the recorder as shown in Fig. 1. The Lf and Lb signals are combined by simple addition to form the Lf + Lb sum signal. A left channel difference signal Lf − Lb is formed by an algebraic subtraction between Lf and Lb, and is then used to frequency modulate a 30-kHz carrier which is confined to a bandwidth of 20 to 45 kHz. Note at the outset that the ultrasonic spectrum is unsymmetrical since it extends −10, +15 kHz around the 30-kHz carrier frequency. The left-channel sum and difference signals are combined and recorded on the groove's inner wall.

The 30-kHz carrier level was picked at 19-dB lower than the sum signal reference level after considering pickup trackability, signal to noise, and interference between the frequency bands. When the sum (Lf + Lb) signal increases in a positive direction, the record wall is cut to move away from the center of the record, and a positive increase in the difference (Lf − Lb) signal modulates the 30-kHz carrier higher in frequency. In a similar way and with the same modulation sense with respect to the record center, the outer groove wall is modulated with the Rf + Rb and the angle-modulated Rf − Rb signals. It is more precise to define the modulation as angle modulation because, as will be explained, both frequency and phase modulation are present when pre-emphasis is considered. By defining the four channels in this way, the system is fully compatible and the original Lf, Lb, Rf, and Rb signals can be retrieved without compromise just as if they had been recorded directly.

During playback a high-compliance, wide-bandwidth cartridge and stylus combination is used to produce the left and right outputs in essentially the same manner as in the two-channel stereo pickup. The sum and FM modulated difference signals are separated with filters and the difference signal is detected with an FM demodulator. The detection scheme is shown in Fig. 2. To compensate for the delay of the bandpass filter, a 40-μs time delay is inserted at the recorder in the sum signal path. When separated in the decoder, the sum and difference signals will be in the correct time relationship if the bandpass filter delay is 40-μs greater than the lowpass. FM demodulation is often done with a phase-locked loop because of its excellent performance with a minimum of LC filter components.

Figure 3 shows how the four channels are recovered by proper matrixing of the sum and difference signals. Matrixing here is simply the term used to describe the signal combining process and should not be confused with the QS or SQ systems which use different signal-combining processes. Addition of the sum and difference signals from either the left or right groove doubles the front signal and eliminates the rear one: (Lf + Lr) + (Lf − Lr) = 2Lf. Subtracting the same two signals cancels the front and doubles the rear one: (Lf + Lr) − (Lf − Lr) = 2Lr.

If a 4-channel disc is played on a stereo player, the left and right sum signals will be reproduced and the ultrasonic difference signals ignored. The sum signals are identical to what a conventional stereo record would contain if the CD-4 process was not being used. Conversely, when a stereo record is played on a 4-channel system there is no 30-kHz signal and the Lf − Lb and Rf − Rb can be replaced with zeros in Figs. 2 and 3. The high-frequency detector channel is muted to eliminate the

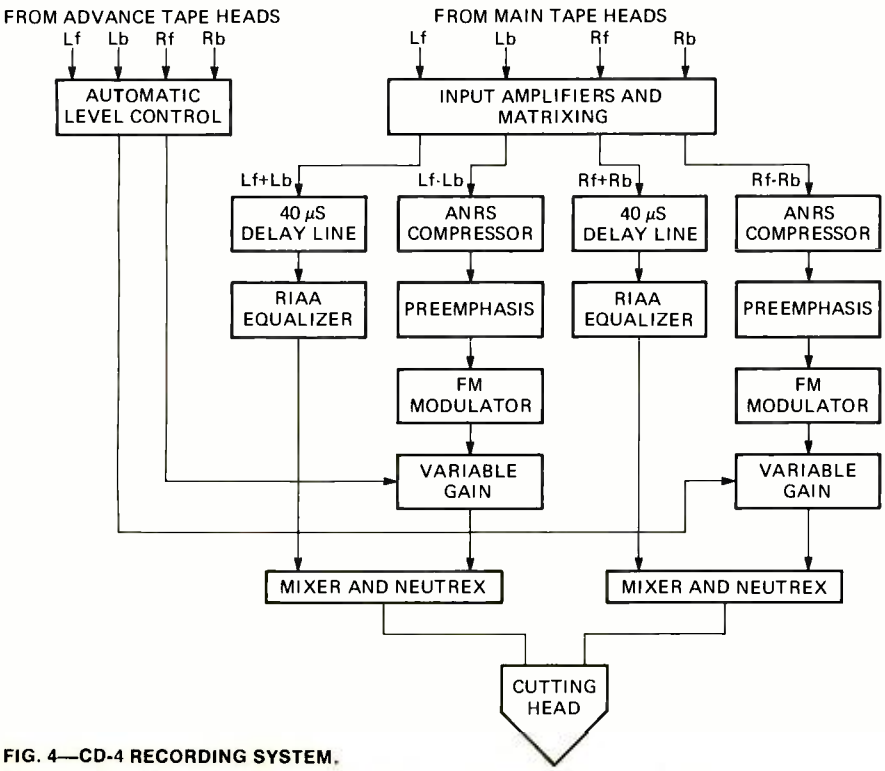


FIG. 4—CD-4 RECORDING SYSTEM.

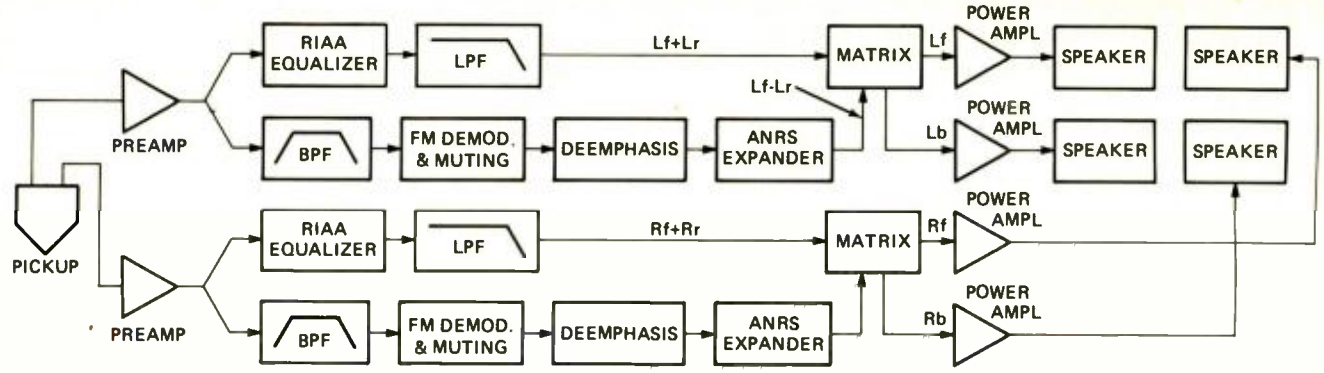


FIG. 5—CD-4 PLAYBACK SYSTEM block diagram showing complete system.

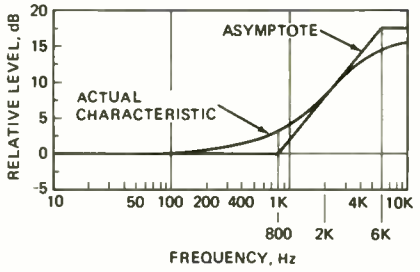


FIG. 6—CHARACTERISTIC CURVES of the pre-emphasis scheme.

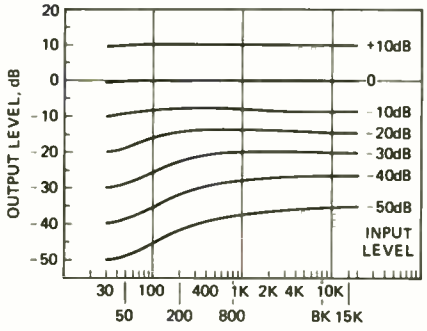


FIG. 7—ANRS COMPRESSOR characteristic curves.

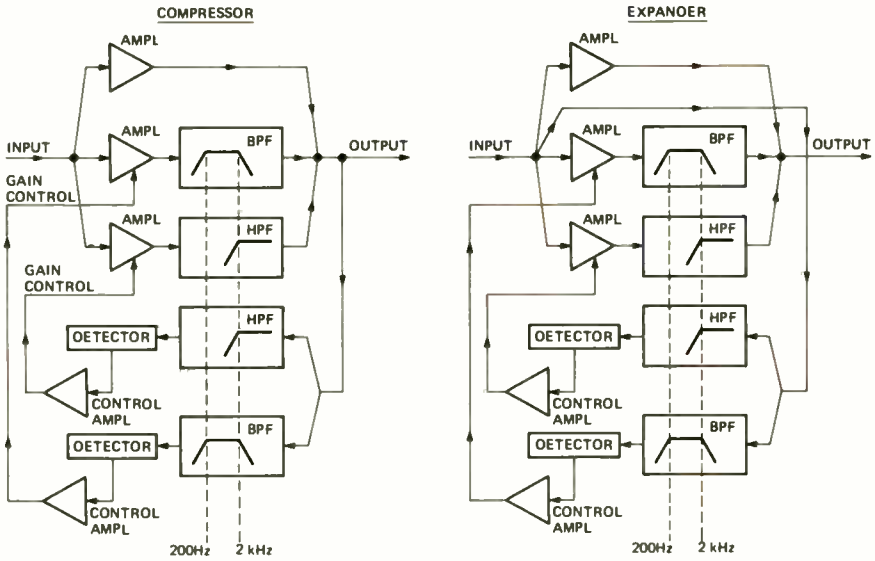


FIG. 8—ANRS COMPRESSION SYSTEM block diagram.

unnecessary band which degrades the signal-to-noise ratio. Lf + Lb is replaced with L and Rf + Rb with R. The left outputs will now both be L and the right outputs R. The rear channels can be silenced to prevent the stereo image from being shifted to a false position. The CD-4 system is then fully compatible with a stereo system since both formats can be interchanged and still retain correct left to right separation.

Preemphasis

In the more complete CD-4 recording and playback system (Figs. 4 and 5) there is a complementary pair of pre-emphasis and de-emphasis blocks. Frequency modulation has a number of unique characteristics. As the modulation frequency increases so does the noise density (noise power per unit bandwidth). The carrier deviation caused by the noise at a particular modulating frequency is directly proportional to that frequency. This well known phenomenom is treated by pre-emphasis in FM broadcasting. If the signal level is increased as the modulating frequency increases the effect of the FM detected noise is cancelled. In considering the application of pre-emphasis to the CD-4 disc, crosstalk and the band limitation must be evaluated.

One large source of crosstalk is in the cartridge and it increases as the modulation index at the recorder increases. The 20 to 45-kHz band limit constrains the modulation difference channel so that pre-emphasis cannot be allowed to continue unbounded. A careful study of the parameters led to the choice of the pre-emphasis characteristic plotted in Fig. 6. Response is kept flat until 800 Hz. Beyond 800 Hz, the response is boosted at a 6 dB/octave rate up to 6 kHz, beyond which the response is again flattened. The total pre-emphasis is a little less than 3 octaves giving a total boost of 17.5 dB. At 6 kHz where the response is 3 dB down the actual boost is 17.5 − 3 = 14.5 dB.

An interesting perspective is gained by realizing that when frequency modulation is carried out with a linear frequency boost, the result is a phase modulated signal. In a frequency modulation scheme, phase deviation decreases inversely with modulating frequency. The same amplitude signal at 2 kHz will phase deviate the carrier half as far as a 1-kHz signal. If the pre-emphasis counteracts this decrease by a corresponding rise in its amplitude, the phase deviation will be independent of frequency, and will only depend on the modulating amplitude. Between 800 and 600 Hz, the difference signals can be considered as phase modulating the 30-kHz carrier. Phase modulation gives excellent signal-to-noise performance at the higher frequencies since increases in phase deviation is not accompanied by increases in noise. The pre-emphasis is only applied to the carrier channel with the sum signals operated on by the conventional RIAA characteristic to maintain compatibility.

The ultrasonic frequency spectrum is proportioned so that the system becomes single sideband frequency modulated at its highest frequencies. This is a refinement in bandwidth use since the higher distortion of the FMSSB operation is unimportant; the second and higher harmonics of frequencies above 10 kHz is beyond the audible range.

ANRS reduces noise

In the same way compression is used to increase the apparent dynamic range of magnetic tape, JVC has applied their ANRS Automatic Noise Reduction System as an integral part of the design.

(continued on page 89)

Many Roads to 4-Channel

Many options are open to the person who wants to listen to 4-channel sound, but there are many questions too. What should I do if I already own stereo equipment? What should I purchase in the way of new equipment? Here are some of the answers.

by HERB FRIEDMAN

DEPENDING ON WHOM YOU'RE TALKING to, and what part of the country he's from, 4-channel equipments can represent anywhere from 20% to 80% of a dealer's total hi-fi sales. In plain terms, 4-channel is a bust or a boom.

Where 4-channel sound gets an adequate demonstration, and where adequate software is available in the form of a substantial record selection, dealers can't get enough hardware to keep up with the demand. But where the demonstration involves second rate speaker placement—or second rate equipment—and where the selection of 4-channel records takes up less than a hand-span out of hundreds of record bins, we find the consumer has little interest and enthusiasm for anything other than stereo; for the difference between even the best mono and second-rate stereo is spectacular, while that of stereo and 4-channel is at best marginal if the listener hears anything other than the finest 4-channel equipment.

We must also face the fact that 4-channel involves considerable additional expense if we wish to maintain the same overall sound quality as provided by a stereo system in the same class. For example, 4-channel means two additional rear speakers of the same quality (preferably identical) as the front "stereo" speakers. Power output for power output, the 4-channel system requires virtually a second complete amplifier (the power supply can be shared), and of course, if we want Quadradisc in addition to the martix format, there is the additional expense of the CD-4 demodulator.

But it really is better!

Regardless of the hard knocks directed at 4-channel by confirmed stereophiles—the same as we heard when mono was replaced by stereo, the truth of the matter is that 4-channel, surround-sound, quadriphonic, or whatever we chose to call it, is superior to stereo when the program material is scored to use the full potential of the system. (Fact is, even ordinary stereo often sounds better when coming from front and rear than "standard stereo".)

But the superiority of 4-channel is only evident when good equipment—designed to provide more than just a semblance of rear information—is used. To explain: While the Quadradisc system provides a discrete output from each of the four channels, as does 4-channel tape, the matrix systems deliver the expansive separation desired by most listeners only when enhanced. Both the SQ and QS (RM) matrix systems have special electronic circuits which provide some 15 to 20 dB separation in all directions, thereby approaching and in some instances equalling the special characteristics of CD-4.

SANSUI SP-2500 3-way seaker system features a 12" woofer, two 5" cone-type midranges, and a pair of 2" tweeters.

But equipment which has the full-enhancement circuitry built in are few and far between; more often, they're available as an optional add-on device for an associated receiver or amplifier. Most of the receivers and amplifiers presently available use a far more simplified matrix decoder which provides anything from "infinite" front/zero front-to-rear separation, to about 20 dB front/8+ dB front-to-rear separation. Now a listener hearing zero, or even 8-dB center front-to-rear separation is not going to be overwhelmed by the advantages of surround-sound.

Consider the future

Because someone is underwhelmed by 4-channel at this time is no reason, however, not to prepare for the future, for 4-channel is growing by leaps and bounds; and it is conceivable that before the year is out many of the most popular records and prerecorded tapes will be available in the 4-channel formats. They will be scored for surround-sound listening, and much of the content and enjoyment will be lost if they are heard in "compatible stereo". (For a listing of available 4-channel software, see Harry Maynard's article, "4-Channel Software—Who Makes What" elsewhere in this issue.)

Almost all high-fidelity equipment manufacturers allow for the *stereo now/4-channel future* listener, and many fine "4-channel" amplifiers and receivers offer some form of amplifier strapping or bridge connection that combines the available rear channels amplifier power output into the front channels for standard stereo (see "Amplifier Switching From 4-Channel To 2-channel by Len Feldman, **Radio-Electronics,** July 1973). Most often, these units are provided with some form of matrix decoder so the listener can move into surround-sound by simply adding the two rear speakers. In addition, several discrete 4-channel inputs are provided for auxilary equipment when the user upgrades to 4-channel. These inputs allow for connecting a CD-4 demodulator, or an enhanced matrix decoder, so obsolescence is avoided. If there are new developments in 4-channel sound the user can upgrade by plugging in the latest device.

Other forms of the latest 4-channel amplifiers and receivers have the amplifier strapping and a built in CD-4 demodulator, and some form of basic matrix decoder. Here, the potential for immediate expansion from stereo to all 4-channel modes is positioned at the end of a front panel switch; but, of course, *all* the features are paid for at one time. Similarly, there are strapped amplifiers with enhanced matrix de-

coders and built-in switching for an add-on CD-4 demodulator; but again, the user might be paying for much more than he wants or needs today.

One of the most effective ways to have your cake and eat it is to take the "building block" approach to 4-channel; using your present stereo components, or even a brand new stereo system. (There's no good reason to put off buying hi-fi equipment simply because you can't decide between stereo and 4-channel and want to avoid being stuck with obsolete equipment.)

By using building blocks to create a 4-channel system you not only get a chance to buy as the budget permits, you also add only those surround-sound features immediately desired. For example, let's assume you presently own a stereo system and you want to experience the "enhanced stereo" available through the "ambient sounds" concealed within an ordinary stereo program (records and tapes). Figure 1 shows how it's done with two rear speakers and a passive ambience sound (Dyna type) decoder. (less than $20).

Note that the ambience sound decoder connects across the stereo (front) speakers, while the rear speakers connect to the decoder. This arrangement extracts the same ambient information from a stereo program as a more complex electronic decoder, and represents the lowest cost way to go.

Once you've dipped your toes into 4-channel you'll probably want to upgrade to other modes, say matrix 4-channel. Figure 2 shows how the original stereo equipment is used with a Decoder/Rear-Amplifier. The signal from the stereo amplifier's tape output is fed into the D/RA, where the rear output from the decoder feeds straight through the integral amplifier. The front signals come out of the decoder and are fed back into the stereo amplifier's tape input—the stereo amplifier now serving as the "front amplifier".

Though the D/RA's often have a rear amplifier of quite good performance, it is rarely up to the power level of the user's main stereo amplifier.

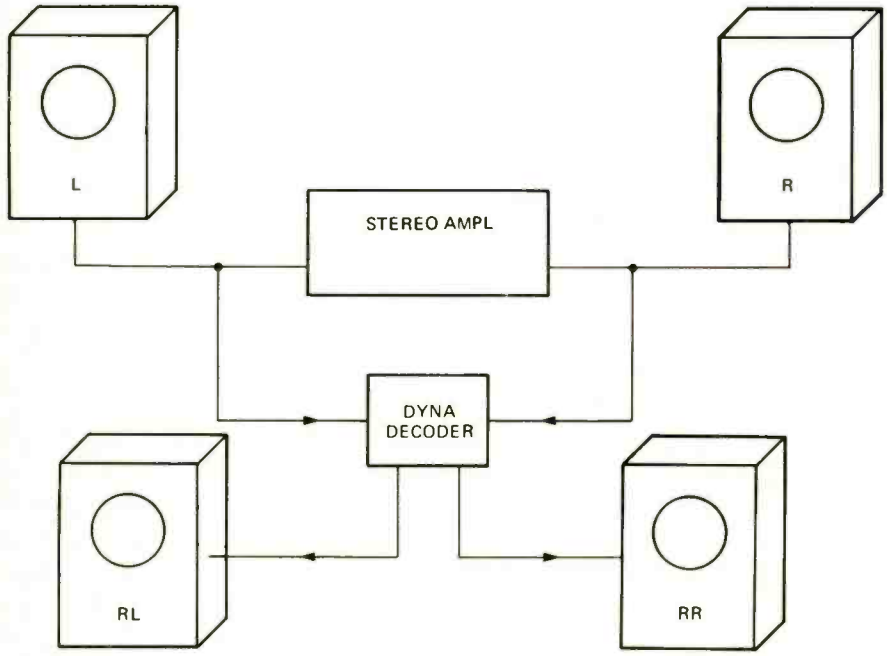


FIG. 1—THE PASSIVE "DYNA" TYPE DECODER extracts ambient sounds of the recording location, such as reverberrations, which are concealed within a stereo program. When these ambient sounds are reproduced from behind a listener the special characteristics of the recording studio or auditorium are approximated. Though touted by manufacturers as "4-channel", ambient surround-sound is really enhanced stereo.

FISHER 222 AM/FM STEREO RECEIVER has 20 watts output power per channel.

CONCORD CR-210 features seperate fine tuning control for FM reception.

Where the total system might be well suited for "background" or "general listening", it rarely will deliver the thunderous sound levels enjoyed by many stereophiles (quadrifiles?).

For high volume levels and sound quality equal to the best in stereo the system shown in Fig. 3 is an ideal solution. Here we find the rear amplifier is an exact duplicate (same model) as the original stereo amplifier, now to be used for the front channels. If the amplifiers are stacked one on the other the total control arrangement is similar to the sophisticated 4-channel equipments. In between the two stereo amplifiers we find an "enhanced" matrix decoder, providing the optimum in matrix decoding.

When it is desired to add CD-4 capability, an optional demodulator is also

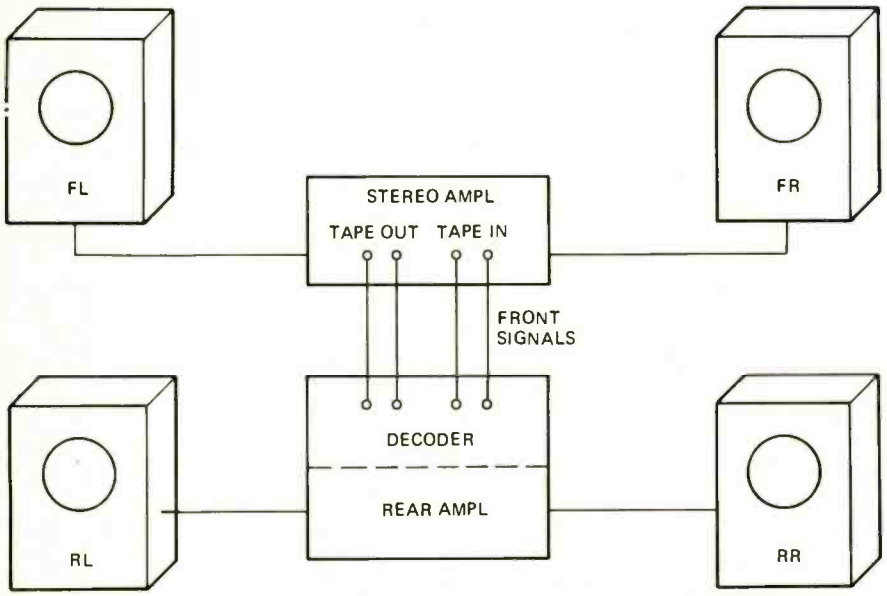


FIG. 2—SMALLER STEREO SYSTEMS are often effectively upgraded to 4-channel by using a combination Decoder/Rear-Amplifier. The decoder takes a matrix encoded 4-channel feed from the main stereo amplifier and decodes the signal into front and rear outputs. The rear outputs pass into the amplifier section while the front outputs are fed back through the tape recorder connections to the "front" stereo amplifier. Some of the newer stereo amplifiers have a special "4-channel output" so the decoder doesn't tie up the tape connections (which are generally "moved" to the D/RA.)

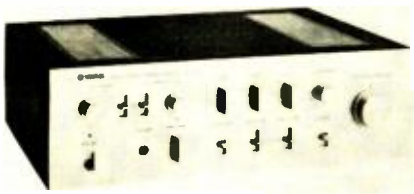
connected between the amplifiers, using the auxiliary inputs. The same applies to 4-channel tape equipments.

As you can see, the building block approach allows any stereo system to be upgraded to any desired degree of 4-channel performance. For those not willing to plunge into 4-channel it offers the most convenient way to assemble a high performance 4-channel system over an extended time period.

Full 4-channel

Complete 4-channel receivers and amplifiers generally provide what you'd build up to with building blocks, the major difference being everything is built into one cabinet. Almost every major manufacturer offers a high-performance receiver with a built in CD-4 demodulator, matrix decoder, at least one 4-channel auxiliary input, and one or two 4-channel tape recorder connections. Some of these high performance units also provide an optical ("scope") relative power output indicator which is used for adjustment of the CD-4 demodulator and/or the speaker sound balance. Other models use VU-meters

PIONEER SX-636 stereo receiver has many features found in higher priced models.



YAMAHA CA1000 integrated stereo amplifier has direct-coupled power amplifier stages.

to indicate the channel balance, though meters cannot usually be used—because of reduced sensitivity—to adjust a CD-4 demodulator.

Some matrix 4-channel receivers allow for expansion to CD-4 with an optional plug-in demodulator. These receivers are completely wired for CD-4, with the requisite front panel switching. The only thing that's missing is the demodulator itself, which is available as a plug-in that becomes an integral part of the receiver itself—just as if it was factory wired. The user acquires the basic AM FM 4-channel receiver with integral matrix decoder and discrete auxiliary inputs, and adds the CD-4 plug-in when it's desired.

Though there have been rumors to the effect that a total 4-channel receiver

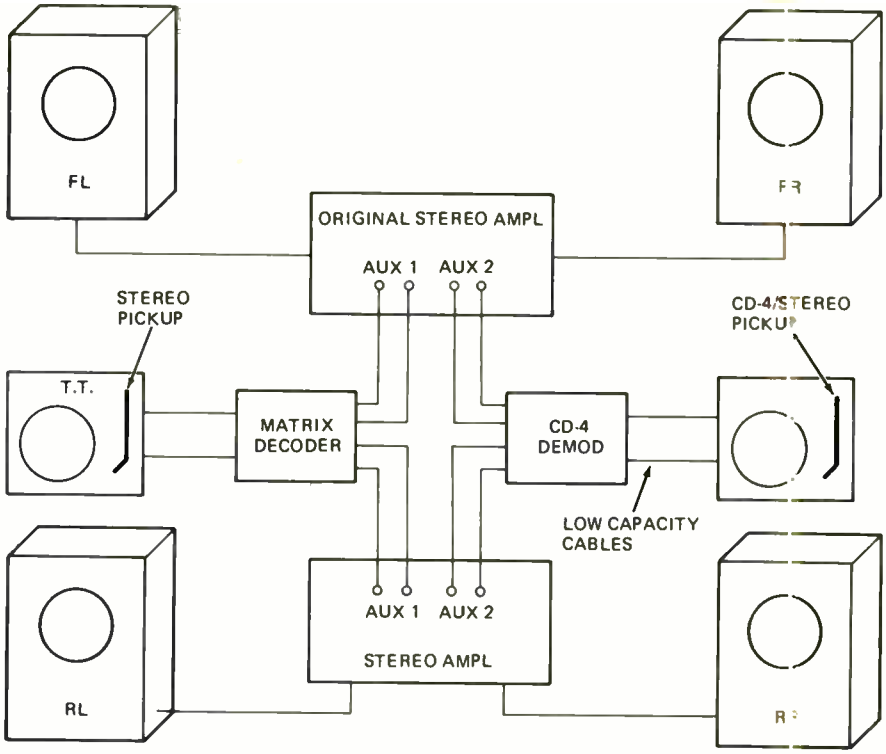


FIG. 3—A SECOND STEREO AMPLIFIER—identical to the user's present equipment—often provides an excellent path towards high performance 4-channel. Decoders, demodulators and tape recorders are easily connected between the auxiliary or tape inputs on both amplifiers. Though we show separate turntables and pickups for matrix and CD-4, one CD-4 turntable/pickup is often all that's needed as the demodulator might have a "pickup bypass" output (around the demodulator) which can feed the matrix decoder.

with CD-4 and *enhanced matrix decoder* is being manufactured, no one has seen a production model. Even with a full-feature 4-channel receiver or amplifier, an accessory enhanced matrix decoder is required for optimum matrix 4-channel. On the other hand, while there are several receivers and amplifiers with enhanced matrix decoders, they don't have CD-4 demodulators; and again an accessory is required.

Most modern 4-channel receivers provide an "FM output" for use with contemplated 4-channel FM broadcast adapters—the same idea used back when stereo got started and the *multiplex adapter* was provided to "upgrade" monophonic tuners. The "FM output" is a take-off ahead of the de-emphasis filter—the same as used for stereo. Since no 4-channel system has been FCC approved for FM broadcast, there's no reason to assume a detector output will be suitable for the system that wins approval. An "FM output" jack, therefore, is not a consideration when selecting 4-channel receivers.

4-channel tape

Though there have been reports of a 4-channel cassette recorder available in Japan, only the 8-track cartridge and reel-to-reel recorders are available, here, with 4-channel capability. In both instances equipment is available in everything from rock-bottom price to high performance. With few exceptions the equipment has both record and play in the 4-channel mode. A few early reel-to-reel recorders had stereo record and 4-channel play, but they are no longer available (thank heaven). In 8-track equipment, however, we find there are still several models which are stereo record and 4-channel play; for the 8-track cartridge market appeals to both the quadriphile who records his own carts (for use, say, in his car) and the hobbyist who uses only pre-recorded 4-channel cartridges.

Speaking of cars, there is a groundswell of interest in 4-channel for vehicles; limited exclusively to 8-track cartridge equipment. The basic package is, of course, the 4-channel cartridge player. There is considerable interest, however, in *enhanced stereo*, with derived ambient sound from the rear speakers. Since the Dyna type rear speaker connection requires nothing in the way of additional circuits other than a pair of speaker outputs, several "standard" stereo 8-track players are now available with a "4-channel"—actually *enhanced stereo*, output. For those who already have an 8-track player in their car, Dyna type ambient sound decoders for vehicle use are to be found in virtually every dealer's cartridge player display. An service shop that sells or installs auto players will also provide you with the ambient

(continued on page 88)

R-C Coupling in

Solid state amplifiers commonly employ multiple stages of amplification together. stable operation. Here's how to

RESISTOR-CAPACITOR COUPLING IS ONE of the most common methods of connecting one amplifier stage to another. In this article we will show how to design these coupling arrangements and work our way through to practical operating circuits.

Capacitive reactance is inversely related to the frequency of the voltage across the capacitor. In the formula

$$X_c = \frac{1}{6.28\ fC} \qquad \text{Eq 1}$$

X_c is the reactance of the capacitor in ohms, f is the frequency of the applied signal in hertz, and C is the capacitance in farads. Include the capacitor in a circuit with a resistor and you have a frequency dependent R—C filter. These filters are part and parcel of the R—C coupled transistor circuit.

R—C filters

Two basic filter circuits using one resistor and one capacitor in each, are shown in Fig. 1. The high-pass filter in Fig. 1-a discrimates against the low frequencies and freely passes the upper end of the spectrum. The exact and approximate frequency curves for this filter are shown as A and B respectively, in Fig. 2. Note the 6 dB-per-octave or 20 dB-per-decade rolloff. The corresponding curves for the low-pass filter of Fig. 1-b are shown in Fig. 3. The corner frequency, f_n, can be determined from the equation

$$f_n = \frac{1}{6.28\ R\ C} \qquad \text{Eq. 2}$$

where R is the resistance in ohms, and C is the capacitance in farads.

Two or more such filters can be connected into the circuit to increase the rate of the rolloff beyond 6 dB/octave. The reduction in gain below maximum at a specific frequency, is equal to the sums of the reduction in gains of the individual filter sections at that frequency. See filters in Fig. 4 and corresponding curves in Fig. 5.

The circuit in Fig. 4-a consists of two low-pass 6 dB/octave filters: one is composed of R1—C1 and the second is R2—C2. The corner frequency of the R1—C1 combination is f_{o1} while that of the R2—C2 section is f_{o2}. If f_{o2} is higher than f_{o1}, the approximate frequency curve of the total filter rolls off at 12 dB/octave below f_{o2} (Fig. 5-a).

In the drawing, the low frequency end of each curve is flat with 0 db attenuation. At f_{o1}, one curve starts to roll off at the rate of 6-dB-per-octave' while beginning at f_{o2}, the second curve rolls off at the same rate. The resultant is the sum of the two curves. Up to f_{o1}, neither R-C combination attenuates the signal, so the curve is flat with 0 dB attenuation.

Between f_{o1} and f_{o2} the rolloff is affected only by R1-C1, so that this portion of the curve rolls off only at the rate of 6 dB-per-octave. From f_{o2} on up to an ideally infinite frequency, the slope due to the roll-off characteristic of the R2-C2 section must be added to the slope due to R1-C1. Since here both 6 dB-per-octave circuits are involved, the final curve is characterized by a 12-dB-per octave rolloff.

Another way of plotting the effect of the total filter is to add the curves of each section vectorally, point-by-point. Up to f_{o1}, the attenuation of both curves are zero so 0 + 0 is 0 dB. At $2f_{o1}$, or at f_{o2}, the attenuation of one curve is 6 dB and that of the second curve is still zero. The point on the sloping line curve is thus 6 dB + 0 dB = 6 dB. Continuing this, at $4f_{o1} = 2f_{o2}$, one curve shows an attenuation of 12 dB while the other is 6-dB down. As the total is 18 dB, this is another point on the final curve.

All points can be connected by a straight line with the resulting response curve being the approximation to the complete filter. The characteristics are altered somewhat from the ideal, because of the loading effect of one filter section on the other. The proceedure outlined is more accurate when the two sections are isolated from each other. This isolation can be provided by placing a high-impedance transistor stage between the two R-C sections.

Should f_{o1} and f_{o2} be coincident, the rolloff is 12-dB-per-octave beginning at the coincident corner frequency. This is shown in Fig. 5-b.

Similar plots are made for the high-pass filter of Fig. 4-b in Figs. 5-c and 5-d.

Characteristic curves of the bandpass filter of Fig. 4-c are in Fig. 7. The vector additions producing the sum curve defining the response of the total filter, are done as before.

An equivalent to the input circuit of a transistor, can take the form shown in Fig. 8-a. While R can be the Thevenin equivalent of the output resistance of a preceeding circuit, R_n will represent the input resistance of a transistor or the resistor placed at the input of a transistor. C could be the input capacitance of a JFET or bipolar device. The actual and approximate attenuation curves of this circuit are shown in Fig. 8-b. However, it is displaced from the 0-dB level by a number of dB determined by the resistive components in the circuit.

The horizontal portions of this curve, from 0 Hz to f_n Hz, is not at 0 dB, as was the

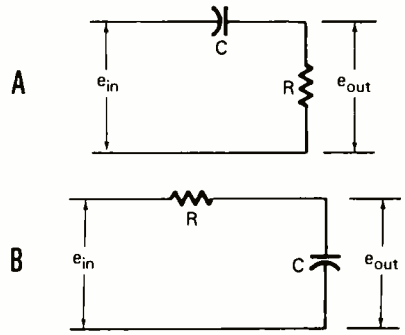


FIG. 1—BASIC HIGH-pass and low-pass R-C filters (a and b respectively). The attenuation depends upon the value of the resistor and the capacitive reactance which is frequency dependent.

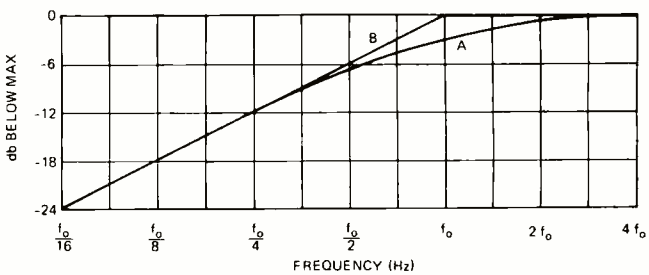


FIG. 2 — THE FREQUENCY RESPONSE CURVES of the high-pass filter shown in Fig. 1-a. Curve a shows the exact response, while curve b is a linear approximation.

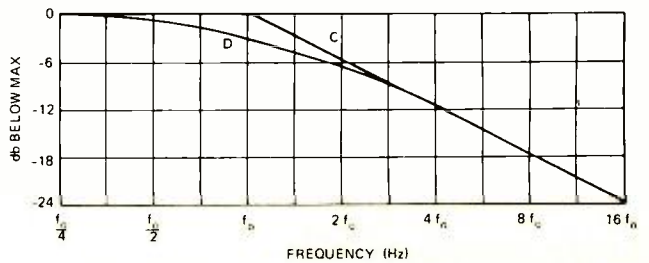


FIG. 3 — THE FREQUENCY RESPONSE CURVES of the low-pass filter shown in Fig. 1-b. Curve d shows the exact response, while curve c is a linear approximation.

Audio Circuits

resistor-capacitor coupling to connect
This method has the main advantage of
design the coupling circuits.

by MANNIE HOROWITZ

case when the curve in Fig. 3 was drawn for the circuit in Fig. 1-b. There is already some attenuation at the low frequencies. At these frequencies, the attenuation is determined by the resistive voltage divider formed by R and R_p, for up to f_o, C is effectively as open circuit. Up to f_o

$$e_{out} = \left(\frac{R_p}{R+R_p}\right)e_{in} \qquad \text{Eq. 3}$$

so the dB attenuation at these frequencies can be determined from the equation

$$\text{dB attenuation} = 20\log_{10}\left(\frac{e_{out}}{e_{in}}\right) = 20\log_{10}\left(\frac{R_p}{R+R_p}\right) \qquad \text{Eq. 4}$$

The corner frequency can be determined by shorting the input voltage, e_{in}, while the output circuit at e_{out} is left open. Note the effective resistance shunting the capacitor, C. For this circuit, R is in parallel with R_p. Using the symbol $R||R_p$ to represent this combination

$$f_o = \frac{1}{2\pi\,(R||R_p)C} \qquad \text{Eq. 5}$$

This equation is identical in form to Equation 2.

A high-pass filter circuit frequently encountered is shown in Fig. 6. In a practical circuit, R_p can be the input resistance or input resistor of a transistor circuit, while C may be a coupling capacitor shunted by resistor R. R may be the resistance due to the leakage of an electrolytic coupling capacitor. The frequency characteristic curve for this circuit is shown in Fig. 9.

As was the case with the circuit in Fig. 8, the output from 0 Hz to f_{o1} Hz is dependent only on the resistive voltage divider formed by R and R_p and can be determined using Equation 4. The lower corner frequency can be calculated from the parallel R-C circuit when e_{in} is open circuited while the output is shorted at e_{out}. It is simply equal to 1/6.28RC as in Equation 2.

The curve from f_{o1} to f_{o2} has a 6-dB-per-octave slope. Equation 5 can be used to determine f_{o2}. As before, e_{in} is shorted to determine the resistance across the capacitor, $(R||R_p)$ while e_{out} remains open. $F_{o2} = 1/6.28\ (R||R_p)C$.

The curve in Fig. 9 is actually the sum of two curves, for there are two corner frequencies. The addition is performed in a manner similar to that described for Fig. 5 and is detailed in Fig. 10.

Let us now observe to see just what we did to determine the corner frequencies.

One corner frequency, f_{o2}, is determined from the parallel R-C circuit when e_{in} is shorted and e_{out} is left open circuited. For the high-pass filter, the low-frequency rolls off or *decreases* below f_{o2}.

The second corner frequency, f_{o1}, is determined from the parallel R-C circuit when e_{in} is open circuited and e_{out} is short circuited. In this case, the output *increases* at the rate of 6-dB-per-octave from the corner frequency.

One more coincidence can be shown with respect to the low-pass filter in Fig 4-c and the representative curve in Fig. 7.

The corner frequency was determined by shorting e_{in} while e_{out} was left open. The

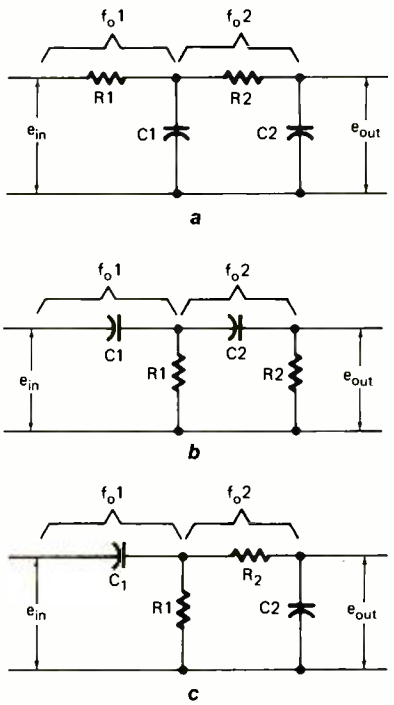


FIG. 4—MULTIPLE STAGE R-C FILTERS. Circuit a is two low-pass filters connected in series to provide additional attenuation. Circuit b shows two high-pass filters connected together. Circuit c consists of a high-pass filter followed by a low-pass filter to form a bandpass filter.

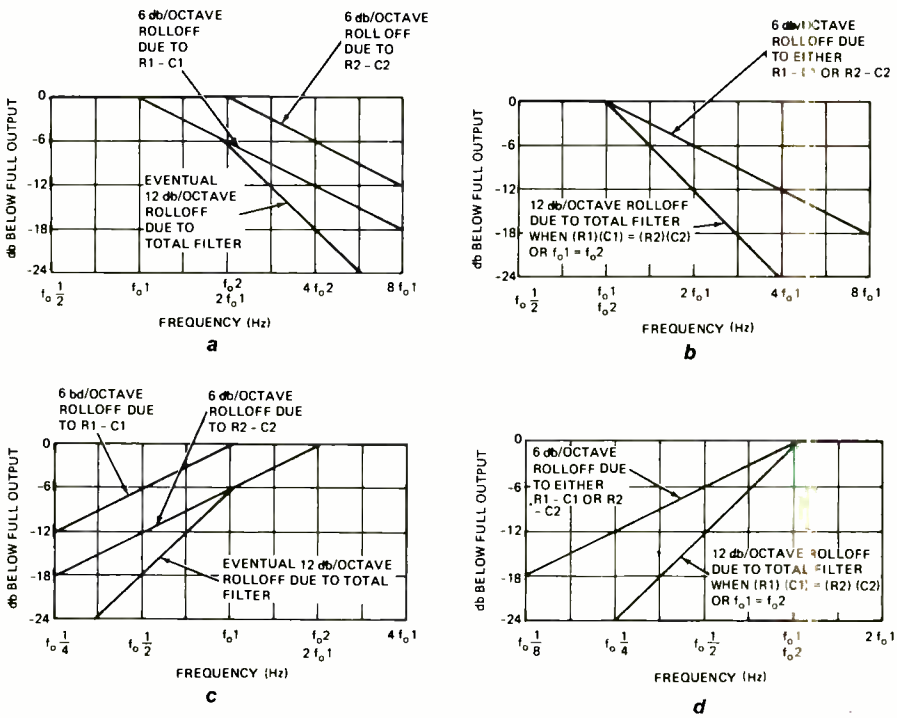


FIG. 5—FREQUENCY RESPONSE CURVES of the multiple stage R-C filters shown in Figs. 4-a and 4-b. Fig. 5-a shows the response of circuit 4a when the two corner frequencies are not equal to each other. Fig 5-b shows the response of circuit 4a when the two corner frequencies are equal to each other. Fig. 5-c shows the response of circuit 4-b when the two corner frequencies are equal. Fig. 5-d shows the response of circuit 4-b when the two corner frequencies are equal to each other.

curve above f_o rolled off or *decreased* at 6 dB-per-octave. This rolloff was common to both the high-and low-pass filters when the corner frequency was determined after e_{in} is shorted while e_{out} is left untouched. We can now write two rules:

1. Determine one corner frequency by shorting the input while the output remains open. Substitute the equivalent resistance of all resistors in parallel with C, into Equation 2. The curve will roll off or *decrease* at the rate of 6-dB-per-octave from this frequency. The direction of the rolloff will depend upon whether the circuit is a high-or low-pass type of filter.

2. Determine a second corner frequency by opening the input circuit while shorting the components at e_{out}. Substitute the equivalent resistance of all resistors in parallel with C. The curve will *rise* at the rate of 6-dB-per-octave from the frequency determined by using all resistance across C. If the parallel R-C combination is in series with the signal, the output will rise to f_{o2} Hz as shown in Fig. 10. If the R-C network is in parallel with the input, the curve will rise to ∞ Hz beginning at the corner frequency.

Let us apply these two rules to the circuit in Fig. 11. As C is across a portion of the output, it is essentially a low pass filter circuit. Determine f_{o1} by shorting the input, e_{in}. The equivalent resistance is $(R + R_S)$ in parallel with R_P, written $(R + R_P)||R_S$. Thus f_{o1}, the frequency at which the rolloff starts is $1/6.28[(R + R_S)||R_P]C$. Leaving e_{in} open and shorting the component at e_{out}, the second corner frequency, $f_{o2} = 1/6.28\ (R_P||R)C$, can be determined. The component curves and the sum of the components, are shown in Fig. 12. The number of dB the horizontal curve is below the 0-dB reference can be determined from the resistor components & is equal to

$$\text{dB below zero} = 20 \log_{10}\left(\frac{R_P+R}{R_P+R+R_S}\right)$$

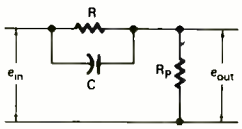


FIG. 6—PRACTICAL HIGH-PASS FILTER which is frequently encountered as an equivalent of the coupling circuit used in transistor amplifiers. The lower corner frequency depends solely on the capacitive reactance and the resistor R. The upper corner frequency depends on the capacitive reactance and the parallel combination of R and R_P.

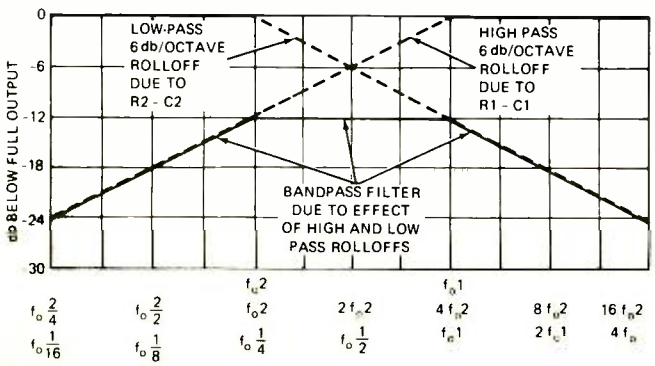


FIG. 7—FREQUENCY RESPONSE CURVES of the band-pass filter shown in Fig. 4-c. The dotted lines show the individual response of each section, while the solid line shows the response of the complete filter.

Frequency characteristics of an R-C stage

The circuits discussed can be applied to practical R-C and direct coupled stages. One possible circuit is in Fig. 13. The input signal is fed through capacitor C1 to the gate of a JFET. The voltage developed across R_D is coupled through capacitor C2 to the base of a bipolar transistor. The output of the two-stage amplifier, appearing across R_C, is fed to load resistor R_L through capacitor C3.

Should e_{in} be a voltage source, the corner frequency for the circuit consisting of R_G and C1 is $1/6.28R_GC_1$. The curve picturing the frequency characteristic of the signal across R_G is curve A in Fig. 2. The identical curve is used for the circuit involving R_D-C_2-R_{in} (R_{in} is the input resistance of the bipolar transistor) where the corner frequency is $1/6.28C_2(R_D+R_{in})$ as well as for the circuit including R_C-C_3-R_L with a corner frequency at $1/6.28C_3(R_C+R_L)$.

Corner frequencies are also determined by the capacitor-resistor combinations in the drain and emitter circuits. Due to these combinations, the gain rises at the rate of 6-dB-per-octave from the corner frequency up to ∞ Hz. For the JFET, the corner frequency is $1/6.28C4R_S$ while for the bipolar device, it is $1/6.28C_3R_E$.

Unbypassed resistor R_E in the emitter, in conjunction with C5 and the balance of the circuit, are all components in a circuit with the frequency characteristic shown in D in Fig. 3. The corner frequency here is

$$\frac{1}{6.28\ C_S}\left(\frac{R_E+R_Q}{R_ER_Q}\right)$$

where R_Q is $R_E + r_e$ + (resistance seen by the base circuit)/β. R_Q is the resistance seen by R_E looking back into the emitter circuit of the transistor.

Response curves are all approximate due to capacitance and resistance ignored in the calculations. All calculations should be checked in the laboratory.

Ac and dc load lines

The load lines for the input transistor in this circuit, the JFET, are drawn in Fig. 14. The dc load line involves all resistors in the drain circuit, and is the sum of resistors R_D and R_S. If, for this discussion, R_S is negligible compared to R_D, the maximum drain current shown in the drawing is $I_D(max) = E_{DD}/R_D$. The quiescent current and voltage point is normally chosen at the center of the load line when the transistor is operated in Class A.

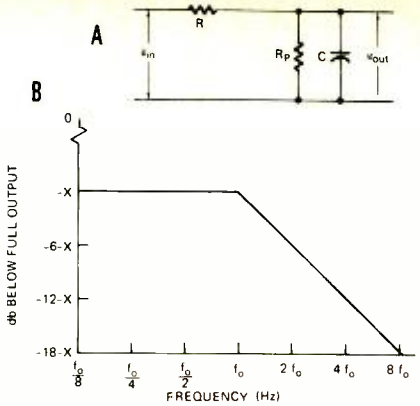


FIG. 8—TRANSISTOR INPUT CIRCUIT equivalent. Circuit A shows the practical form of the equivalent circuit at the input to a transistor. The frequency response characteristic curve is shown in curve B. The response curve is shifted below the 0-dB reference line by an amount which depends upon the value of the resistive elements in the circuit.

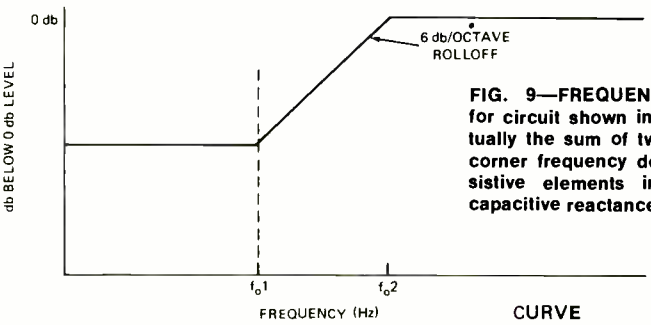


FIG. 9—FREQUENCY RESPONSE CURVE for circuit shown in Fig. 6. This curve is actually the sum of two seperate curves. Each corner frequency depends upon the two resistive elements in conjunction with the capacitive reactance.

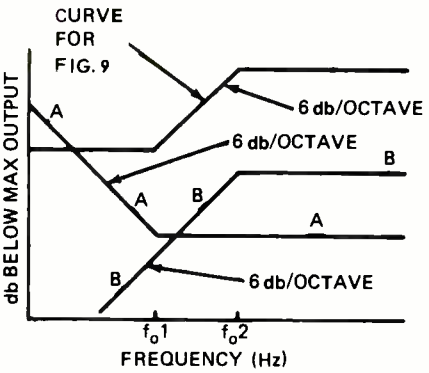


FIG. 10—FREQUENCY RESPONSE CURVE details for the circuit shown in Fig. 6. The total response curve is the result of a point-by-point summation of curves a and b.

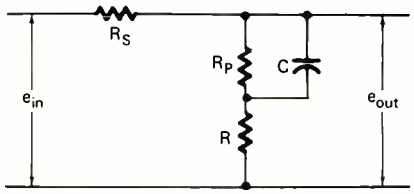


FIG. 11—PRACTICAL LOW-PASS FILTER used in analysis (see text). The corner frequencies are determined from the series-parallel combinations of the resistive elements in conjunction with the capacitive reactance.

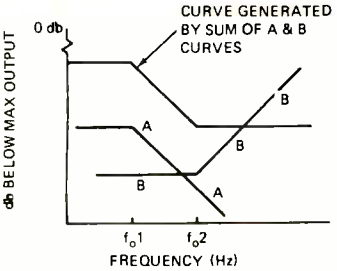


FIG. 12—FREQUENCY RESPONSE CURVE for circuit shown in Fig. 11. The total response curve and the two individual components that comprise the total response are shown.

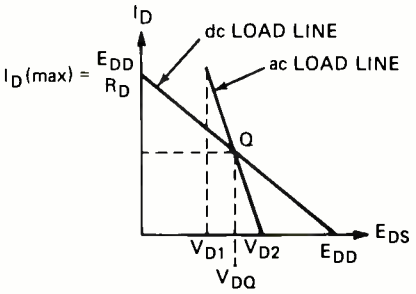


FIG. 14—LOAD LINES for the JFET input stage of the circuit shown in Fig. 13.

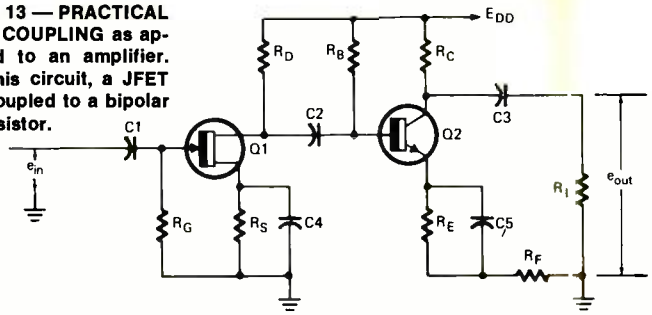


FIG. 13 — PRACTICAL R-C COUPLING as applied to an amplifier. In this circuit, a JFET is coupled to a bipolar transistor.

At the mid-frequencies, all capacitors are considered as short circuits. The mid-frequency ac load line is therefore determined by R_D shunted by R_B while this combination is in turn shunted by the impedance looking into the base circuit of the bipolar transistor or $r_b + \beta (r_e + R_F)$. Assign R_{ac} as the symbol for the resistance shunting R_D when the ac load line is considered. The effective ac load line is then determined by R_{ac} in parallel with R_D.It passes through the quiescent point on the dc load line.

Note that the possible voltage swing across the dc load resistance is from 0 to E_{DD}. Shunting the resistor R_D with R_{ac}, as is required to determine the ac load line, the possible output voltage swing is limited from V_{D1} to V_{D2}. It is obvious that the larger R_{ac} is made with respect to R_D, the larger the voltage swing of the output signal can be. R_{ac} is normally designed to be at least equal to R_D although it is more desirable that its resistance be more than ten times that of the resistor in the drain circuit.

Should the input transistor be a bipolar type, the identical considerations are involved when the resistor in the collector circuit is shunted by all other resistors capacitively coupled to it, which are needed to compose the ac load line. Regardless of the input transistor, R_{ac} is due to the loading of the second device on the output circuit of the first transistor. If the second transistor is a JFET, the gate resistor of the second amplifier stage must be considered. Should the second device by a bipolar transistor, R_{ac} is the sum of the base resistance, r_b, beta times the emitter resistance and the unbypassed resistor in the emitter circuit, such as R_F. All this is shunted by the components used to bias the device.

As in the case of all coupled circuits, the mid-frequency gain is the product of the ac gains of each stage when the gains are calculated using the proper ac load at the output. The *proper* ac load includes all components in, and the loading effect of the succeeding stage.

Coupling without capacitors

The capacitor C2 in Fig. 13 is vital in keeping the dc from the first stage out of the input circuit for the next stage of amplification. Improper dc voltage appearing at the input of the second transistor will upset the quiescent bias conditions of the device.

Capacitors in coupling circuits have several disadvantages. They are frequency selective. They limit the swing of the output voltage. They may cause noise pulses to be produced at the output while the capacitors are charging. There may be a delay in the establishment of the final stable bias conditions and a delay before the transistor begins to amplify. They may cause the transistor to conduct heavily while charging the capacitor, causing the semiconductor to break down.

These drawbacks can be overcome by using direct coupled circuits. They will be described in detail in another article in this series. **R-E**

SQ DECODER

(continued from page 35)

provided in the kit). Make sure to use low-capacitance cable and keep the lengths as short as possible.

When the unit is completely assembled check for cold solder joints, shorts and to make certain all parts are in the right locations. Then hook up your power supply. You'll need 20 volts at 75 mA, rather well regulated. You may tap this power out of your existing preamp, or you can build a simple supply to do the job.

Ready to go

With the decoder completed, hooked up between preamp and amplifiers, set all balance controls to the center of their ranges. Set the volume control to minimum. Now play a record with the preamp volume set to about its mid point. Turn up the volume control on the decoder until the music is at a satisfactory level. Now using the balance controls on the decoder balance the four speakers for the listening location you intend to use.

Once set, you will rarely have to readjust these balance controls, unless you decide you'd like to move out of the audience and sit with the musicians.

Use one of the available 4-channel test records or even a 4-channel sound-effects record to check operation of the decoder. We think you'll find it a pleasure to use and a grand way to get into 4-channel music with a minimum of expense. **R-E**

Saved from rattler by two-way radio

Lloyd Allison, owner of Economy Electric Co. near Tampa, FL, credits his two-way radio with saving his life. Mr. Allison used to leave the windows of his car rolled down at night to let it cool off, a practise that produced an undesirable side effect. On the day he tells about, he says he noticed nothing unusual when driving to work in the morning. On the way home, he says: "I felt something against my leg a couple of times, but didn't take notice of it. I haul a lot of stuff around in the car, and thought it was something rolling around on the floor. I heard a kind of buzzing noise from time to time too, but I'm a little hard of hearing and thought it was something in the engine."

But when Mr. Allison leaned forward to turn off the ignition, he glanced down and saw what he describes as a three-foot rattlesnake. "Most of the snake's body was under the front seat, and the head and neck were protruding between my legs."

Remembering that the safest action in such cases is to remain perfectly still, Mr. Allison did just that for the next five to seven minutes. Finally he got courage enough to reach very slowly for the microphone of his two-way business radio and call a plumbing company that was on the same frequency as his.

The plumbing company called the sheriff's office for help. While Mr. Allison maintained his immobile posture, the car door was edged open gently and the snake, after making sure there were no enemies in sight, slithered out.

"I got this bad habit about leaving the windows in my car rolled down," says Allison. "You better believe I'll start closing them now!"

New submarine telephone cable doubles transatlantic capacity

A new telephone cable between Canada and Britain, just installed by Standard Telephone and Cables Ltd., a British unit of ITT, adds 1840 two-way telephone circuits across the North Atlantic. This more than doubles the present figure of 1,555 circuits available from the other seven cables between Europe and America.

The new cable, which stretches 2,800 nautical miles (about 3,200 statute miles) from Canada to England, has 501 electronic repeaters spliced into it at intervals throughout its length. These two-way amplifiers have to work for more than 20 years unattended. **R-E**

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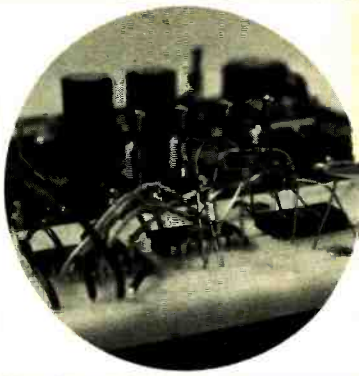

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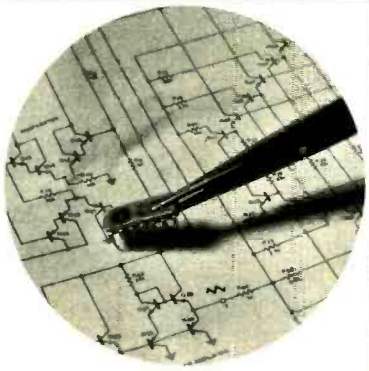

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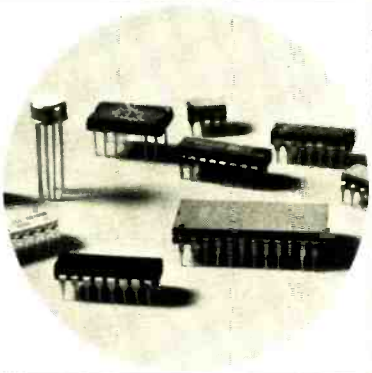

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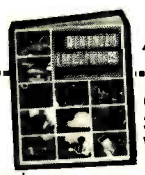

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4-Channel Software
who makes what?

by HARRY E. MAYNARD

TODAY OVER 50 RECORDING COMPANIES in the U.S. and abroad are producing quadriphonic discs, Q-8 cartridges, and some reel-to-reel tapes. As of June 1 there was a worldwide total of 576 CD-4 discs, 618 QS discs, and 500 SQ discs. Added to this was more than 400 Q-8 cartridges and approximately 100 reel tapes. To buy all this software would cost you well over $10,000. But if you are a typical consumer perhaps the best reason for buying a four-channel system is the considerable increment of improvement you'll get when you play your stereo records, or decode a stereo FM broadcast through any one of the better matrix decoders.

Most buyers of hi-fi equipment on the average invest three to five times as much money in recordings as they do in hi-fi equipment, so no matter how fast sales of quadriphonic equipment grows it will be years before the larger percentage of software available to you and I will be recorded in the quadriphonic mode. Remember it has been 20 years since stereo equipment was first introduced commercially (1954); but after the first four years of stereo there were only 650 stereo tapes and no discs. It was only in the early 60's that stereo discs started to hit the market place from most of the major companies.

In the U.S. the SQ decoded discs leads the pack with over 300 releases from the CBS group, and 17 other licensees of the SQ system. SQ leads in number of releases in the U.S. and also in the commercial popularity of their artists. Available also from Columbia and SQ licensees are 210 Q-8 cartridges. A total of 15 companies have released over 200 titles.

SQ

Columbia Recording Group	Discs	Q-8 Cartridges
Columbia Records	159	133
Epic	17	17
Barnaby	2	2
Monument	5	4
Philadelphia International	7	7
Stax	1	1
Blue Sky	1	1
T-Neck	1	1
A & M Records	1	
Golden Crest Recordings	10	
Capitol Records	7	
Vanguard Recording Society	40	
Ampex Records	2	44
Connoiseur Society	11	
Creative World	4	
Project 3	18	
C.I.T.	6	
Stanyan Records	8	
Audio Fidelity	1	

In Japan and Europe 18 companies have released 200 records, for a worldwide total of 500 SQ discs with considerable box office fire power from these companies:

Japan
Canyon
CBS/Sony
Toshiba
Tro
WB Pioneer

U.K.
CBS Records
EMI

France
Pathe Marconi

The Netherlands
CBS-Artone

Germany
CBS-Schallplatten
Electrola
Ariola
Bellaphon
BASF

Italy
CBS-Sugar

Spain
Iberofon

Czechoslovakia
Supraphon

QS (Regular Matrix)

Over 40 record companies in the U.S. and abroad have released a total of 618 discs, with a total of 334 in the U.S.

	Discs
ABC-Dunhill	100
Black Jazz	10
Audio Treasury	2
Blue Thumb	1
Kilmarnock	1
Longines	60
Ode	4
Ovation	30
Project 3	37
Quad Spectrum	20
RTV	1
Telecast Marketing	7
Alshire	24
BASF	2
Tumbleweed	1
Blueseway	4
Vox	6
Everest	24

Currently there are 49 QS records distributed in Europe from Decca-France and Pye-England.

In Japan 249 QS discs have been distributed by: Techiku, Crown, Nippon Columbia, Toho, King, Polydor Japan, Toshiba, Minruphone.

Reel to reel tapes need to be treated separately since they do not have the wide distribution of the disc or Q-8 cartridge. Often sold by direct mail by the manufacturer, sub-distributor or a large tape catalogue house such as Ampex who sells directly to the consumer and acts as a sub-distributor for many companies.

For those dealers and hi-fi buffs who like to make comparisons between various type of quadriphonic discs Project 3 is the single record company that allows you to do so. Project 3 produces many of its discs in two and often three formats, SQ, CD-4, QS. R-E

CD-4

A total of 130 CD-4 discs have been released in the U.S.

	Discs	Q-8 Cartridges
RCA	52	128
Warner Group		
Reprise	2	2
Warner	18	18
Mobil	3	3
Atlantic	8	8
Altco	2	2
Elektra	11	11
Nonesuch	9	
Project 3	23	46
Team Electronic	1	
Mirror Records	1	

JVC has also released for limited distribution in the US via K & M publishing in New York City (142 West 57th St., N.Y., N.Y. 10019) for direct sale in the New York Metropolitan area 59 CD-4 discs. In Japan a total of 303 discs have been released from these companies:

Victor Musical
Teichiku
Polydor
Trio-Kenwood
Toshiba-EMI
Nippon Phonograph (Philips)
Warner Pioneer

Tapes

Ampex Music Division
2201 Lunt Ave.
Elkgrove Village, Ill. 60007 — 4

Project 3
1133 Avenue of Americas
New York, N.Y. 10036 — 42

Ambiphon Records
One Riverdale Avenue
Bronx, N.Y. 10463 — 4

WEA
Warner Communication
15 Columbus Circle
New York, N.Y. 10023 — 16

40 PROJECTS

Using COSMOS Digital IC's

Are you up on COSMOS, the latest in solid-state technology? If not, you can learn what it's all about by building these simple circuits yourself. They are useful as well as educational

by R. M. MARSTON

Last month, in part one of this series, we discussed the COSMOS family of digital ICs and explored its operating characteristics. RCA's CD4001 was introduced as an example of a versatile COSMOS digital IC.

This month we will discuss some practical applications of the CD4001 and look at some bistable multivibrator projects.

Inverters and gates

We have already seen that a NOR gate can be made to function as a simple inverter or pulse amplifier by merely connecting its input terminals together as shown in Fig. 8-a. Note that since only one of the four available gates is used in this application, the input terminals of the remaining three unused gates are strapped directly to ground.

All four gates can be used as inverters, if required, by using the connections shown in the quad pulse amplifier/inverter circuit of Fig. 8-b.

Figure 9-a shows how a CD4001 can be connected as a simple pulse-disabling gate. Here, the signal input is applied to pin 1 and the gating input is applied to pin 2: the output signal is available at pin 3. Normally, with a zero or logic 0 gating input applied, the circuit acts as a simple pulse amplifier and produces an inverted version of the input signal at output pin 3. When, however, a logic 1 gate input is applied to pin 2, the circuit acts like a gate and its output is driven to logic level 0, so the input signal no longer reaches the output. The gate is thus "disabled."

The pulse-disabling gate of Fig. 9-a is intended to work with signal inputs that fluctuate fully between the logic 0 and logic 1 levels. The circuit can be modified for use with low-level input signals by interposing a direct-coupled transistor amplifier between the input signal and the input of the gate as shown in Fig. 9-b. This particular circuit can be used with input signal pulses that vary alternately from less than 200 mV to greater than 1 volt.

Note in the Figs. 9-a and 9-b that only one of the four available CD4001 gates is used and that all input terminals of the remaining three unused gates are strapped to ground.

All four gates can be used as pulse disablers, if required, by using the connections shown in the quad pulse-disabling gate circuit of Fig. 9-c.

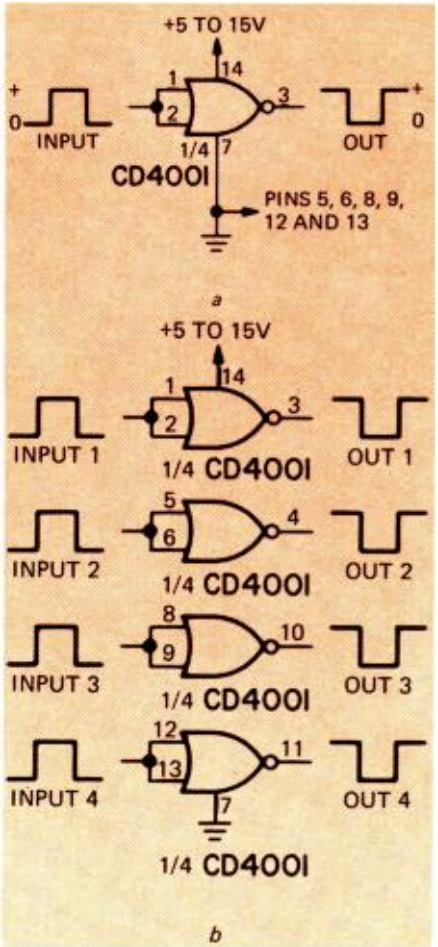


FIG. 8-a—SIMPLE PULSE amplifier/inverter. b—QUAD PULSE amplifier/inverter.

The pulse-disabling gate can readily be converted into a pulse-enabling gate which passes signals only when the gating input signal is high or at logic level 1 by simply interposing an inverter stage between the gating input signal and the gate input pin of the disabling gate as shown in Fig. 10. Note that two of these pulse-enabling gate circuits can be built from a single CD4001.

The pulse-enabling gate of Fig. 10 can be converted to an electronically or manually triggered START/STOP gate which starts passing signals at a START command and stops passing them on a separate STOP command by feeding the command signals to the circuit's gate input terminal via a simple bistable multivibrator element. Figure 11 shows the electronically triggered version of such a circuit and Fig. 12 shows the manually triggered version.

The two circuits operate in the same basic way and use the two left-hand gates as a bistable multivibrator and the two right-hand gates as a conventional pulse-enabling network. Normally, the output of the bistable is low or at logic 0, so the pulse-enabling circuit's output is grounded and none of the input signal reaches the output terminal. When the START command is given, the bistable changes state and locks in this new state even when the command signal is subsequently removed.

As the bistable changes state, its output goes to logic 1 so the enabling gate opens and passes the input signals to its output. These signals continue to flow until a STOP command is given, at which point the bistable flips back to its original "logic 0 output" condition and the enabling gate turns off: the input signals then cease to reach the output again. Note that since four gate elements are needed to make a single START/STOP gate, only a single circuit of this type can be built from each CD4001.

A practical application of the START/STOP gate is in a sports-event timer. In this appli-

cation, the signl input is derived from an accurate 1-kHz crystal-controlled oscillator and the gate's output is taken to an electronic counter. The START command signal can be derived from the race starter's gun and the STOP signal can be derived from the photocell of a light beam unit projected across the finishing tape. As soon as the starter's gun is fired, the gate opens and starts feeding 1-kHz pulses to the counter. As soon as the winner reaches the finishing tape and breaks the light beam, the gate closes and the 1-kHz pulses stop reaching the counter. Thus, the number of pulses registered on the counter from the 1-kHz oscillator are equal to the duration of the race to the nearest millisecond. For longer races, the oscillator can be a 1-Hz type, in which

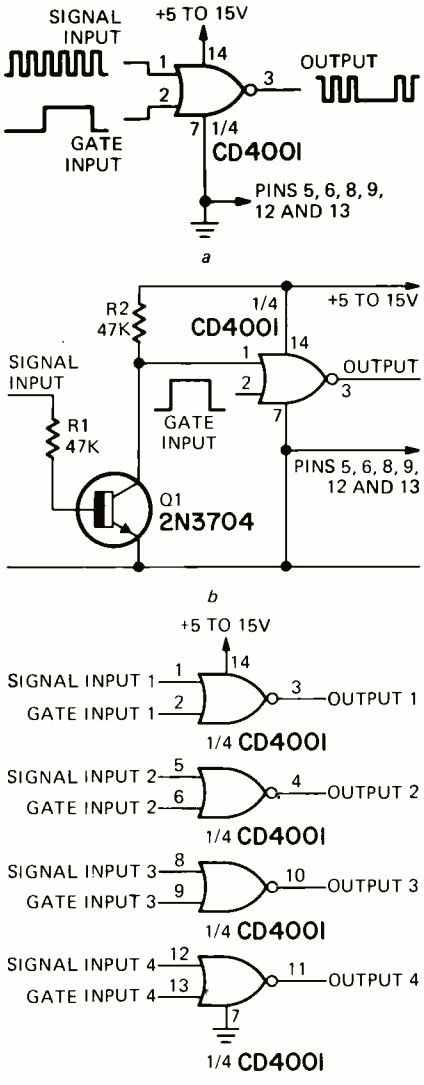


FIG. 9-a—PULSE-DISABLING GATE. b—SAME GATE ADAPTER for use with low-level signal input. c—QUAD PULSE-DISABLING gate.

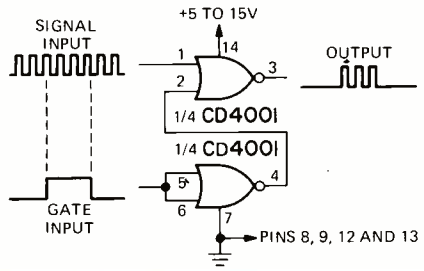


FIG. 10—PULSE-ENABLING GATE.

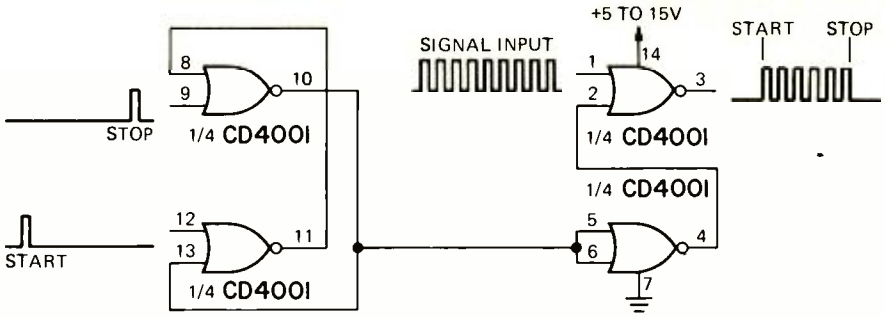


FIG. 11—ELECTRONICALLY TRIGGERED start/stop gate.

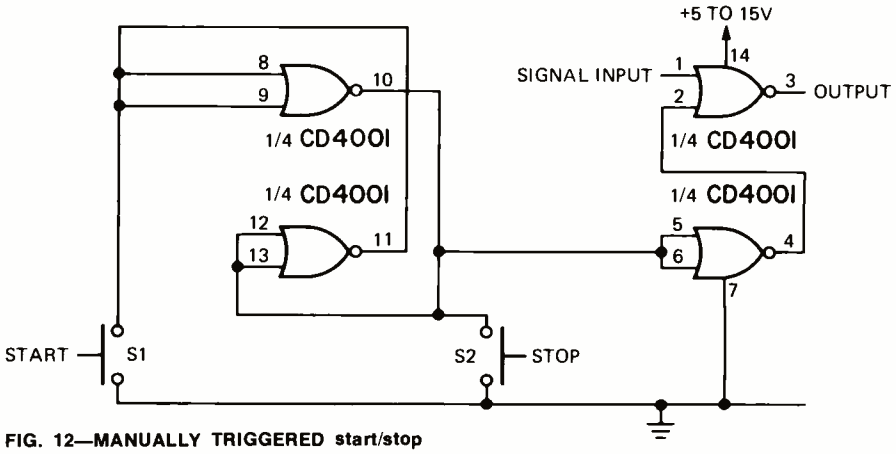


FIG. 12—MANUALLY TRIGGERED start/stop gate.

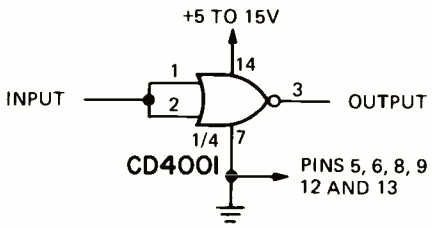


FIG. 13—NOT LOGIC CIRCUIT is simply an inverter.

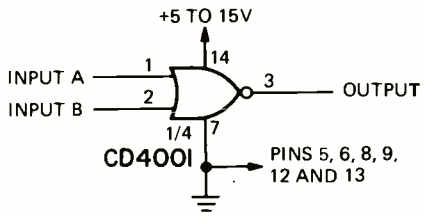


FIG. 14—NOR LOGIC CIRCUIT. Output is high only if all inputs are low. Output is low if any input is high.

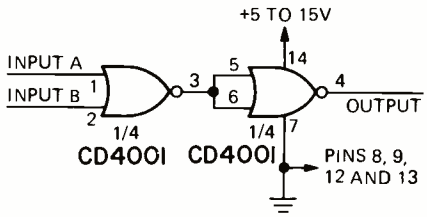


FIG. 15—OR LOGIC CIRCUIT. Output is low only if all inputs are low. Output is high if any input is high.

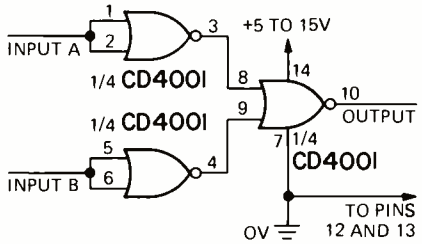


FIG. 16—AND LOGIC CIRCUIT. Output is high only if all inputs are high. Output is low if any input is low.

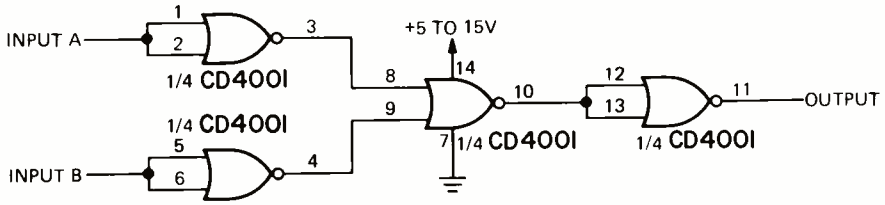


FIG. 17—NAND LOGIC CIRCUIT. Output is low only if all inputs are high. Output is high if any input is low.

TABLE I—BASIC DETAILS OF THE FIVE AVAILABLE TYPES OF CD4001 COSMOS IC

DEVICE NO.	PACKAGE	OPERATING VOLTAGE RANGE	OPERATING TEMPERATURE RANGE
CD4001AD	CERAMIC DIL	3 TO 15V	-55 TO +125°C
CD4001AE	PLASTIC DIL	3 TO 15V	-40 TO +85°C
CD4001AK	FLAT PACK	3 TO 15V	-55 TO +125°C
CD4001D	CERAMIC DIL	5 TO 15V	-55 TO +125°C
CD4001E	PLASTIC DIL	5 TO 15V	-40 TO +85°C

case the counter will register the race time in seconds.

Logic circuits

The CD4001 can be made to function as any one of five basic types of logic circuit. Figure 13 shows how one of the IC's gates can be connected so that it functions as a NOT logic circuit or pulse inverter by simply shorting its two input terminals together as described earlier. Four NOT gates can be built from each CD4001.

Figure 14 shows the connections for making a NOR logic circuit from one quarter of the CD4001. The action of the circuit is such that the output goes high or to logic 1 only when both inputs are low or at logic 0: the output goes low if any input is high. Four NOR logic elements are available from each CD4001.

An OR logic circuit can be obtained from a NOR logic element by simply inverting the output of the NOR element as shown in Fig. 15. The action of this circuit is such that its output is low only when all inputs are low: the output goes high if any input is high. Two OR logic circuits can be made from each CD4001.

Figure 16 shows how an AND logic circuit can be made by inverting each of the two inputs of a NOR logic element. The action of the circuit is such that its output is high only when both inputs are high. The output is low if either input is low. Note that only one AND gate can be made from each CD4001, but that a spare gate element is available as a NOT or NOR logic element.

Finally, Fig. 17 shows how a NAND logic circuit can be made by simply inverting the output of an AND logic element. The action of the circuit is such that its output is low only when all inputs are high: the output goes high if any input is low. Only one NAND circuit can be built from each CD4001.

Bistable multivibrator projects

A simple bistable multivibrator circuit can be made by cross-coupling the inputs and outputs of a pair of NOT or NOR logic gates. Figure 18 shows the practical connections for making an electronically triggered bistable from two NOR gates.

Here, the output of gate A is direct-coupled to one of the input terminals of gate B, and the output of gate B is direct-coupled to one of the input terminals of gate A. The 'spare' input terminal of each gate accommodates an input command signal, and both are normally low or at logic level 0.

To understand the circuit operation, assume initially that the output of the circuit, taken from the output terminal of gate A, is at the low or logic 0 level. In this case, both inputs of gate B are also at logic level 0, so the output of gate B is at logic level 1. Since the output of gate B is direct-coupled to one of the input terminals of gate A, the output of gate A is driven to logic level 0. The output of gate A is thus locked in the logic 0 state by the cross-coupling under this condition.

Suppose now that a positive trigger pulse is applied to the 'set 1' input terminal of the circuit. In this case, the output of gate B drops to logic 0 for the duration of the pulse and under this condition both input terminals of gate A are held at logic level 0, so its output goes to logic 1.

Since the output of gate A is direct-coupled to one input terminal of gate B, the output of gate A is locked in the logic 0 condition. Consequently, the output of the circuit goes to logic 1 as soon as the input 'set 1' pulse is applied, and the circuit then locks into this condition and stays there even when the input pulse ceases to be applied.

Finally, suppose that a positive trigger pulse is now applied to the 'set 0' input terminal of the circuit. In this case, the output of gate A drops to logic 0 for the duration of the pulse and under this condition, both input terminals of gate B are held at logic level 0, so the output of gate B goes to logic level 1. Since the output of gate B is direct-coupled to the input terminal of gate A, the circuit is then locked in this condition, and its output remains at the logic 0 level.

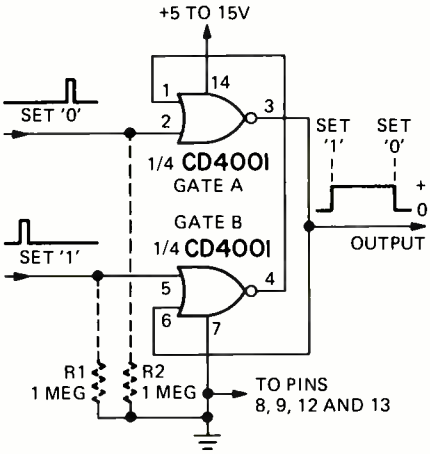


FIG. 18—BISTABLE MULTIVIBRATOR or memory unit.

Thus, the output of the Fig. 18 circuit can be locked at the logic 0 or logic 1 level by applying a brief command pulse to one or other of the two input terminals. Note that these command signals should be direct-coupled from a source that switches between the logic 0 and logic 1 levels: If the command signals are to be derived from 'floating' sources, the pin 2 and pin 5 input terminals of the bistable must be taken to ground via high value resistors, as shown dotted by R_1 and R_2 in the diagram. Also note that two complete bistable multivibrator or memory circuits can be built from a single CD4001.

Figure 19 shows how the Fig. 18 circuit

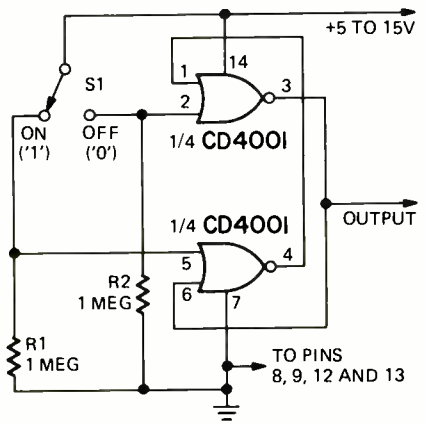


FIG. 19—"NOISELESS" ON/OFF Switch

can be modified for use as a "noiseless" ON/OFF switch. A normal mechanical switch generates a good deal of noise (caused by point bounce, dirty contacts, etc.) when it is used to switch voltage or current, and this noise appears in the form of a series of high-amplitude voltage spikes at the start or end of the basic switching waveform.

If a mechanical switch is coupled directly into a sensitive section of a high-speed pulse generating or counting circuit, therefore, this noise can cause the sensitive circuit to malfunction. This snag can be overcome by using the Fig. 19 circuit to process the normal switching signals. The circuit's state is unaffected by noise, since its state is changed by the first noise pulse that occurs from the mechanical switching action, and cross-coupling then causes the circuit to self-latch and be immune to following noise pulses.

Finally, Fig. 20 shows how a manually

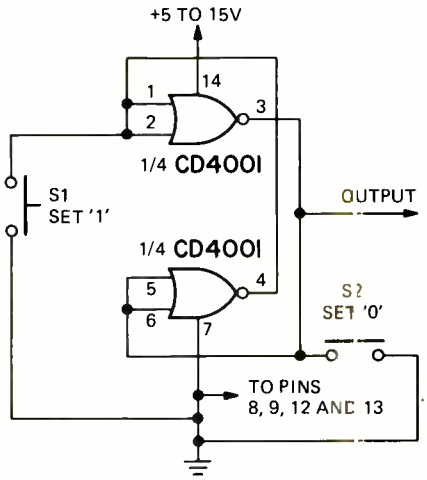
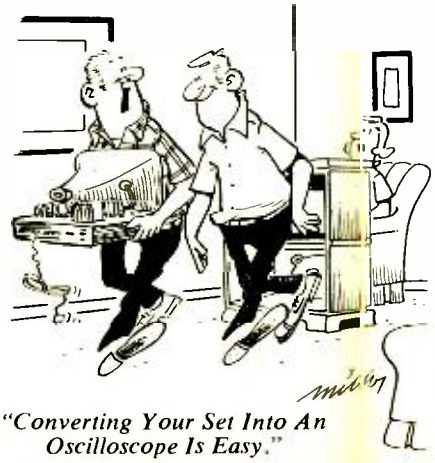


FIG. 20—MANUALLY TRIGGERED bistable multivibrator.

triggered bistable can be made by cross-coupling two NOT gates. The operation of the circuit is basically similar to that of Fig. 18: The output of the circuit sets to the logic 1 state when S_1 is momentarily closed, and resets at the logic 0 level when S_2 is momentarily closed. Note that, since both input terminals of each gate are direct-coupled to the output terminals of their opposing gates, the input terminals can be allowed to 'float' without having to be tied to ground via separate resistors.

In this second part of this series we discussed some practical applications of the CD4001 IC and looked at bistable multivibrator projects.

Next month we will show the monostable and astable projects, using the CD4001 IC. **R-E**



"Converting Your Set Into An Oscilloscope Is Easy."

11 Ways to Use Your VECTORSCOPE

"SEEING IS BELIEVING", AND WHEN we are using the vectorscope, we may add "Seeing is understanding"—provided of course that we know how to interpret waveform language. We will find that this language is based on principles of ac circuit action. For example, a simple R-Y/B-Y vectorgram displays a two-phase ac signal in vector (more precisely, phasor) form. Therefore, a vectorgram provides information concerning the amplitudes, phases, and waveshapes of the two-input ac signal voltages. There is no royal road to reading vectorgrams—expertise is achieved solely by study and practical experience. The following practical applications illustrate some of the capability of a vectorscope.

TEST PROCEDURES

1. To Check Automatic Tint Control Action

Equipment: Vectorscope, keyed-rainbow generator.

Connections: Connect equipment as shown in Fig. 1.

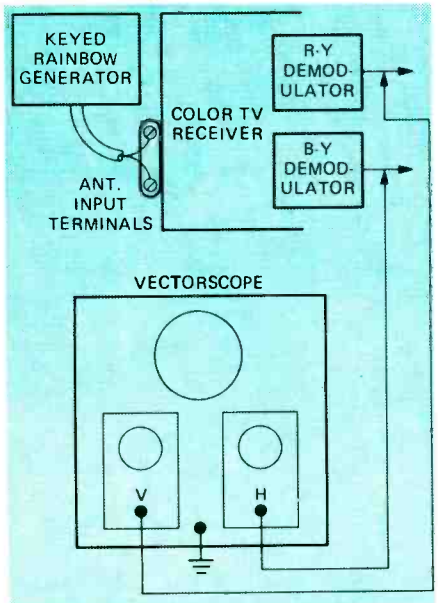


FIG. 1—EQUIPMENT CONNECTIONS used for most test procedures. A standard keyed rainbow generator and vectorscope is needed.

Procedure: Adjust vectorscope controls to obtain a vectorgram display such as illustrated in Fig. 2.

Evaluation of Pattern: With the atc control turned off, each "petal" in the vectorgram should have a phase difference of approximately 30° from its flanking "petals". Next, with the atc control turned partially on, the first and third petals should move about 15° toward the second "petal". Finally, with the atc control turned fully on, the first and third "petals" should merge with the second "petal". Also, the fourth "petal" should have moved approximately 40° toward the second "petal". In case of abnormal atc action, check circuit capacitors first. For example, in Fig. 3, C_1, C_2, and C_3 are prime suspects.

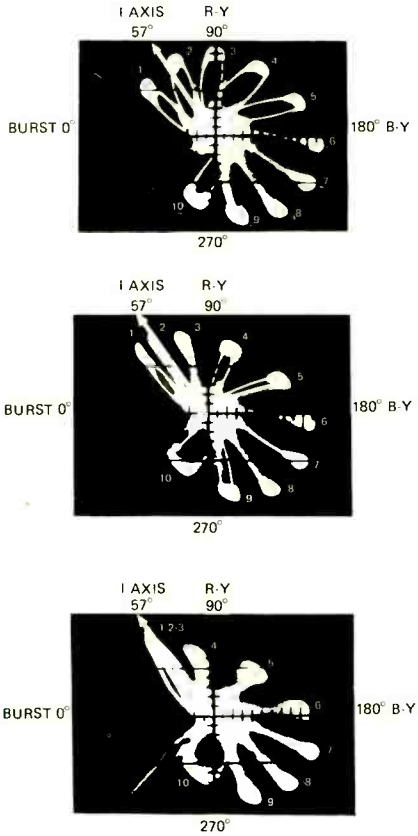


FIG. 2—VECTORGRAM PATTERNS obtained from test procedure 1. The top display is with the ATC off; center is with ATC partially on; bottom is with ATC fully on.

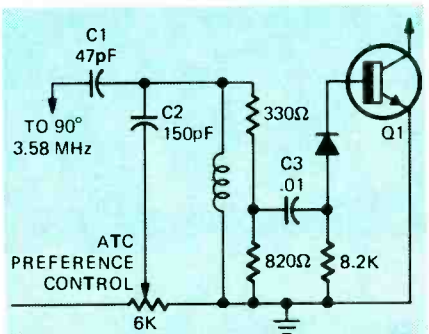


FIG. 3—AUTOMATIC TINT CONTROL CIRCUIT. Any variation from the normal vectorgrams in Fig. 2 indicates a malfunction in this circuit.

Note 1. Automatic tint control, as described in Test Procedure 1 operates by changing the +(R−Y) and +(G−Y) 90° chroma phases into the +I phase. Fig. 4 depicts the phase sequence that is displayed in the absence of atc. We will observe that atc entails a trade-off between stabilization of flesh tones and ability of the receiver to reproduce true colors. This is why a preference control is provided.

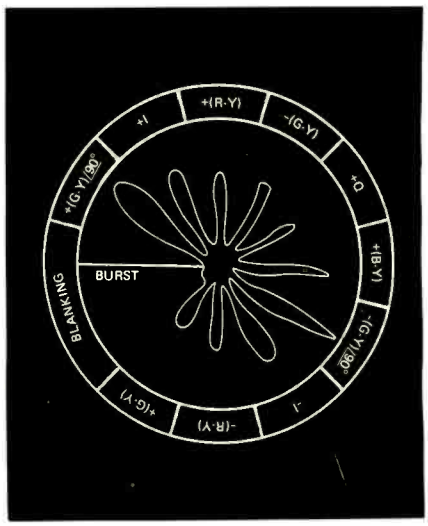


FIG. 4—PHASE SEQUENCE and vectorgram that is normally displayed when the automatic tint control circuit is turned off.

2. To Check for High-Frequency and Low-Frequency Attenuation

Equipment: Vectorscope, keyed-rainbow generator

Connections: Same as in Test Procedure 1.

Procedure: Adjust vectorscope controls to obtain standard vectorgram display.

Evaluation of Pattern: If the sides of the "petals" extended down to the center of the pattern, and form a central dot, neither high-frequency nor

Troubleshooting a color television set can be simple, if you have a vectorscope and know how to use it.

by ROBERT G. MIDDLETON

low-frequency attenuation is occurring in the chroma circuits. On the other hand, if high-frequency attenuation is taking place, there will be an "open space" in the center of the pattern. Conversely, if low-frequency attenuation is taking place, there will be a crossover design in the center of the vectorgram. A crossover design also appears if one chroma circuit has high-frequency attenuation, and the other has low-frequency attenuation. These principles are depicted in Fig. 5.

Note 2. Normally, a chroma channel has a bandwidth of at least 0.4 MHz. In the event that a coupling circuit has too short a time constant, for example, low-frequency attenuation occurs, as shown in Fig. 6. On the other hand if there is excessive series resistance or excessive shunt capacitance in a chroma circuit, high-frequency attenuation occurs. It is helpful to compare

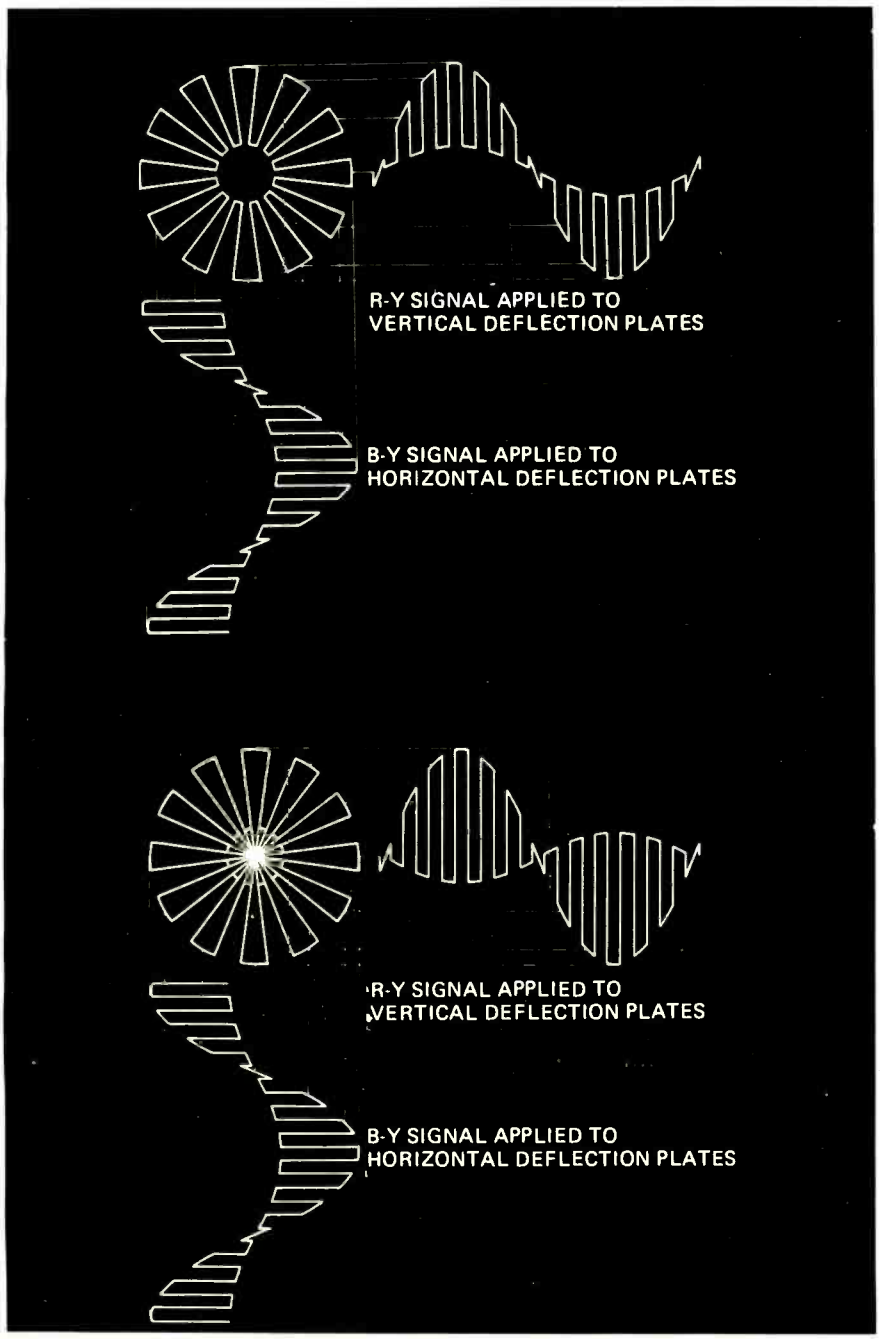


FIG. 5—ABNORMAL VECTORGRAMS resulting from attenuation. Top display shows hf attenuation in both R-Y and B-Y channels, which produces an open space in center of vectorgram. Below shows lf attenuation in R-Y and hf attenuation in B-Y producing crossover in center of vectorgram.

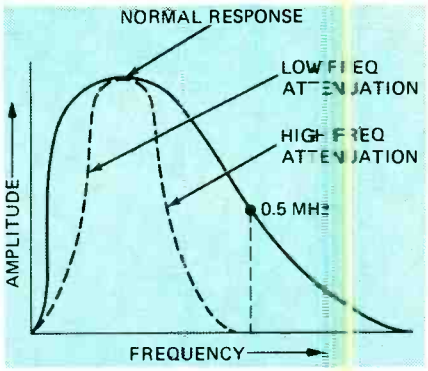


FIG. 6—FREQUENCY RESPONSE of chroma channel showing hf and lf attenuation as well as the normal response.

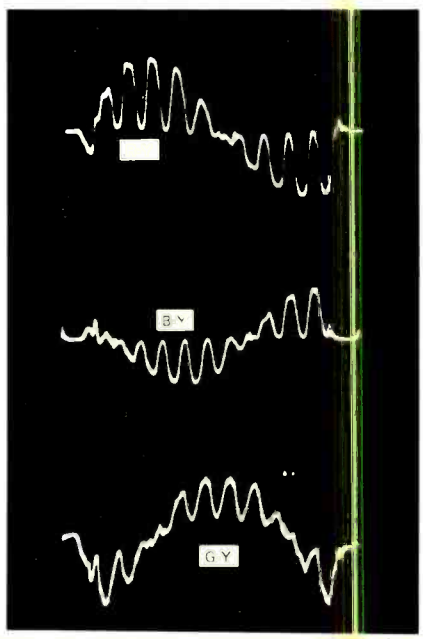


FIG. 7—CHROMA CHANNEL DISPLAYS. Top two are normal while the bottom G-Y display shows high-frequency attenuation.

the idealized waveforms in Fig. 5 with the practical examples illustrated in Fig. 7. Note that the R-Y and B-Y channels have adequate bandwidth, whereas the G-Y channel has high-frequency attenuation, with resulting baseline curvature.

3. To Check the Linearity of a Chroma Amplifier

Equipment: Vectorscope, keyed-rainbow generator.

Connections: Connect equipment as shown in Fig. 8.

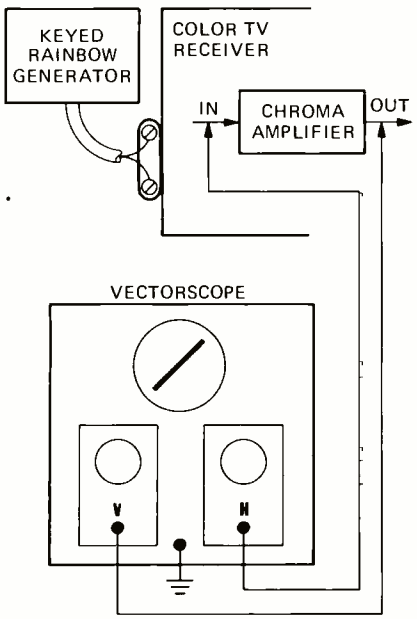


FIG. 8—EQUIPMENT CONNECTIONS used for checking the linearity of the chroma demodulation. Vectorscope is adjusted to display a diagonal line or pattern.

Procedure: Adjust vectorscope controls to display a diagonal line or pattern on the CRT screen.

Evaluation of Pattern: A straight line (or narrow ellipse with a straight major axis) will be displayed if the chroma amplifier is operating linearly. Nonlinear operation is indicated by a curved, angled, or hooked line (or narrow ellipse).

Note 3. Chroma amplifiers that have a very linear amplitude characteristic may nevertheless show more or less phase shift when energized by a keyed-rainbow signal. This is a result of the comparatively wide frequency spectrum of the test signal. Any amplifier will develop phase shift when operated near the edge of its passband.

4. To Check the Range of the Hue Control

Equipment: Vectorscope, keyed-rainbow generator.

Connections: Same as in Test Procedure 1.

Procedure: Adjust vectorscope controls to obtain a normal vectorgram display. Turn the tint (hue) control of the receiver through its range, and observe the amount of angular rotation of the vectorgram.

Evaluation of Pattern: The third "petal" of the vectorgram normally appears at the R-Y phase when the hue control is set to its midpoint. Next, a 30° phase-shift clockwise and counterclockwise should be obtainable by turning the hue control. Some receivers provide up to 40° phase shift. Incorrect midpoint setting and/or incorrect range are most often the result of defective capacitors in the 3.58-MHz circuitry.

5. To Check the Linearity of Chroma Demodulation

Equipment: Vectorscope, keyed-rainbow generator.

Connections: Same as in Test Procedure 1.

Procedure: Adjust receiver and vectorscope controls to display a vectorgram pattern with peak-to-peak voltages as specified in the receiver service data.

Evaluation of Pattern: Linear chroma demodulation is indicated by a vectorgram with a true elliptical outline. On the other hand, nonlinear demodulation shows up as an "egg-shaped" vectorgram, such as depicted in Fig. 9. The most common cause of nonlinear demodulation is a demodulator diode with a deficient front-to-back ratio. In turn, the demodulated waveform has unequal positive- and negative-peak voltages, as illustrated in Fig. 10.

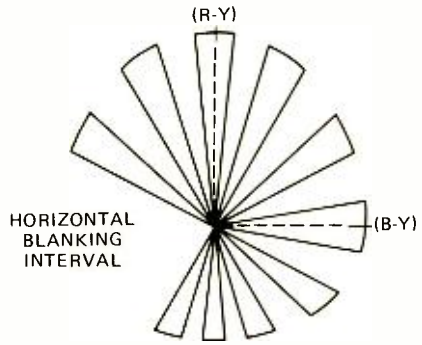


FIG. 9—EGG-SHAPED VECTORGRAM shows non-linear chroma demodulation. Fault is in the chroma demodulation circuit.

6. To Check Demodulation Angles With an Ellipse Guide

Equipment: Vectorscope, keyed-rainbow generator, set of ellipse guides.

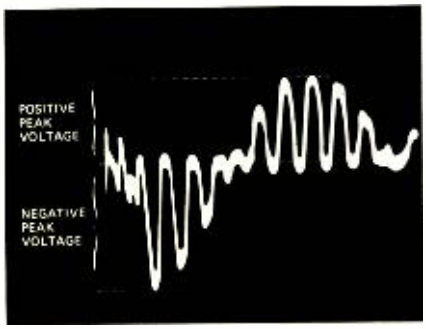


FIG. 10—DEMODULATOR OUTPUT WAVEFORM showing unequal positive and negative peak voltages. Most common cause is in demodulator diode.

Connections: Same as in Test Procedure 1. (X-Z, R-B, or B-G demodulators can be checked with the same method).

Procedure: Adjust vectorscope controls to obtain a normal vectorgram display, with the major axis of the pattern making a 45° angle with respect to the horizontal and vertical axes. Hold ellipse guide in front of the CRT screen, to determine the demodulation angle. Readjust vectorscope gain controls, as required, to make the pattern fit the guide outline, or to fit as nearly as possible.

Evaluation of Pattern: Select the ellipse guide that most nearly matches the outline of the vectorgram. In turn, the demodulation angle is indicated. A 90° demodulation angle provides a circular vectorgram outline. Again, a 125° demodulation angle provides an elliptical vectorgram outline.

Note 4. Ellipse guides are generally available at drafting supply stores in the form of transparent plastic plates. Guides with 2-inch or 3-inch major axes are most convenient for checking vectorgram patterns. Note that the guides indicate elliptical angles in 5° steps up to 90°. In color-TV work, it is customary to express demodulation angles in values from 90° to 180°. For example, if the demodulation angle is 125°, the matching outline on the ellipse guide will be marked 55°. That is, 180°−55° = 125°. We call 125° the supplementary angle of 55°. A 55° ellipse has the same outline as a 125° ellipse.

7. To Check Demodulator Output Amplitude Ratios

Equipment: Vectorscope, keyed-rainbow generator.

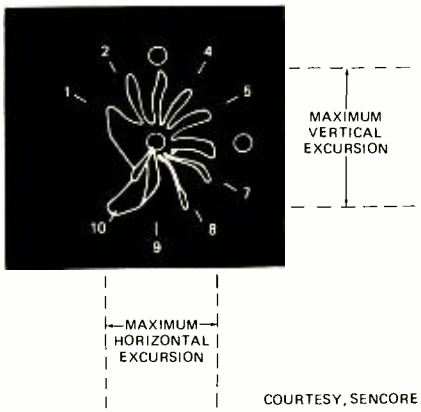


FIG. 11—VECTORGRAM PATTERN showing maximum vertical and horizontal excursions. Both excursions should be within ±10% of each other.

Connections: Same as in Test Procedure 1.

Procedure: Set the vectorscope gain controls to the same value (such as 2 volts per inch). Observe the vector-

(continued on page 100)

Low Noise Hi-Fi

A new ruling by the Federal Communications Commission changes the pre-emphasis and de-emphasis standards in FM transmissions. The adoption of these new standards is an option left up to the radio stations. Here's why they did it and what it means to you.

by LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

PROGRESS IN THE WORLD OF HIGH FIdelity components seems to happen in ten-year cycles of technological advances. The 1950's saw the birth of hi-fi components that were intended for use by music lovers as opposed to engineers and technicians. That decade witnessed reduction in size of components, improved aesthetics and packaging, popularization of the long-playing record, and the emergence of the open-reel tape recorder as a home product.

The 1960's witnessed the birth of stereo FM broadcasting which, in turn, helped to popularize stereophonic sound in the home and served as the auditioning hall for the stereo record industry. During those years, the transition from vacuum-tube circuitry to solid-state circuitry also took place—haltingly at first (and with a fair amount of "jumping the gun" on the part of manufacturers who converted to solid-state circuitry without adequate designs). The end of the decade witnessed refinements in tape technology and equipment which, even now, are responsible for ever-improving home stereo cassette recorders and better tape to go with them.

Everyone connected with the high-fidelity industry would have guessed that the major innovation of the 1970's would be the transition to 4-channel sound. Indeed, quadriphonic equipment abounds, even if the number of records and other program sources is somewhat minimal as of this writing. If we have been over-optimistic about 4-channel acceptance, most industry experts feel that this overoptimism will be justified before the decade is over as systems (matrix, discrete, etc.) sort themselves out and equipment becomes more universal in its ability to handle the various formats that may well continue to coexist for at least the next few years. There is hope, too, that long before the present decade ends the FCC will have tested and approved a system for discrete four-channel broadcasting which will, again, provide the vast listening audience needed to really put quadriphonics over.

The near future

Almost as if to coincide with the major trade show of the consumer electronic industry (the CES show, held in Chicago from June 9 through June 12), the Federal Communications Commission made a startling ruling which took most everyone by surprise. It is this ruling which gives a clue to the title of this article—conquering noise in hi-fi. For with all forms of audio distortion now at such low levels as to be inaudible (in really top equipment), with sensitivity and quieting of many fine FM products approaching theoretical limits, the new frontier of improved fidelity seems to be in the area of noise reduction. Noise, of course, can also be looked upon as a form of audio distortion if we accept the broadest definition of distortion as being the presence of anything in the reproduced signal that was not in the original program source.

FM pre-emphasis and de-emphasis

It was the presence of noise which prompted the FCC to specify pre-emphasis and de-emphasis for standard FM and stereo FM transmission in the first place. When an FM signal is received, interactions occur between the station carrier and the random electrical noise voltages. Both amplitude modulation and phase modulation are produced. With a sufficiently strong signal (one that is fully into "limiting"), the amplitude modulation is removed. As for the phase modulation (which is really a form of FM) it will increase in amount with increased separation of noise frequency from carrier frequency, as illustrated in Fig. 1. The graph illustrates that noise interference becomes greater as the frequency between the carrier and the noise voltage increases. Although the diagram extends to 75 kHz, we can disregard the noise content above 15 kHz or so—the limits of our own hearing ability.

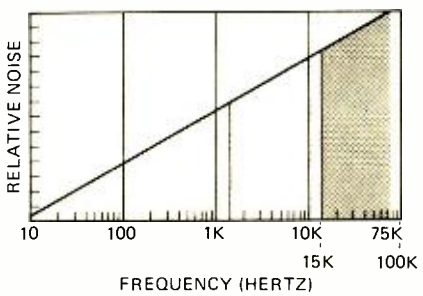


FIG. 1—NOISE FOLLOWS A TRIANGULARLY increasing pattern in FM—increasing in amplitude at higher frequencies (lightly shaded portion between 10 Hz and 15 kHz is audible noise).

In studies of frequency versus energy content of music, it was determined long ago that most of the energy is contained in the low and mid-frequencies. In addition, it's well known that the noise which irritates listeners most is that found at higher audio frequencies, above 3 kHz or so. These two facts, plus the masking effect of loud sounds upon low-level noise help to explain the use of pre-emphasis and de-emphasis. Pre-emphasis involves boosting the relative level of high frequencies during the transmission process, as shown in Fig. 2, while de-emphasis applied to FM tuners in accordance with Fig. 3 restores "flat" response to the overall system while at the same time reducing high frequency noise by a fixed amount. The triangular noise response originally illustrated in Fig. 1 is effectively changed to that of Fig. 4 such that a large portion of the noise has been "sliced away." The circuit that causes this roll-off in the receiver usually consists of a single capacitor and resistor combination for each channel, chosen so the product of R and C equals 75×10^{-6}. This product is said to have a 75-μs time constant. In Europe, a 50-μs time constant is used.

Dolby and FM broadcasting

Readers are probably familiar with

the famous noise-reduction system developed by Dr. Ray Dolby and used with such great success in tape recording products (particularly cassettes, which suffer most from poor signal-to-noise ratios). As you may know, the Dolby process works exactly like FM pre-emphasis and de-emphasis—except that it does so *dynamically*. The amount

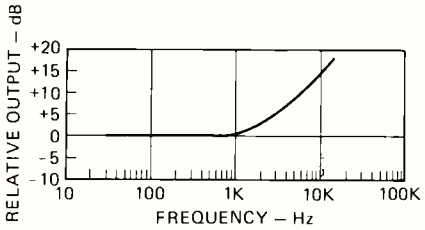


FIG. 2—PRE-EMPHASIS USED BY FM STATIONS in United States (75 microseconds).

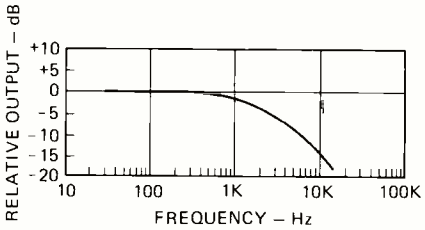


FIG. 3—DE-EMPHASIS BUILT INTO most FM tuners and receivers in United States (75 microseconds).

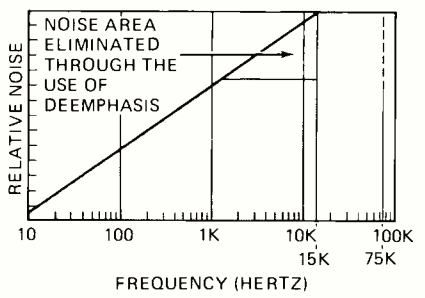


FIG. 4—DE-EMPHASIS REDUCES MOST audibly annoying noise in FM without affecting overall audio frequency response.

of pre-emphasis and de-emphasis varies depending upon loudness level of the music at any instant. At loud levels of music, noise is masked by the music itself, while during soft passages we tend to hear the hiss and background noise more distinctly.

Dolby proposed some years ago that his dynamic noise suppression system could do as much for FM as it does for tape recording products and for some time now stations in various cities have broadcast some of their programming in "Dolbyized" form (using the Dolby B system which unlike the sophisticated Dolby "A" system, affects only frequencies above 1000 Hz). Without a Dolby decoder added to the FM tuner or receiver, listeners to good equipment have sensed an over-brilliance during soft recorded passages since the second half of the system was missing. Adding Dolby B at the station increases the level of frequencies above 1000 Hz during the soft passages and has increasingly less effect on them as the level increases. The corresponding Dolby B decoder in the receiver will restore normal sound. When it is not there, the added boost to low-level high-frequency music shows up as added brilliance.

It was as if the tuner or receiver had no de-emphasis during such periods and the highs were accentuated but not correspondingly attenuated at the receiving end. Simply turning down the treble control doesn't really solve the problem, for then the loud passages seem deficient in treble, since during those instants of music little or no Dolby boosting takes place.

Dolby therefore proposed that the standard pre-emphasis/de-emphasis be changed from the present 75 μs to 25 μs. This change accomplishes several things, not the least of which is increased dynamic range. Figure 5 helps to illustrate why. Despite the fact that most musical energy is in the low and mid-frequency audio range, there are many times when upper mid or lower highs do have enough energy to cause full 100% modulation of the FM carrier. Let us suppose that a given modern recording, having wide dynamic range, contains bursts of musical energy at 10 kHz that can cause 75-kHz FM deviation (100% modulation for FM.) To allow for this, the studio engineer would have to restrict levels at lower frequencies by some 13 dB. By so doing, the hoped for improvement in signal-to-noise ratio is sacrificed in favor of increased dynamic range. In actual practice, however, most stations use all manner of limiters and compressors to prevent overmodulation, but these devices in turn reduce dynamic range and make many FM transmissions sound as lifeless as "background music"—with the range from softest to loudest passages reduced considerably.

Figure 5 also shows what would happen if the 25-μs time constant were substituted for the 75-μs system used to date. With reduced high-frequency pre-emphasis, the average program level could be increased by about 9 dB without danger of high-frequency overmodulation. Then, the dynamic action of Dolby noise reduction would be added to reduce soft passages background noise without sacrificing dynamic range. A second benefit would accrue in terms of listeners with low-cost sets who did not wish to spend the extra money for the home portion of the Dolby system. Since their sets are equipped with 75-μs de-emphasis networks, the treble tones at medium and low level passages of music would, in effect, be slightly attenuated because of the discrepancy between 25-μs pre-emphasis and 75-μs de-emphasis and the tone controls could remain in their flat position. More important, cheap sets not equipped with any tone controls at all (such as table models, car AM/FM sets, etc.) would not be penalized.

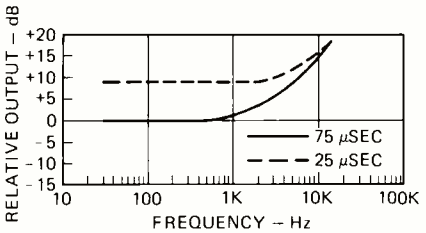


FIG. 5—CHANGE TO 25-μS PRE-EMPHASIS provides more "headroom" without danger of overmodulation.

When Dolby proposed this scheme just a couple of years ago, many industry experts felt sure that the FCC would drag its feet because the change represented what was felt to be a major one. Usually, such rule changes take years, as was the case with the approval of a stereo FM broadcasting system and as is presently taking place with regard to quadriphonic discrete FM broadcasting. Much to our surprise, the FCC acted very quickly this time and as of the opening of the recently concluded Consumer Electronic Show it authorized any station to change its pre-emphasis to 25-μs and to use Dolby B encoding (the same system used in home tape products) in conjunction with the change.

A few products on the market, such as Marantz's top-of-the-line stereo and 4-channel receivers are already equipped with a switch which changes the built-in de-emphasis characteristics from 75 μs to 25 μs. Needless to say, those manufacturers so equipped were quick to put up hastily printed signs in their show exhibits boasting of their foresight. There are also some tuners and/or receivers on the market which have built-in Dolby decoding circuits but lack the switching facility for 25-μs de-emphasis and finally, of course, there are the millions of quality high fidelity components that have neither built-in Dolby decoding or 25 μs de-emphasis.

Most stereo tuners accomplish the required de-emphasis *after* stereo MPX decoding, with individual de-emphasis networks inserted in the left and right audio output lines following the stereo decode circuitry. In simplest form, the de-emphasis network will appear as shown in Fig. 6. Note that the product

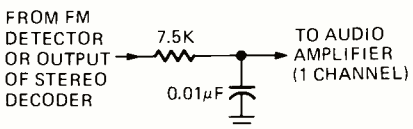


FIG. 6—SIMPLE RC NETWORK provides 75-μs de-emphasis in many tuners and receivers.

of the resistor and capacitor values (expressed in ohms and farads) equals 75×10^{-6}. In some receivers or tuners, you may find that the product adds up to somewhat lower values, say 68×10^{-6} or so, with wiring capacitance contributing the remaining few pF of capacitance in the de-emphasis circuits.

To change a receiver or tuner over to 25-μs de-emphasis requires a change in either the value of the resistor or the capacitor shown in Fig. 6. Given a choice, the capacitor should be changed, rather than the resistor so as not to upset any dc levels which might be established by this resistor in your

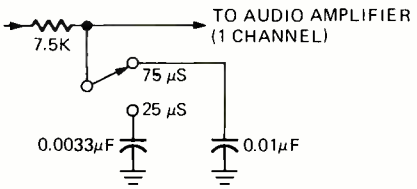


FIG. 7—SIMPLY SWITCHING IN an alternate capacitor can change de-emphasis to newly approved 25 μs when new Dolby broadcasts are transmitted.

particular design. Figure 7 shows a suitable switching arrangement.

Filter stages

Unfortunately, many modern tuners and receivers use a combination filter network (often encapsulated) to combine the functions of de-emphasis *and* 19-kHz or 38-kHz sub-carrier product attenuation. These networks generally have the response characteristics shown in Fig. 8—following first the required 75-μs de-emphasis curve and then sharply attenuating any 19-kHz or 38-

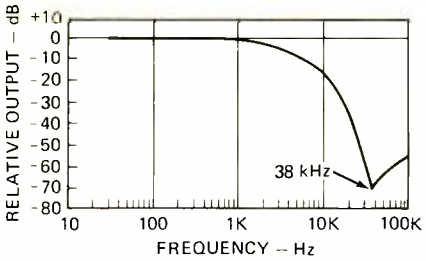


FIG. 8—SOME SETS COMBINE de-emphasis and 38-kHz filtering in non-alterable filter blocks.

kHz residual products. Obviously, it is no simple matter to alter the response curves of these filter blocks by the simple change of a component. Owners of tuners or receivers with this kind of tuner output filtering would do best to consult the manufacturer of the equipment for advice on how to convert de-emphasis from 75 μs to 25 μs.

There is, of course, no point in converting the de-emphasis characteristics of your tuner or receiver unless you also plan to (or already) have Dolby decoding equipment—either built-in to your tuner or receiver or as an accessory device which can be added to your system at the outputs of the tuner or, in the case of a receiver, at the tape-monitor jacks. Greatest improvement in signal-to-noise ratio during Dolby broadcasts will be experienced by listeners who were only getting marginally acceptable signal-to-noise ratios in stereo broadcasts originating from fairly distant stations. Improved dynamic range, however, should be experienced by everyone who is fortunate enough to have samplings of the new Dolby broadcasts in his local area.

Other breakthroughs

In line with the new efforts in the area of noise reduction and improved dynamic range (which are really interrelated), we note that more and more manufacturers are coming up with "one-sided" circuitry that accomplishes these ends. By one-sided, we mean that rather than employing an encode/decode scheme, some of the new devices are able to act upon audio signals in such a way as to reduce apparent noise and increase dynamic range by simply applying them to the reproduction end of the chain. Perhaps the best known of these is the *dbx Model 117 Dynamic Range Enhancer* which is designed along classical compressor/expander lines but can also work as a "one-sided" system with some dynamic range benefits. Other, more sophisticated one sided approaches come in the form of dynamic filters (an example is Philips DNL circuitry) and, more recently, an autocorrelator noise-reduction system developed by Phase Linear for use in their model 4000 preamplifier. It distinguishes between random noise and musical frequencies and, by a series of complex gating circuits permits the music to come through while suppressing residual noise.

As we examine these and other noise reduction schemes in the future, we will attempt to describe one or more of them in greater detail in future articles. In the meanwhile, the battle against noise and for greater realism through increased dynamic range goes on. **R-E**

CALIFORNIA ELECTRONICS ASSOCIATION OPPOSES EXTENDED WARRANTIES

After an extended discussion of the present lengthening warranties and their effect on the independent service dealer, the California State Electronics Association's Board of Directors passed the following resolution:

WHEREAS the Board of Directors for the California State Electronics Association, while meeting in due session in Los Angeles, California, did discuss at length the detrimental effects of manufacturers "expressed (extended) warranties" applied to consumer brown good products, and

WHEREAS said discussion dwelt upon detriments experienced by both the consumer and the Independent Consumer Electronics Servicing Industry as a result of such "expressed (extended) warranties," and

WHEREAS the manufacturers require the Independent Electronic Service Dealer to **invest his own money** in parts, modules, freight and handling charges, etc., to effectively carry out the provisions of the "expressed (extended) warranty", and

WHEREAS this would indicate that the manufacturers are engaged in the manipulation of Independent Electronics Service Dealers in an effort to offset or acquire the additional funds **vitally** necessary to allow them (the manufacturers) to fulfill their commitment to the consuming public, and

WHEREAS it would appear that in the absence of such financial support the manufacturers offering "expressed (extended) warranties" in a manner which would cause the public to assume that the manufacturers themselves were satisfying the provisions of such warranties when, in fact, they are not, would be impossible, and

WHEREAS the consumer too is contributing to the manufacturers attempt to satisfy the cost of providing "expressed (extended) warranties" through increased product prices which, in turn, creates an inequity not necessarily in the consumers favor.

BE IT THEREFORE RESOLVED that the California State Electronics Association does strongly oppose the continuation of "expressed (extended) warranties" offered by the manufacturers of consumer brown goods products and, also, the manufacturers of replacement parts and materials for said products. The California State Electronics Association, furthermore, implores the National Electronic Service Dealers Association, the Federal Trade Commission, interested consumer groups, et al, to work diligently toward causing this matter to become a predominate topic of discussion at the manufacturers conference tables in a sincere effort to seek and secure an equitable solution to the benefit of all parties involved. The California State Electronics Association regards this matter to be a **priority measure** for the Association to pursue.

Adopted unanimously by the Board of Directors of the CSEA.

Step-by-step TV Troubleshooters Guide

The horizontal output stages of an RCA CTC35A color TV are not the simplest circuitry you ever saw—far from it. Here's a handy guide on how to find troubles in this chassis, and lick them fast

by STAN PRENTISS

SOME SAY THAT TROUBLESHOOTING is an art: but any scene can be erased with a brush stroke. Therefore, let's treat troubleshooting as a science, because there are occasions when pigments and bristles don't mix.

For instance, how would you handle one CTC35A RCA delivered to you sans picture tube and be told the width had "shrunk somewhat." Further, let's say you didn't have the right pix-tube yoke jig to look at the picture. Then when you made tentative measurement of the sync separator you got waveform 1 W1) shown in Fig. 1, and when you measured the high voltage you found 20.5 kV instead of 25 kV in the absence of beam current. You'd what? Please—that's not nice!

The three senses, plus probes

But that waveform you just looked at may not be such a problem after all. In 1967, RCA said the vertical sync waveform should measure 100 volts peak-to-peak at the plate of the sync separator, horizontal sync from the same point should measure 60 Vp-p, and the dc plate supply ought to read 105V. So the only real problem with W1 is that the vertical oscillator is out of sync. Why not the horizontal oscillator? With time base set for 2 ms/div, the false pulses aren't fast enough to be anything but vertical interruptions. However, with vertical amplifiers attenuated to 50V/div (including 10X probes), dc of 100V is positive and the vertical pulses are about 70V, so we're probably in the ballpark.

Why did we go to the sync separator first? Because it's good indicator of

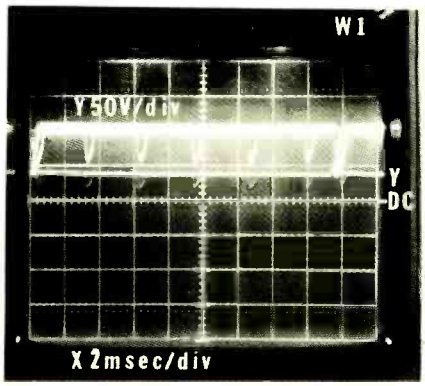


FIG. 1—LOOKING AT THE SYNC SEPARATOR we were faced with this waveform plus 20.5 kV instead of the expected 25 kV.

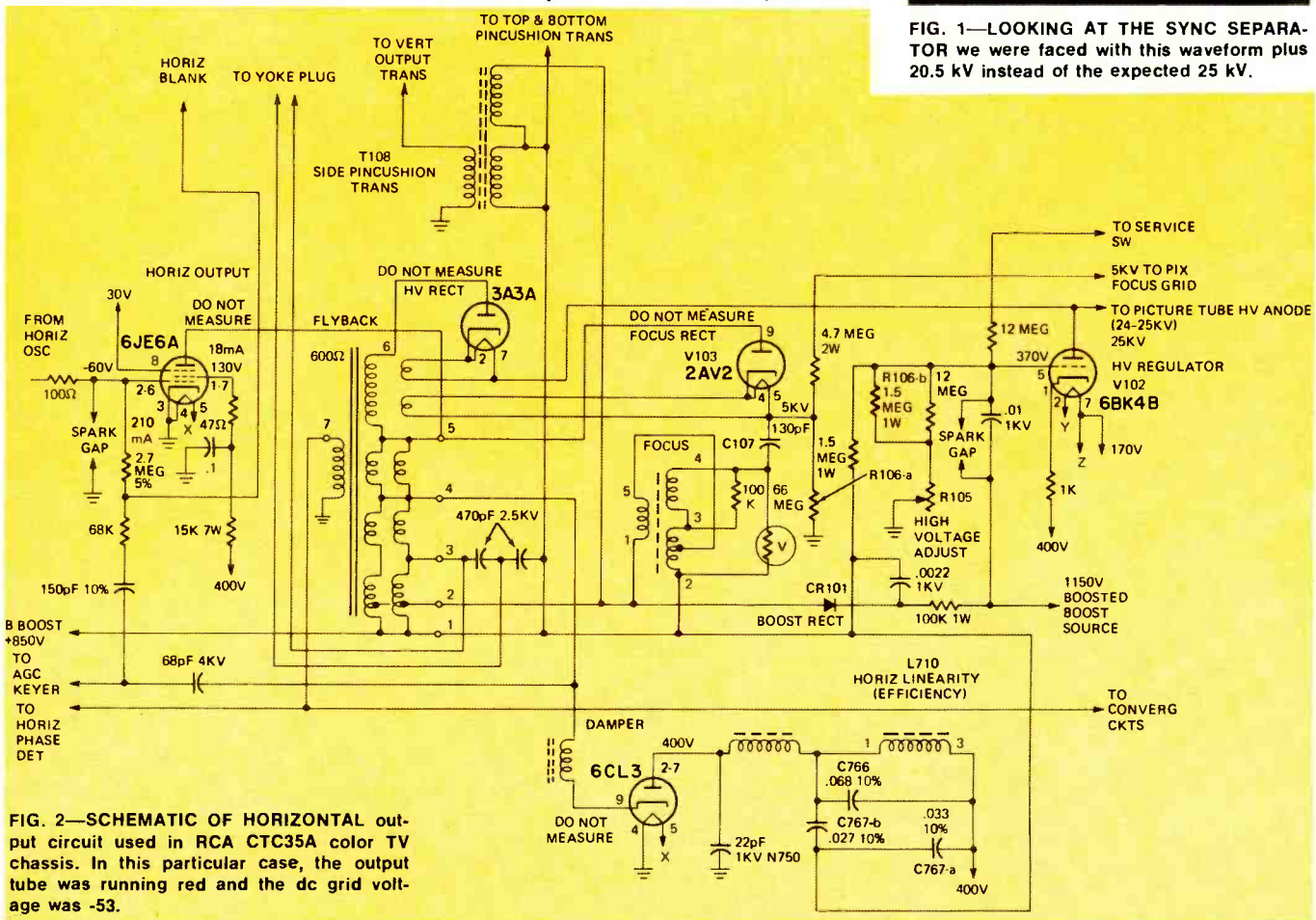
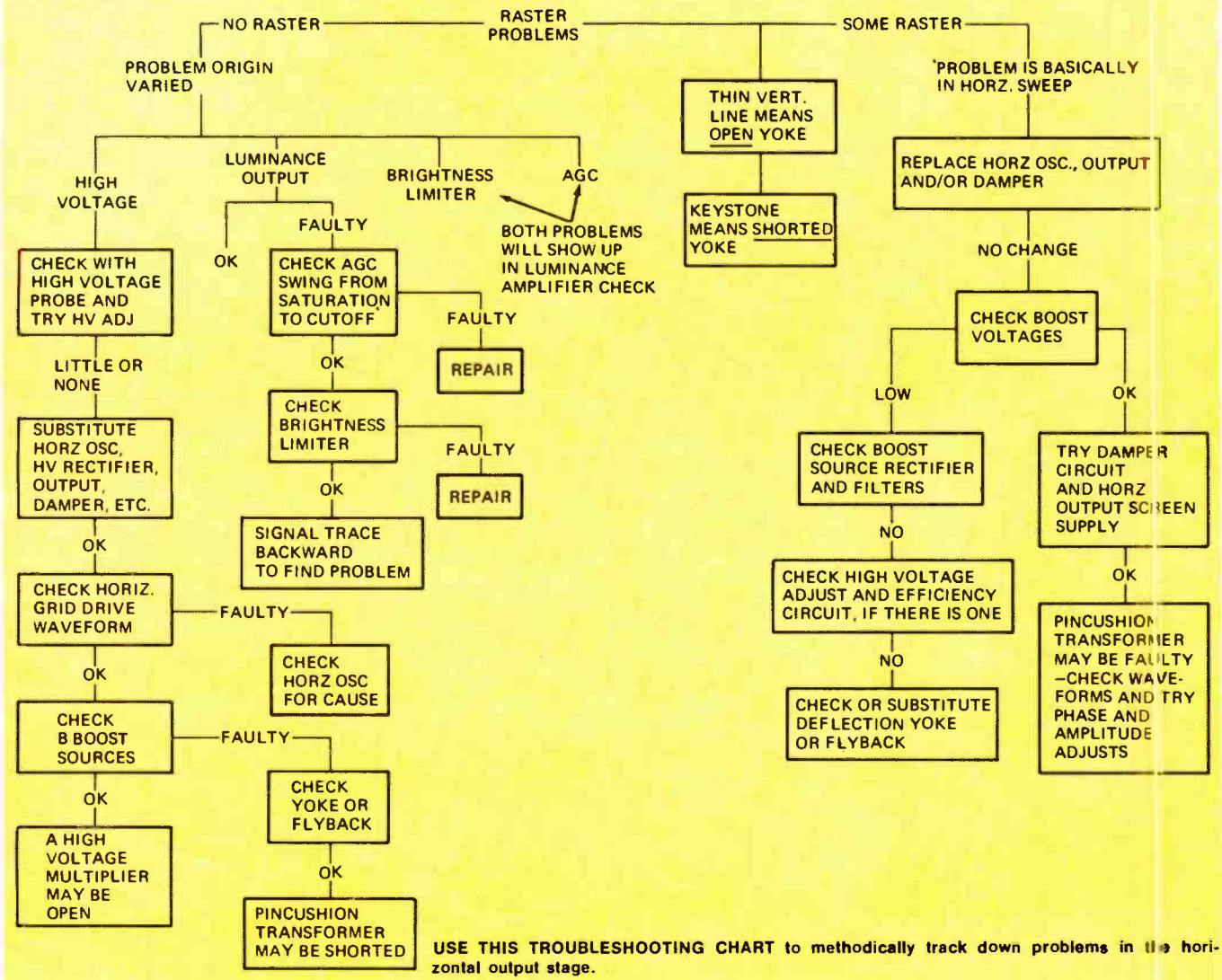


FIG. 2—SCHEMATIC OF HORIZONTAL output circuit used in RCA CTC35A color TV chassis. In this particular case, the output tube was running red and the dc grid voltage was -53.

TROUBLESHOOTING CHART FOR HORIZONTAL OUTPUT STAGE



USE THIS TROUBLESHOOTING CHART to methodically track down problems in the horizontal output stage.

composite video operation and also a handy reference in any sync or sweep investigation to trigger your dual-trace scope on one channel and maintain overall sync while you probe about the sweep sections with the other.

Since we have horizontal width problems, according to the owner, let's take a look - and a smell - there. With the receiver *on* for 10 minutes or so, the plate of the horizontal output tube (Fig. 2) begins to glow red, and the rather acrid smell of some passive element singing is fairly obvious. A quick look shows some resistors may possibly be discolored, and the dc grid voltage measures a negative 53V *both* on an oscilloscope and a FET multimeter.

Waveform W2 (in Fig. 3) indicates that the p-p vertical output grid voltage (Y2) is 250V p-p and, interestingly, the Y1 sync output at a horizontal rate is 70V p-p, just about what it should be. So you can now safely say that the sync separator is operating well, and that both dc and ac voltages at the grid of the output are positively within tolerance since the carefully calibrated scope used here would, undoubtedly, be considerable more accurate than ac, recurrent sweep scopes with varying input impedances and input filter effects available seven years ago.

Consequently, our problem immediately transforms itself from this stage's oscillator drive to either load or supply problems or, perhaps, the tube itself. Dc voltages at the screen and

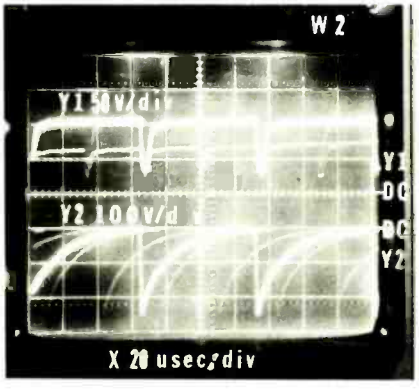


FIG. 3—PEAK-TO-PEAK vertical grid output voltage (Y2) is 250 volts and Y1, the sync output is 70 volts peak-to-peak.

suppressor are well within tolerance, so our troubles are decidedly now in the tube or somewhere beyond. Remember, the high voltage is 5 kV low. Inserting a new 6MJ6/6LQ6/6JE6C did produce another kilovolt—a partial solution for glowing plates—but not enough for a fully adjustable 25 kV; so something more is needed.

Measurements of the 850V boost, and the 1150V boosted boost also showed both down by about 20%. Further, twisting the HIGH VOLTAGE ADJUST potentiometer produced no additional high voltage. So in effect, the new tube simply was more durable and could withstand additional plate current drain, at least temporarily. What we have at the moment is the possibility of a bad regulator - because it's connected to boost - and also there may be difficulties in the boost supplies themselves. As you might have suspected, the usual shunt regulator, damper, and high voltage tubes brought no relief whatsoever. Actually, a new shunt regulator even brought the high voltage down to under 20 kV and, by

now, the situation was not at all funny.

Settling down and digging in

But by "dig" we don't mean ripping out one component after another and substituting at random. For under such circumstances, there's every possibility something will be connected wrong, left out, or damaged beyond repair. Your best bet in these conditions is to study the circuit and know how it works, then tackle the problem again. Especially noteworthy is the horizontal efficiency circuit that's designed to modify yoke current so it is linear when passing through zero, thereby forming a smooth transition between horizontal output and damper tube currents as one ceases to flow and the other begins.

The efficiency network consists of L710, C766, C767-a, C767-b and is tuned for minimum horizontal output tube cathode current. The focus adjust transformer is another circuit worth understanding too. Here, a pulse of some 5 kV is rectified by V103 to supply focus voltage, with part of the focus transformer connected across B boost rectifier CR101, and the other in series with the 2AV2 focus rectifier through C107. An adjustable core then regulates flux between the windings. In one position, a positive high voltage pulse is coupled to the cathode of the 2AV2 tube, while in another position, a negative pulse is permitted on the cathode of the rectifier. Thus, when negative pulses reach the cathode the total ac voltage output is larger and there is greater dc focus voltage available. When only positive pulses are rectified through the anode, there is less dc voltage and a smaller focus voltage is produced.

The 6BK4C/6EL4A shunt regulator (latest tube) uses the 850 B boost as grid control voltage, after being divided down by R106-B, and the 500K R105 high voltage adjust control itself. The cathode of this tube returns to regular 400V B+. When loads such as brightness, contrast, and picture modulation change, high voltage is inclined to vary also because of CRT beam current. As this occurs, B boost also rises or falls in direct proportion to high voltage. To control this condition, a high voltage regulator tube is shunted across the flyback transformer and, as boost becomes less, the regulator load diminishes and permits more high voltage output. With greater boost, the grid of V102 is driven more positive and therefore further loads the flyback, lowering high voltage output.

With this operational information tucked away in the deduction memory, it's wise to re-establish the prime problem points: A second check on B boost shows about 550V, and boosted B boost is only 700 V. This would indicate the worst load is possibly on boosted boost and that is what is dragging both down. But beware of any general assumption just now.

Problem approach and solution

But let's consider that either boost or boosted boost could be the problem. Fortunately, these old vacuum tube receivers still have some hand wiring that can be easily disconnected for something of a "trial run." The pincushion transformer is always a good suspect when there are high voltage problems, so let's disconnect the red lead to the T108 side pincushion transformer, since this will disturb little else.

Immediately we found the high voltage could be adjusted, at least downscale, but not above 21 kV. This then says that *some* of the undesirable shunt load has been removed, but the prime problem still remains. A disconnect of the top green wire simply lost much of the high voltage, but did return all boost. So the pincushion transformer is virtually eliminated because its overall disconnect reaction isn't enough to remove the entire unwanted load. The red wire we removed at the pincushion transformer is the B-boost bus, and it also goes to the focus transformer and horizontal efficiency coil.

So what about the efficiency coil? Is your cathode current at or below the specified 235 mA. Breaking the ground strap at pin 3 and inserting a milliammeter in series, we found a reading of 240 mA. Now this suggests that the cathode current should be reduced, so you simply tune your horizontal efficiency coil for less than 235 mA. When high voltage first comes on, the efficiency coil did tune a bit, and high voltage immediately increased — just how much we don't know except by the sizzling sound—because within just a few seconds, the output tube's cathode current had again increased to 240 mA, the high voltage hiss had generally subsided, and the L710 efficiency coil was not effective. However, when a tan wire directly from B boost to the coil was disconnected, high voltage immediately jumped to 26 kV, boost potentials returned, and the receiver was obviously operating.

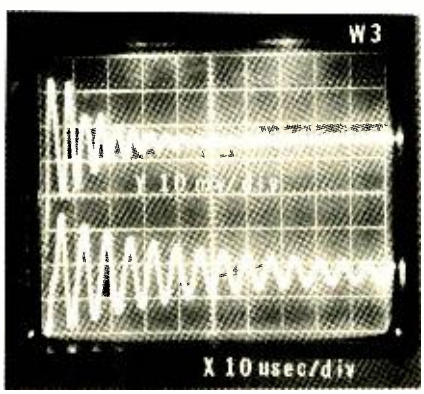


FIG. 4—THE DEFECTIVE TURNS in the flyback show up in trace Y1. Trace Y2 shows a good flyback under a ringing test.

So what do you make of this? Wasn't the horizontal efficiency coil operating for a short length of time? And doesn't this tell you that the coil is probably OK, but other parts associated are possibly at fault. Now, what charges when current begins to flow, and what could damp the efficiency coil most effectively, changing the entire reactive impedance of this ac circuit? How about C766 or C767-a, or C767-b? Check or substitute C766 first, because the other two are matched and will therefore be special parts. A capacitance checker here is handy, and the parts come off the old pc board with ease. Sad to relate, however, all capacitors were within tolerance, and easily withstood more than their rated voltage.

Now, back once more and consider the initial problem. . .Weren't the output tube plates glowing red and wasn't there a smell of something singing? Obviously, some component had to be drawing excessive current and, so far, we haven't really pinned the donkey's tail on anything but supposition. What about the flyback transformer? In some of the old CTC7 series a few shorted turns could produce contracted width, but in this instance it is hardly likely - and even less so in the newer receivers

(continued on page 108)

R-E's Substitution guide for replacement transistors

PART XX

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

G-E—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

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578

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

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

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N4152	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4153	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4154	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4155	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4156	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4159	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4160	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4161	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4162	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4163	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4164	NA	S-620	GEMR-4	ICC-620	NA	NA	HEP-620	NA	NA	NA	NA	NA
2N4167	NA	SR-1241	GEMR-4	ICC-R1241	IR-1771	NA	HEP-R1241	NA	NA	NA	NA	NA
2N4168	NA	SR-1241	GEMR-4	ICC-R1241	IR-1771	NA	HEP-R1241	NA	NA	NA	NA	NA
2N4169	NA	SR-1242	GEMR-4	ICC-R1242	IR-1772	NA	HEP-R1242	NA	NA	NA	NA	NA
2N4170	NA	SR-1243	GEMR-4	ICC-R1243	IR-1774	NA	HEP-R1243	NA	NA	NA	NA	NA
2N4171	NA	SR-1244	GEMR-4	ICC-R1244	NA	NA	HEP-R1244	NA	NA	NA	NA	NA
2N4172	NA	SR-1245	GEMR-4	ICC-R1245	IR-1777	NA	HEP-R1245	NA	NA	NA	NA	NA
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2N4175	NA	SR-1241	GEMR-4	ICC-R1241	IR-1771	NA	HEP-R1241	NA	NA	NA	NA	NA
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2N4195	NA	NA	GEMR-4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N4196	NA	NA	GEMR-4	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N4199	NA	SR-1244	NA	ICC-R1244	NA	NA	HEP-R1244	NA	NA	NA	NA	NA
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2N4202	NA	SR-1247	NA	ICC-R1247	NA	NA	HEP-R1247	NA	NA	NA	NA	NA
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2N4215	NA	SR-1004	NA	ICC-R1004	NA	NA	HEP-R1004	NA	NA	NA	NA	NA
2N4216	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	NA	NA	NA
2N4220	RS276-2028	T-801	GE-FET-1	ICC-801	NA	PTC 152	HEP-801	SK 3112	RT-176	NA	WEP-801	NA
2N4221	RS276-2028	T-801	GE-FET-1	ICC-801	NA	PTC 152	HEP-801	SK 3112	RT-176	NA	WEP-801	NA
2N4222	RS276-2028	T-801	GE-FET-1	ICC-801	NA	PTC 152	HEP-801	SK 3112	RT-176	ECG 133	WEP-801	NA
2N4223	NA	T-801	GE-FET-2	ICC-801	NA	PTC 152	HEP-801	SK 3112	NA	ECG 133	WEP-801	NA
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2N4228	NA	T-715	GE-21	ICC-715	TR-30	PTC 103	HEP-715	NA	NA	NA	WEP-715	ZEN 106
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2N4232	NA	T-241	GE-66	ICC-241	NA	NA	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
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2N4234	RS276-2025	T-242	GE-29	ICC-242	IRTR-56	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4235	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 111	HEP-242	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4236	NA	TS-3031	NA	ICC-S3031	NA	PTC 111	HEP-S3031	NA	NA	NA	WEP-3031	NA
2N4237	RS276-2018	T-243	GE-63	ICC-243	IRTR-87	PTC 144	HEP-243	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4238	RS276-2018	T-243	NA	ICC-243	NA	PTC 144	HEP-243	NA	NA	NA	WEP-243	NA
2N4239	NA	T-714	NA	ICC-714	TR-74	PTC 144	HEP-714	NA	NA	NA	WEP-S3021	NA
2N4240	NA	NA	NA	NA	NA	PTC 104	NA	SK 3021	NA	ECG 124	WEP-240	NA
2N4241	RS276-2006	T-230	GE-16	ICC-230	TR-01	PTC 105	HEP-230	SK 3013	RT-127	ECG 121	WEP-232	ZEN 325
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2N4243	MA	T-625	GE-76	ICC-625	NA	NA	HEP-625	NA	NA	NA	WEP-232	NA

NA=NOT AVAILABLE

(continued on page 68)

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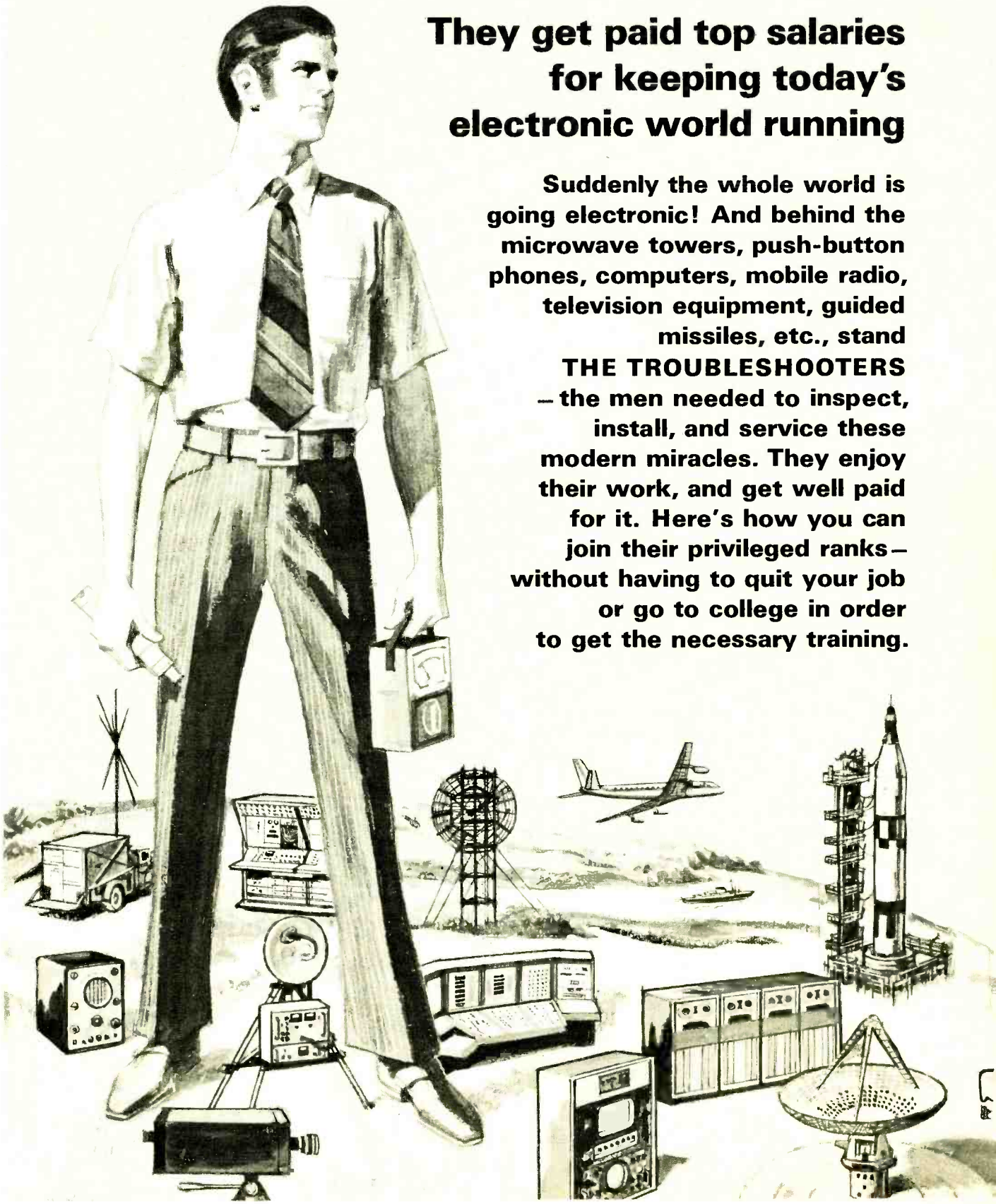

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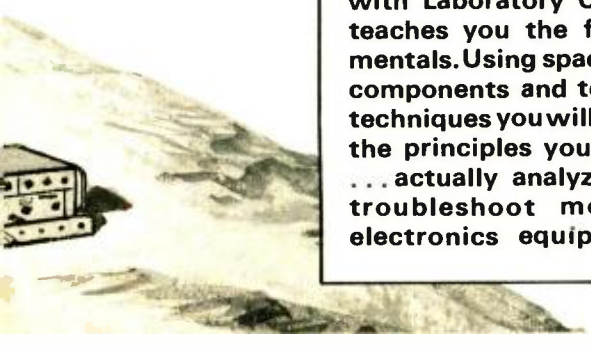

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2N4244	NA	T-232	GE-76	ICC-232	TR-01	PTC 105	HEP-232	NA	NA	NA	WEP-232	ZEN 326
2N4245	NA	T-625	GE-76	ICC-625	NA	NA	HEP-625	NA	NA	NA	WEP-232	NA
2N4246	NA	T-625	GE-76	ICC-625	NA	NA	HEP-625	NA	NA	NA	WEP-232	NA
2N4247	NA	T-232	GE-76	ICC-232	TR-01	PTC 105	HEP-232	NA	NA	NA	WEP-232	ZEN 326
2N4248	RS276-2021	T-715	GE-21	ICC-715	TR-30	PTC 103	HEP-715	SK 3114	RT-115	ECG 159	WEP-717	ZEN 106
2N4249	RS276-2021	T-708	GE-67	ICC-708	TR-19	NA	HEP-708	SK 3118	RT-115	ECG 159	WEP-717	NA
2N4250	RS276-2024	T-57	GE-22	ICC-57	TR-54	PTC 103	HEP-57	SK 3118	RT-115	ECG 159	WEP-717	ZEN 106
2N4251	RS276-2011	T-56	NA	ICC-56	NA	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N4252	NA	T-709	GE-61	ICC-709	NA	PTC 126	HEP-709	NA	NA	NA	WEP-709	ZEN 105
2N4253	NA	T-709	GE-61	ICC-709	NA	PTC 126	HEP-709	NA	NA	NA	WEP-709	ZEN 105
2N4254	RS276-2011	T-56	GE-61	ICC-56	IRTR-82	PTC 133	HEP-56	SK 3039	RT-108	ECG 107	WEP-720	ZEN 104
2N4255	RS276-2011	T-56	GE-61	ICC-56	IRTR-82	PTC 133	HEP-56	SK 3018	RT-108	ECG 107	WEP-720	ZEN 104
2N4256	RS276-2009	T-55	GE-62	ICC-55	IRTR-24	PTC 139	HEPO-55	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 103
2N4257	RS276-2024	T-52	NA	ICC-52	TR-25	PTC 131	HEP-52	SK 3118	RT-115	ECG 159	WEP-717	NA
2N4258	RS276-2023	T-52	NA	ICC-52	TR-20	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4259	RS276-2009	T-50	GE-20	ICC-50	TR-21	NA	HEP-50	NA	RT-102	ECG 123A	WEP-735	ZEN 100
2N4262	NA	NA	NA	S-0004	NA	NA	NA	NA	NA	NA	NA	ZEN 127
2N4263	NA	NA	NA	ICC-720	NA	NA	NA	NA	NA	NA	NA	ZEN 109
2N4264	NA	T-50	GE-20	ICC-50	TR-21	PTC 136	HEP-50	NA	NA	NA	WEP-50	ZEN 100
2N4265	NA	T-50	GE-20	ICC-50	TR-21	PTC 136	HEP-50	NA	NA	NA	WEP-50	ZEN 100
2N4269	NA	T-712	GE-27	ICC-712	IRTR-78	PTC 117	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N4270	NA	T-712	GE-27	ICC-712	IRTR-78	PTC 117	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N4271	NA	T-714	GE-32	ICC-714	IRTR-74	PTC 110	HEP-714	NA	NA	NA	WEP-S3021	NA
2N4273	NA	T-241	NA	ICC-241	NA	NA	HEP-241	NA	NA	NA	WEP-241	NA
2N4274	RS276-2009	T-50	GE-20	ICC-50	IRTR-88	PTC 141	HEP-50	SK 3039	RT-113	ECG 108	WEP-56	ZEN 100
2N4275	RS276-2009	T-50	GE-20	ICC-50	IRTR-88	PTC 141	HEP-50	SK 3039	RT-113	ECG 108	WEP-56	ZEN 100
2N4284	NA	NA	GE-22	ICC-739	TR-30	PTC 103	NA	NA	NA	NA	WEP-717	NA
2N4285	NA	NA	GE-21	ICC-739	IRTR-52	PTC 103	NA	NA	NA	NA	WEP-717	NA
2N4286	RS276-2016	T-54	GE-62	ICC-54	IRTR-53	PTC 139	HEP-54	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N4287	RS276-2016	T-54	GE-62	ICC-54	IRTR-53	PTC-153	HEP-54	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N4288	RS276-2024	T-57	GE-67	ICC-57	NA	PTC 141	HEP-57	SK 3118	RT-115	ECG 159	WEP-717	NA
2N4289	NA	T-708	GE-67	NA	IRTR-52	PTC 103	NA	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4290	RS276-2024	T-57	GE-21	ICC-57	IRTR-54	PTC 103	HEP-57	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4291	RS276-2024	T-57	GE-67	ICC-57	IRTR-54	PTC 103	HEP-57	SK 3114	RT-115	ECG-159	WEP-717	NA
2N4292	NA	NA	GE-61	ICC-727	NA	PTC 115	NA	NA	NA	NA	WEP-56	NA
2N4293	NA	NA	GE-61	ICC-727	NA	PTC 115	NA	NA	NA	NA	WEP-56	NA
2N4294	NA	TS-0004	GE-20	ICC-S0004	TR-21	PTC 136	HEP-S0004	NA	NA	NA	WEP-56	ZEN 127
2N4295	NA	TS-0004	GE-60	ICC-S0004	NA	PTC-121	HEP-S0004	NA	NA	NA	WEP-56	ZEN 127
2N4296	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP-240	ZEN 200
2N4297	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP-240	ZEN 200
2N4298	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP-240	ZEN 200
2N4299	NA	T-240	GE-32	ICC-240	IRTR-81	PTC 104	HEP-240	SK 3021	RT-128	ECG 124	WEP-240	ZEN 200
2N4300	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-S3007	NA
2N4302	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP-801	ZEN 123
2N4303	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP-801	ZEN 123
2N4304	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP-801	ZEN 123
2N4307	NA	TS-3002	GE-66	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-S3002	NA
2N4308	NA		GE-88	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N4311	NA	TS-3002	GE-66	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-S3002	NA
2N4312	NA	NA	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP-S3020	NA
2N4313	RS276-2023	T-52	NA	ICC-52	TR-20	PTC 103	HEP-52	SK 3118	RT-126	ECG 106	WEP-52	NA
2N4314	NA	TS-3031	NA	ICC-S3031	IRTR-73	PTC 141	HEP-S3031	SK 3025	NA	ECG 129	WEP-3031	NA
2N4315*	NA	T-733	NA	ICC-733	TR-24	PTC 139	HEP-733	NA	NA	NA	WEP-723	NA
2N4316	NA	SR-1221	NA	ICC-R1221	NA	NA	HEP-R1221	NA	NA	NA	NA	NA
2N4317	NA	SR-1221	NA	ICC-R1221	NA	NA	HEP-R1221	NA	NA	NA	NA	NA
2N4318	NA	SR-1222	NA	ICC-R1222	NA	NA	HEP-R1222	NA	NA	NA	NA	NA
2N4319	NA	SR-1222	NA	ICC-R1222	NA	NA	HEP-R1222	NA	NA	NA	NA	NA
2N4332	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	NA	NA	NA
2N4333	NA	SR-1002	NA	ICC-R1002	NA	NA	HEP-R1002	NA	NA	NA	NA	NA
2N4334	NA	SR-1003	NA	ICC-R1003	NA	NA	HEP-R1003	NA	NA	NA	NA	NA
2N4335	NA	SR-1004	NA	ICC-R1004	NA	NA	HEP-R1004	NA	NA	NA	NA	NA
2N4336	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	NA	NA	NA
2N4338	NA		GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP-801	NA
2N4339	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP-801	NA
2N4340	NA	NA	GE-FET-1	NA	NA	PTC-152	NA	SK 3112	NA	ECG 133	WEP-801	NA
2N4341	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	NA	NA	NA	WEP-801	NA
2N4342	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N4343	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N4346	NA	T-248	GE-25	ICC-248	TR-27	PTC 122	HEP-248	SK 3035	NA	ECG 127	WEP-235	NA
2N4347	NA	T-707	GE-73	ICC-707	IRTR-61	PTC 118	HEP-707	SK 3079	NA	NA	WEP-707	ZEN 204

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve tracer or lab-type transistor checker.

NA = NOT AVAILABLE

(continued next month)

R-E's Service Clinic

The flyback transformer

Perform these tests before you replace one.

by JACK DARR
SERVICE EDITOR

THERE IS NOTHING MORE EMBARRASSING than replacing a flyback, turning the set on, and finding exactly the same old symptoms you had before. Besides being expensive, this kind of thing has a tendency to make you doubt your ability to make a living at your chosen profession. So we need to be *sure* before we take that last step.

There are several tests which will give a good indication of the condition of a flyback. Notice that I said "good" — not *definite*. There is only one absolutely definite test for a shorted flyback — this is done with the Well-Calibrated Eyeball, and consists of observing a thick layer of soot on the inside of the cage, and the flyback itself lying in a charred lump in the bottom.

Load loops

The worst faults are the ones which indicate that there is a short in a flyback, when the actual short is *external*. There are a few of these in a B/W TV set — in color sets, quite a few more. A flyback/yoke circuit is actually a *tuned circuit*. Like a radio transmitter, anything which draws energy from this circuit is a *load*. If one of these normal loads is shorted, it will draw excessive energy from the flyback, cause a very high load current to flow, and in time overheat the transformer and make it burn up.

The quickest single test to show up an overload is the cathode current of the horizontal output tube or transistor. This stage *controls* all of the *power* used in this circuit (doesn't *supply* it; it comes from the low voltage or B+ supply, but it does control it). If there is even a small overload in *any* of the load circuits, it shows up instantly as an increase in the cathode current of the output stage.

There is your key symptom. From this point on, your job is to find out what is causing this excess current to be drawn. If the flyback does have shorted turns, you'll get this kind of symptom. However, there are quite a few things which can "fake you out" on this, so let's watch out for them. We'll assume that the B+ supply is normal, the tube or transistor is good, and that the input drive signal is normal. These are easy to check. So are things like a shorted boost capacitor, and so on. The object of these tests, from here on, is to *make sure* that the flyback actually is internally shorted, or isn't.

Test instruments

One essential tool for this is a cathode-break adapter, to let you read the cathode current of the output tube during operating tests. (Pomona 2599-A for 6JE6's and any Novar tube with the cathode on pin 2, etc.) For actually testing the flyback for shorted turns, my pet test instrument is a very old design, the "Flybacker" type; this was made by Radio City Products Co. a long time ago, and is still being built by several companies. Figure 1 is the schematic of a typical unit.

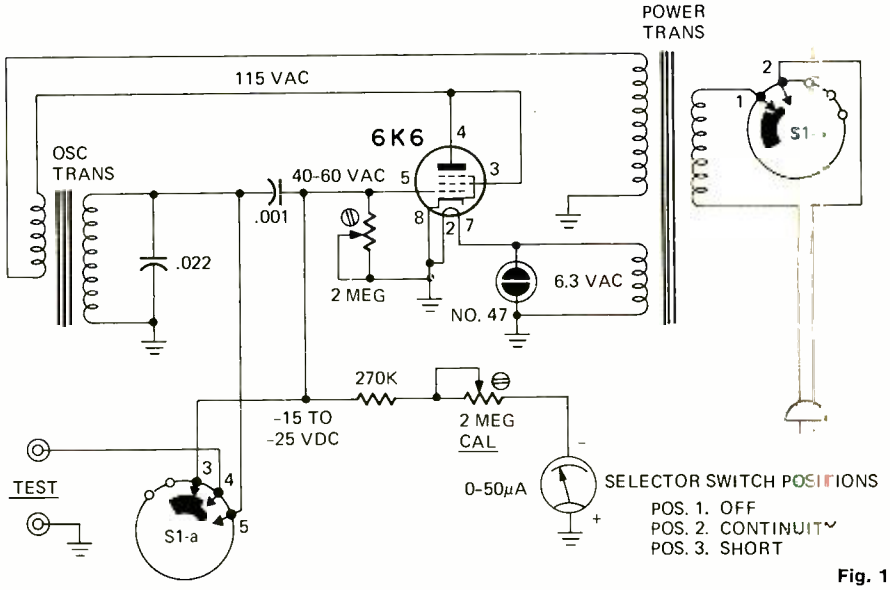

Fig. 1

This nothing but a 16-kHz oscillator. The meter reads the grid current. If a good inductance is connected across the test leads, it will not damp the oscillations, and

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the meter stays in the GOOD sector. If the inductance has only *one* shorted turn, it will reduce the Q of the whole circuit so badly that the oscillation will be reduced, and the meter will fall and read in the REPLACE sector. This simple unit is amazingly accurate. You can verify this: connect a good flyback to it, note the reading, then wrap one turn of wire or solder around the core. Short the ends of this, and watch the meter fall into REPLACE. This makes a "one shorted turn" loop coupled to the inductance, and pulls the Q down.

However, you *and* the flybacker can be fooled, if there is too much external loading on the transformer. Especially in color sets where many circuits are connected to the flyback; pulse circuits, the high-voltage rectifier, focus rectifier, and so on. The filament circuits of the rectifier tubes make up a "closed-loop," and can show fake loading.

Now let's run through the whole procedure, to see how much of it we need to use in any given case. The dc voltage supply has been checked, drive checked, tubes checked. There is no normal output (sufficient high voltage, sweep, and so on) and the cathode current meter shows a reading far above normal. Ohmmeter tests around the boost circuit, etc. show that there are no nice easy shorts to ground. So, the chances are at this point, that there *is* a distinct possibility that the flyback is shorted.

We pull the high-voltage rectifier and focus rectifier tubes (to open those closed loops), and take the cap off the horizontal output tube. Connect the Flybacker between the plate caps of the output tube and high-voltage rectifier. It says SHORT. There you are. However, *if* you stop testing at this point and order a new flyback, you may be in deep trouble. All of the returns aren't in yet.

There is one thing that we *must* do, before making a definite decision that a flyback is shorted. Make sure that *all* external loads have been taken off. This is not too hard to do, and it can save you a lot of time. Check the schematic to see how many normal loads are used. There won't be too many.

First, disconnect the yoke. Next, take off anything like a width coil, which is connected in shunt across a part of the flyback windings. In many color sets, you'll find one of the focus transformer windings connected directly across the bottom of the flyback. While doing this, leave the Flybacker hooked up to the plate caps of the output tube and high-voltage rectifier.

Each time you unhook a wire, watch the meter. If there's no change, keep on going. If you get *all* of the wires off the flyback, and it is still in the SHORT sector, go ahead and order a new flyback. However, if your short is in one of the load loops, you'll see the meter jump happily back up into the GOOD sector. Figure 2 shows a partial schematic of a typical flyback, with the different load loops indicated.

Case histories

Let's look at a few actual fake short cases. One of them was a Magnavox 920 color chassis. The 6JE6 was glowing red-hot, and there was no raster or high voltage. New tube didn't help; cathode current was 400mA plus (that's as far as my meter went). The Flybacker showed a short, when connected to the 6JE6 and 3A3 plate caps. Disconnecting the yoke didn't help; it

(continued on page 72)

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stayed there until I took off the leads going to the focus transformer winding. This eliminated the short; the meter went upscale. It will do this when connected to a good high-Q flyback, which most color sets use. That was that; the focus transformer was shorted and the flyback was saved.

In an RCA CTC-22 portable color set, same thing. Flyback showed short, and all of the typical symptoms were present; high cathode current, no high voltage, etc. This one was caused by a shorted damper diode, which in this case was a solid-state type under the chassis. In similar circuits, a shorted boost capacitor, or the capacitor connected across the solid-state damper will show the same thing.

In a very small GE hybrid B/W TV chassis, there was no high voltage. In-circuit tests showed the flyback shorted. This one was mounted directly to a PC board. Taking the flyback out with a desoldering iron, it checked perfectly good. Here the short was in the horizontal yoke winding, another dandy load loop.

Time to sum up

Once the high cathode current of the horizontal output tube, together with the lack of "normal output" (no high voltage, no horizontal sweep, etc.) has shown you that there is a possibility that the flyback is shorted, make the necessary tests. **BUT! Don't stop short of making all of them!** Take off every external load and repeat the test for shorts. Even in a color set, this won't mean disconnecting more than about seven or eight wires. Leaving the flybacker hooked up and checking its reading each time you take off a wire will give you an "instant clearance" on the flyback, or a definite indication that it is bad.

The only place you can get into trouble with this type of instrument is with very low inductance *yokes*. These will normally read very low, in some cases into the short sector. If there is a doubt, take the cap off the back, and check each half of the yoke separately. If these readings are the same, the chances are that the yoke is good. Very few yokes show identical shorts in *both* halves. **R-E**

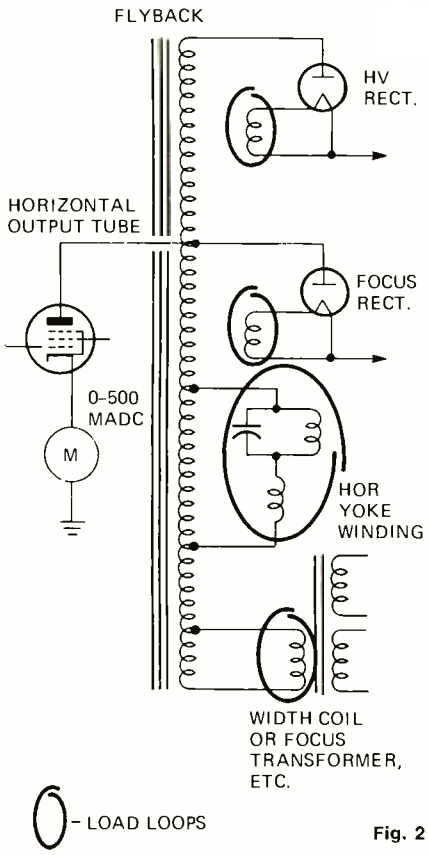


Fig. 2

reader questions

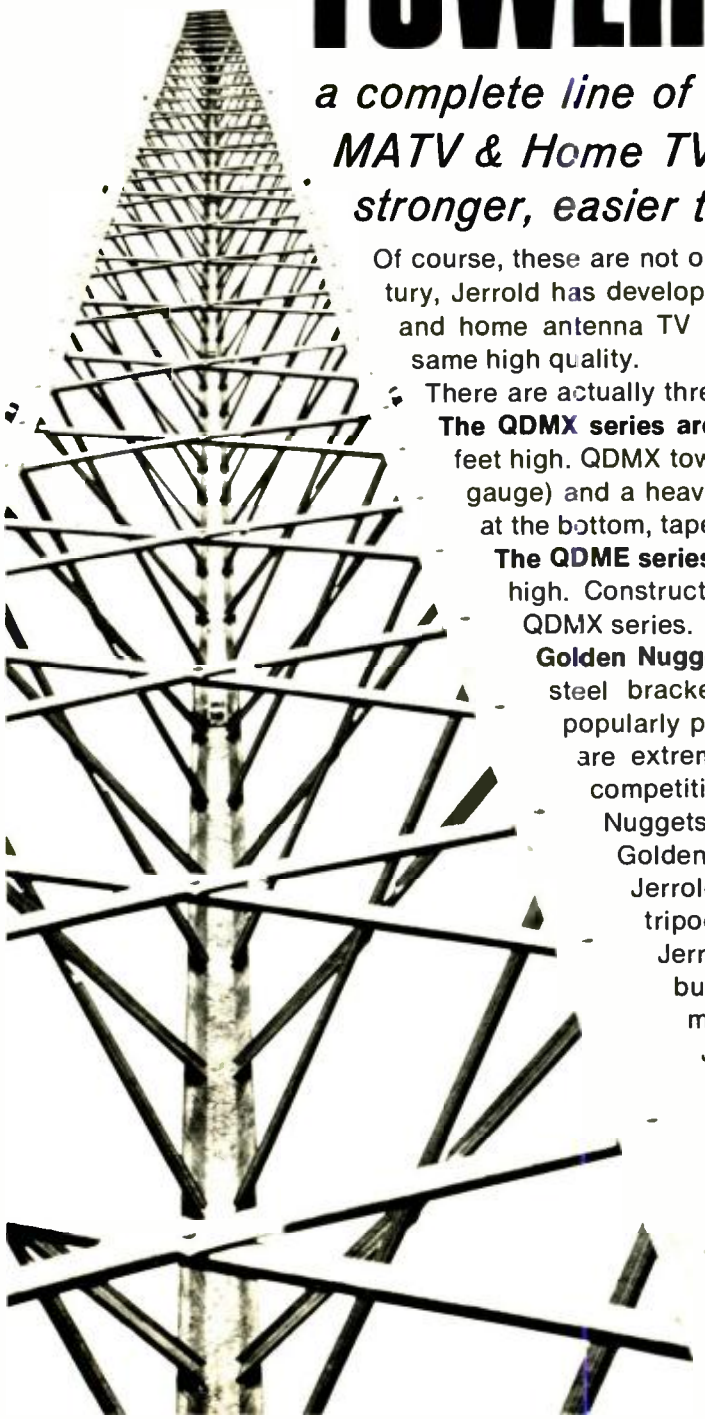
VERTICAL PROBLEMS

This little hitty TV set has a couple of big problems (Singer TV6). If I adjust for good vertical linearity, there's about 1-1.5 inches of picture chopped off, top and bottom. It also has a vertical sinc problem, that seems to get a little better as the thing warms up. Dc voltages throughout the vertical section close to normal. Oscillator and amplifier transistors replaced; no help. What do you have on this one?—M.S., Amarillo, Tex.

This seems to have all the earmarks of an electrolytic-capacitor problem. Suspect any *coupling* capacitors in the

(continued from page 78)

Look up to Jerrold's new line of TOWERS



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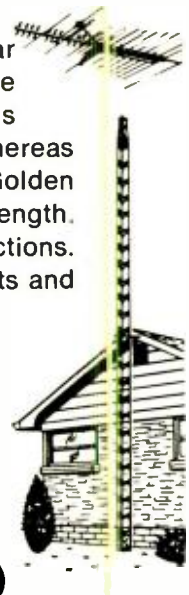

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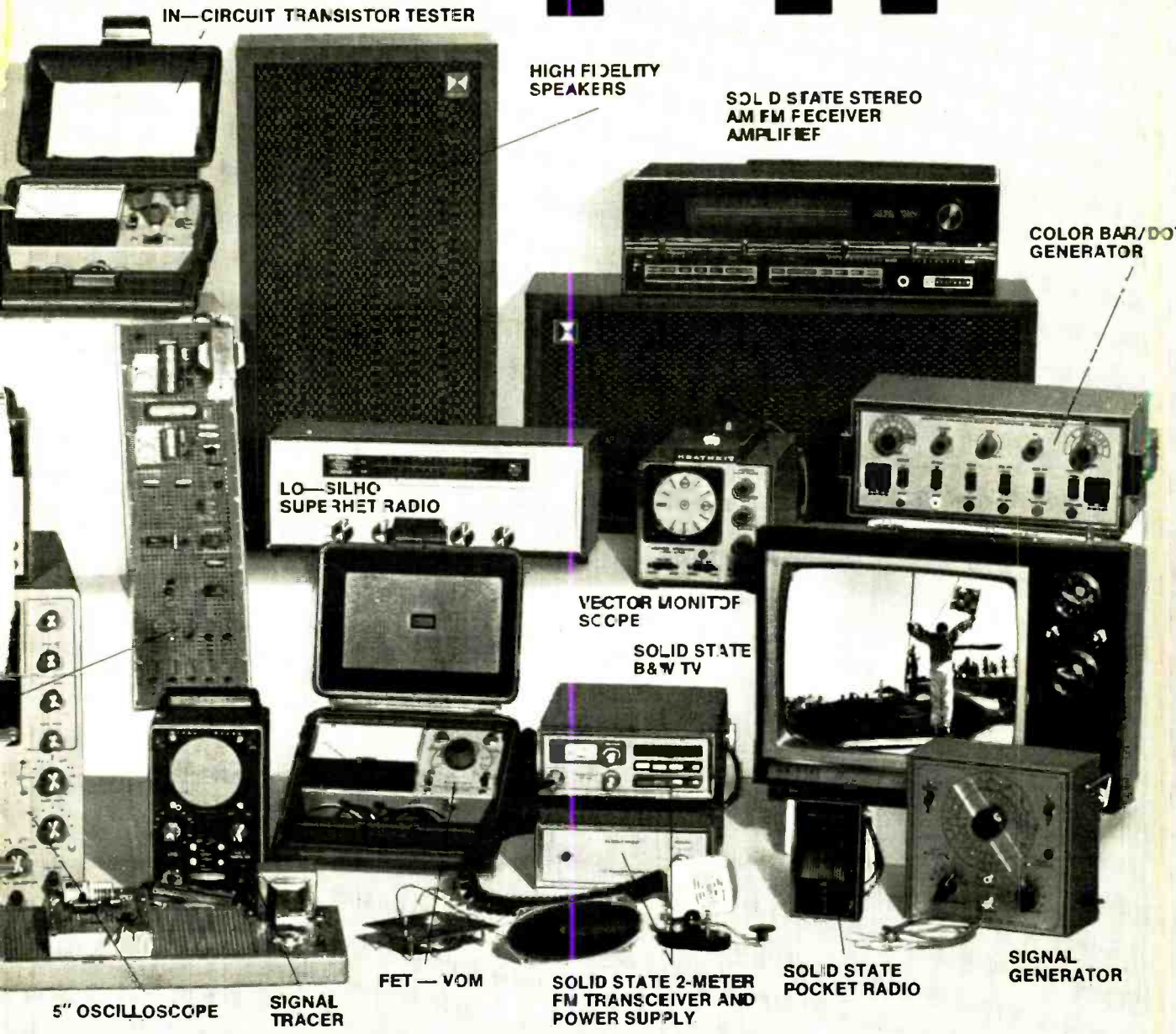

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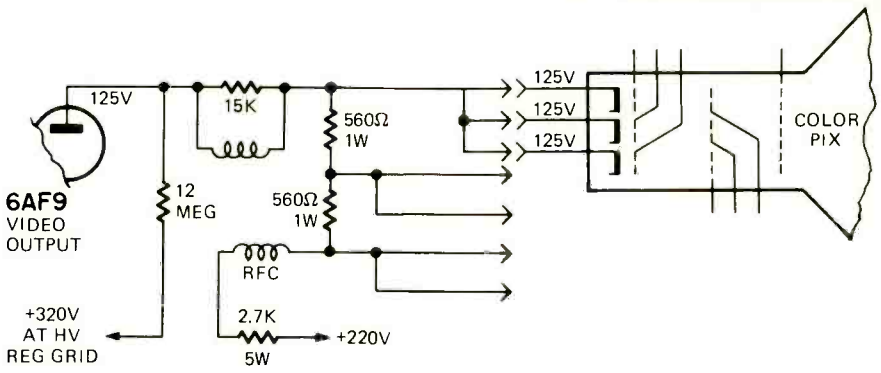
vertical amplifier and output circuit. Low-voltage electrolytics can cause some weird symptoms. On the sync problem, check any *emitter* bypass capacitors, in the sync amplifier, etc. If these are open, they'll reduce the sync amplitude.

(I came out of this one smelling like a rose! The reader wrote back; "I found a thermal capacitor; the 10-μF coupling capacitor between the oscillator and vertical amplifier stage. When I cooled it, I lost the vertical sweep! Heat it up with a soldering iron, and it came back. What threw me was that this was a *replacement* capacitor! Sync problem *was* due to an open emitter bypass, another 10-μF, on the oscillator transistor emitter! Thanks". Thanks to Mark Sims of Amarillo, Tex., for the "feedback".

ODD RASTER

After I changed the picture tube in this Truetone EIS2885A-86, I got sound but no picture. There was just a faint glow along the bottom of the screen. When I turned up the brightness control, the screen lit up from the bottom up, like a window-shade being raised. When the brightness control got all the way up, the screen flashed and went out. This repeats if I turn the brightness control all the way off and bring it up slowly.

Some voltages are weird; I read ±400 volts on the video output plate, which should be +125 V. With the picture tube socket off, I read a −50 volts on 2, 6, and 11. High voltage reads 25K with the screen dark and only about 3 kV with brightness up, Need ideas!—M.F., Wichita, Kan.



Here are a few. Check the continuity in the connections to the picture tube *cathodes*. That negative voltage you got with the base off is badly wrong. This should have been at least +150 volts or more. The dc voltage is fed to these cathodes and the video amplifier plate through a network of resistors and peaking coils. Frankly, it sounds very much as if the cathode disconnects have been fouled up or accidentally pulled loose. This would take the load off those resistors, and let the video amplifier plate voltage go way up. Since it's fed from +220 volts, I don't know yet where your +400 volts comes from. However, if your cathodes are all at zero voltage, this *will* definitely cause the picture tube to draw a very heavy beam current and kill the raster by overloading the high-voltage supply.

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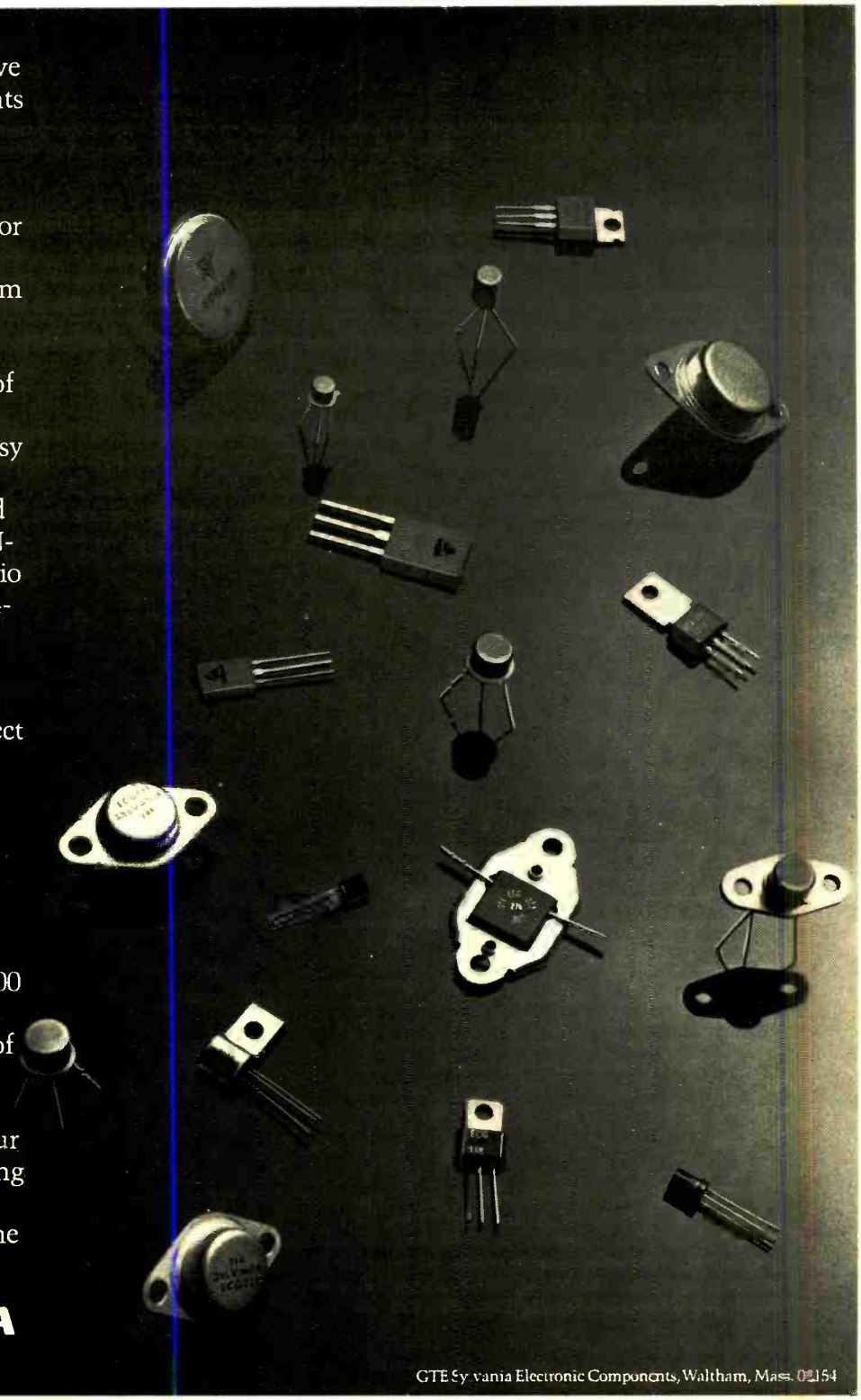
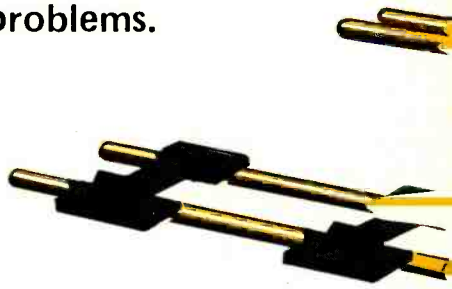


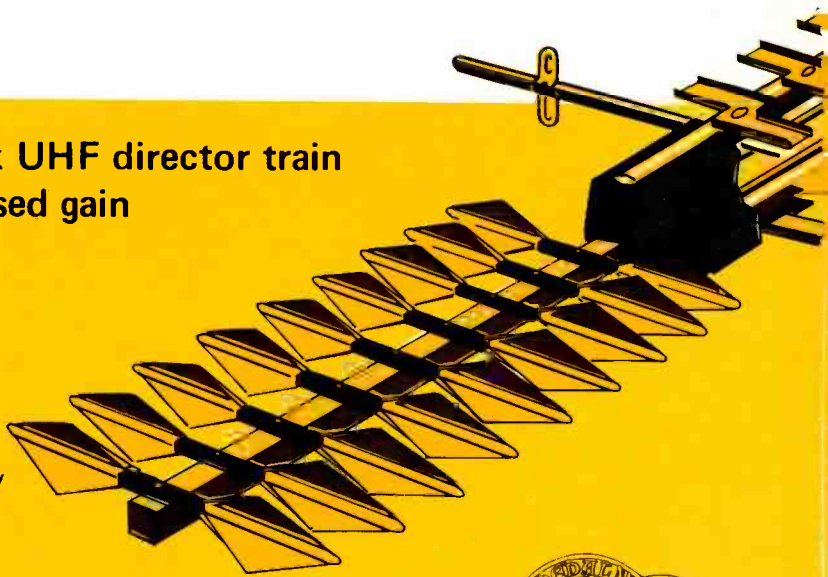
GTE Sylvania Electronic Components, Waltham, Mass. 02154

Why pay more for the Quantum?

Because the Channel Master Quantum is the most highly engineered reception system available today! It uses the finest state of the art technology to provide superior color and black and white reception under any conditions, in the face of any problems.



Massively engineered to stand up under hurricane force winds and the equivalent of 12" snow loading, the Channel Master Quantum costs more because it delivers more. It's unmatched for power, directivity and flexibility!



The bold new diamond back UHF director train provides significantly increased gain ---along the entire band--- than previous Quantum models did at specific channel settings.

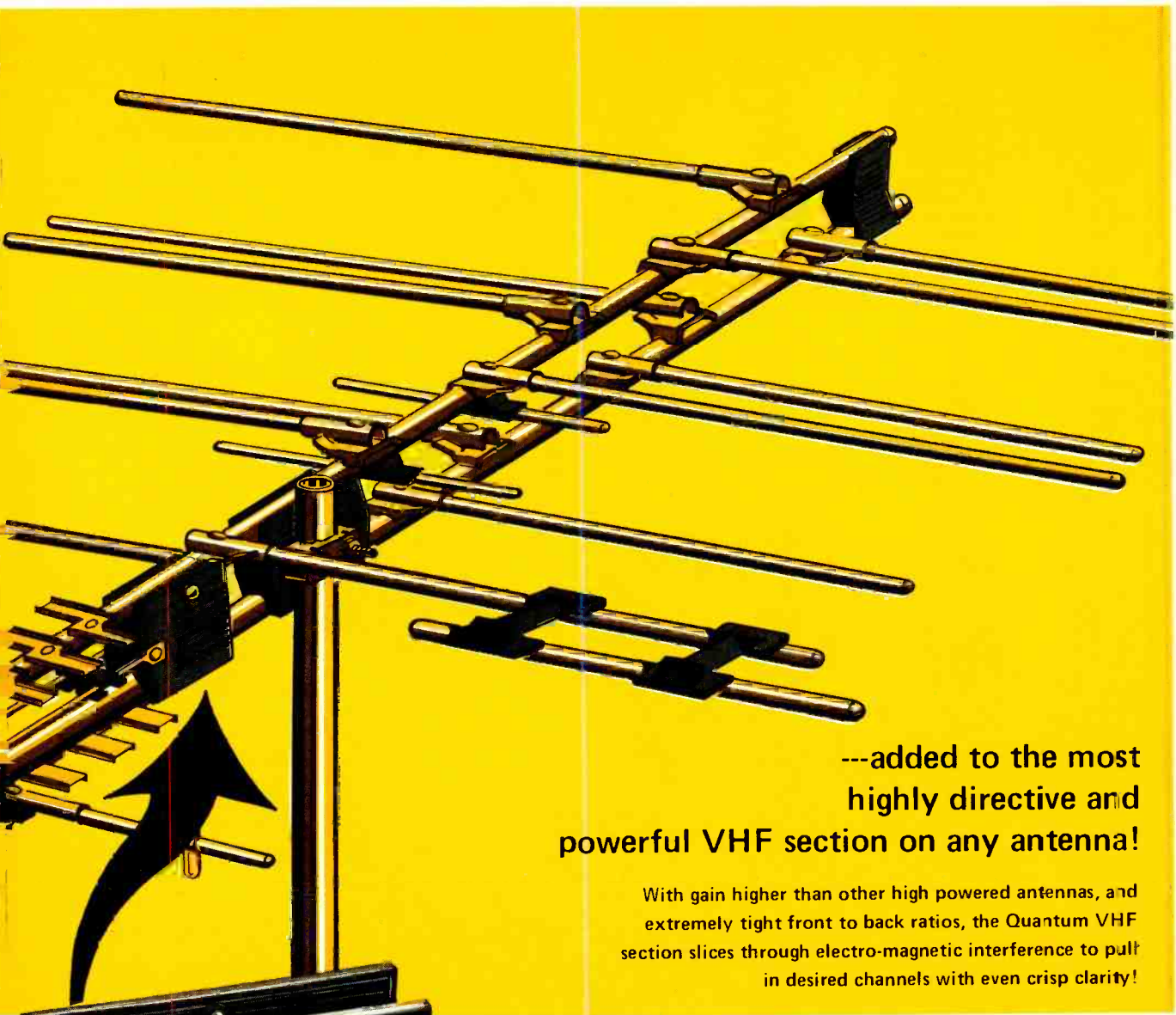
UHF tabs used on VHF directors eliminates any possibility of signal interaction between the two bands.

The result is a sparkling new level of crisp, sharp color and black and white performance through random channel assignments within any given area.

The new *Channel Master* Quantum

costs more... *and it's worth it!*

FROM THE WORLD'S LARGEST MANUFACTURER OF TV/FM RECEPTION EQUIPMENT



---added to the most highly directive and powerful VHF section on any antenna!

With gain higher than other high powered antennas, and extremely tight front to back ratios, the Quantum VHF section slices through electro-magnetic interference to pull in desired channels with even crisp clarity!

And for added flexibility... Custom engineered accessories slip into the Quantum's weather protected terminal housing to handle any problem you're likely to face----

- For melting snow in weak signal areas, modular solid state amplifiers provide up to 15dB gain, with switchable FM traps. (models 0093-0096)
- Where FM is a problem, the Quantum's optional solid state FM trap attenuates interferring signals by as much as 25dB. (model 0091)
- For 75 ohm mounting, use the Quantum's optional balun/matching transformer. (model 0089)

Circle 21 on reader service card

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.

TESTING INSTRUMENT, *Check-U-Ground* checks 3-way, grounded ac receptacles to assure optimum working condition. Two-step testing mode provides both visible and audible readouts. Checks for absence of line voltage, open ground lead, open neutral lead, reversed

polarity (hot and neutral), hot ground (reversed hot and ground leads) and verifies the presence of low effective resistance of the receptacle ground.

Compact hand-held unit requires no batteries, power is derived from the receptacle under test. Readout display has three lights and buzzer alarm. Solid-state circuitry; housed in fully insulated high-impact plastic.—**Communications Technology Corp.,** 2237 Colby Avenue, Los Angeles, CA 90064.

Circle 31 on reader service card

VHF RADIOTELEPHONE, *Half Pack.* 12- channel, all-transistor miniature vhf radiotelephone. Includes built-in "S" meter for visual signal report. Only one crystal is necessary for each

channel which minimizes the cost of installing additional channels in the future.

Everything is built into this model, including the speaker so all that's necessary for installing it is an area on the steering console that will accommodate the 2-½- x 3-½- x 9-½-inch unit. Just connect to 12 V, hook up a vhf antenna and you're on the air. Weighs less than 2 lbs. Comes with crystals for channels 6, 16 and 26; $398.00; each additional channel costs $7.50.—**Standard Communications Corp.,** 639 North Marine Avenue, Wilmington, Ca 90744.

Circle 32 on reader service card

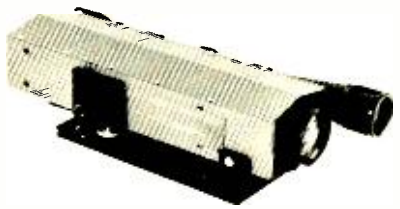
DESOLDERING TIPS. Two small-size desoldering tips for removing miniature components have an I.D. of .025 and .031. These bring to eight the number of tips for use with *model 510* Endeco pencil style desoldering iron; all eight are included with the firm's desoldering kits.

Tips also fit desoldering head that converts any Endeco soldering iron into desoldering tool. Tip sizes range from .025 to .090 with the .063 standard. All are ironclad for longer life. Set of three in each size is blister packed.—**Enterprise Development Corp.,** 5127 East 65th Street, Indianapolis, IN 46220.

Circle 33 on reader service card

LASER COMMUNICATOR, *model 736.* Long range voice and digital laser communication system consists of a separate transmitter and receiver, each housed in identical weather resistant anodized aluminum housings. Both transmitter and receiver include a 10X alignment telescope.

Transmitter uses single heterostructure GaAs injection laser with peak pulse power of 10 watts and maximum repetition rate of 10 kHz.

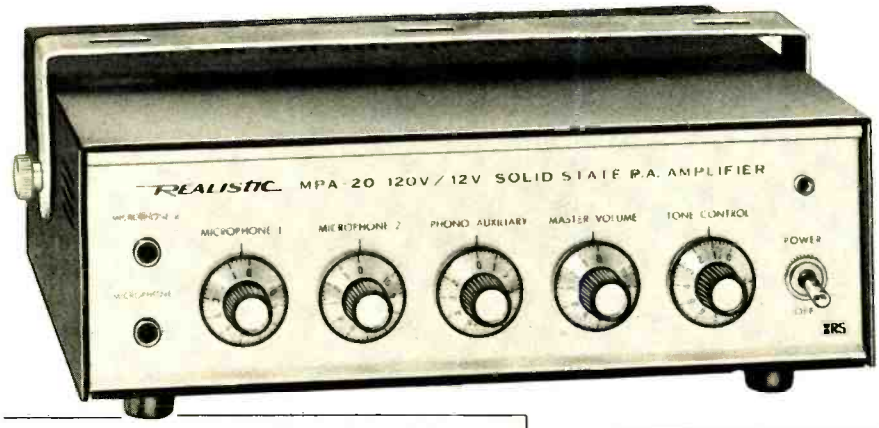


Temperature-compensation circuitry is incorporated to maintain constant laser output power from -18°C to 65°C. Receiver uses silicon avalanche photodiode protected from excessive ambient light by a narrow-bandpass filter. Has bandpass of 5 MHz and can detect an optical signal of only 0.58 nanowatt at this frequency. Operates from 115 Vac. Transmitter consumes 2.2 watts and receiver 360 mw. Both transmitter and receiver are supplied with mounting fixture and standard 135 mm optics. 4 x 4 x 13 in.; transmitter $1500, receiver $1500.—**American Laser Systems, Inc.,** 106 James Fowler Road, Santa Barbara Airport, Goleta, CA 93017.

Circle 34 on reader service card

Amplify Your PA Budget at Radio Shack!

More Power to Your Audience–With a Realistic® Amplifier!



All-Purpose Realistic MPA-20 PA Amplifier. Use it on a sound truck, outdoors, indoors—it's got power cords for 12 VDC and 120 VAC. Features 2 mike inputs with up-front panel jacks and faders for Mike-1 and Mike-2, Aux/phono fader, master volume & tone controls for controlling all inputs simultaneously. Separate power-on switch with pilot light. Outputs: 4, 8, 16 ohm speakers; 25- and 70-volt line. Power: 20 watts RMS at 8 ohms. Response: 200-10,000 Hz at full power. With case, carrying handle/mobile bracket. U.L. listed. There's only one place you can find it... Radio Shack! #32-2020.

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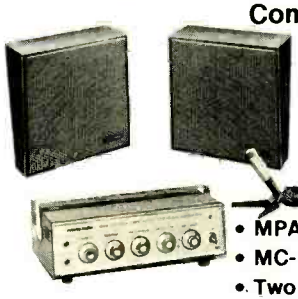

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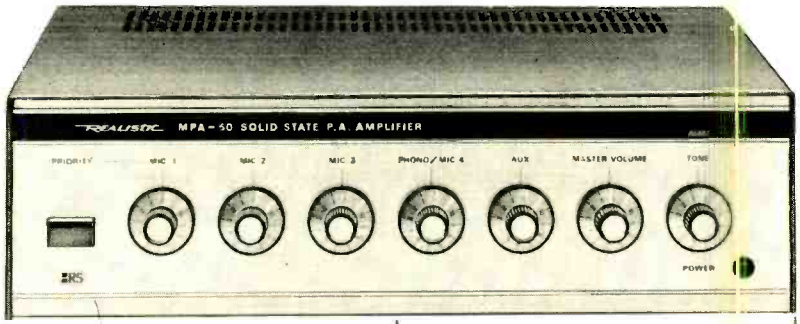
- MPA-20 PA Amplifier
- MC-1000 Mike & Stand
- Two 8" Wall Speakers



Realistic MPA-50—Our Best PA Amplifier. There are five MIXABLE inputs—4 mikes and Aux for tuner or tape—plus a "Priority Paging" switch for Mike-1 that overides all inputs. Master volume and tone controls, magnetic/ceramic phono input. Protective circuit cuts off output and "alert light" flashes on if overload occurs. Outputs: 4, 8, 10 ohms; 25- and 70-volt line. Power output: 50 watts RMS at 8 ohms. Frequency response: 100-10,000 Hz at full power. With walnut grain metal case. U. L. listed #32-2021.

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Complete MPA-50 System

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- 3 PA-12 12" 30-Watt Powerhorns
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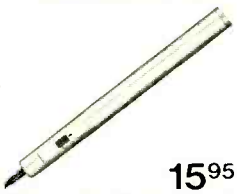

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Circle 23 on reader service card

NEW PRODUCTS

(continued from page 82)

STEREO RECEIVER, *model TX-560* includes direct-coupled/differential amplifier circuitry; ASO type and thermal protection circuits; transient killer circuits and provisions for three sets of speaker systems. FM sensitivity: 1.8μV, de-

livers 48 watts rms power per channel at 8 ohms, both channels driven. Total harmonic distortion: 0.2% at rated power; frequency response: 15 to 30,000 Hz (±1 dB); power bandwidth in amplifier section: 20-40,000 Hz. Seven pushbuttons on front panel control high and low filters, loudness, mode, tape monitors 1 & 2 and FM muting. Speaker selection switch. There are right/left tone controls as well as balance and volume control.

Tuner section has FET front end with four-section variable capacitor and there are ceramic filters in the FM and AM i.f. stage plus IC's for FM i.f. Capture ratio: 1.5 dB; stereo separation: 40 dB at 400 Hz; image rejection ratio: 7 dB; signal-to-noise ratio in tuner: 70 dB. 5-½ x 18-½ x 14-¾ in.; 26-½ lbs.; $429.95.—**Onkyo Sales Section/Mitsubishi Int'l. Corp.,** 25-19 43rd Avenue, Long Island City, NY 11101.

Circle 35 on reader service card

OUTDOOR SPEAKERS have Mylar cones and plastic baskets and are precision-fabricated to be completely waterproof. Designed for headphones and component applications in audio systems for outdoor, underwater and high humidity environments.

Sizes range from 1-¾" to 2-¼" in diameter. Frequency response: 0 to 20 kHz; resonant fre-

quency: 200 to 400 Hz ±50 Hz; sensitivity: 78-86 dB ±2 dB/W; voice coil impedance; 3.2-600 ohms; nominal output: 0.1-0.2 watts. Waterproof speakers are also available to custom size and specification requirements.—**Shigoto Industries Ltd.,** 350 Fifth Avenue, New York, NY 10001.

Circle 36 on reader service card

SHIELDED ATTENUATOR, *model WM-542A.* 75-ohm attenuator is used in both low-level signal calibration of test equipment and MATV/CATV installation and service applications. Five-step attenuator has step switches arranged in a 3-6-10-20-20 dB sequence that provides a selection of the most used attenuator

values from 3 dB to 59 dB. Can be used to reduce the signal level as required by switching in the proper attenuator value and then substituting a single fixed attenuator pad of the same value.

Attenuation of rf signals with a 1 dB accuracy up to 250 MHz is provided; unit is usable for signals up to 900 MHz. While the device is designed for signals up through the i.f. and vhf television spectrum, it can be used to attenuate uhf signals with only a small accuracy loss and increase in VSWR. 1-⅛ x 1-$^3/_{16}$ x 4-$^5/_{16}$ in.; 6-½ oz.; $29.50.—**RCA Electronic Instruments,** Harrison, NJ 07029.

Circle 37 on reader service card

CARTRIDGE RECORDER/PLAYER, *Wollensak model 8080* records and reproduces conventional stereo and plays back pre-recorded 4-channel tapes. Dolby noise suppression circuit functions in stereo record and playback modes and with Dolbyized FM broadcasts. Tape selector switch enables unit to record and play

either standard or Classic cartridge tapes. Has digital minute and second counter for timing of recordings, fast forward mode of 3½-times actual speed and end of tape shutoff that reverts automatically to stop mode.

Frequency response: 30-Hz to 15 kHz with special high performance tape or 40 to 12 kHz with standard tape; signal-to-noise ratio: with Dolby system on, better than 60 dB at 4000 Hz

and above and with Dolby system off, better than 50 dB; wow/flutter: 0.1%WTD rms. 19-¾ x 10-¼ x 5 in.; 17 lbs.; $344.95.—**3M Co.,** P.O. Box 33600, St. Paul, MN 55133.

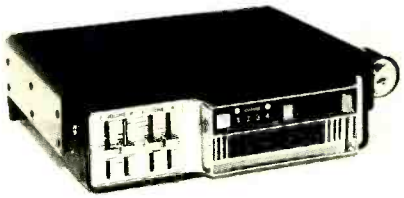
Circle 38 on reader service card

MAGNETIC TAPE ERASER, *model R24017.* Although designed as a consumer product for reel-to-reel, cassette and 8-track cartridge tapes, this unit is also suited to computer and other professional applications using up to ¼" wide tape. Hand-held bulk eraser has handle

that permits moving the eraser across reel or cartridge of any size, obliterating the recording in seconds without having to rewind the tape. Background noise is reduced below normal erase-head level. Operation is on 110-120 V, 4 A, 50-60 Hz ac. 4 x 2-¼ x 4-¼ in.; 2-¼ lbs.; $26.50.—**Robins Industries Corp.,** 75 Austin Blvd., Commack NY 11725.

Circle 39 on reader service card

CAR STEREO PLAYER, *model 434.* Discrete quad 8-track car stereo player has 4-channel separation that totally surrounds the user with sound. Features front and rear slide volume and tone controls, slide balance control, repeat switch, automatic manual track changer, vertical head tracking and fully integrated circuitry.



Frequency response: 50 to 10,000 Hz; signal-to-noise ratio: 45 dB or better; wow and flutter: less than 0.3%. $139.95.—**Clarion Corp. of America,** 5500 Rosecrans Avenue, Lawndale, CA 90260.

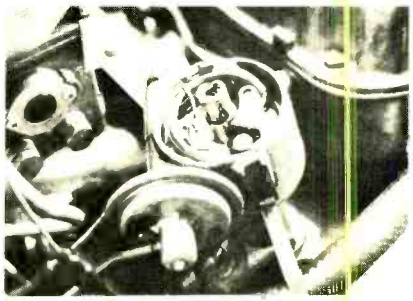
Circle 40 on reader service card

AMPLIFIER, *model UVF-1520.* Solid-state 20-dB home TV distribution amplifier has two built-in FM traps and a lighted on-off switch. Unit is

rated at 75 ohms; has a front mounted fuse for easy replacement. — **Antennacraft,** Box 1005, Burlington, Iowa 52601.

Circle 41 on reader service card

BREAKERLESS IGNITION SYSTEM, *Type 120* will fit most 4-, 6- and 8-cylinder cars, foreign or American (12-volt negative ground only. Features simple installation that consists of only two electrical connections and fitting the breakerless triggerhead within the existing distributor. Various distributor adaptor plates are used to adapt the one unit to



different cars. The *120* fits most cars, will not affect operation of electronic tachometers and it reduces radio interference. Uses the existing high-tension coil and electrical wiring. It is an inductive discharge system with a dwell extender (variable dwell extends the dwell at high speeds when the coil has less time to build up the required voltage). $59.90.—**Mobelec Inc.,** 1512 Bexley, Austintown, OH 44515.

Circle 42 on reader service card

CD-4 DEMODULATOR ADAPTOR, *44+* is used with existing 4-channel receivers that lack CD-4 circuitry. Provides impedance characteristics required by special cartridges necessary for discrete disc playback and feeds high level inputs on existing quad receivers.

Has only push on/push off power switch and three-position function switch on its face along with LED indicators for power on and CD-4 auto. Function switch's three positions allow

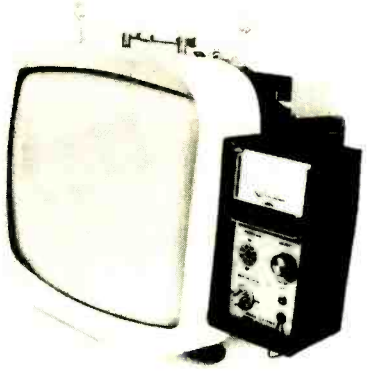
for: CD-4/auto (which actuates CD-4 circuitry when carrier frequency impressed in groove walls of all CD-4 discs is present), stereo (which

defeats CD-4 circuitry completely) and bypass (which directs the signal from turntable or record changer into amplifier or receiver). $119.95 — **Harman-Kardon,** 55 Ames Court, Plainview N.Y. 11803.

Circle 43 on reader service card

YOKE PROGRAMMER KIT, *Rig-A-Jig CK1900X* makes it possible to fully test most solid-state color TV sets using existing tube sweep test jigs. When installed on any 19-inch color test jig, it will provide performance comparable to the company's existing CK1500X Chek-A-Color test unit. Has a self-contained anode meter. Receiver deflection output is coupled to test jig and inductance is matched to the receiver with assortment of patented programmer plugs.

Package includes listings of set-up information available—covering 48 brands and 7000 models. Color TV receivers are listed by manufacturer and by chassis number with an indicated set-up number. Set-up number prescribes proper programmer plug and adapter/extender combinations to couple with test jig. Information is updated periodically.—**GTE Sylvania,** ECG Marketing Dept., 100 First Avenue, Waltham, MA 02154.



Circle 44 on reader service card

new lit

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

1974 POWER SUPPLY CATALOG. 50-page catalog provides detailed specifications on over 200 precision dc power supplies and power modules. Catalog is sectionalized starting with a glossary of power supply terms and application notes that define the purpose and use of dc power supplies. The following sections provide detailed descriptions of digitally programmable power supplies, laboratory units and modular power supplies that are rack adaptable for systems and OEM applications.—**Systron-Donner Corp.,** 1200 Shames Drive, Westbury, NY 11590.

Circle 45 on reader service card

CIRCUIT DESIGN & BREADBOARDING EQUIPMENT. 20-page catalog features the Adam modular breadboarding system, two op-amp designers, the *Digi-Designer* (in kit or assembled form), instruction and teaching manuals, the SK-10 solderless component socket, the SK-20 socket, printed circuit boards, socket boards, power supply designer, low-cost power supplies, pulse generators, logic probes, breadboarding systems with built-in power supplies, function generators, monitor lamps and more. Specifications for all instruments are listed and a separate price list is included.—**E & L Instruments, Inc.,** 61 First Street, Derby, CT 06418.

Circle 46 on reader service card

GENERAL COMPONENTS CATALOG. 64-page catalog contains over 10,000 products. Among them are Duracell alkaline and mercury batteries, Duratape recording tape, capacitors, controls, resistors, security sytems, semiconductors, switches, timers and many other electronic components for consumer, replacement and industrial use. Features a product index on pages 2 and 3.—**Mallory Distributor Products Co.,** Box 1284, Indianapolis, IN 46206.

Circle 47 on reader service card

RESEARCH AND EDUCATION PRODUCTS. 16-page catalog contains education/holography kits, helium neon lasers, modulated lasers, cylindrical laser, lasers, tubes and power supplies, speed-of-light kit, blackboard optics, laser power meters and detectors, optics bench equipment. Includes descriptions of each kit as well as many illustrations. — **Metrologic Instruments, Inc.,** 143 Harding Avenue, Bellmawr, NJ 08030.

Circle 48 on reader service card

DIGITAL MULTIMETER BULLETIN. 8-page catalog describes the *model 3500* digital multimeter with ac and dc voltage, resistance, remote triggering and three major circuit advances. Contains many illustrations and specifications as well as functional characteristics.—**Data Precision Corp.,** Audubon Road, Wakefield, MA 01880.

Circle 49 on reader service card

MANY ROADS TO 4-CHANNEL

(continued from page 41)

decoder equipment or installation.

Turntables

Any turntable or record changer suitable for use in a high fidelity system is suitable for, at the least, matrix type 4-channel. Similarly, any high-fidelity type phono pickup is suitable for matrix sound (generally speaking). Often, budget pickups which are perfectly acceptable for stereo records, or matrix records played in stereo, develop some unusual phase relationships when the output signal is processed by a decoder. As a general rule, optimum matrix sound is obtained from the higher quality pickups.

CD-4, however, is something else. First off, a pickup specifically designed for the extended frequency range of CD-4 is required. Originally, the Shibata stylus pickup was *the* CD-4 pickup, but as with all things, there are now several excellent CD-4 pickups using other stylus designs.

A special pickup is not the only requirement for excellent CD-4 sound; the turntable is almost as important. Firstly, best results are attained from CD-4 records if the turntable's tonearm has an anti-skate adjustment to prevent excess tracking pressure on the inside of the groove. Secondly, there must be minimal horizontal tonearm bearing friction; the turntable that delivers reasonably decent stereo by literally dragging the pickup arm across the record won't deliver even acceptable CD-4 if the arm is fighting every inch of the way. As a general rule, the best in CD-4 reproduction requires a turntable of modest quality or better—not budget.

Another CD-4 turntable requirement is the ability to change the shielded output cables. CD-4 pickups require special low capacitance turntable cables, which are available with phono plugs on both ends. If the turntable's output cables connect to exposed phono jacks it's a simple matter to plug in the new cables.

Some high performance turntables, however, make no allowances for any new developments, and the output cables are soldered directly to a terminal strip, or connectors. It's a little more difficult to substitute low capacitance cables, but it can be done.

For the sound enthusiast looking for the easiest way to add CD-4 there are several complete turntable packages consisting of an automatic turntable, CD-4 pickup and an integral CD-4 demodulator. The four outputs are at line level and connect to a 4-channel amplifier's auxiliary (or tape) inputs. The internal demodulator automatically switches from the stereo to CD-4 mode when it senses the Quadradisc's high frequency subcarrier.

Which road for you?

Obviously, there are not only several roads to 4-channel sound, there are several types of surround sound: *matrix; CD-4;* and *enhanced stereo* (ambient rear sound), which is often touted as 4-channel. While no specific advice or recommendations would necessarily apply to all listeners, or even a few, there is one hard and fast rule that must be considered in this age of rapid technological changes: Be certain your basic amplifying equipment provides for expansion to accommodate new developments and improvements to 4-channel techniques. Since any new type of matrix and CD-4 equipment can be made available as an add-on, and since we can expect *something* in the near future in the way of discrete 4-channel FM broadcasts, any amplification equipment you obtain specifically for 4-channel should have sufficient line level auxillary inputs to accommodate several (at least two) optional add-on accessory decoders or demodulators. If you have sufficient inputs and front panel switching you can take virtually any road to 4-channel and come up with a winning system. **R-E**

4-CHANNEL CD-4

(continued from page 38)

In effect, the dynamic range of the 4-channel disc is being overworked by the addition of the 19-dB down added ultrasonic band. ANRS compresses the difference signal at the recorder as the frequency increases and as the level decreases as shown in Fig. 7. At 30 Hz the signal is uncompressed, while at 15 kHz there is a maximum compression of 10 dB. An input signal range of 0 to −50 dB is compressed into a 0 to −40-dB range on the record.

This results in an improvement in the signal to noise ratio because the −50-dB input at 15 kHz has been boosted by 10 dB. Distinguish between compression and pre-emphasis by observing that the compression is dependent upon the input level. A 0-dB input is not boosted regardless of frequency. The set of curves in Fig. 7 is generated by a compressor which is based on a two-band scheme with a bandpass filter with 3-dB corner frequencies at 200 and 2000 Hz, and a high-pass filter with a 3-dB corner frequency at 2000 Hz as shown in Fig. 8. The response of the ANRS compressor is determined by the decreasing S/N ratio above 2 kHz which is due to the FM/PM/FM characteristic's reversion to frequency modulation, and to reduce crosstalk which is characteristically centered around 700 Hz. Compression and expansion circuits will compensate when the amplifier gain in the expander is the complimentary function of the compressor gain.

The compressor is inserted before pre-emphasis. Response time of the compressor is carefully chosen to make the noise improvement arrangement as inaudible as possible during the automatic gain adjustments. At 630 Hz the rise time is specified at 5 μs when the level is increased in a jump from −30 to −10 dB, and the restoration time is 100 μs for the reverse transition. Above 2 kHz the rise time is decreased to 0.5 μs for a step level change from −40 to −10 dB and the restoration time is 10 μs.

Cartridge and stylus

As pointed out earlier the CD-4 disc required the development of new pickups to operate up to 45 kHz. Most of the modification in cartridge design involves reducing the dynamic mass. Shibata developed their unique stylus which has an extended high frequency response and contacts the record groove over an area about four times greater than the elliptical stylus. The tip measures 0.4 x 0.8 mil and has about the same radius as the elliptical stylus. The Shibata stylus is conical in two planes with the plane intersection rounded with a 7 micron radius.

As a stylus traces the record groove, the elastic record material deforms in response to the stylus pressure which causes distortion. The lowering of pressures and record deformation reduces the distortion. Almost all the CD-4 cartridges in production use the Shibata stylus or one with a similar shape, and some stereo cartridges work acceptably when equipped with it. Some stereo cartridges may produce reversed front and rear channels when used because they may not give positive outputs as the stylus moves toward the outer edge of the record.

Recording for CD-4

Many of the improvements made to the CD-4 system have been made in the recording technique to reduce distortion and economize the process. At first record cutting was done at a lathe speed reduction of 2.7 times. The reduction is now only 2 times. Speed reduction is needed to deal with the frequency response limitations of the adapted stereo equipment.

An automatic carrier level control (See Fig. 4) uses advance heads on the master tape recorder to give warning of upcoming high signal excursions. If the high-frequency end of the sum signal is large, mistracking of the pickup results, reducing the detected carrier level and raising the susceptability to interference and noise. The automatic level control changes the carrier level accordingly to reduce the problem.

Beside the direct effects of tracking errors in producing distortion, it also affects the 30-kHz carrier and tends to reduce separation. JVC uses their Neutrex system to predistort the shape of the cut disc groove so that when it is tracked by the playback stylus the net distortion is reduced. It turns out that the Neutrex processor also improves the sum signal. This system allows the stylus radius to be increased from 5 to 7 microns, so the CD-4 disc wears at the same rate as a stereo record. **R-E**

First you've got to find it . . . then you can repair it.

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 TWO YEARS 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.

This time we tested some CD-4 records along with matrix records. The added equipment was a CD-4 decoder provided by JVC along with a JVC CD-4 cartridge. We listened to records by both RCA and JVC. You'll find them in the listing that follows.

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.

Record playing times vary widely in both matrix and CD-4 formats. We noted for example, that Columbia's *Pearl* had only 17 minutes of music to a side while the Buddy Miles Band

would deliver 21 minutes of music. In the RCA Quadradisc group *Neil's Diamonds* ran as short as 15 minutes while *Debussy/Ravel, La Mer* was 25 minutes long. this appears to be a continuation of a trend that seems to be growing—record makers are giving the purchaser less listening time for his dollars.

AUDIO FIDELITY

DFSQ-7054 Sound Effects, Volume 15 ****

BLUE SKY

ZQ-32481 Rick Derringer, All American Boy **

COLUMBIA

CQ-30322 Pearl, Janis Joplin/Full Tilt Boogie ***
CQ-31096 Upendo Ni Pamoja, The Ramsey Lewis Trio **
CQ-31474 Angel Clare **
CQ-31748 Loggins And Messina **
CQ-32048 The Buddy Miles Band, Chapter VII ***
CQ-32079 The Best Of Mountain, Featuring Leslie West & Felix Pappalardi ***
CQ-32212 Herbie Hancock, Sextant ***
CQ-32275 Nice Day For Something, Lee Michaels ***
CQ-32216 West, Bruce & Laing, Whatever Turns You On **
MQ-32298 Stars & Stripes Forever And Other Favorite Marches, Morman Tabernacle Choir ****
MQ-32301 Mozart Violin Concertos, Pinchas Zuckerman, English Chamber Orchestra, Daniel Barenboim Conductor **
CQ-32381 250 Years of Film Music, John Keating Conducts London Symphony Orchestra **
CQ-32450 New Riders, The Adventures Of Panama Red ***
CQ-32540 Loggins & Messina, Full Sail ***

EPIC

EQ-30209 Poco, Deliverin', Recorded Live At Boston Music Hall & New York Felt Forum ***
EQ-30325 Sly & The Family Stone Greatest Hits ***
EQ-32158 My Merry Go Round, Johnny Nash ***
EQ-32247 Charlie Rich Behind Closed Doors **
EQ-32354 Poco, Crazy Eyes **

JVC (CD-4 encoded) (made in Japan)

CD4B-5002 Dock Of The Bay, New Created Sounds, S. Arima & Misty Sounds ****
CD4B-5012E Rock & Drums/Free ***

MILL CITY RECORDS (45 rpm, 7-inch SQ encoded)

MCR-457303 Kevin Odegard, Can't Turn Back/Sunshine Silver Mine ***

MONUMENT

ZQ-32749 The Fastest Harp In The South, Charlie McCoy **
PZQ-32914 Kris Krist Offerson, Spooky Lady's Sideshow ***

OVATION

OVQD/14-27 Laura Comin' Apart, Laura Yager **

PHILADELPHIA INTERNATIONAL

ZQ-32409 Billy Paul, War Of The Gods ***
ZQ-32707 MFSB: Love Is The Message **

RCA (CD-4 encoded Quadradisc)

ARD1-0002 The Fantastic Philadelphians, Volume 1, Eugene Ormandy, The Philadelphia Orchestra ***
ARD1-0026 Bach's Greatest Fugues, Eugene Ormandy, The Philadelphia Orchestra ***
ARD1-0029 Debussy/Ravel, La Mer, Prelude To The Afternoon Of A Faun, Daphnis And Chloe: Suite No. 2, Eugene Ormandy, The Philadelphia Orchestra **
ARD1-0081 Heavy Organ At Carnegie Hall, Virgil Fox, Live Bach Concert ***
ABD1-0132 Neil's Diamonds Fashioned By Hugo Montenegro ****
ABD1-0245 Hair, Original Broadway Cast Recording **

VANGUARD

VSD-723/724 The World Of Louis Moreau Gottschalk, Utah Symphony Orchestra, Maurice Abravanel, Conductor, (2 records) **
VSQ-40004/5 The Life And Times Of Country Joe Fish From Haight-Ashbury To Woodstock (2 records) ***
VSQ-40013 Offering, Larry Coryell ***
VSQ-40033/4 The Clancy Brothers With Lou Killen, Greatest Hits (2 records) ***

EXPERTS AGREE
The TV of the future is here... in the Heathkit Digital-Design GR-2000 TV

At **ELEMENTARY ELECTRONICS** they said: "The fact is, today's Heathkit GR-2000 is the color TV the rest of the industry will be making tomorrow . . . there is no other TV available at any price which incorporates what Heath has built into their latest color TV."

The **FAMILY HANDYMAN** reviewer put it this way: "The picture quality of the GR-2000 is flawless, natural tints, excellent definition, and pictures are steady as a rock. It's better than any this writer has ever seen."

POPULAR SCIENCE pointed out "more linear IC's, improved vertical sweep, regulators that prevent power supply shorts, and an industry first: the permanently tuned I.F. filter."

The **RADIO-ELECTRONICS** editors said the Heathkit Digital TV has "features that are not to be found in any other production color TV being sold in the U.S.:

"*On-screen electronic digital channel readout* . . . numbers appear each time you switch channels or touch the RECALL button . . . *On-screen electronic digital clock* . . . an optional low cost feature . . . will display in 12- or 24-hour format . . . *Silent all-electronic tuning*. It's done with uhf and vhf varactor diode tuners . . . *Touch-to-tune reprogrammable, digital channel selection* . . . up to 16 channels, uhf or vhf . . . in whatever order you wish . . . there's no need to ever tune to an unused channel. *LC IF amplifier* with fixed ten-section *LC IF bandpass filter* in the IF strip . . . eliminates the need for critically adjusted traps for eliminating adjacent-channel and in-channel carrier beats. No IF alignment is needed ever. *Touch volume control* . . . when the remote control is used . . . touch switches raise or lower the volume in small steps."

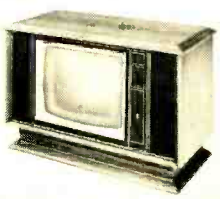
POPULAR ELECTRONICS took a look at the 25-in. (diagonal) picture and said it "can only be described as superb. The Black (Negative) Matrix CRT, the tuner and IF strip, and the video amplifier provide a picture equal to that of many studio monitors . . ."

Furthermore, the Heathkit GR-2000 is an easier kit-form TV to build. **POPULAR ELECTRONICS** pointed out that "Each semiconductor has its own socket and there are 12 factory-fabricated interconnecting cables . . . The complete color adjustments can be performed in less than an hour."

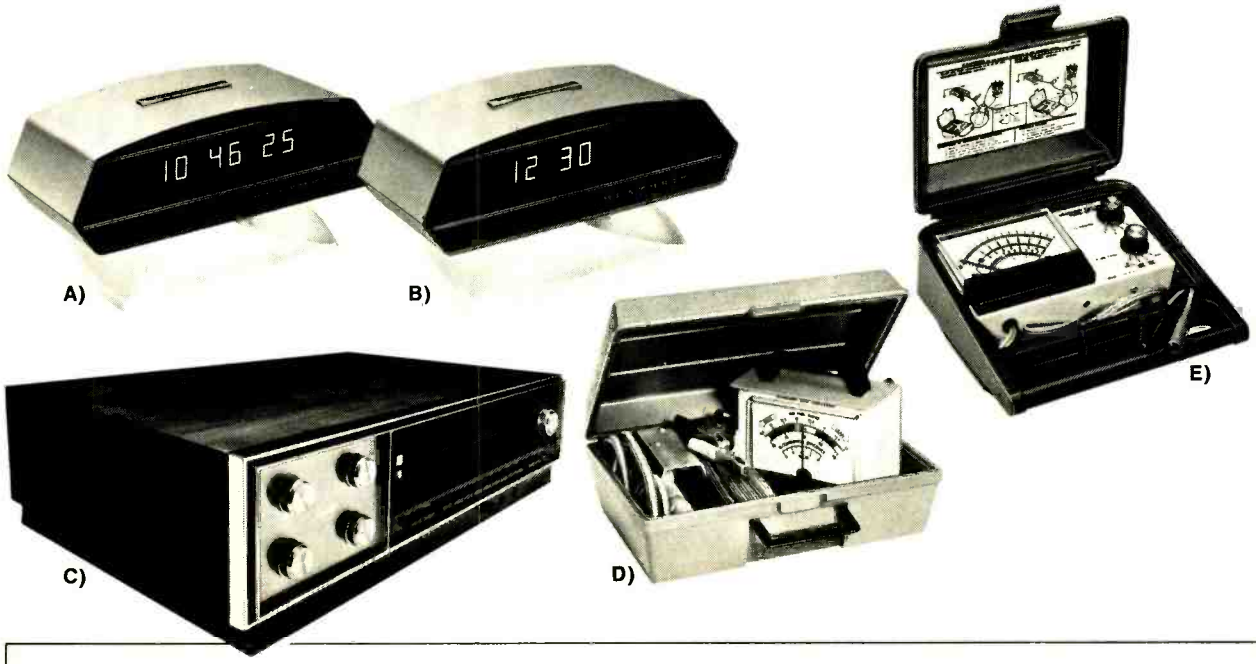
To sum up, **POPULAR ELECTRONICS** concluded its study by stating, "In our view, the color TV of the future is here — and Heath's GR-2000 is it!"

Why not see what the experts have seen? The Heathkit Digital Design Color TV — without question the most remarkable TV available today.

Mail order price for chassis and tube, **$669.95.** Remote Control $89.95 mail order. Clock, $29.95 mail order. Cabinets start at **$154.95.** (Retail prices slightly higher).



TOMORROW'S PRODUCTS are in kit-form today- with Heathkit electronics



(A) New Heathkit Digital Electronic Alarm Clock. Like no other clock you've ever owned . . . with features as new as tomorrow! Wakes you with an electronic "beep" and shuts off at a touch — no fumbling for knobs or switches. And if the power goes off, you still get to work on time — the clock has its own emergency battery supply. Other features are a 24-hour alarm cycle with AM indicator light to aid in setting; 7-minute repeatable snooze cycle; 12 or 24-hour time format; automatic brightness control. Kit GC-1092A, 82.95*. Shipping weight, 5 lbs.

(B) New Heathkit Digital Electronic Calendar/Clock. In this unique timepiece, we swapped the alarm feature for the date — and held the same low kit price featured in its alarm clock twin. Reads out the time in hours, minutes & seconds, with big orange digits. Plus, it gives you the month and day, either automatically for 2 seconds out of every 10, or anytime at the touch of an electronically activated control. It also features 12 or 24-hour time format, automatic brightness control, and built-in fail-safe reserve battery supply. Kit GC-1092D, **82.95*.** Shipping weight, 5 lbs.

(C) New Heathkit AR-1500A, 180-Watt AM/FM Stereo Receiver. Sequel to the famed "AR-1500" — now with these important new performance & kit-building improvements: a new Phase Lock Loop (PLL) multiplex demodulator with only one simple adjustment — gives maximum separation, drift-free performance, long-term stability; improved AGC circuit for better AM performance; improved output protection for today's wider range of speaker impedances; separate check-out meter & factory-installed cable connectors for even easier kit assembly. Precedent-setting specs are retained: 180 watts (IHF) per channel into 8 ohms, both channels driven with less than 0.25% harmonic distortion; 90 dB FM selectivity, 1.8 μV sensitivity. Kit AR-1500A, 399.95* less cabinet. Shipping weight, 53 lbs.

(D) New Heathkit Exhaust Gas Analyzer. A timely kit for the week-end mechanic and the professional alike. Checks exhaust gas of cars for pollution level and measures air/fuel mixture to help you tune for top economy. Also a great training aid in automotive mechanics classes for demonstrating results of proper anti-pollution system adjustments. Easy to assemble, simple to use. Kit CI-1080, 59.95*. Shipping weight, 6 lbs.

(E) New Heathkit Tune-up Meter. Successor to the popular Heathkit ID-29 — now with new, extended 0-20 VDC range. Checks dwell on 4-cycle, 3,4,6 & 8 cylinder engines with conventional ignition. Two rpm ranges. Reads voltage from 0-20 VDC. Use on 6 or 12V systems, either ground. No batteries required. Kit CM-1073, 29.95*. Shipping weight, 5 lbs.

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Circle 100 on reader service card

equipment report

Triplett Model 615 Appliance Tester VOM

Circle 92 on reader service card

A VOM IS A MULTI-PURPOSE INstrument; an instrument like Triplett's new Model 615 could only be called a "multi-multi-purpose" instrument, if I must coin silly words. This is specifically designed to make all of the tests *needed* for home and even industrial electrical equipment. It will measure a great many things that we haven't been able to read up till now, at least without elaborate equipment. (It won't read atomic radiation, but it wouldn't surprise me if they didn't come up with an adapter that would.) It will help you locate "metal", in the form of *money*!

Standard ac and dc voltage ranges are provided. Dc volts from 0-3 to 0-300 volts, with 5 scales; 20,000 ohms per volt. Ac volts, from 0-3 to 0-600 volts, 5000-ohms per volt. Three resistance ranges give coverage from 0-1000 ohms to 10 megohms. The low range has a 10-ohm center-scale reading which makes it very useful for those low resistances.

Now we come to the "goodies"; the special tests we need, to service many kinds of electrical appliances and equipment quickly and accurately. The 615 has a special set of dc voltage ranges, 0-60, 0-300 and 0-1500 *millivolts*, at 20,000 ohms-per-volt. These are essential for checking the output of small thermocouples, such as those used in the "millivolt-powered" control systems on gas and other heaters.

Leakage testing of all electrical appliances, for safety is now almost mandatory. The 615 has the standard ac leakage tester, built in, with the network simulating the resistance of the human body. Three ranges are provided, with their own scales on the meter: "Short", for finding dead shorts, and two more, with full-scale readings of 0-0.6 ac mA, and 0-6 ac mA. The last are used to find those very minute leakages, which can develop into dangerous shorts later on.

Another handy feature, which can be very useful to technicians working with all kinds of heating and cooling equipment, is the temperature scales. (Each of these special functions has its own scale.) Using a small Constantan thermocouple, the 615 can read temperatures from −50 to +150 F, and −50 to +1500 F. The low range can be used for air-conditioners and refrigerators, while the high range is suitable for ovens and all types of heating equipment. Special sockets on the panel allow the use of up to three thermocouple probes at the same time. Just switch from one to the other. For one thing, this permits instant comparison of air temperatures going into and coming out of air-conditioning systems of all kinds, home or automotive.

Using the Model 20-A Clamp-On ac ammeter adaptor, ac current can be read from 0-6 A to 0-120 A. This uses the same proven circuit that Triplett has used for many years; a current transformer feeding the 0-3 ac volts range of the vom. This position on the selector switch is marked AC AMPS, but they tell you that it is also the 0-3 volt ac scale! The clamp-on ammeter adaptor is simply clamped over either wire of the ac supply; the desired range is selected by a switch on the adaptor unit. A nice long cord is provided, making things easier.

To save separating the wires of a line-cord, for example, another unit is used; this is the Model 101 LINE SEPARATOR. It is plugged into the outlet, and the device under test is plugged into it. It separates the line wires; the clamp-on ammeter is clipped into the hole in the Line Separator. This has more features; the middle outlet of the

separator is DIRECT, and there are two more. One giving a DIVIDE BY 10 reading, and the other a DIVIDE BY 20. These are very handy for getting a greater reading on the meter on low wattage things such as electric blankets, etc.

The Model 615 has all of the standard features of the better vom's. The meter movement is protected against accidental overload by diodes. The circuitry is protected by two fast-blow fuses, a 1/2 A and a 1/32 A. They were thoughtful enough to put in *spare* fuses for each one clipped inside the case. (This is fine; I *never* have the right fuse with me, when something happens about 15 miles from the shop.)

The 615 itself is built into a stout plastic case, with a carrying handle that can be used as a prop for bench work. A carrying case, very well padded with foam, holds the 615 and all accessory probes, current adaptors, test leads, etc. This is also made of heavy plastic, and is an extremely good looking as well as practical item.

The 615 can also be used for radio-TV and other electronics work, of course. A high-voltage probe, 0-30 kV dc, can be obtained. For special work, probes capable of reading 0-30 kV ac, and 0-60 kV ac are available.

Additional thermocouple probes can be obtained, including a heavy-duty type which is protected by a stainless steel mesh housing around the thermocouple, for use in abrasive atmospheres, etc.

The regular, very complete instruction manual comes with the 615. This gives complete data for making any kind of test. Full maintenance, calibration and servicing data are also in here.

The Model 615 is a really versatile instrument. It should fill a long-felt need for an instrument that will make many measurements that have been either impossible or very difficult in the past. It will give you those special readings, such as temperature, that you need for quick diagnosis of the problems. Properly used, this should be a real money-maker for any appliance or electrical technician. Many Vocational-Tech schools are using this in their Electrical classes; since this is the type of instrument they'll be using when they start work, they get a head-start! **R-E**

Simpson Model 360 Digital VOM

Circle 93 on reader service card

THE LATEST ADDITION TO A LONG AND distinguished line of VOM's, the Simpson 260's, is the Model 360, a full-range digital vom. In place of the familiar meter, it has a 3½ digit LED display, of the 7-segment type. These are a bright red, and big enough for easy reading at a distance. The circuit used is the now-familiar dual slope integrator, A/D converter type. IC's make it possible to build highly complex circuits into a compact case.

The Model 360 dvom has 0.25% accuracy. It will operate from internal rechargeable batteries, or from 117 volts, or 234 volts ac (over a frequency range from 50 to 400 Hz!) Its ranges are based on the "2-scale"; on ac and dc voltage, for example, they are 200mV; 2.0V.; 20V; 200V and 1000V. The maximum indication on any range is "1.999"; the decimal point shifts automatically. For example, on the 20-volt range, the maximum reading would be "19.99". Polarity of the voltage being read is also displayed automatically by a + or − sign.

For resistance readings, the low range is 200 ohms, then 2k, 20k, 200k, 2 megs and 20 megs, full-scale. On the two lowest ranges, the Model 360 has the very useful "Low Power Ohms" feature. Only 150 mV is applied to the circuit under test. This will not turn transistors on, even germanium types. So in-circuit readings will be accurate.

For current readings on ac or dc the Model 360 starts with a *full-scale* range of 20 microamperes, then to a 200-uA range, then 2.0, 20.0 and 200 mA. Then 2.0A and 10.0A. The two lowest and two highest current ranges use separate jacks.

When you go over-range on any scale, the LED display goes to 1.999 and the lower half of the left-hand "1" blinks on and off, until the switch is turned to a higher range.

The Model 360 has an unusual feature for a portable instrument. Two

jacks are provided for a *recorder* output. The analog value of the input to the 360 can be recorded on strip charts, etc; such recorder units as the Simpson 603 or 604 will work with the 360. This will provide the technician or engineer with a permanent record of whatever happens to the values being read.

Another unusual and handy feature is the inclusion of an "analog readout" device. This is the little red and white cylinder-shaped thing just below the LED's. It's actually like a meter-needle. The red "X" moves up or down as voltages are applied, etc. This can be used for several purposes, such as adjusting circuits to a zero, etc. It took me quite a while to find out what this was; but, by taking the drastic step of reading the instruction book, I finally made it. Turned out to be very useful.

The Model 360 is powered by four NiCad batteries, or straight from the dc power supply; from the ac line. It will operate from the ac line without the batteries. The dc power supply recharges the batteries in about 16 hours, on BATTERY CHARGE position.

In full operation, ac line cord plugged in, the batteries will recharge in 30 hours. Fully charged batteries will run the 360 continuously for 5 hours.

A LED pilot light indicates that the batteries are charging. A "self-test" check can be made; it will check its own batteries. Just switch to the 20-volt dc range, and touch the + test lead to the BATTERY TEST jack on the front panel. A reading above 4.7 volts shows that the batteries are high enough for use; full-charge will be about 5.1 volts. (1.25 volts apiece, nominal, for NiCad batteries.) In emergencies, standard C cells can be used.

The standard, well-written, and very complete Operator's Manual covers all operating features of the 360. Each range and function is explained in detail. A complete circuit description is included, as is a very complete troubleshooting chart, maintenance procedures, calibration tests, and so on.

I made my standard set of complicated tests with this one: I put it on the bench and *used* it. In quite a few jobs, from audio equipment to color TV, it turned out to be a very *handy* instrument, and easy to use. The LED display is easy to read in any lighting conditions. RANGE and FUNCTION switches are marked with lettering big enough to read, so that there's no doubt what you're set on. The Model 360 is one of those "stout" instruments that Simpson specializes in. The construction, and the 4.5 pound weight, give an impression of toughness that is correct.

A very handy instrument, and one that should do very well from the small TV shop up to lab and industrial work. **R-E**

"How was I to know you had bugs planted in there?"

TeleMatic Model KT-370 TunerMate

Circle 94 on reader service card

THE TELEMATIC CO., WHICH IS THE company making all of those so handy test adapters, jigs, cables, and many other things to save time in the service shop, has come up with another one. This is a tuner substitution tester called the TunerMate (Model KT-370). Completely self-contained, it uses a brand-new transistorized vhf tuner with a 40-MHz i.f. output. All you have to do is pull the coax plug from the set tuner to the i.f. input, and plug in the TunerMate. No other wiring on the tuner need be disturbed. Connect the antenna to the TunerMate input. Test cables are provided to fit either the RCA-type phono plug or solder-in type of connection.

This gives you an instant answer to that puzzling question, "Is it the tuner, or isn't it?" Hook up the TunerMate, and if you get good picture and sound, the set tuner is bad. An rf gain control is provided. By using this to adjust the output, you can simulate low-signal levels, for checking sets that must work on an outside antenna or high-signal levels to check sets used on cable systems. AGC circuits can be checked out, too.

Being completely portable, this instrument can save a lot of time. Another helpful test is for the signal level from the home antenna, etc. If you have a weak snowy picture on both set tuner and TunerMate, suspect the antenna or leadin.

On the bench, this can be used for an i.f. signal source, in making signal tracing tests, gain-per-stage tests, and so on. By starting at the last i.f. and feeding the 40-MHz i.f. into the base/grid of the last amplifier stage, the agc action can be checked out. (Most circuits use agc on only the first two stages; so, a signal fed in at the last stage should go through and develop normal agc voltage on the first two stages. If it does not, *then* you go and dig into the agc.)

UHF tuners can be tested with the TunerMate, too. Plug it into the i.f. input, as before. Now pull the cable from the uhf tuner to the set's vhf tuner, and plug this into the jack on the TunerMate marked UHF TUNER TEST. Set the TunerMate dial to UHF, and the uhf tuner should give a good picture, if it's working. So, both vhf and uhf tuners can be quickly and easily checked out.

The TunerMate is housed in a sturdy compact metal cabinet which gives excellent shielding. A red LED pilot lamp on the front of the case reminds you to turn it off when you're through. **R-E**

11 WAYS TO USE VECTORSCOPE

(continued from page 56)

gram pattern for its maximum vertical and horizontal excursions, as shown in Fig. 11.

Evaluation of Pattern: If the demodulators are operating normally, the vertical and horizonal maximum excursions will be equal, with in a tolerance of ±10%. If the demodulator output amplitude ratio is out of limits, check the diodes and capacitors in the demodulator circuits. This test applies to other varieties of chroma demodulators also, such as X, Z, G-Y, R, G and B types.

Note 5. Although the outputs from the chroma demodulators are normally equal, unequal amplification is provided in the channels from the demodulators to the color picture tube. This is done not only to obtain unadjusted chroma values, but also to compensate for differing phosphor sensitivities. Comparative signal voltages at the picture tube terminals are specified in the receiver service data.

8. To Check Demodulation Angles With an NTSC Signal

Equipment: Vectorscope, NTSC color-bar generator.

Connections: Same as in Test Procedure 1, with the substitution of an NTSC generator for the keyed-rainbow generator.

Procedure: Set the NTSC generator for R-Y/B-Y chroma output. Adjust vectorscope controls for display of an R-Y/B-Y vector pattern, such as illustrated in Fig. 12.

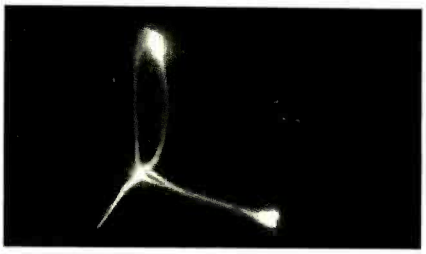

FIG. 12—VECTORGRAM shown is produced by the R-Y and B-Y signals and is used to check the demodulation angle.

Evaluation of Pattern: The ends of the vectors are indicated by the three bright dots in the pattern. A protractor can be used o measure the angle between the vectors accurately; this angle is the demodulation angle. In the example of Fig. 12, the demodulation angle is 103°. This test applies to other chroma demodulators, also.

9. To Check Demodulation Angles With Individual NTSC Signals

Equipment: Same as in Test Procedure 8.

Connections: Same as in Test Procedure 8.

Procedure: Set the NTSC generator

for R-Y output. Adjust receiver hue contril so that the vector trace falls along the vertical axis of the CRT. This positioning provides a convenient reference. Then, set the generator for B-Y output. The first vector trace disappears and the second appears.

Evaluation of Pattern: The vector angle is measured basically as in Test Procedure 8, knowing that the first vector trace was positioned along the vertical axis. Use this method when the generator does not provide simultaneous R-Y and B-Y outputs.

10. To Obtain an Equivalent Unkeyed Rainbow Pattern

Equipment: Same as in Test Procedure 6.

Connections: Same as in Test Procedure 6.

Procedure: Same as in Test Procedure 6, except that color sync action is disabled in the receiver by shunting a bypass capacitor between the output of the burst amplifier and ground.

Evaluation of Pattern: The outline of the vectorgram now appears as a continuous ellipse, as in Fig. 13. This

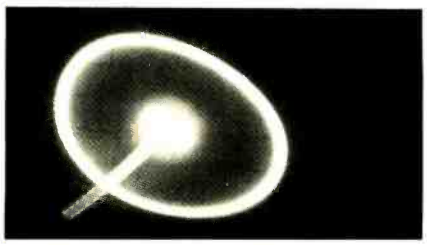

FIG. 13—EQUIVALENT UNKEYED RAINBOW VECTORGRAM produced by disabling the color sync action in the receiver.

equivalent unkeyed-rainbow vectorgram is somewhat easier to compare with ellipse-guide than the "petal" pattern used in Test Procedure 6.

11. To Check the Effect of the I.F. Amplifier on a Vectorgram Pattern

Equipment: Vectorscope, keyed-rainbow generator.

Connections: Same as in Test Procedure 1.

Procedure: Same as in Test Procedure 1. Then, disconnect the generator from the antenna-input terminals of the receiver. Using the video-frequency output from the generator, inject the test signal at the input of the video amplifier in the receiver.

Evaluation of Pattern: Compare the first vectorgram pattern with the second. Any differences in outline and petal shapes is due to distortion introduced by the i.f. amplifiier. In rare cases, distortion may be introduced by the vhf tuner.

Note 6. Some keyed-rainbow generators provide video output, and others provide vhf output only. Unless video output is available, Test Procedure 11 cannot be used. **R-E**

try this

SCR IMPROVES SLIDE PROJECTOR

The addition of a low-cost 200-volt, 3-amp Triac and one resistor to the slide-change mechanism of the GAF-Sawyer 747AQ slide projector greatly inhances the reliability of this part of the unit.

Normally, the cycle motor draws its full load current through slide cam switch S2 (with inherent arcing) when the momentary manual switch is activated. With the modifications illustrated in the pictorial in Fig. 1 and schematic in Fig 2, the Triac now carries the full load current of the motor until the slide cycle is completed as S2 is opened by the slide cam. Q1 then turns off.

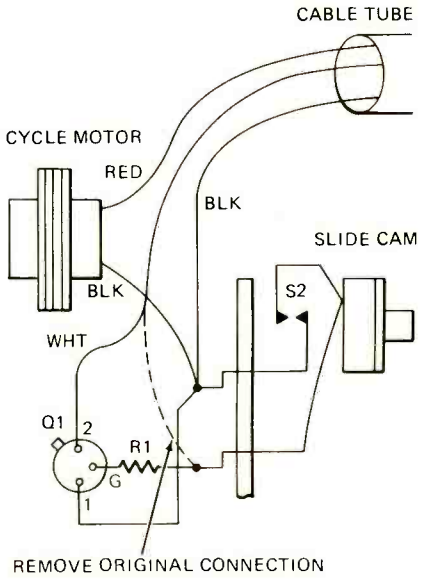

FIG. 1

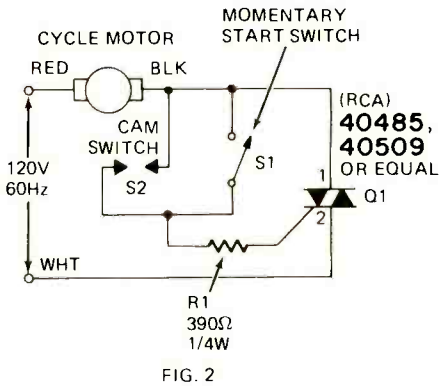

FIG. 2

Initially, the motor is not operating, and does not start operating until switch S1 is closed (Fig. 2.) When S1 is closed, a portion of the ac voltage is applied to the gate of Q1. Q1 conducts and supplies current to the motor until it completes a cycle. When the cycle is completed, switch S2 is opened, and Q1 stops conducting.—*Paul Calluzi*

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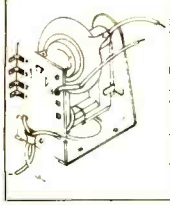

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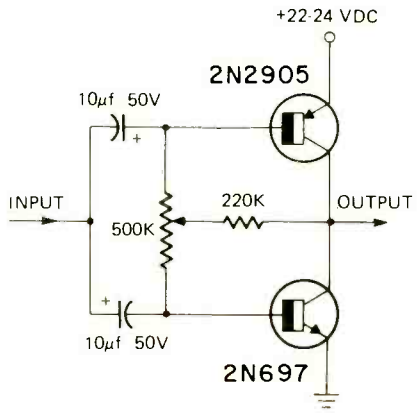


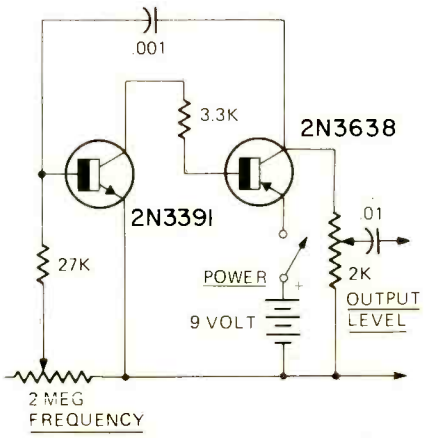
Disadvantages of the circuit are relatively low input impedance and relatively high output impedance. Both of these conditions can be corrected, if required, by using emitter followers at the input and output.

The circuit "likes" 22 to 24 volts dc (Vcc). Adjust the potentiometer for ½Vcc at the collector junction or symmetrical clipping at the output. Frequency response is excellent over the audio range—depending on the capacitor values; 1 mV input produces 5.0V_{rms} output with a distortion level so low that it is not visible on a scope.

—*James Baloghy*

SPECTROSCAN

This little test equipment item fulfills the need for a small, portable, inexpensive signal source for field testing



of all types of equipment. By only using two inexpensive transistors (both units together costs less than a dollar!)

and making the unit battery powered, all of the above needs are met.

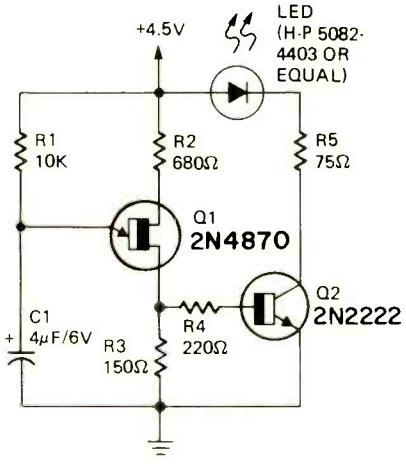
The circuit consists basically of an oscillator which uses a minimum number of components. The final unit should be built into a package that is as small as practical.

This unit is really very simple and the wiring is not critical, but keep all leads as short as possible so that the complete unit is as small as is practical. The two main controls, the 2K output level pot and the 2-Meg frequency pot, may be the miniature trimpot type if space is more important than the additional cost of the minipots. The power switch may be either an individual switch or may be attached to either the LEVEL or the FREQUENCY pot.

The completed unit may be mounted in any suitable enclosure. I used a plastic cigarette case and standard sized pots. The basic frequency of this unit falls within the audio spectrum making it very usefull in audio work. The waveform is extremely rich in harmonic content and extends well up to several megahertz. The low current drain and intermittent use of the unit yields battery life comparable to shelf life.—*William R. Shippe*

BATTERY SAVER

You'll appreciate this circuit if you tend to leave your battery-powered test equipment on overnight. It features a flashing light-emitting diode (LED) which is sure to catch your eye. Uni-junction transistor Q1 conducts brief pulses of current at a rate determined by the supply voltage and the R1-C1 time constant. The resultant voltage developed across R3 supplies base drive to Q2, which con-



ducts to energize the LED. Diode current is limited to a safe value by R5. The circuit draws a peak current of 20 mA for a few milliseconds at a 20-Hz rate, resulting in an average current of about 1 mA. The extra current drain on the battery when the flasher is operating is more than compensated for by the current not drawn by the test equipment overnight.

The circuit shown was designed for use in a VOM powered by a 4.5-volt battery. Increase R1 and R2 if your equipment uses a higher voltage.—*Donald R. Hicke*

new books

SIMPLIFIED COMPUTER PROGRAMMING — THE EASY RPG WAY by Kelton Carson. TAB Books. Blue Ridge Summit, PA 17214. 240 pp. 8-1/2 x 5-1/4 in. Hardcover $8.95; Softcover $5.95.

A computer, being a very complex system, requires literally thousands of steps and instructions to perform even a simple operation. The instructions are provided by a program which may be compared to a list of intruction for computing the square root, for example. Rather than actually write out the thousands of intructions for a computer, the programmer uses a language to have the computer prepare a program for him. By doing this, all that is left for the programmer is to write a few instructions in a few simple forms. The computer then translates the simple people language of the forms to the complex machine language of the computer. This book shows how it's done.

TTL COOKBOOK, by Donald E. Lancaster. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 335 pp. 8-1/4 x 5-1/4 in. Softcover $8.95 (in Canada $10.75).

In mid-1972, an electronic revolution took place. For the first time, a person could go out and purchase a logic gate for 5¢ provided you bought four of them at once in single 20¢ package. These gates were TTL (transistor-transistor-logic), a very versatile, widely available and fast way of performing logic operations. The *TTL Cookbook* is about TTL. It shows you what TTL is and how to use it. It is written at a time when TTL IC's are widely and readily available. After covering the basics of TTL, who makes it and where to get data, it goes on to a kind of catalog of TTL devices. Ten applications and illustrations of TTL IC use start coming up. There is a complete chapter on logic applications, another on gate and timer circuits, still another on clock logic and off we go. We continue through divide-by-N counters, shift registers, noise generators and rate multipliers. The final chapter, called "Getting It All Together," shows several up-to-the-minute applications of real devices that can be built using TTL logic.

LOGICAL DESIGN OF SWITCHING CIRCUITS, 2nd Edition, by Douglas Lewin. American Elsevier Publishing Co., Inc., 52 Vanderbilt Avenue, New York, NY 10017. 368 pp. 9-1/4 x 6-1/4 in. Hardcover $12.95.

This book describes those methods of designing logic circuits which have emerged as useful techniques from the vast amount of published work on switching theory. It is an engineering approach rather than the more usual mathematical treatment. The book is self-contained. It begins with an introduction to digital systems, set theory and Boolean algebra and progresses through the design of various circuits to their actual implementation. There is a final chapter on automatic design and an appendix provides a useful introduction to computer programming.

ELECTRONIC TECHNIQUES: SHOP PRACTICES AND CONSTRUCTION, by Robert S. Vilanucci, Alexander W. Avtgis & William F. Megow. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 569 pp. 9-1/2 x 7 in. Hardcover $14.95.

Here is a practical and realistic approach to help the reader develop skills in the planning, layout and construction of electronic equipment. The clear and concise coverage of all aspects of fabrication techniques provides a solid background of needed information. A quick rundown of the chapter subject areas starts off with design factors for packaging, preparing detailed drawings, shearing, chassis layout techniques and goes on through printed-circuit board materials, printed-circuit board processing, chassis hardware and assembly, harness and cable fabrication and a final chapter with seven construction projects.

RESISTIVE AND REACTIVE CIRCUITS, by Albert Paul Malvino. McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. 592 pp. 9-1/4 x 7-1/4 in. Hardcover $12.95.

A comprehensive textbook that provides all the information needed to prepare a technician for more advanced electronic courses. The first part of this book discusses resistive circuits with dc or ac sources as these are very prominent today because of direct-coupled circuits. The second part of the book covers reactive circuits such as transients, ac theory without using trigonometry or complex numbers. The final section of the book which does require a knowledge of trigonometry goes into extensive coverage of things such as phasor analysis, resonance and instantaneous ac analysis. Definitely a textbook quite valuable to anyone who wants to more fully understand both resistive and reactive circuitry.

HANDBOOK OF MODERN SOLID-STATE AMPLIFIERS, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 414 pp. 9-1/4 x 6 in. Hardcover $15.00.

Here is a detailed treatment of both the theory and practice of modern electronic amplifiers. It is perhaps the most comprehensive handbook available today on circuit theory and analysis at the technician level featuring simplified guidelines for practical design, complete test procedures and practical troubleshooting techniques. The book describes all types of amplifiers in common use — audio, rf, direct-coupled, differential, compounds and op-amps. It also covers both discrete amplifier circuits and selected IC's. It is well suited to a broad readership—students, designers, technicians and anyone else who would like to have a source of up-to-date information on solid-state amplifiers.

MANUAL OF LINEAR INTEGRATED CIRCUITS, by Sol D. Prensky. Reston Publishing Co., Inc., Box 547, Reston, VA 22090. 289 pp. 9 x 6 in. Hardcover $16.95.

This volume explains and illustrates the field of linear integrated circuits including op-amps and all other forms of linear IC's. If offers a thorough discussion of the underlying principles strenghtened by a host of application schematics. In addition, there is a comprehensive selection guide and cross-references for IC type numbers. There is also a complete section on bread-boarding and testing techniques. As a practical presentation of basic principles, there are more than 100 application schematics and the cross-reference index describes well over 300 manufacturers type numbers with identifying codes for second source types.

ZENITH COLOR TV SERVICE MANUAL, Volume Three, by Robert Goodman. TAB Books, Blue Ridge Summit, PA 17214. 179 pp. 10-3/4 x 8-1/4 in. Hardcover $7.95; softcover $4.95.

Packed with more information than ever before, this new Zenith color TV manual provides all the servicing data needed for many of the latest Zenith color TV receivers. Complete descriptions of varactor and mechanical tuning and remote control units for all model variations are included along with model-by-model alignment instructions and precautions. Even the new integrated circuits are described externally and internally. Fifteen full-size fold-out schematics accompany the text in addition to three useful color TV troubleshooting charts. **R-E**

next month

NOVEMBER 1974

■ **Build High-Power Electronic Flash**
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STEP-BY-STEP
(continued from page 62)

because of the terrifically high voltages. Furthermore, in this receiver you must actually dismantle the flyback cage and go through all sorts of gyrations to change one. But you *can* unplug the dynamic convergence board and *flyback*, provided there is one available to substitute.

If there isn't one around, how about applying the old transformer ringing test? Any modern scope with a gate output, a 10X low-capacitance probe (this isn't really necessary), and 10 mV deflection sensitivity will do nicely. Taken across the yoke, the defective turns are readily seen in trace Y1 of Fig. 4 (W3), and those of a good replacement yoke appear in Y2.

The same test should work with flyback transformers too. Now, if you still have doubts, or a comparison isn't available, first note the symmetrical damped ringing, then do a simple calculation. . . The scope time base for this test is set for 10 μs/div., there are approximately 1.5 Hz per division, and the equation for frequency amounts to $F = 1/T$, where T is time. Therefore:

$$F = 1/(1.5 \times 10 \times 10^{-6}) =$$
$$1\ (15 \times 10^{-6}) = 67\ \text{kHz}$$

And that's close to the resonant frequency of the usual horizontal circuit. The upper waveform is resonating at some 59 kHz, is damped much too quickly, and does not tail off in a smoothly diminishing sinewave. Obviously the yoke is your problem - and the moral of the story is: don't fail to look at the cathode ray tube *before* servicing, it might just tell you something! **R-E**

Voice communications boxes improve fire alarm systems

New York City is doubling the number of its two-way voice communications alarm boxes, bringing the total to 6,000. They are direct replacements for the old-fashioned fire alarm boxes. Plans are to change the whole 15,000-box system over to voice communications.

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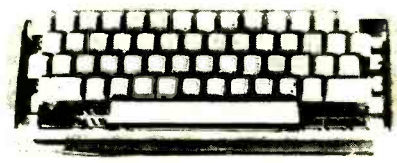

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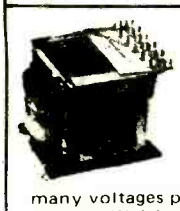

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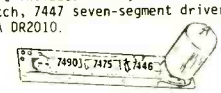

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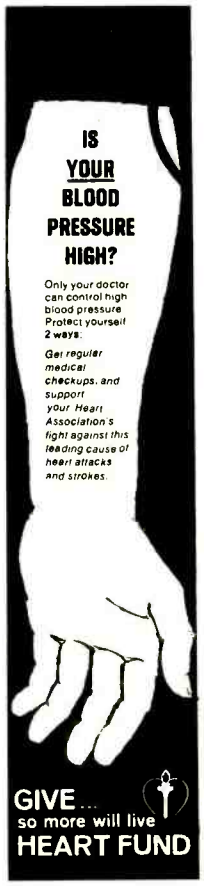

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FE/RE 72, JA1, 2, or 3 series, 25-50 MHz, 12 volts, 100 watts, front or rear mount, fully solid state receive, 4 tubes in transmitter, fully narrow band, complete with accessories
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251 Rt. 46, Saddle Brook, N. J. 07662
Phone: (201) 489-9000

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(All "LED" TYPES)

Type	Char.	Each	Special
☐ MAN-1	.27	$3.75	3 for $9.
☐ MAN-3	.12	1.49	3 for $3.
☐ MAN-4	.19	2.50	3 for $6.

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☐ SLA-1**	.33	2.10	3 for $5.
☐ SLA-3**	.70	4.95	3 for $13.
☐ SLA-11**	.33†	2.50	3 for $6.
☐ SLA-21**	.33††	2.50	3 for $6.

**By Opcon, equal to MAN-1 or MAN-4 specs. Color - RED. †Green, †† yellow

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One of Poly Paks exclusive ultra-brite offers at "dull" prices. Kit includes: 3 REDS, 3 GREENS, 3 YELLOWS, each including JUMBOS, MEDIUM and MICROS.

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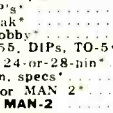

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- ☐ 10—FAIRCHILD-NATIONAL, 9000 Series ICs, dips, hobby... $1.

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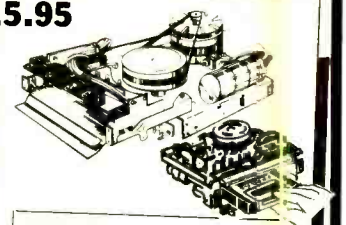
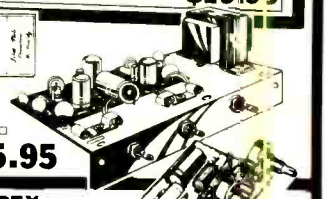
FOR HOME USE



Same type unit found in the most expensive home tape players. It's a complete 8-track player system with BUILT-IN PREAMP — just plug into any stereo amplifier (see some of our low-priced units). Excellent replacement unit, or you can design your own high-quality stereo tape system. It's the type you insert a cartridge to turn-on deck, then enjoy up to 80 minutes of non-stop, non-repeat stereo. Remove cartridge and player "shuts off" automatically. Built-in output controls in preamp. Features: 4 PROGRAM INDICATOR LIGHTS, automatic or manual program change, plays your car tapes at home, WOW-FREE precision fan-cooled motor, which operates off 115Vac. Requires external 12Vdc supply, for the electronics. With diagrams.

8-Watt Stereo Amplifier, 8-Track Tape Transport and hook-ups both. ☐ Only **$19.95**

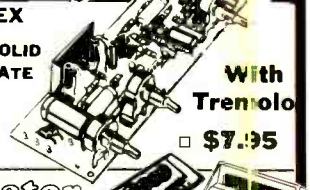
8 WATT STEREO AUDIO AMP



The factory "snipped" most of the cables to this compact 8 watt stereo unit with aluminum escutcheon plate. It's easy to use because we have all the cables marked ready to use. With power supply, 115vac, 3 controls, LEFT and RIGHT VOLUME controls for two speakers for balancing and center TONE control. With knobs, 7 x 3½ x 3½. Hookup spec sheets. ☐ **5.95**

4 WATT GUITAR AMP AMPEREX

• SOLID STATE



Musical instrument amplifier at low, low price! Peak power output 10 watts. Two input circuits are equalized for normal or solo guitar. The four controls are VOLUME, TONE, TREMOLO INTENSITY and TREMOLO SPEED. There are terminals on board for normally open foot switch connection. Supply voltage 18vdc. Output to 8 ohm hi-quality speaker. Input impedance 33,000 ohms. Current drain 20 mils. External power supply required. Wt. 1 lb. With instructions, hookups and diagrams. Size 8 x 2⅝ x 3.

With Tremolo ☐ **$7.95**

INTEGRATED CIRCUIT SOCKETS

- ☐ 14-Pin, DIP ..... $.45
- ☐ 14-Pin, Side Mount 1.00
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- ☐ 8 -Pins (Mini DIP) ..... .39

Buy Any 3 Take 10% Discount! ☐ 14-Pin, Wire Wrap ... 69c ☐ 16-Pin, Wire Wrap ... 89c

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THREE QUARTER INCH DIGITS BY OPCOA

3 for $13. Any color **$4.95** RED — GREEN YELLOW

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- * 0 to 9
- * 7 Segments 30 mils

Order by type number

Type	Color
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☐ SLA-4H*	RED
☐ SLA-13	GREEN
☐ SLA-14*	GREEN
☐ SLA-23	YELLOW
☐ SLA-24*	YELLOW

*Plus or Minus one

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Using OPCOA SLA-3H

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- ☐ LM-7522 ☐ LM-7523
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Buy 3 take 10% **95¢ ea**

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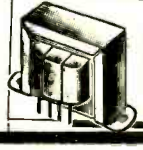

Input all 115/60 cycles. Open frame and metal encased.

Output			Sale
☐ 5.0V	@	.120A	$1.00
☐ 6.3V	@	3A	2.95
☐ 12.0VCT	@	3A	2.95
☐ 18.0VCT	@	2A	2.50
☐ 150.0V	@	50MA.	
☐ 7.0V	@	1A*	2.95

*Nixie tube transf.

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MAKE YOUR OWN CALCULATORS WITH OUR LOW PRICED ☐ 6-8-12 DIGIT Your Choice **$16.95**

CALCULATOR BASICS

BASIC KIT #1 — includes case, all-function Flex Key Keyboard, Cal Tech CT5002 calculator chip, 9-digit Antex LED display with built-on individual magnifiers, plus sheets.

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☐ CT5001	12-Digits, 40 Pin	$5.95	3 for	$17.
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3 for $1 **39¢ ea**

*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.

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

No.		No.	
☐ 0*	☐ 8*	☐ 0†	☐ 8†
☐ 1*	☐ 9*	☐ 1†	☐ C/T
☐ 2*	☐ C/T	☐ 2†	☐ C/T
☐ 3*	☐ -	☐ 3†	☐ -
☐ 4*	☐ + =	☐ 4†	☐ + =
☐ 5*	☐ .	☐ 5†	☐ .
☐ 6*	☐ X	☐ 6†	☐ X
☐ 7*	☐ ÷	☐ 7†	☐ ÷

CALCULATOR KEYBOARD SWITCH KITS

Kit of 17 for $4.95

☐ 10-pc. kit, 0-to-9 only same type as above. **2.50**

Each switch made by Oak #415, SPST normally open, 24V 1 amp contacts. Kit includes 0-to-9 (10 switches white with black numerals), decimal, white with black dot, and CE, CL and = functions blue with white characters.

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Value	1	10-90*	100-240*	Value	1	10-90*	100-240*
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2.2 UFD/50V	14c	12c	11c	100 UFD/25V	24c	18c	17c
3.3 UFD/35V	14c	12c	11c	220 UFD/16V	24c	18c	17c
4.7 UFD/35V	14c	12c	11c	220 UFD/25V	35c	25c	24c
10 UFD/16V	14c	12c	11c	330 UFD/16V	35c	25c	24c
10 UFD/25V	14c	12c	11c	330 UFD/25V	44c	35c	32c
22 UFD/16V	14c	12c	11c	470 UFD/16V	37c	30c	27c
22 UFD/25V	15c	13c	12c	470 UFD/25V	49c	39c	35c
33 UFD/16V	15c	12c	11c	1000 UFD/16V	49c	39c	35c
33 UFD/25V	17c	13c	12c	1000 UFD/25V	75c	60c	55c
47 UFD/16V	17c	14c	13c	2200 UFD/16V	75c	60c	55c
47 UFD/25V	19c	15c	14c				

*** 10 pcs. per capacitance value**

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PRICE $29.95 Postpaid USA & Canada

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7400N	.32c	28c	7446N	$1.30	$1.10	7496N	$1.20	$1.07
7401N	.32c	28c	7447N	$1.30	$1.10	74107N	.55c	50c
7402N	.32c	28c	7448N	$1.35	$1.15	74121N	.70c	60c
7403N	.32c	28c	7450N	.32c	28c	74122N	.72c	62c
7404N	.35c	31c	7451N	.32c	28c	74123N	$1.11	99c
7405N	.35c	31c	7453N	.32c	28c	74141N	$1.61	$1.43
7406N	.52c	46c	7454N	.32c	28c	74150N	$1.56	$1.39
7407N	.52c	46c	7459N	.32c	28c	74151N	$1.20	$1.07
7408N	.36c	32c	7460N	.32c	28c	74153N	$1.58	$1.40
7409N	.36c	32c	7470N	.36c	32c	74154N	$2.25	$2.00
7410N	.32c	28c	7472N	.40c	35c	74155N	$1.46	$1.29
7411N	.35c	31c	7473N	.52c	45c	74156N	$1.17	$1.04
7413N	.63c	56c	7474N	.52c	45c	74157N	$1.56	$1.39
7416N	.50c	44c	7475N	.85c	72c	74158N	$1.56	$1.39
7417N	.50c	44c	7476N	.60c	55c	74160N	$1.95	$1.74
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7426N	.36c	32c	7486N	.60c	55c	74164N	$1.95	$1.74
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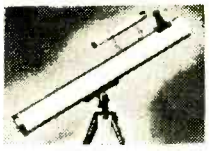

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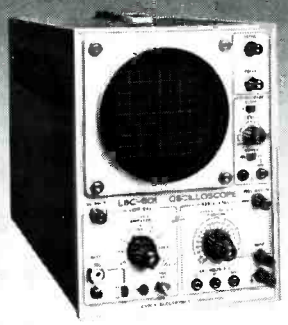

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