Radio-Electronics

60¢ ■ MAR. 1974

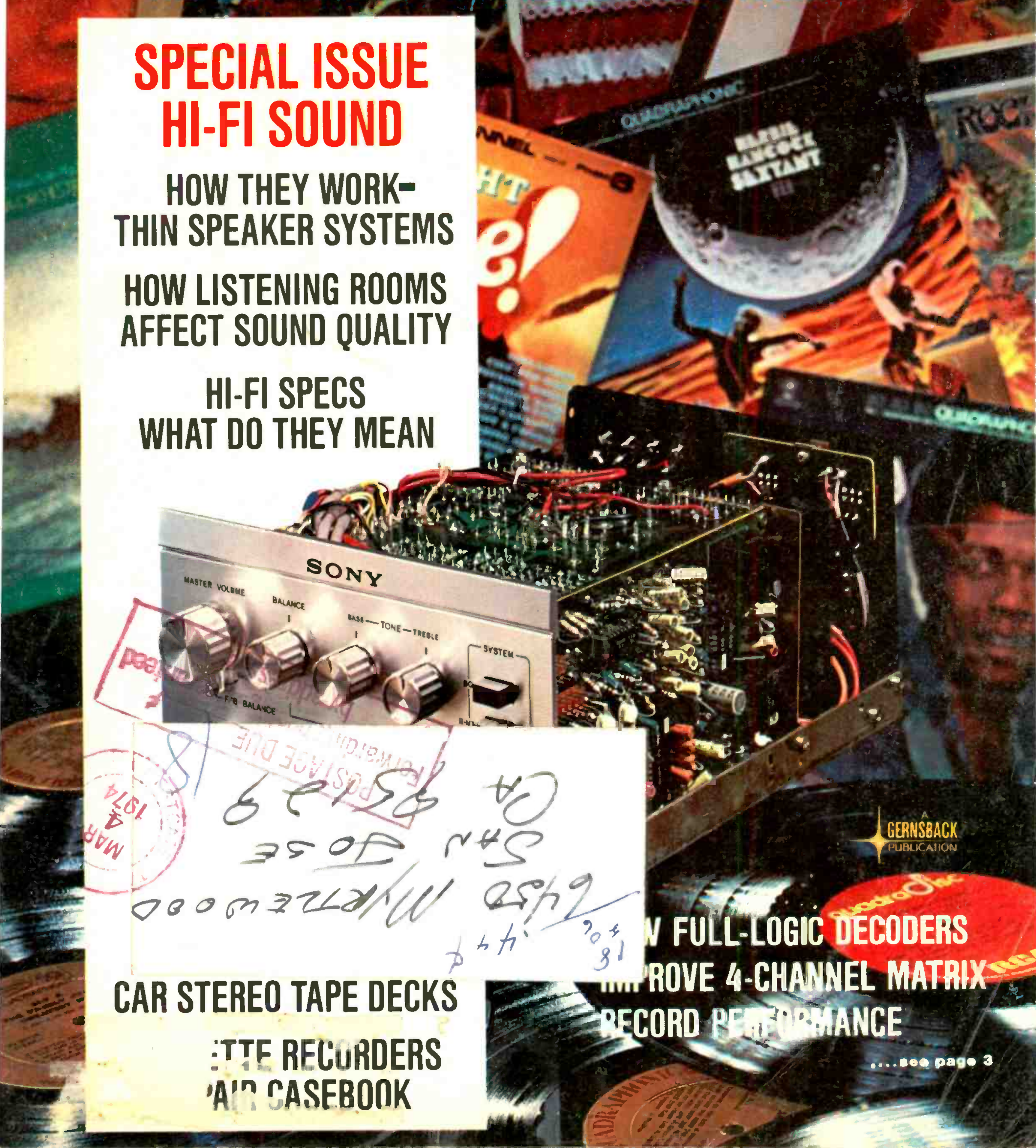
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

SPECIAL ISSUE HI-FI SOUND

HOW THEY WORK—
THIN SPEAKER SYSTEMS

HOW LISTENING ROOMS AFFECT SOUND QUALITY

HI-FI SPECS
WHAT DO THEY MEAN



...W FULL-LOGIC DECODERS
...ROVE 4-CHANNEL MATRIX
RECORD PERFORMANCE

....see page 3

A GERNSBACK PUBLICATION

CAR STEREO TAPE DECKS

...TTE RECORDERS

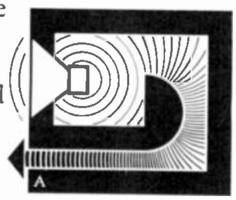
...AIR CASEBOOK

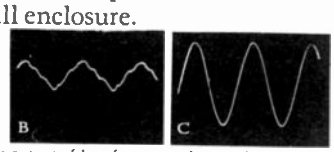
Now BIC VENTURI™ puts to rest some of the fables, fairytales, folklore, hearsay and humbug about speakers.

Fable

Extended bass with low distortion requires a big cabinet.

Some conventional designs are relatively efficient, but are large. Others are small, capable of good bass response, but extremely inefficient. The principle of the BIC VENTURI systems (pat. pend.) transforms air motion velocity within the enclosure to realize amplified magnitudes of bass energy at the BIC VENTURI coupled duct as much as 140 times that normally derived from a woofer (Fig. A). And the filtering action achieves phenomenally pure signal (Scope photos B & C). Result: pure extended bass from a small enclosure.





B—Shows output of low frequency driver when driven at a freq. of 22 Hz. Sound pressure reading, 90 dB. Note poor waveform.

C—Output of venturi coupled duct, (under the same conditions as Fig B.) Sound pressure reading 111.5 dB, (140 times more output than Fig. B.) Note sinusoidal (nondistorted) appearance.

Fairytale

It's okay for midrange speakers to cross over to a tweeter at any frequency.

Midrange speakers cover from about 800 Hz to 6000 Hz. However, the ear is most sensitive to midrange frequencies. Distortion created in this range from crossover network action reduces articulation and musical definition.

BICONEX™horn

BIC VENTURI BICONEX horn (pat.pend.) was designed to match the high efficiency of the bass section and operates smoothly all the way up to 15,000 Hz, without interruption. A newly designed super tweeter extends response to 23,000 Hz, preserving the original sonic balance and musical timbre of the instruments originating in the lower frequencies.

Folklore

Wide dispersion only in one plane is sufficient.

Conventional horns suffer from musical coloration and are limited to wide-angle dispersion in one plane. Since speakers can be positioned horizontally or vertically, you can miss those frequencies so necessary for musical accuracy. Metallic coloration is eliminated in the BICONEX horn by making it of a special inert substance. The combination of conical and exponential horn flares with a square diffraction mouth results in measurably wider dispersion, equally in all planes.

Hearsay

A speaker can't achieve high efficiency with high power handling in a small cabinet..

It can't, if its design is governed by such limiting factors as a soft-suspension, limited cone excursion capability, trapped air masses, etc. Freed from these limitations by the unique venturi action, BIC VENTURI speakers use rugged drivers capable of great excursion and equipped with voice coil assemblies that handle high power without "bottoming" or danger of destruction. The combination of increased efficiency and high power handling expands the useful dynamic range of your music system. Loud musical passages are reproduced faithfully, without strain; quieter moments, effortlessly.

Humbug

You can't retain balanced tonal response at all listening levels.

We hear far less of the bass and treble ranges at moderate to low listening levels than at very loud levels. Amplifier "loudness" or "contour" switches are fixed rate devices which in practice are *defeated* by the differences in speaker efficiency. The solution: Dynamic Tonal Compensation.™ This circuit (patents pending) adjusts speaker response as its sound pressure output changes with amplifier volume control settings. You hear aurally "flat" musical reproduction at background, average, or ear-shattering discoteque levels—automatically.

A system for every requirement

FORMULA 2. The most sensitive, highest power handling speaker system of its size (19¾ x 12 x 11½)." Heavy duty 8" woofer, BICONEX mid range, super tweeter. Use with amplifiers rated from 15 watts to as much as 75 watts RMS per channel. Response: 30 Hz to 23,000 Hz. Dispersion: 120° x 120°. $98 each

FORMULA 4. Extends pure bass to 25 Hz. Has 10" woofer, BICONEX midrange, super tweeter. Even greater efficiency and will handle amplifiers rated up to 100 watts. Dispersion: 120° x 120°. Size: 25 x 13¼ x 13." $136 each.

FORMULA 6. Reaches very limits of bass and treble perception (20 to 23,000 Hz). Six elements: 12" woofer complemented by 5" cone for upper bass/lower midrange; pair of BICONEX horns and pair of super tweeter angularly positioned to increase high frequency dispersion (160° x 160°). Size: 26¼ x 15¾ x 14¾." $239 each.

Sturdily constructed enclosures. Removable grilles in choice of 6 colors. Optional bases for floor standing placement. Write for brochure RE-3.

Audition today's most advanced speakers at your BIC VENTURI dealer.

BRITISH INDUSTRIES Co., Inc.
Westbury, New York 11590.
A division of Avnet, Inc.,
Canada: C.W. Pointon, Ont.

BIC VENTURI™

Circle 3 on reader service card

Radio-Electronics

THE MAGAZINE FOR IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

MARCH 1974

4-CHANNEL SOUND STEREO HI-FI

33 **The New SQ Generation**
From basic 4-channel SQ to full-logic matrix, and beyond
by Len Feldman

36 **Panel Speaker Designs**
Two kinds of "thin" speakers you'll want to know about.
by Donald D. Grieg and Herbert Schoengold

39 **Getting To Know Hi-Fi Specs**
How to interpret equipment specifications so you'll know what you are buying. *by Ken Sessions*

42 **How To Improve Room Acoustics**
It's one important way to get better hi-fidelity sound in your home. *by Louis Challis*

54 **Cassette Recorder Casebook**
Actual repair historys you can learn from.
by Gary McClellan

56 **Installing Car Tape Decks**
Fully illustrated step-by-step installation instructions.

TELEVISION

63 **Service Clinic**
A look at VTR problems. *by Jack Darr*

69 **Reader Questions**
R-E's Service Editor solves reader problems.

SOLID-STATE ELECTRONICS

44 **Electronic Casino**
Here's the design for five games of chance, complete with sound effects. If you're a true experimenter, you are going to want to try some of these. *by Waller Scott*

60 **R-E's Transistor Replacement Guide**
Two more pages of replacement types.
by Robert & Elizabeth Scott

GENERAL ELECTRONICS

4 **Looking Ahead**
Tomorrow's news today. *by David Lachenbruch*

22 **Appliance Clinic**
They go modular, too. *by Jack Darr*

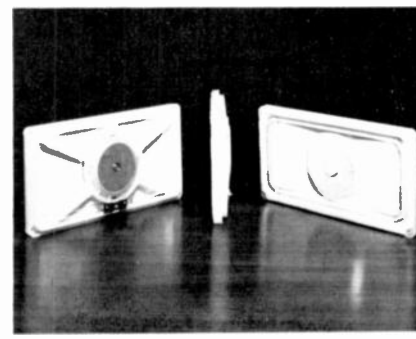
58 **Technical Topics**
A variety of new and interesting circuits presented for R-E readers. *by Robert F. Scott*

DEPARTMENTS

106 Ad Index
99 Books
16 Letters
82 New Literature
78 New Products
6 New & Timely
98 Next Month
87 Noteworthy Circuits
111 Reader Service Card

ON THE COVER

Culminating the SQ generation is the Sony model 2030 full-logic SQ matrix decoder shown in its natural habitat—amid a covey of 4-channel records. For the full story on the development of the matrix system that makes this piece of equipment possible turn to the SQ Generation . . . page 33.



There are many ways to make "flat" speakers for hi-fi reproduction. Here's the story behind one of today's popular systems.

. . . see page 36

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

Radio-Electronics, March 1974 Vol 45 No 3 Published monthly by Gernsback Publications Inc 200 Park Avenue South New York City 10003 Second-class postage paid at New York N Y and additional mailing office One-year subscription rale U S A U S possessions and Canada $7 Pan-American countries $8 Other countries $8 50 Single copies 60c

Subscription Service: Mail all subscription orders changes correspondence and Postmaster Notices of undelivered copies (Form 3579) lo Radio-Electronics Subscription Service Boulder Colo 80302

looking ahead

China Color

Hong Kong—The People's Republic of China has selected the German-developed PAL color system, according to unofficial reports here. Mainland China thus becomes the second Communist country to go with Western Europe in the long-running battle over color standards, whose implications are political as well as technical. Yugoslavia was the first to break with the Soviet-French alliance which advocated the use of the French SECAM system. Before the deterioration of Russian-Chinese relations, China was counted in the SECAM camp. U.S.-dominated Taiwan (Formosa) uses the American NTSC color system.

A recent Chinese government report states that "trial production" of color sets on the mainland is now under way, and other reports—not from Chinese sources—indicate that China is shopping for technical assistance from major companies in the U.S., Europe and Japan in establishing its own integrated color TV production.

Electronics progress

Although electronics in the West evolved from the consumer-oriented radio into sophisticated industrial products, China is understood to be taking the route of industrial electronics first, to be followed by the development of a strong consumer electronics industry. A government statement gives no actual figures, but says: "China's electronics industry produced three times as much in the first half (of 1973) as in the same period of 1965, and production capacity for electronic elements and devices rose eleven-fold." China's electronics industry, it continues, "has developed from small to big, from dependence on imports to home production of whole sets of equipment, from copying foreign models to designing independently. All provinces, municipalities and autonomous regions have electronics plants. Total output value of the locally run electronics industry in 1972 was 5.6 times that in 1965." One major accomplishment of Chinese electronics is the development of an IC computer capable of performing a million operations per second.

The Germans meet 'TeD'

The Telefunken videodisc system, jointly developed with British Decca, is now being sold to the German public under the tradename "TeD." A Berlin factory is manufacturing the players, and 15 companies are listed in an extensive catalog of visual records. Telefunken began player production October 5 but delayed the start of deliveries to consumers until Jan. 1 to build up a backlog. It's believed that about 10,000 players are now in the stockpile, and that Telefunken has the capacity to produce 75,000 to 100,000 in 1974. Decca is expected to produce its own version in the United Kingdom later this year, and Telefunken officials hint that a Japanese-built unit (for NTSC color standards) will be coming along soon.

7-day wonder

A developmental LSI device which permits a viewer to program his television set for an entire week was demonstrated by Sanyo at the Electronic Parts Show in Tokyo. The gadget, which looks like a pocket calculator, may be removed from the set for programming. The viewer uses its 10-digit keyboard to select day, time and channel for up to 32 programs. The program selector, with built-in electronic clock, then automatically switches the set on at the desired time and tunes it to the pre-selected channel, changing channels at the proper time, etc.

New X-ray problems?

Back in the U.S., the Department of Health, Education and Welfare is taking a new look at potential X-radiation problems as the result of the trend by manufacturers to soup up color tube anode voltages to increase picture brightness. When the color TV X-ray regulations went into effect, maximum picture-tube voltage was 25 or 26 kV. The tendency in recent chassis designs is to move toward 30 kV and higher. HEW concedes that the industry's record in complying with radiation limits has been good, but it recently sent a questionnaire to receiver manufacturers asking them about safety measures being employed in the new higher-voltage sets.

There is some concern about the possibility of several simultaneous circuit failures potentially causing radiation emission that would exceed the permissible level of 0.5 milliroentgens. Although all sets being manufactured now—regardless of anode voltage—meet the government's X-ray standards, HEW hinted that it was considering tightening its rules or testing procedures to make sure that no combination of defects can cause excessive radiation.

Another area of concern is picture-tube replacement. Higher-voltage sets use tubes with an increased lead content in the glass, and HEW is searching for a way to prevent the use of low-lead tubes as replacements in these new souped-up sets. Manufacturers are currently required to use labels inside their sets specifying high-lead tubes as replacements, but HEW apparently feels this isn't enough.

RCA MagTape delayed

RCA missed its target of "late 1973" for the start of marketing of its home color videotape deck, MagTape SelectaVision. Difficulties in start-up production of the mechanical transport system were cited by RCA spokesmen, who, at presstime, were aiming at a "first-half 1974" retail premiere. The company is trying hard to adhere to its goal of a suggested retail price of $795, but officials acknowledged that inflation and unexpected costs may make it necessary to remove some features (stop-motion, for example) to come to market at this price.

Not-so-bitter PIL

The "Precision In-Line" (PIL) color tube developed by RCA, which uses in-line electron guns and a slotted shadow mask, is now spreading to other countries. One of the main—and most controversial—features of the PIL tube is the permanently affixed yoke. Japanese manufacturers Toshiba and NEC (Nippon Electric Co.) have now indicated that they'll build a similar tube for their sets sold in the United States. In Europe, ITT and General Telephone & Electronics are also expected to produce versions of the PIL tube.

A competing approach, "ChromaLine," has been developed by GE and Sylvania. Like RCA's PIL, it has an in-line gun array and a slot mask, but it uses a wide neck and separate yoke. Sylvania's first such tube is a 13-incher; RCA's are 15, 17 and 19 inches. GE has a 10-inch. The resulting picture bears striking resemblance to that of the highly successful Sony Trinitron.

Turned off

Instant-On TV devices may become a casualty of the energy crisis. In response to requests by the Consumer League, the Japanese government has issue a non-compulsory "advisory ruling" to television set manufacturers urging them to drop the feature, which it says wastes electricity.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Take a leaf from the Mallory Money Tree and save on famous Mallobins.®

Our Mallobin benchtop organizers are worth many times their modest cost in keeping electronic components neatly sorted, labeled, protected and ready for use. Now, you can save on buying them, too. For instance, this PTC semiconductor Mallobin organizer can be purchased at a special discount at your Mallory Distributor. Just present the Mallory Money Tree coupon below.

MALLORY

MALLORY DISTRIBUTOR PRODUCTS COMPANY
a division of P. R. MALLORY & CO. INC.
Box 1284, Indianapolis, Indiana 46206; Telephone: 317-636-5353

Batteries • Capacitors • Controls • Security Products • DURATAPE® • Recorders • Resistors • SEMICONDUCTORS • SONALERT® • Switches • Timers

Money Tree Coupon

This coupon valid through Sept. 1, 1974. Only one coupon valid on each purchase. This coupon not valid where prohibited or taxed by law. Coupon does not apply to sales tax, if applicable.

TO MALLORY DISTRIBUTOR
This coupon redeemable for $1.00 credit towards the purchase of any Mallory products or $1.00 in cash provided it is tendered to Mallory Distributor Products Company, a division of P. R. Mallory & Company Inc., Indianapolis, Indiana prior to Oct. 1, 1974. Invoices showing purchase of Mallobin organizers sufficient to cover coupon must be shown on request.

Worth $1.00 OFF on any purchase of any Mallory Mallobin organizer at a Mallory Distributor.

RE 34

DURATAPE® and SONALERT® are registered trademarks of P. R. Mallory & Co. Inc.

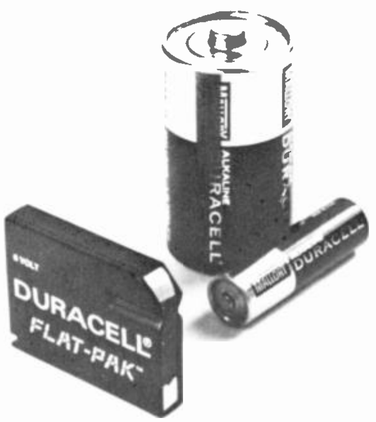
Circle 4 on reader service card

new & timely

New dry-cell battery is one-third inch thick

Designated the *Flat-Pak* and sold under the Mallory *Duracell* label, a new, exceptionally thin, rectangular-shaped 6-volt battery will permit innovative design concepts not previously possible, in a variety of battery-powered products, according to Mallory's president.

The new battery is 1⅞ inches long, 1⅜ inches wide, and less than ⅓ inch thick. It contains four alkaline cells in series, and has a new terminal design that insures correct insertion. Its first major application will be in new thin shirt-pocket calculators.



NEW DURACELL FLAT-PAK BATTERY for miniature applications is 1/3 inch thick.

Videotapes may clear jammed trial dockets

Following some experiments in recording the testimony of a witness on tape and playing it to a jury later, Judge James McCrystal of Sandusky, Ohio, tried 14 related civil cases before a jury that never saw any of the witnesses. The cases were all concerned with appropriating land to widen a major highway.

The lawyers' opening and closing statements, as well as the judge's instructions to the jurors, were "live." Otherwise the jurors depended entirely on the TV monitor, with the screen showing attorney and witness alternately during the questions and answers, with occasional closeups of exhibits.

The attorneys felt that opening statements were better because, being made after the testimony had been recorded, the lawyer "knew what the witnesses were going to say." One juror reported: "It is easier to concentrate on TV than if we had the people here," and lawyers stated they were more relaxed when questioning a witness before the TV camera than before a jury. The witnesses appeared to be more relaxed, too.

But the great advantage was increased efficiency and saving of time. In reviewing objections alone, the judge was able to do in three hours what he would have had to sit through 52 hours of testimony to do otherwise. (If an objection was raised, the witness was permitted to answer the question. Then, after all the testimony was in, the judge reviewed all the objections in a single sitting. If an objection was sustained, the court clerk was instructed to erase the question and answer.)

The whole 14 trials were completed in 11 working days. It was estimated that with normal procedure, they would have taken from 40 to 45 working days.

It was suggested that it might not be possible to try bitterly contested, emotion-charged cases, particularly criminal cases, "on camera." On the other hand, the absence of a human audience might well reduce the amount of emotion displayed in a trial, and the TV camera would be entirely unimpressed by a "courtroom outbreak."

New imaging technique uses ultrasonics

A new imaging technique, *ultrasonic isometric imaging*, produces quasi-three-dimensional projections on a display scope of the objects scanned. Developed by the Hanford Engineering Development Laboratory, operated by Westinghouse for the Atomic Energy Commission, the ISO-SCAN technique has several advantages over conventional B and C scans and ultrasonic holography. These include the ability to combine depth and spatial information in a form easily interpreted on a single record; the ability to shift perspective; the possibility of calibrating height and spatial position, and higher-quality images than can be obtained by ultrasonic holography.

Existing C-scan devices are easily modified for ISO-SCAN imaging.

To obtain the information for the display, the ultrasonic transmitter-receiver ("camera") takes X and Y scans of the object. In addition, a Z-axis scan shows the distance to the object at each point in the scanning. The three voltages are fed into an *isometric display generator*, which feeds x' and y' signals to the X and Y inputs of the display scope. These produce the perspective images shown in the photograph.

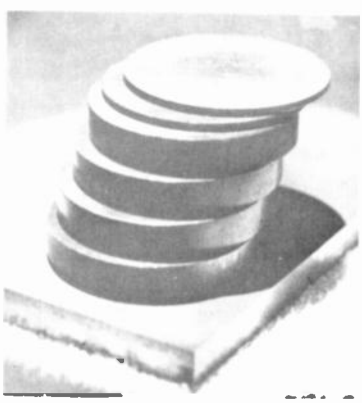
The X, Y, and Z information can be recorded on an endless tape and played back—with an operator adjusting the generator controls—to show the object from different perspectives, rotating or tilting the image as desired. This is particularly useful in selecting the optimum perspective for evaluating the image of an unknown object or flaw.

World-famous scientist celebrates 100th birthday

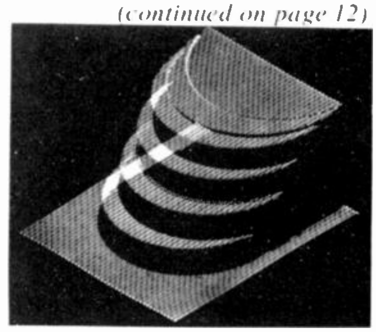
Dr. William D. Coolidge, the scientist responsible for the modern tungsten-filament electric lamp and inventor of X-ray equipment that transformed a laboratory curiosity into a practical medical and industrial tool, celebrated his 100th birthday October 23, 1973.

Joining the research staff of the General Electric Co. in 1905, he took up the search for a better lamp filament. With filaments then in use, lamps were notoriously unreliable and short-lived. Dr. Coolidge turned his attention to tungsten, a metal with a high melting point, but so brittle as to be useless as filament material. In a little over two years of research, he was able to produce a ductile tungsten that could be drawn into a lamp filament. Lamps with the new filaments were sturdier and longer-lived than earlier types, could be burned in any position, and could stand the vibration of automobiles

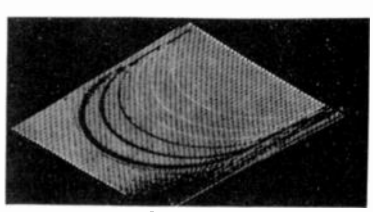
(continued on page 12)



SIX 1.5 IN. DIA. DISKS.
FOUR 0.250 IN. AND
TWO 0.160 IN. THICK.

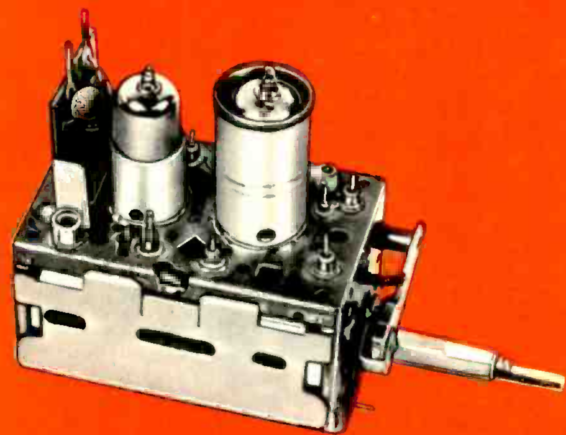


ISO-SCAN



C-SCAN

ISO-SCAN IMAGE OF STACK OF DISCS compared with conventional C-scan



$9.95

ALL PARTS INCLUDED
except tubes and transistors

ONE YEAR GUARANTEE

TUNER SERVICE CORPORATION

PROVIDES YOU WITH A COMPLETE SERVICE FOR ALL YOUR TELEVISION TUNER REQUIREMENTS.

REPAIR

VHF Or UHF Any Type $9.95.
UHF/VHF Combo $15.00.

In this price all parts are included. Tubes, transistors, diodes, and nuvistors are charged extra.

Fast efficient service at our conveniently located service centers. This price does not cover mutilated tuners.

All tuners are cleaned ultrasonically, repaired, realigned and air tested.

REPLACE

Universal Replacement Tuner $9.95.

This price buys you a complete new tuner built specifically by SARKES TARZIAN INC. for this purpose.

All shafts have a maximum length of 10″ which can be cut to 1½″.

Specify heater type parallel and series 450mA or 600mA.

CUSTOMIZE

Customized tuners are available at a cost of only $15.95. **(With trade-in $13.95)**

Send in your original tuner for comparison purposes to:

TUNER SERVICE CORPORATION

FACTORY-SUPERVISED TUNER SERVICE

Backed by the largest tuner manufacturer in the U.S.—SARKES TARZIAN, Inc.

TSC

WATCH US GROW

HEADQUARTERS	BLOOMINGTON, INDIANA 47401,	537 South Walnut St.	Tel: 812-334-0411
ARIZONA	TUCSON, ARIZONA 85713,	1528 S. 6th St. (P.O. Box 4534)	Tel: 602-7919243
CALIFORNIA	BURLINGAME, CALIFORNIA 94010,	1324 Marsten Road	Tel: 415-347-5728
CALIFORNIA	MODESTO, CALIFORNIA 95351,	123 Phoenix Ave.	Tel: 209-521-8051
CALIFORNIA	NORTH HOLLYWOOD, CALIF. 91691,	10654 Magnolia Blvd.	Tel:213-769-2720
FLORIDA	TAMPA, FLORIDA 33606,	1505 Cypress St.	Tel: 813-253-0324
GEORGIA	ATLANTA, GEORGIA 30310,	938 Gordon St., S.W	Tel: 404-758-2232
ILLINOIS	CHICAGO, ILLINOIS 60621,	737 W. 55th St.	Tel: 312-873-5556-7
ILLINOIS	SKOKIE, ILLINOIS 60076,	5110 W. Brown St.	Tel: 312-675-0230
INDIANA	INDIANAPOLIS, IND. 46204,	817 N. Pennsylvania St.	Tel: 317-632-3493
INDIANA	HAMMOND, INDIANA 46323,	6833 Grand Ave.	Tel: 219-845-2676
KENTUCKY	LOUISVILLE, KENTUCKY 40208,	2920 Taylor Blvd.	Tel: 502-634-3334
MARYLAND	BALTIMORE, MD. 21215,	5505 Reisterstown Rd. (P.O. Box 2624)	Tel: 301-358-1186
MISSOURI	ST. LOUIS, MO. 63132,	10530 Page Ave.	Tel: 314-429-0633
NEVADA	LAS VEGAS, NEVADA 89108,	3816 Vegas Drive	Tel: 702-648-1450
NEW JERSEY	JERSEY CITY, NEW JERSEY 07307,	547-49 Tonnele Ave. (On U.S. Highway 1 & 9)	Tel: 201-792-3730
NEW JERSEY	TRENTON, NEW JERSEY 08638,	901 N. Olden Ave.	Tel: 609-393-0999
OHIO	CINCINNATI, OHIO 45216,	7450 Vine St.	Tel: 513-821-5080
OHIO	CLEVELAND, OHIO 44109,	4597 Pearl Road	Tel: 216-741-2314
OHIO	TOLEDO, OHIO 43624,	119 N. Erie St.	Tel: 419-243-6733
OREGON	PORTLAND, OREGON 97210,	1732 N.W. 25th Ave.	Tel: 503-222-9059
TENNESSEE	GREENVILLE, TENNESSEE 37743,	1215 Snapps Ferry Rd.	Tel: 615-639-8451
TENNESSEE	MEMPHIS, TENNESSEE 38111,	3158 Barron Ave.	Tel: 901-458-2355
TEXAS	DALLAS, TEXAS 75218,	11540 Garland Rd.	Tel: 214-327-8413
VIRGINIA	NORFOLK, VIRGINIA 23502,	4538 E. Princess Anne Rd.	Tel: 804-855-2518-9955

Franchises available-Contact headquarters for information.

Circle 5 on reader service card

nri firsts make learning Electronics at home fast and fascinating— give you priceless confidence.

Some NRI firsts in training equipment

first to give solid state 25" diagonal color TV, 5" wide band oscilloscope, color bar generator and other professional equipment engineered specifically for education. You work directly on the receiver as you build it, discovering the practical aspects of TV servicing as you create a handsome new color console. Only NRI includes an attractive woodgrain cabinet without extra charge.

first to give you a unique, exciting digital computer *with memory* built especially for home training. You learn organization, troubleshooting, operation, programming as you build and use it. Performs the same functions as commercial computers. Lessons stress computer repair. You conduct a hundred experiments, build hundreds of circuits. A solid-state TVOM is included among ten training kits.

NRI's "discovery" method is the result of over half a century of leadership simplifying and dramatizing training at home

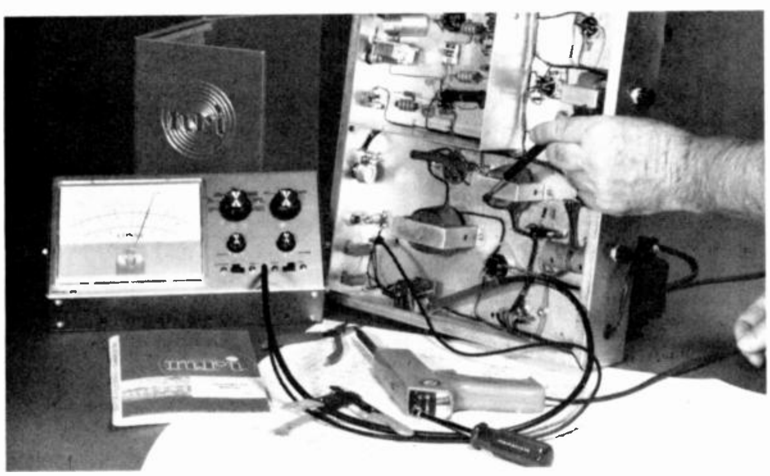
The FIRSTS described below are typical of NRI's half century of leadership in Electronics home training. When you enroll as an NRI student, you can be sure of gaining the in-demand technical knowledge and the priceless confidence of "hands-on" experience sought by employers in Communications, Television-Radio Servicing and Industrial and Military Electronics. Everything about NRI training is designed for your education . . . from the much-copied, educator-acclaimed Achievement Kit sent the day you enroll, to "bite-size" well-illustrated, easy to read texts programmed with designed-for-learning training equipment.

YOU GET YOUR FCC LICENSE OR YOUR MONEY BACK

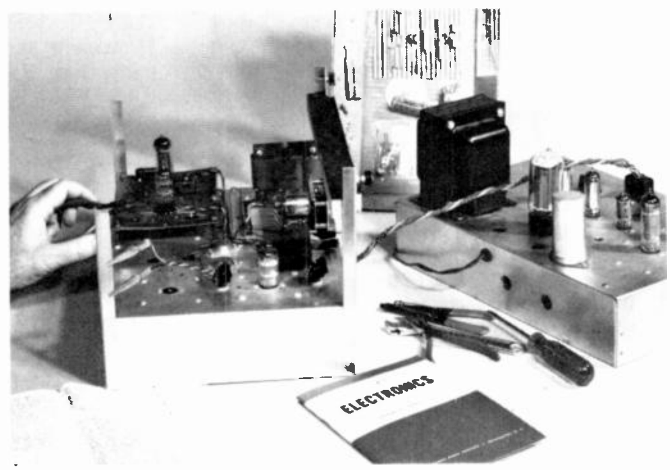
There is no end of opportunity for the trained man in Electronics. You can earn $6 or more an hour in spare time, have a business of your own or qualify quickly for career positions in business, industry, government. And if you enroll for any of five NRI courses in Communications, NRI prepares you for your FCC License exams. *You must pass* or NRI refunds your tuition in full. No school offers a more liberal money-back agreement. The full story about NRI leadership in Electronics training is in the new NRI Catalog. Mail postage-free card today. No salesman is going to call.
NATIONAL RADIO INSTITUTE, Washington, D.C. 20016

APPROVED UNDER NEW GI BILL If you have served since January 31, 1955, or are in service, check GI line on postage-free card.

designed from chassis up for your education



first to give you true-to-life experiences as a communications technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 15-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and troubleshooting become a matter of easily remembered logic.



first to give you completely specialized training kits engineered for business, industrial and military Electronics. Shown above is your own training center in solid state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, and problem-solving digital computer circuits are also included in your course.

new & timely

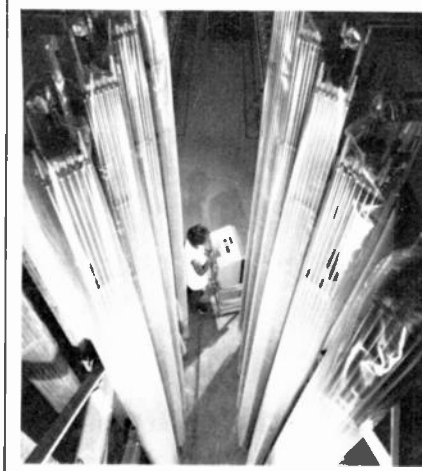
(continued from page 6)

and railroad cars of that day.

Around 1913, Dr. Coolidge developed a practical X-ray tube, with a hot tungsten cathode instead of the cold cathode of older tubes, and exhausted to a high vacuum. The hot filament made it possible to regulate the tube output with a rheostat, and the hard-vacuum tubes were reliable enough for use in medical work, and later, in industrial X-ray equipment.

Dr. Coolidge became director of the General Electric Research Laboratory in 1932, retiring in 1945.

COOLIDGE BIRTHDAY CAKE HAS 100 tiny tungsten lamps instead of candles. Center decoration is the target from an early Coolidge X-ray tube, encrusted with 100 little diamonds around a large GE laboratory-made gem diamond. At Dr. Coolidge's left is Dr. C. Guy Suits, who followed him as director of the laboratory, and at his right, Dr. Arthur M. Bueche, who became General Electric's vice president for research and development when Dr. Suits retired in 1965.



"ORGAN PIPES" IN THE FOREGROUND are bundles of nuclear fuel rods that will feed commercial reactors. The computer terminal far below is part of a system that checks and keeps track of each of the tens of thousands of uranium fuel containers as it passes through the General Electric nuclear fuel plant in Wilmington, N.C., pinpointing the location of each at all times and recording information on quality control and other checks required. R-E

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

ADVERTISING SALES

EAST
Stanley Levitan, Eastern Sales Mgr.
Radio-Electronics
200 Park Ave. South
New York, N.Y. 10003
(212) 777-6400

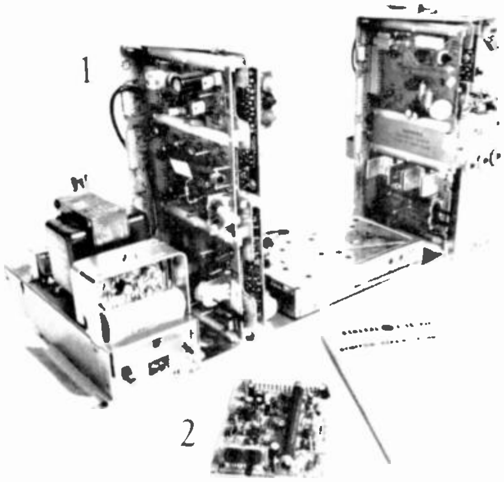
MIDWEST/Texas/Arkansas/Okla.
Ralph J. Bergen
The Ralph J. Bergen Co.
6319 N. Central Ave.
Chicago, Ill. 60646
(312) 792-3646

PACIFIC COAST/Mountain States
Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd., 4th Floor
Los Angeles, Calif. 90069
(213) 659-3810

420 Market St.,
San Francisco, Calif. 94111
(415) 981-4527

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

We're making it our business to make your business easier.



1

2

3

We've made the commitment to make General Electric the most serviceable TV in the industry. We began by bringing in panels of independent service experts to tell us how. And we listened. These are some of the results:

1. A CHASSIS STANDARDIZATION PROGRAM. The more standard chassis we make, the fewer you have to familiarize yourself with. So we're building more standard chassis. For example, our J chassis can be found in 19, 16 and 10-inch diagonal screen sizes.

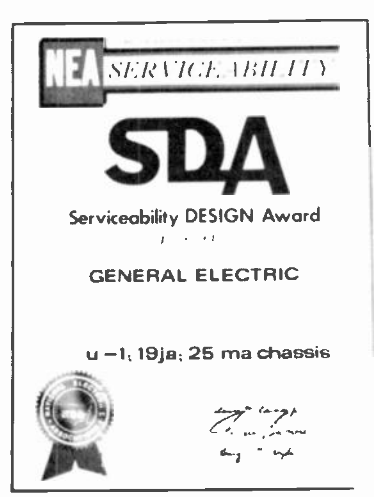
2. GE's MODULAR SOLID-STATE SETS SERVICE LIKE TUBE SETS. They're designed for one-call service in the home; and, believe it or not, are easier to service than a tube set. Also like a tube set, you can actually trouble shoot the problem while the set is operating. Then you have a choice. Either change the module or repair it.

3. AN STC PROGRAM DESIGNED TO TAKE THE "TOUGH" OUT OF "TOUGH DOG" SERVICE. The "S" stands for Symptom Repair Manual. It lists 60% of all faults and how to find them. The "T" stands for Trouble Shooting Flow Charts. These charts will take you through the next logical sequence of checks to find unlisted faults. These two service aids are designed to cope with 95% of all GE television problems. They were created to keep you from getting to "C"—time consuming Circuit Analysis.

4. A SERVICEABILITY DESIGN AWARD COVERING THREE CHASSIS. All three received a 90%+ NEA serviceability rating. And all three have special design features. Like modules, plug-in transistors and replaceable main circuit boards. The compact portables can be opened like a book for servicing.

There's a lot more. For additional information about the STC Program or any GE service question, call collect or write: "Dutch" Meyer, General Electric, Portsmouth, Va. (703) 484-3521.

4



GENERAL ELECTRIC

Circle 7 on reader service card

a cost breakthrough in distribution amplifier design!

Winegard's engineers have done themselves proud with this one — an amplifier that does the job at ⅔ the cost of competition* — and more importantly, without sacrificing all these important features:

HIGH OUTPUT LEVEL: 46 dbmv (200,000 microvolts) on each of 7 VHF channels at 0.5% cross modulation; 45 dbmv (178,000 microvolts) on each of 5 UHF channels at 0.5% cross modulation . . . enough to handle up to 48 taps without additional line amps.

HIGH INPUT LEVEL: Allows use in strong signal areas. 20 dbmv (10,000 uv) on each of 8 VHF channels, 22 dbmv (12,000 uv) on each of 5 UHF channels, both at 0.5% cross modulation.

HIGH GAIN: 26 db on VHF, 23 db on UHF for use in most reception areas.

LOW NOISE FIGURE: 3.6 db VHF, 6.0 db UHF for perfect color fidelity.

PASSES MID & SUPER BANDS (108-174 & 216-300 MHZ) — compatible with any CATV system.

LINE AMPLIFIER VOLTAGE to operate model L-213B or L-483B line amplifiers.

PLUS BUILT-IN FM TRAP, REGULATED POWER SUPPLY, LIGHTNING PROTECTION and more!

*Ask your distributor for full specs and prices, or write direct.

WINEGARD
TELEVISION SYSTEMS

Winegard Company
3000 Kirkwood Street
Burlington, Iowa 52601

Circle 8 on reader service card

letters

de FOREST COMMENTS

Radio-Electronics has received two letters calling attention to what the writers believe to be an error in the article "Lee de Forest—Father of Radio," which appears in the August 1973 issue. Both writers point out that the article errs in stating that de Forest was the discoverer or inventor of regeneration—which, in fact, was invented by E. H. Armstrong. The author's comments follow:

I was mildly surprised to receive only two letters on the subject, which would have been good for dozens just a couple of decades ago. Both of the authors appeared to be unaware that even Armstrong himself had dropped the claim of priority before the final 1934 trial.

The original Armstrong patent was based on claims of priority. It was "van Etten's notebook" that gave de Forest a pair of patents in 1924. These were immediately challenged by Armstrong, and a legal battle ensued that was not ended for ten years.

In the final 1934 case, Armstrong admitted the priority of de Forest, but claimed that his invention applied to signals of audio frequency only; that de Forest—even though he had noted that the frequency could be changed by varying the inductance and capacitance in circuit—did not understand that his invention would work up into the radio frequencies.

Such arguments—nonsense to radiomen—often worked in courts where knowledge of electronics (or even physics) was a rarity. The judge in this case appeared to have done his homework, and the decision very clearly states the situation. According to the decision, which says: "(Armstrong) says there was then no perception of thought that the Audion plate could be made to oscillate at radio as well as audible frequencies through a coupling of the circuits. This de Forest denies. He maintains . . . that he at once understood that by controlling the inductance or capacity in the oscillating circuit, he could also control the frequency . . . ."

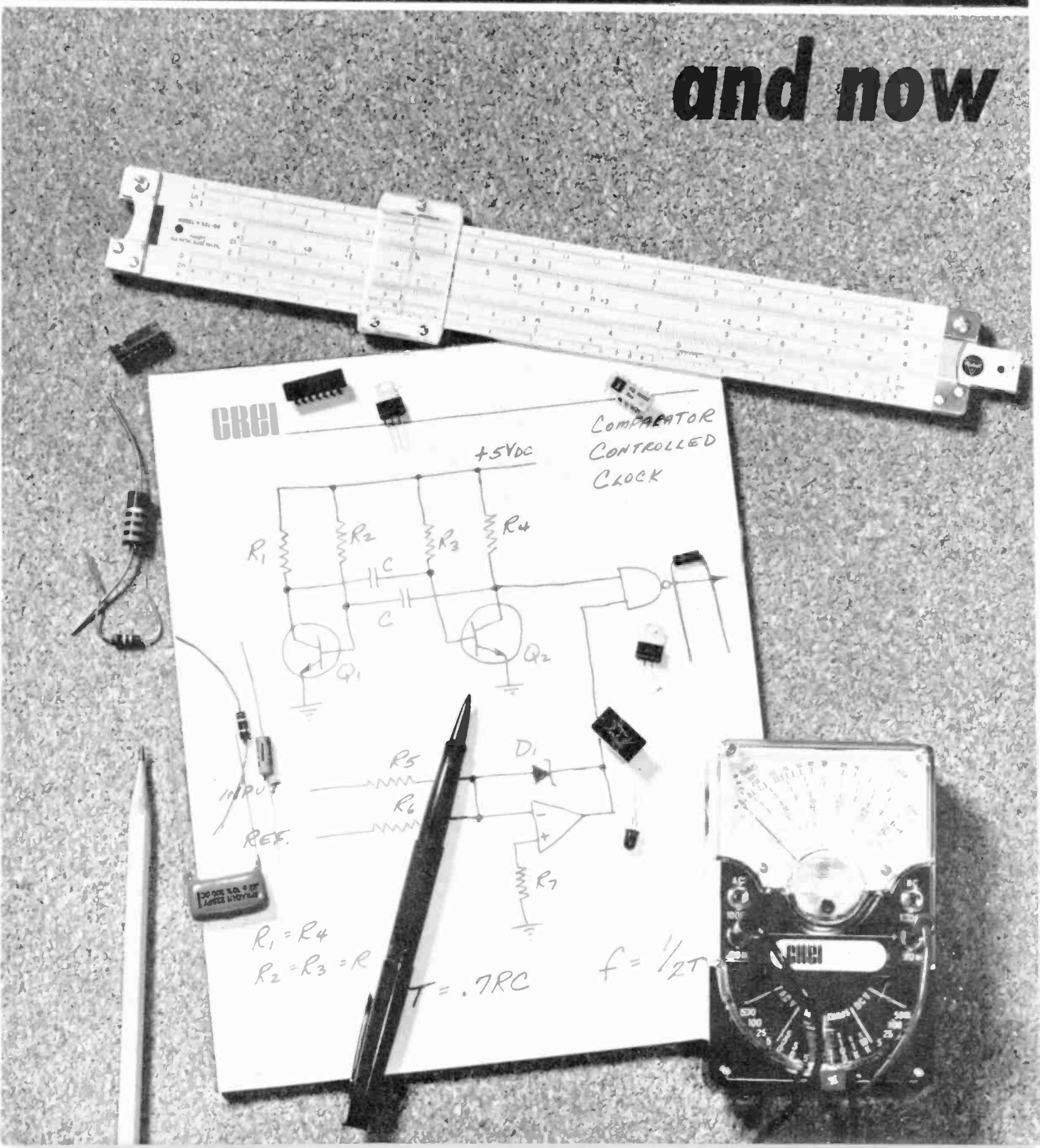
The decision goes on to cite evidence that de Forest discussed the use of the Audion at radio frequency with his assistants, and refers to the reception of radio signals from the San Francisco Beach station with a regenerative circuit.

The stature of Armstrong was so much greater in the minds of influential persons that Armstrong received a great deal of support. The incident of the returned award is often cited. However, it is doubtful that any of the Board who returned the award to Armstrong had read the decision. De Forest was a small-time operator—more often broke than not—and prudent businessmen had learned that putting money in a de Forest enterprise was only too often to make a permanent investment. Armstrong represented success and connections with powerful companies—in other words, respectability.

It is likely that today—as then—few radiomen would believe that a person could understand regeneration in audio circuits, yet believe that there must be some point in frequency where the effect would cease, and that the point was in the audio band. It seems especially absurd in de Forest's case, since he was much more at home with radio than audio.

FRED SHUNAMAN
Plainfield, N.J. *(continued on page 86)*

CRE[I]—the only home-study college-level training



program which gives you in electronic circuit design

<u>only</u> CREI offers you a complete college-level Electronic Design Laboratory to speed your learning

Electronic circuit design—source of all new development in the application of electronics to new products and services. Without this skill, we would be unable to monitor the heartbeat of men in space. Without it, the computer revolution would never have occurred. And we would have yet to see our first TV show. *Yet, only CREI teaches electronic circuit design at home.*

ELECTRONIC CIRCUIT DESIGN
A key skill which paces our nation's progress in countless fields—from pollution control to satellite tracking to modern medicine to exploring the ocean's depths. And beyond. A skill which *you* must have to move to the top in advanced electronics.

CREI programs open up new worlds of opportunity for you.

In addition to electronic circuit design, CREI provides you with a full advanced electronics education in any of thirteen fields of specialization you choose. Communications, computers, space operations, television, nuclear power, industrial electronics—to mention just a few of the career fields for which CREI training is qualifying. With such preparation, you will have the background for a career which can take you to the frontiers of the nation's most exciting new developments. And around the world.

This free book can change your life. Send for it.

If you are a high-school graduate (or equivalent) and have previous training or experience in electronics, then you are qualified to enroll in a CREI program to move you ahead in advanced electronics.

Send now for our full-color, eighty page book on careers in advanced electronics. In it, you will find full facts on the exciting kinds of work which CREI programs open up to you. And full facts on the comprehensive courses of instruction, the strong *personal* help, and the professional laboratory equipment which CREI makes available to you. All at a surprisingly low tuition cost.

And when you have it, talk with your employer about it.
Tell him you're considering enrolling with CREI. He'll undoubtedly be happy to know you are planning to increase your value to him. *And he may offer to pay all or part of your tuition cost.* Hundreds of employers and government agencies do. Large and small. Including some of the giants in electronics. *If they are willing to pay for CREI training for their employees, you know it must be good.*

Send for Advanced Electronics today. You'll be glad you did.

CREI Dept. E 1403E
3939 Wisconsin Avenue
Washington, D.C. 20016

Rush me your FREE book describing my opportunities in advanced electronics. I am a high school graduate.

Name ____________ Age ______

Address ____________

City ____________ State ______ ZIP ______

If you have previous training in electronics, check here ☐

Employed by ____________

Type of Present Work ____________

Veterans and servicemen, check here for G. I. Bill information ☐

CREI
CAPITOL RADIO ENGINEERING INSTITUTE
WASHINGTON, D.C. 20016

appliance clinic

MODULAR APPLIANCES

by JACK DARR
SERVICE EDITOR

EVERYTHING IS "GOING MODULAR" these days.

So, guess what? Yep. Modular electric appliances! One major appliance manufacturer has brought out a line of small household electric appliances, which can actually be taken apart and put back together "no-tools"! The parts are designed in subassemblies or modules which snap in, plug in or are latched in place.

This line includes four of the most common units, so far; a toaster, toaster-oven, electric percolator, and wonder of wonders (at least to those of us who have struggled to get the things apart for so long) an electric iron! A steam iron, too.

The iron is built in five major units; the soleplate, which includes the thermostat; the plastic water reservoir; the handle; the spray assembly, and the line cord. To take it apart, start with the cord. Slide a latch aside, and the cord comes out (see Fig. 1). Next comes the handle unit. A release lever knob under the reservoir unit is moved, and the whole handle lifts up and off (Fig. 2).

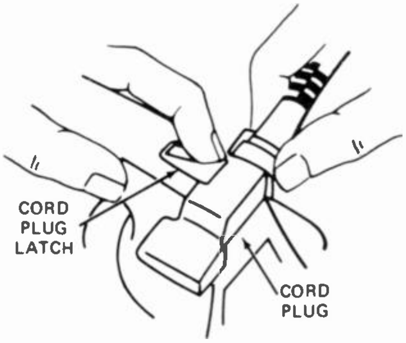


Fig. 1

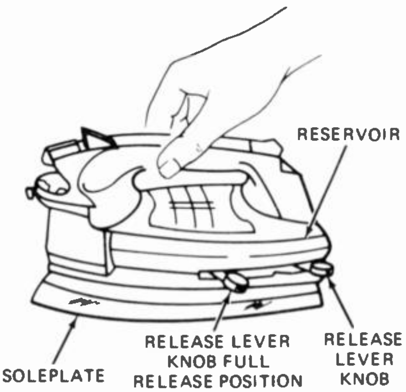


Fig. 2

The reservoir can then be taken off the handle unit, by pushing down on one end and sliding it out (Fig. 3). The

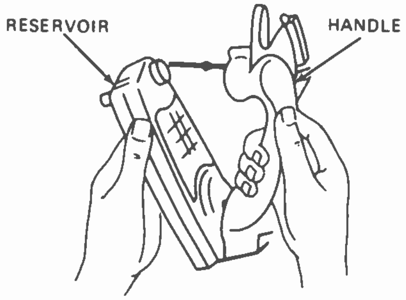


Fig. 3

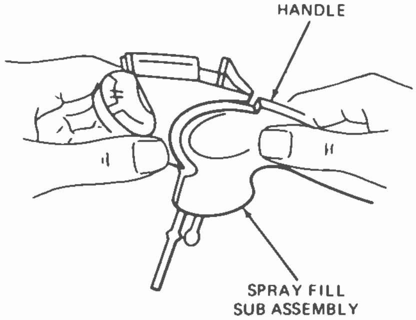


Fig. 4

spray pump and filler assembly then comes off, by lifting it up and away (Fig. 4). That's it. To put it back together, just go through these steps in reverse order and there you are.

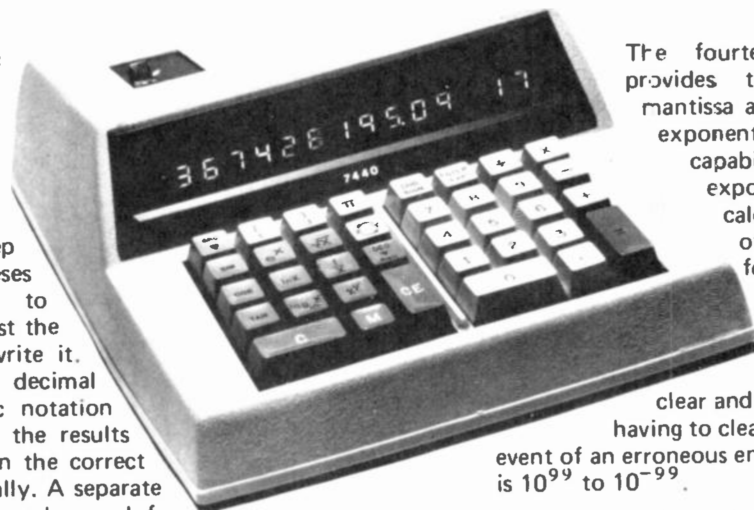
All of the standard tests can be used. As usual, most of the electrical troubles will be in the line cord. This is due to the normal flexing while in use. If the cord checks open, a replacement unit can be plugged in. The cord, by the way, can be changed from side to side, for the convenience of left-handed or right-handed users. Just reverse the plug on the handle.

The spray pump and water-drip to the steam unit are another common source of trouble. This is frequent in areas where tap-water has a fairly high mineral content. When the water is heated to steam, it may leave a hard mineral deposit which clogs up the tiny holes in the spray-pump or drip nozzle.

(continued on page 26)

The MITS 7440

Desk-Top Scientific Calculator — Your Assistant for Expert Results.



The 7440 Scientific Calculator does the basic arithmetic functions plus ten trancendental functions. Algebraic problem entry with two deep nesting parentheses make it possible to enter a problem just the way you would write it. Either floating decimal mode or scientific notation may be used and the results will be displayed in the correct manner automatically. A separate memory register can be used for storage of an intermediate result or of a constant. Trigonometric functions can be performed using either degree or radian entry. There is also a radian mode indication. Two convenience functions ($\sqrt{x}$, 1/x), a separate π key, and factor reversal (x↔y) are also featured.

The fourteen digit LED display provides ten digit precision for mantissa and two digit precision for exponent. There is full sign change capability for both mantissa and exponent, and full chain calculation with any sequence of functions desired. Also featured are automatic error indications for overflow, underflow, and forbidden operations. The thirty-six key keyboard has separate clear and clear entry keys to prevent having to clear the whole problem in the event of an erroneous entry. The calculation range is 10^{99} to 10^{-99}.

*Price: Kit . . . $199.95 Assembled . . . $299.95

KEYBOARD FUNCTIONS:

Sine • Arcsine • Cosine • Arccosine • Tangent • Arctangent • e^x • $\ln^x$ • $\log_{10}x$ • x^y • 1/x • Addition • Subtraction • Multiplication • Division

Programmer: Desk-Top Computer —

to be used with MITS 7440 desk-top scientific calculator.

- 256 programming steps with option of expandability to 512 steps.
- Program code for each function key on calculator.
- Two RUN modes of operation: continuous or step.
- Ability to look at any instruction in memory and/or its execution.
- Programs all calculator functions plus commands:
  A. "If neg", B. "Go to", C. "Return", D. "Remember", E. etc.

*Prices: Kit: Programmer . . . . . $199.95 Expansion: $79.95
Assembled: Programmer . . . . . $299.95 Expansion: $129.95

(Also models available to interface with MITS 816, 1440, and 908DM desk-top calculators.)

Warranty: Full two-years warranty on assembled units, ninety days on kits.
*Prices subject to change without notice. Available from your local Olson Electronics Dealer.

MITS INC. ®

"Creative Electronics"

6328 Linn, N.E., Albuquerque, New Mexico 87108
505/265-7553 Telex Number 660401

☐ Enclosed is a Check for $ ________
or ☐ BankAmericard # ________
or Master Charge # ________ RE-3-74
Credit Card Expiration Date ________ ☐ Kit
Include $5.00 for Postage and Handling ☐ Assembled
☐ Model 7440 ☐ Programmer ☐ 7440 & Programmer
☐ Please Send Information on Entire MITS Line
NAME ________
ADDRESS ________
CITY ________
STATE & ZIP ________
MITS/ 6328 Linn, N.E., Albuquerque, New Mexico 87108 505/265 7553 Telex # 660401

Circle 13 on reader service card

A good number of reasons

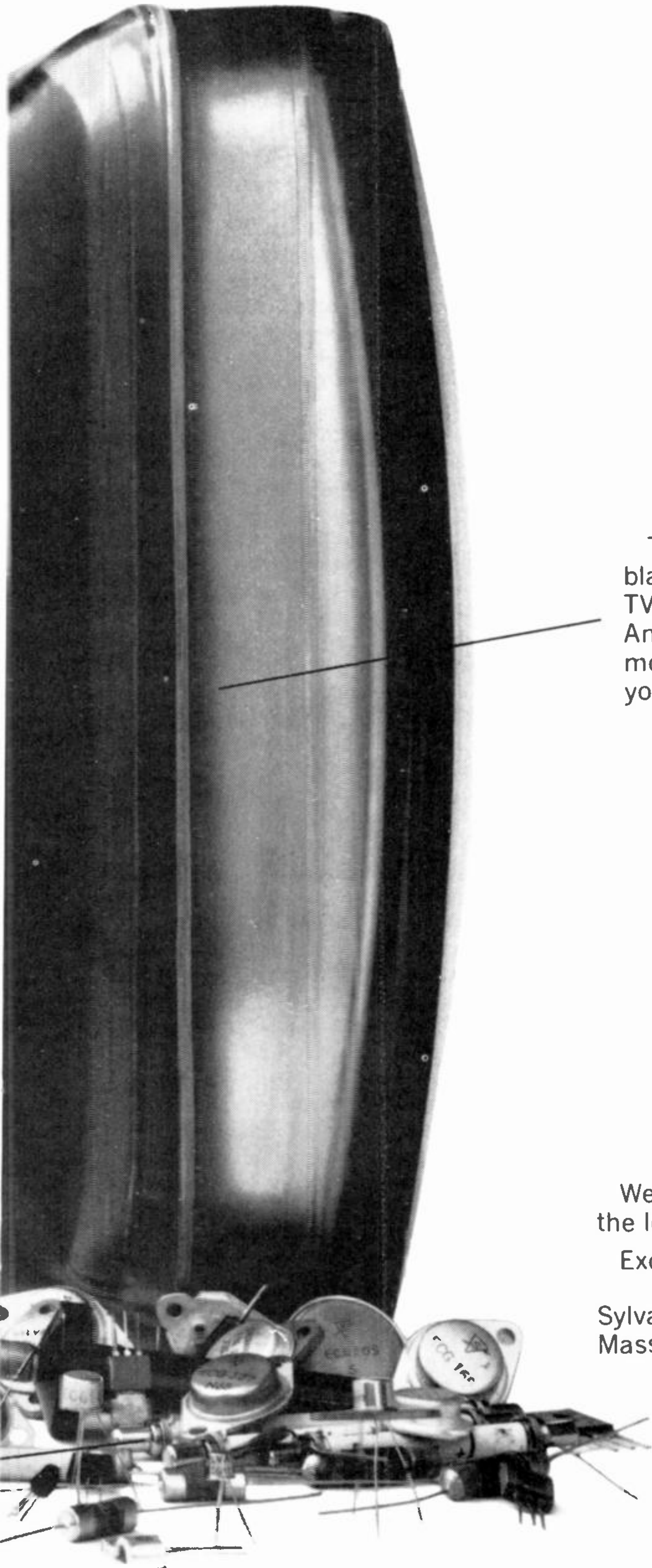
3,000,000,000

That's a lot of receiving tubes, but when you've been in the business as long as we have you're bound to have produced billions. In fact, our "Receiving Tube Characteristics" brochure (ET-1350), right now, lists over 2000 different tube types. Pick up a copy at your local distributor and see what made us a leader.

75,000

Who needs that many semiconductor replacement parts? You don't. Actually, what we have is an ECG Semiconductor Replacement Guide (ECG-212E) that will let you replace 75,000 parts with a total number in the low hundreds. That makes it easier for everybody to have a complete stock. And our Replacement Guide makes it easier to select the part you need right when you need it. Just pick up a copy of our Replacement Guide at your local distributor and you'll see why we're the leader.

why we're the leader.



55,000,000

That's how many cathode-ray tubes we've made. Both black-and-white and color. This year alone, we made more TV picture tubes than any other American manufacturer. And our Interchangeability Guide (ET-1496) lets you replace more tubes with fewer types. Get a copy of the Guide at your distributor. You'll see why we're the leader.

We've just given you 3,055,075,000 reasons why we're the leader. What more can you ask for?

Except Sylvania.

Sylvania Electronic Components, 100 First Avenue, Waltham, Mass. 02154

GTE SYLVANIA

APPLIANCE CLINIC
(continued from page 22)

The makers have thoughtfully included a spare rubber valve cap, and even a short piece of cleaning wire, just the right size for opening up the hole in the spray pump nozzle! (Which is great, for I never have a piece of wire of *just* the size I want)

If the drip valve in the plastic reservoir clogs up, so that the water doesn't drip into the steam unit (the soleplate) this can sometimes be cleaned with the wire. If it cannot, the whole plastic tank unit can be changed at a reasonable price. The use of distilled water will help to avoid this problem, in "hard-water" areas. This is available at drugstores and auto-supply stores, in bottles of several sizes.

The "Modular Percolator" is made in seven units, which include all of the "pieces" inside the bowl—the coffee basket, lid, etc. The heating element is a sealed unit, locked inside the plastic base.

The heating element is designed so that it can be replaced by simply turning a locking-knob on the underside of the base. A special bracket is used on the element; it cannot be taken out unless the appliance plug is removed. This eliminates any possibility of electrical shock to the repairman or user. If the element is bad, a new one is simply slipped into place, and the locking knob turned to the "Closed" position; that's all.

The toaster units are made in the same way. All parts can be removed by lifting latches or levers. The toaster-oven is a combination pop-up toaster and "table-oven", made in the same way. All parts can be taken off and put back without tools.

Complete, well-illustrated instructions and service manuals come with each unit. The complete disassembly and reassembly process is illustrated, so that even the novices can do the job. This should make life quite a bit easier for the home handyman. However, he won't have any excuses left, not even the original one about "I can't find my favorite screwdriver!" Oh well; you can't win 'em all.

Thanks very much to the SCM/Proctor-Silex Co. for the illustrations and service manuals.

R-E

COMING IN APRIL

A complete security system for your home will help you protect your loved ones and your property. In the April issue we will show you how to build your own system, using readily available parts. Don't miss it. April 1974 issue goes on sale March 18.

After so many high-fidelity and consumer publications rated our HD 414 "open-aire" headphones tops in sound, comfort and value, why would Sennheiser introduce another model?

The reason is perfection.

Not that our new HD 424 is perfect. But our engineers—the same engineers who developed our dynamic and condenser microphones for the recording industry—have made some significant advances. Enough, we feel, to warrant a new model. Enough, that a certain kind of music lover will appreciate the added fidelity, despite the added cost.

The primary difference is response. As linear as our HD 414 is, the HD 424 boasts even greater accuracy—particularly at low bass and high treble frequencies. Due to an improved transducer assembly and redesigned earpiece geometry. Heard on the HD 424, low organ notes assume an additional, fundamental richness without sacrificing the "tightness" of good transient response. While violins and other high-overtone

Sennheiser HD 414 "open-aire" headphones. Rated "best" by everyone.

instruments retain the additional "transparency" their overtones produce.

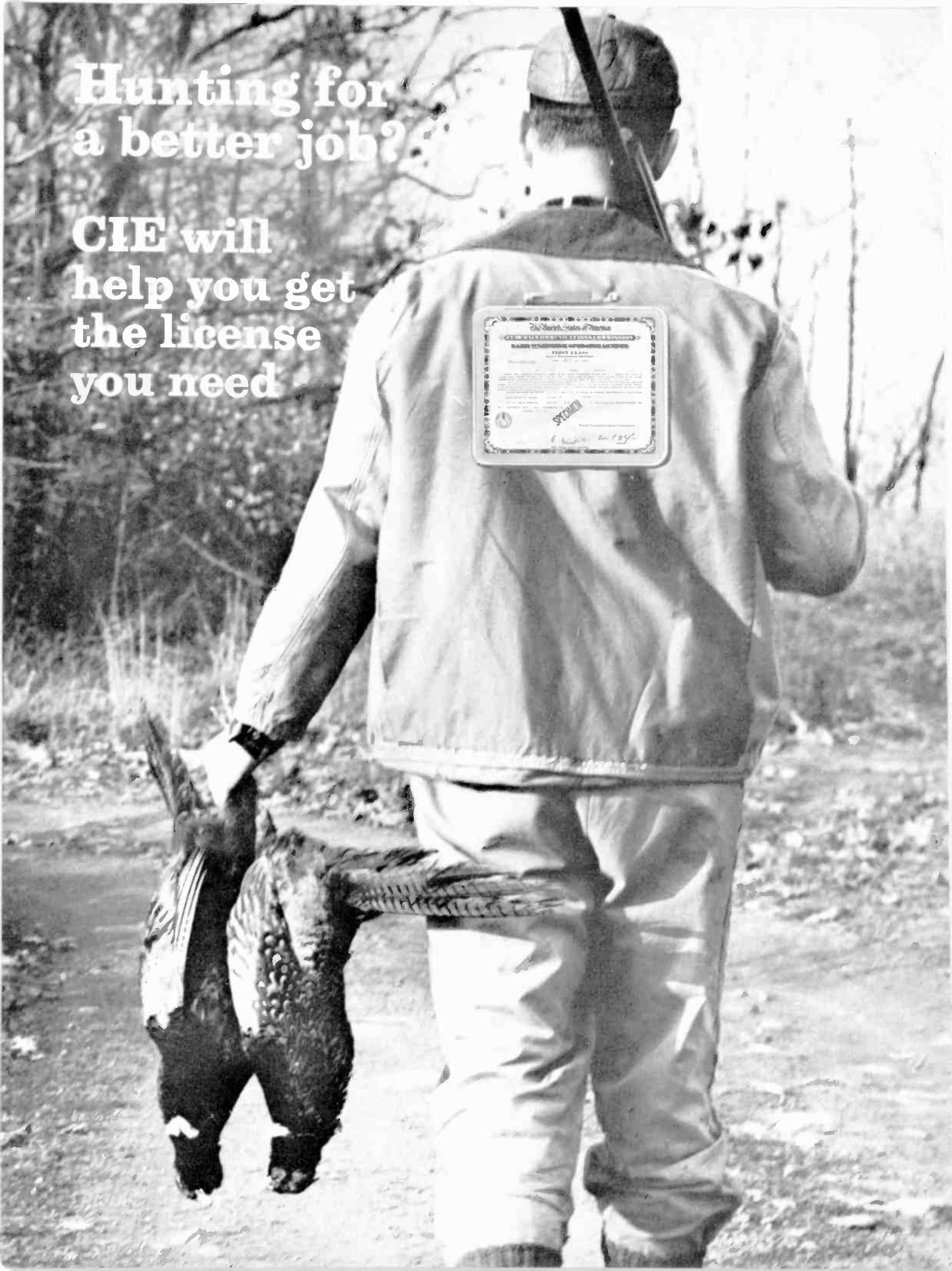
No less important, especially for long listening sessions, is comfort. Retaining the "unsealed" free-air feeling so many praised in the HD 414, the new HD 424 provides even less (!) pressure on the ear, distributing it over wider, thinner acoustically transparent cushions. For this reason—and an improved, cushioned head-band—the HD 424 actually seems lighter than the 5 oz. HD 414, even though it is slightly heavier.

Now, there are two Sennheiser "open-aire" headphones for you to choose from. The HD 414, rated best for sound and comfort. And a new model offering something more. That's why.

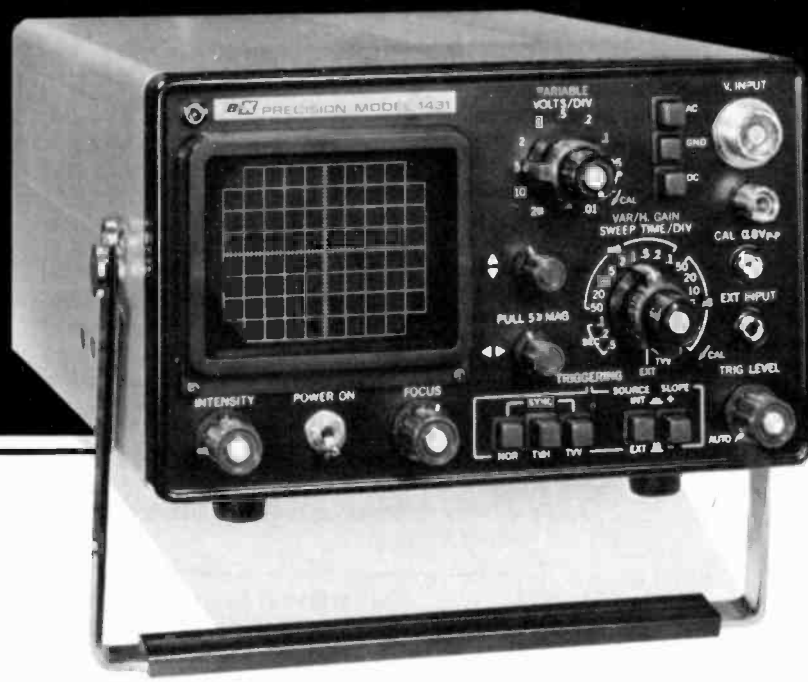
Hear them both at your Sennheiser dealer, or write us for more information. Sennheiser Electronic Corporation, 10 West 37th Street, New York 10018.

Manufacturing Plant: Bissendorf, Hannover, West Germany

Circle 15 on reader service card


Hunting for a better job?
CIE will help you get the license you need
SPECIMEN

This 10 MHz Triggered Scope is 1/3 the size of comparably performing scopes.



MODEL 1431 $399.95

It's a lightweight 13 pounds in your hand and a heavyweight performance wideband scope with a 35 nanosecond rise time on your bench or jobsite. Whether you're servicing or designing industrial equipment or TV, there's the right sweep speed and sync for easiest operation. If you know our Model 1460, the leader in wideband 5" CRT scopes, you know our new 3" Model 1431 which gives you the same high performance in one third the size. (Only 4¾"Hx7⅞"Wx12⅞"L)

Shown with optional carrying cover and probe pouch.

Servicing, production, inspection, quality control and lab applications are all easier with this versatile all solid-state instrument. Triggering is accomplished with only 0.5V peak-to-peak. Ten millivolts per division sensitivity, 0.5 usec/cm to 0.5 sec/cm automatic and triggered sweep in 19 calibrated ranges, and external trigger input are just a few of the reasons you'll like it.

If you have been waiting to buy a portable scope until you could get all the features you'll ever need at a price you want to pay, you've been waiting for Model 1431. Contact your distributor or write Dynascan Corporation.

B&K PRODUCTS OF **DYNASCAN**

1801 W. Belle Plaine Ave.
Chicago, IL 60613 • (312) 327-7270

Circle 17 on reader service card

The New SQ Generation

Systems for quadriphonic phono reproduction have evolved around several forms of matrixing. Our Hi-Fi Editor discusses the system that may become the standard in the United States.

BY LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

WHEN SQ QUADRIPHONIC DISCS AND decoders first appeared on the market CBS Laboratories who developed the system made much of the fact that full left-to-right separation was maintained through the entire encode-decode process. While it is true that a simple decoder yields a left-front signal that has no right-front content (and vice-versa) the same left-front signal will produce 71% of right-back, left-back and center-back reproduced signals, even though these signals were not instantaneously present in the original, discrete four channel program. This situation is shown in Fig. 1. Benjamin Bauer, developer of the SQ system, prefers to depict the decoded signals in the various channels by using "phasors" or vectors which at once denote both amplitude and phase of the various signal contents to each speaker. In the case of a simple SQ decoder, then, the "phasor" diagrams for each channel would appear as in Fig. 2. Note that this presentation confirms the numerical results in dB shown in Fig. 1 (0.71 of something is 3 dB lower than that something). Note that there is no R_b content in L_b nor is there any L_b in the R_b speaker output, but there is left front, right front, center-back and even center-front information all attenuated by only 3 dB.

In the absence of sophisticated logic circuits, even the less critical quadriphonic listener found that more front-to-back separation was needed to create a surround-sound for the listener located anywhere but in the exact center of the listening room.

10-40 blend

In 1971, CBS decided that perhaps some of the side-to-side separation which at first seemed so important might be sacrificed in favor of greater front-to-back separation. The result was the so-called 10-40 blend scheme

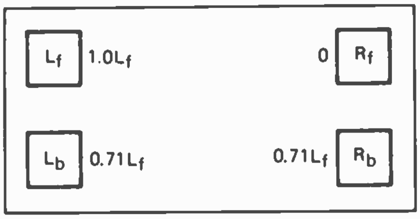


FIG. 1—WITH AN L SIGNAL applied to the SQ encode-decode system, complete separation is achieved only at right-front speaker system.

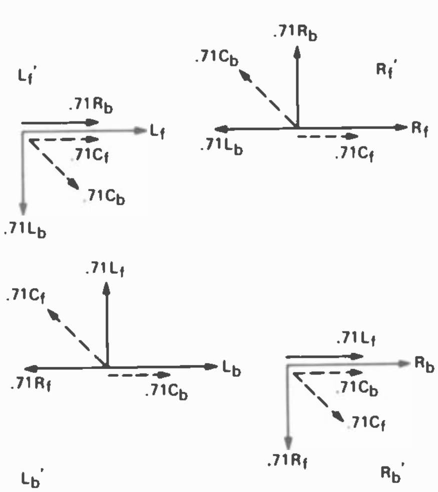


FIG. 2—PHASOR DIAGRAMS used to represent speaker outputs when all channels (plus center outputs) are present in SQ encoded disc and are decoded with basic matrix decoder.

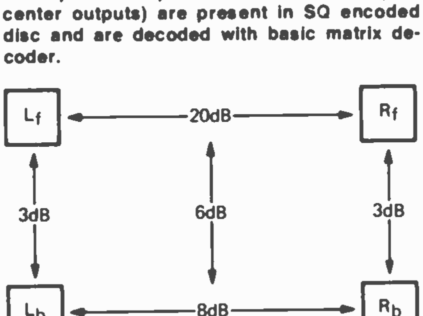


FIG 3—CENTER-FRONT TO CENTER-BACK separation improved at the expense of left-right separation, using 10-40 blend arrangement.

which was accomplished by a simple cross-blending of front and rear decoded channels using a couple of inexpensive resistors. 10% blend was used across the front channels and 40% was used across the rear outputs. Without getting into the mathematics of this modification the results can be diagrammed as shown in Fig. 3. Note that front-to-back separation is now improved to 6 dB while L_f to R_f separation is reduced to 20 dB—not really much of a sacrifice since most phono cartridges don't do much better than that even when playing conventional stereo records. The 10-40 blend scheme adds practically no cost to an SQ decoder and is used in a majority of lower priced products.

Logic control signals

The encoded signals from an SQ disc (prior to any decoding) are shown as the "phasor" composites applied to terminals "A" and "B" of Fig. 4. At these terminals, signals 0.71 C_f are in phase, while signals 0.71 C_b are out of phase. If the signals were added together C_b would be cancelled while if one of these signals was subtracted from the other, C_f would be cancelled. Such processing would provide a control voltage to determine if matrix

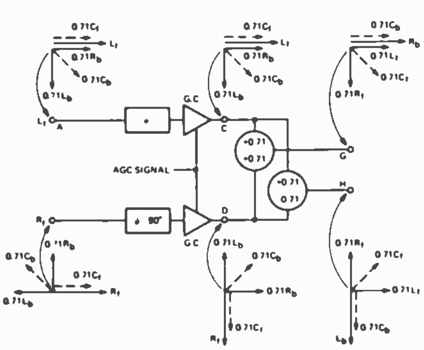


FIG. 4—DERIVATION OF FRONT-BACK and wave-matching logic signals.

power should be shifted to the front or back—providing a means for front-back logic.

Similarly at terminals C and D in Fig. 4, signals 0.71 R_b are in phase while signals 0.71 L_b are out of phase, since the composite inputs have been rotated by 90° with respect to each other. The two signals could be added and subtracted to determine the presence or absence of an L_b and R_b corner signal and a new form of control voltage could thereby be derived.

In actual practice, if the signals at terminals C, D, G and H are first rectified and then subtracted in pairs, control voltages are derived. For example, suppose only L_f and R_f signals are present at a given instant. If we perform the subtractions of signals C−D and G−H the rectified waves of L_f and R_f at C and D, being different in signal content, will have dissimilar waveforms and the subtracted result will be finite. The waveforms 0.71 R_f at terminals G and H are equal in magnitude and are either in phase or out of phase. When rectified they will "match" each other and when subtracted will produce zero output.

Similarly, if signals R_b and L_b are present, the equivalent 0.71R_b and 0.71 L_b at the C and D terminals will wave-match upon rectification and subtraction and produce no output while at G and H a finite output will result. In other words if C−D signals are greater than G−H (after rectification) that provides a clue that signals L_f or R_b are present while if C−D signals are less than G−H signals, L_b or R_b signals are present. This technique provides a means for developing a control voltage with which to transfer the matrix power to the front or back channels depending upon the presence of front or back corner signals. CBS calls this approach "wave matching" logic.

Applying logic control signals

Fig. 5 shows, in block diagram form, how the control voltage developed from front-back signal relationships or from the wave matching technique can be applied in an actual SQ decoder. The signal voltages produced from a simple SQ matrix decoder are shown as four generators having an internal impedance. Identified by the usual designations L'_f, R'_f, L'_b and R'_b they are applied to appropriate corner loudspeakers through variable gain amplifiers J, K, M and N. Since a "basic" matrix is used in this instance (without 10-40 blend) side-to-side separation is excellent and only front-to-back separation needs enhancement.

Suppose first that an L_f signal is present in the encoded input. The wave-matching logic recognizes this as a front signal and proper bias voltages are applied to terminals P and Q so that the gains of amplifiers J and K are increased approximately 3 dB while the gains of amplifers M and N are reduced by 14 dB. Total power corresponding to the original L_f signal in the listening room remains essentially constant while front-back separation is improved from a minimal 3 dB (without logic) to almost 20 dB.

As the sounds in the various channels appear and decrease, the logic continuously modifies the circuit by varying the gains of the four gain-controlled amplifers so that sounds are given proper dominance in their respective channels while total power of the signals remains constant. Both front-back and wave-matching logic can be utilized by applying the control signals to terminals P and Q in Fig. 5.

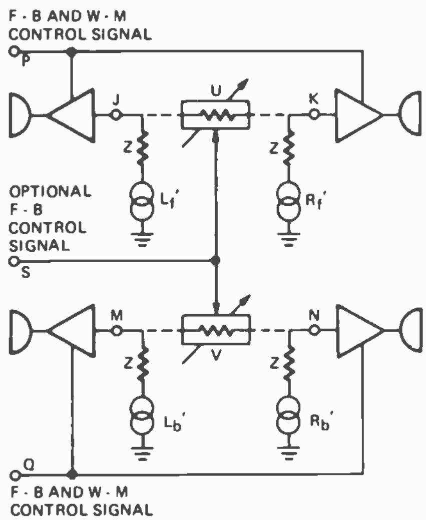


FIG. 5—CONTROL OF MATRIX gain using logic signals developed from circuits of Fig. 4.

Of course, as multiple musical signals appear simultaneously, the logic becomes progressively less active. CBS maintains however, that adequate logic action remains even under such conditions since it becomes more difficult for us to follow the action of individual program sources even in the case of "discrete" four-channel reproduction when all four channels are producing approximately the same power output, however different their musical content might be.

Improved separation

The separation diagram of Fig. 6 shows separation capability using only front-back logic and minimal 10-10 blending. Note that with this arrangement front-back separation is increased to 10 dB (compared to 6 dB in the 10-40 blend arrangement shown earlier) while back left-to-right separation is improved from 8 dB to 20 dB—equal to the left-right separation up front.

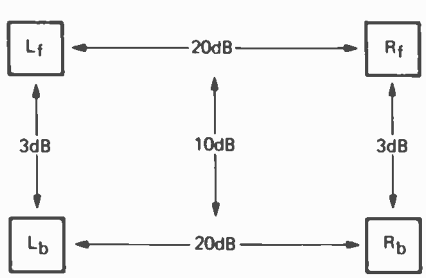


FIG. 6—SEPARATION ACHIEVED with front-back logic and minimal 10-10 blend. Note improvement in back left-to-right separation as well as front-back separation compared to passive 10-40 blend arrangement.

Fig. 7 shows what happens to separation when both front-back and wave- matching logic control voltages are used. Now, for single-channel signals at least, separation in every direction is improved to a full 20 dB.

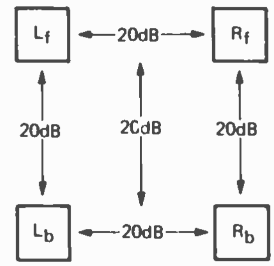


FIG. 7—FULL 20 DB OF SEPARATION is obtained for fixed signals in every direction using front-back and wavematching logic plus 10-10 blending.

Variable blend logic

As explained earlier, fixed blend across the front and rear pairs of outputs of an SQ matrix decoder can improve separation between center front and center back signals. It does so at the expense of some side to side separation. CBS has developed a system that substitutes dynamic or variable blend for the fixed blend scheme. Referring again to Fig. 5, a front-back control signal can be applied to terminal S and thereby varies the values of voltage-controlled resistors U and V. In the absence of a center-front or center-back signal, these blend resistors are effectively an open circuit (infinite) and full left-right separation exists between front and back channel pairs. The moment a center signal appears, the control voltage applied at terminal S reduces the values of resistors U and V and a measured amount of cross blending takes place. By adjusting the amount of this blend and the attack and decay time of the blend control signal, very effective front-back separation is achieved with little audible loss of separation between front or back channel pairs. The diagram of Fig. 8 shows instantaneous separation capability when variable blend is substituted for the previous form of front-back logic and used as an adjunct to the wave-matching logic already discussed. sed.

Decoder circuits using this latest technique are already available for consumer use and both Sony and Lafayette Radio are marketing the circuit in a complete receiver.

In their very excellent technical paper presented before the AES convention in Rotterdam in February 1973, Ben Bauer, Richard Allen, Gerald Budelman and Dan Gravereaux, all of CBS Labs, predictions of even more sophisticated SQ decoding are made. They envision the use of signals in one branch of the decoder to selectively cancel the transferred signals in other branches as a

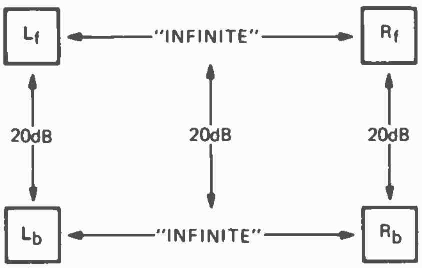


FIG. 8—SUBSTITUTING VARIABLE-BLEND for front-back while retaining wavematching restorer full side-to-side separation inherent in SQ system while maintaining good front-back separation.

function of logic demands and indicate that such approaches are currently under investigation and have been dubbed "paramatrix." The ultimate goal of these efforts is, of course, infinite separation in every direction as shown in Fig. 9. If successful, the industry might well ponder the need or justification for so-called "discrete" discs (CD-4 Quadradiscs, etc.).

In discussing separation capability, we often lose sight of the fact that most

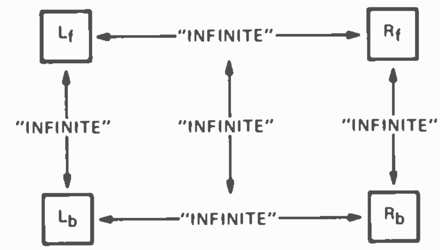


FIG. 9—THE ULTIMATE GOAL OF CBS Lab experiments with "paramatrix" logic circuits would be "infinite" separation in all directions. This has yet to be reached.

phono cartridges have a built-in separation capability of not much more than 20 or 25 dB to begin with, and that applies to mid-frequencies. At high-frequencies, separation capability of cartridges generally diminishes rapidly. This is equally true of the new CD-4 cartridges, despite their super-high frequency response and specially shaped stylus tips.

In a practical sense, these discussions tend to ignore listening-room effects and the limited ability of most listeners to truly perceive channel separation in excess of about 10 dB even under the very best controlled listening conditions. It's one thing to develop special test records, using spot announcements designed to be heard from one channel at a time, with complete absence of sound from the other three channels.

It's quite another thing to listen to properly orchestrated musical selections which invariably call for a certain amount of cross-blending even in their original encoding. Many of us remember the early "gimmicked" stereo records which served to introduce us to stereo sound back in the early '60's but were hardly aesthetically or musically satisfying. Ultimately, such "sales aids" were overshadowed by recordings having greater artistic integrity. The same pattern will probably hold true with respect to quadriphonic discs. Only when that happens will we listeners be able to judge the merits of the most sophisticated SQ logic decoders versus the merits of "discrete" discs played through ever improving demodulator circuits using new CD-4 cartridges.

Until that time comes, equipment manufacturers continue to play it safe, by providing both kinds of playback circuitry in their newer products. If this appears to be even a partial catering to "built in obsolescence", bear in mind that the eventual dominance of either matrix or discrete records is a long way off. Even if it should come, the then useless circuits in your new quadriphonic receiver or amplifier will represent a very small percentage of your total investment—well worth it when you consider the years of pleasure in listening you will have had from the discs made using the "losing" system. R-E

MATRIX-TUBE PURITY SET-UP

The matrix (black-surround) tube purity set-up requires greater yoke positioning accuracy than a non-matrix tube to eliminate color fringing—regardless of whose matrix tube is being considered. For the job you need a degaussing coil, a

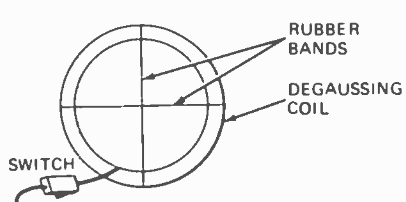


FIG. 1

12-volt dc supply, two long rubber bands and a 24-inch straight edge.

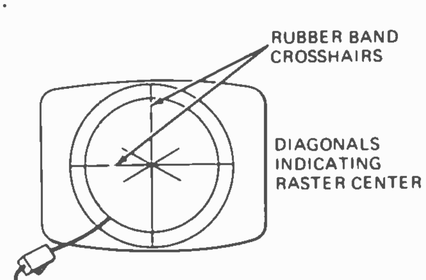


FIG 2

The procedure is as follows:

1. Stretch rubber bands on degaussing coil (Fig. 1) to form a cross-hair arrangement.

2. Draw diagonals on the raster to find its center (Fig. 2).

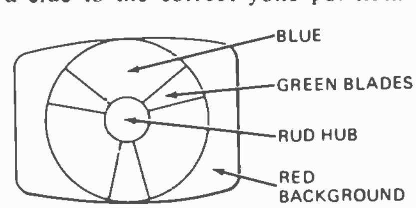
3. Turn off all but the RED SCREEN control.

4. Hook 12-volt supply to degaussing coil.

5. Center degaussing coil on raster (Fig. 2).

6. Turn on 12-volt dc supply.

[Note the pattern: It should look like a 3-bladed green propeller with a red hub on a red background, with some blue in the areas between the blades (Fig. 3). The position of the blades is a clue to the correct yoke position. Two of the



F G.3

green blades should be pointing directly into the raster corners—either top or bottom—with the third blade pointing vertically, up or down.]

7. Center the red hub on the diagonals crossover point with the centering tabs.

8. Loosen yoke wing bolts and move yoke forward or back until the green blades are located correctly in the raster corners, then tighten wing bolts.

9. Hook degaussing coil to 117 volts ac and demagnetize the picture tube for a pure red raster.

10. Check green and blue rasters for purity.

11. Set up gray scale.—*Sylvania Service Notebook*

PANEL SPEAKER DESIGNS

The flat non-cone loudspeaker has substantial advantages and some important disadvantages. This article presents both so you can draw your own conclusions

DONALD D. GRIEG and HERBERT SCHOENGOLD

THE FAMILIAR CONE SPEAKER HAS BEEN AVAILABLE FOR MORE than 45 years, and during this period there has been remarkably little change in its basic design. There have been changes in material, improvements in magnetic structures and more efficient manufacturing methods which have substantially lowered costs. But the fundamental method of construction has not changed since Rice and Kellog first described the dynamic loudspeaker back in 1925. This represents a unique case of technological longevity particularly in view of some rather fundamental drawbacks of the device.

To produce sound over a wide range of frequencies the conventional dynamic speaker attempts to solve the problem of low mass and high stiffness ratio by arranging the reproducing element in the form of a cone. While this is an ingenious solution that provides necessary stiffness without sacrificing mass, a severe penalty is paid in the form of a substantial reduction in radiating efficiency relative to the diameter of the cone. To provide a given sound level in the listener's direction, the cone displacement must be substantially increased and this requires a large driving force.

The magnetic structure necessary to produce the increased displacement becomes heavy and bulky. Linearity suffers from the difficulties of maintaining uniform fields and proportionate coefficients over the larger throw. Further, since the cone is a three-dimensional structure it must be supported at the apex as well as at the rim to maintain the voice coil within the magnetic gap. These restraints add to the mass, affect the stability, restrict the frequency response, and further reduce the sensitivity and conversion efficiency. To properly support the bulky structural elements of the speaker a heavy metal frame or "basket" is required. This in turn can give rise to secondary effects such as rim reflections and distortion in the gap fields.

Over the years there have been numerous attempts to eliminate these shortcomings. One key approach has been to utilize a flat diaphragm in place of the cone structure, but until the availability of low mass cellular materials practical designs were not feasible. There has been a continuous series of improvements and refinements to the point where the cellular material "wafer" or "panel" speaker not only has become practical but these new designs have begun to replace the conventional cone speaker in many applications.

Theoretical considerations

Loudspeakers reproduce sounds by the mechanical motion of a loosely-supported, rigid diaphragm or "piston." The magnitude of the sound produced as a function of a wavelength depends not only on the amplitude of the displacement, but also on the size of the piston and the degree to which any rear wave produced is prevented from cancelling the front wave. Assuming this cancellation is suppressed by mounting the speaker in an infinite baffle or other equivalent enclosure the relative sound output at any given frequency is governed by the so-called "radiation resistance" that the speaker sees.

Figure 1 illustrates the radiation resistance per unit area of a piston mounted in an infinite baffle as a function of the ratio of the piston circumference to the radiated wavelength. From the curve we see if we want to increase acoustical power at a given wavelength or frequency, we need only a larger piston or diaphragm area. While this is theoretically feasible, there are a number of physical limitations imposed on increasing the size of conventional cone speaker

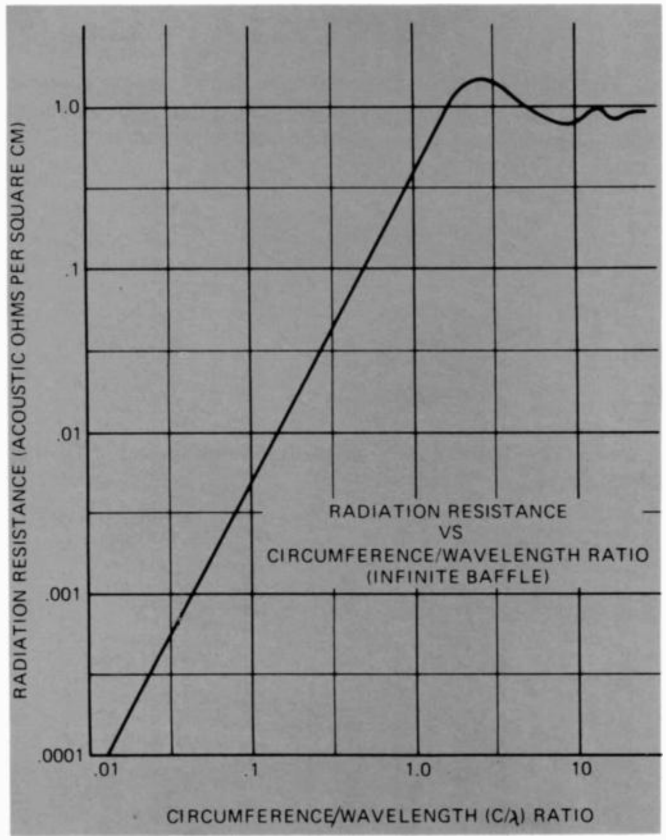
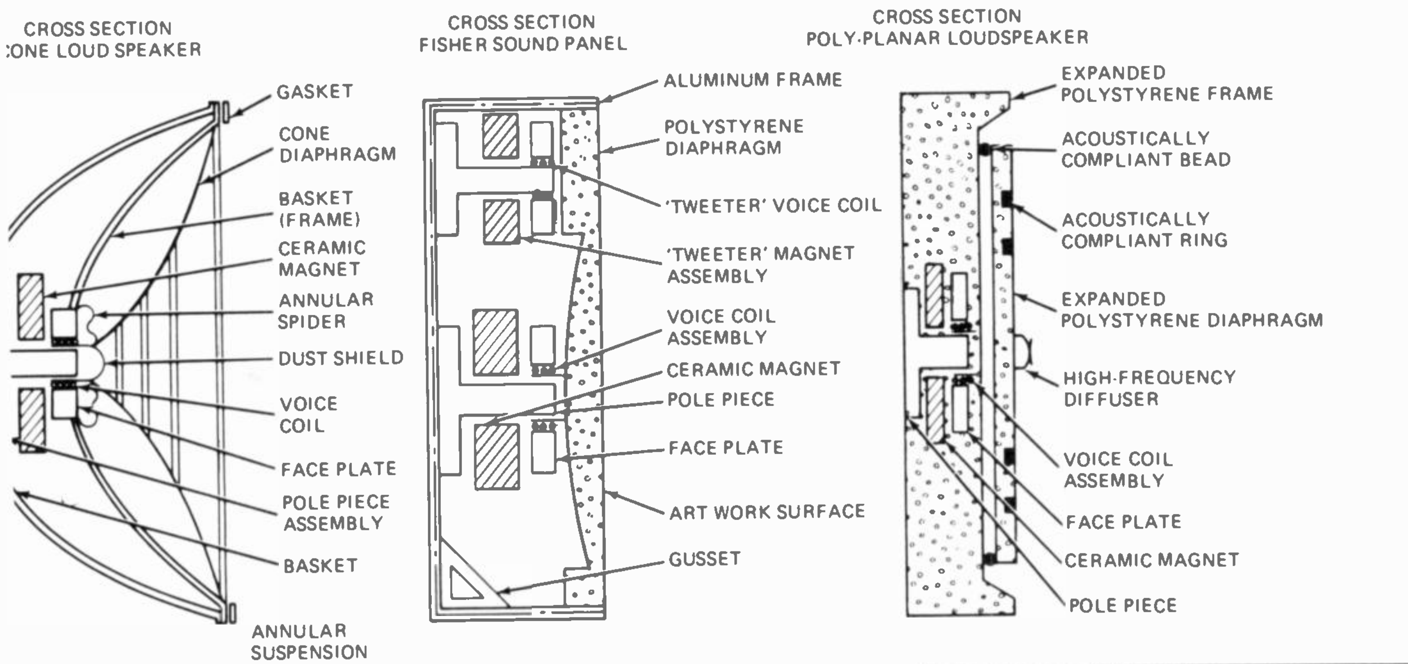


FIG. 1—RADIATION RESISTANCE per unit area of a piston mounted in an infinate baffle.

A NOTE ABOUT THE AUTHORS

Mr. D. D. Grieg is a well-known contributor to the electronic and related fields. He was with the International Telephone & Telegraph Co. for many years where he was Director of their Special Projects Laboratory. He also served as Director of Engineering for University Loudspeakers Inc. Currently he handles technical and administrative responsibilities at ERA Acoustics Corporation, Moonachie, N.J. Mr. Grieg is a Fellow of the IEEE, the author of many basic technical papers, and holds over 185 patents in the electronics fields.

Mr. Herbert Schoengold is a pioneer and experimentor in the hi-fi field. He spent many years as a development engineer with Racon Sound Systems and University Loudspeakers and was responsible for many innovations in the loudspeaker field. He is currently Chief Engineer with ERA Acoustics Corporation, Moonachie, N.J. Mr. Schoengold has contributed directly to panel and wafer speaker designs and holds several patents in this area of loudspeaker design.



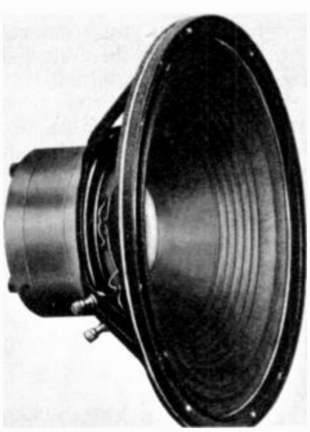
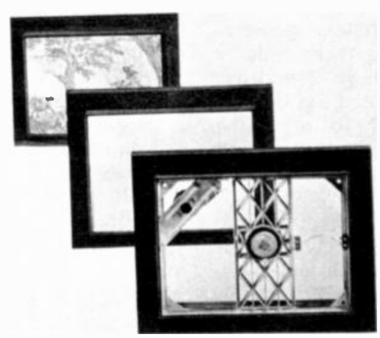
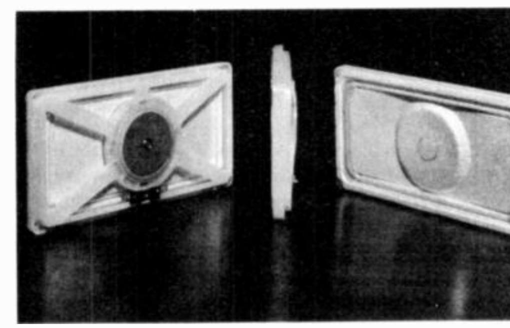




FIG. 2—CROSS-SECTION DIAGRAMS and photos of three popular types of speakers. (left) Cone loudspeaker. (center) Fisher Sound Panel. (right) Poly-Planar loudspeaker.

diaphragms. When a cone made of molded paper becomes too large it tends to become unstable, starts to flex and produces breakup.

The larger the cone the deeper it must be made to maintain rigidity which further accelerates the mechanical instability. Also, the effective radiating area of a cone diaphragm varies as the cosine of its apex angle and hence its circumference must be further increased to compensate. In effect, as the apex angle increases, the cone approaches a cylindrical configuration and becomes less and less effective as a piston for pushing air. From the preceding it is obvious that a flat panel acting as a piston is more efficient for producing maximum acoustical output at a given frequency, as long as it has the qualities of sufficiently low mass and adequate rigidity.

If a loudspeaker was required to reproduce only a single frequency or limited to a narrow band of frequencies, its design would be comparatively simple. Unfortunately, a loudspeaker is generally called upon to reproduce a wide band of frequencies perhaps in excess of 10 octaves and to accomplish this within a small variation of amplitude and phase. One way to get wide-band performance is to divide the piston into separate segments with each segment reproducing a small portion of the desired spectrum. With cone speaker design this generally evolves into separate speaker units; i.e., woofer, mid-range reproducers, tweeter, etc., and accompanying electrical coupling or crossover networks. With a flat diaphragm multiple drivers can be used on a single panel and it also becomes feasible to design a single panel in such a manner so as to operate as if it was a multiplicity of separate pistons.

An additional factor which affects the performance of loudspeakers is rim reflections occurring between the edges of the diaphragm and the supporting frame or "basket" of the loudspeaker. A further factor is the transverse sound propagation through the diaphragm material itself. These anomalies can add resonant peaks or anti-resonant valleys to the frequency response and detract from the smoothness of the frequency response characteristics. To aid in eliminating edge reflections, the conventional cone speaker uses special damping materials between the edge and the supporting frame. This unfortunately introduces additional problems in the form of increased mass, changes in compliance, etc.

A different approach can be taken where the flat panel is made of material such as cellular polystyrene. The supporting frame can be made of similar material which acts as an acoustical match. Edge vibrations can be absorbed by the frame material and sufficiently attenuated so that reflections are minimized. With respect to transverse vibrations, the inherent stiffness of conventional diaphragm materials such as saturated paper as used in the cone speaker, encourages the propagation of such vibrations through the diaphragm. Where a cellular diaphragm material is used, this mode of transmission through the sound-absorbing cell structure can be substantially attenuated.

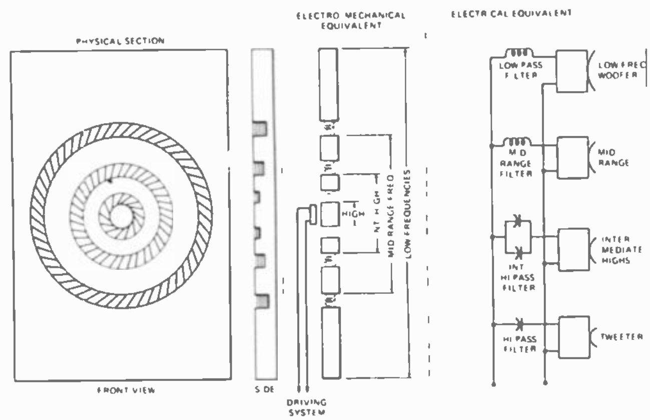


FIG. 3.—SCHEMATIC DRAWING showing mechanical and electrical action of Poly-Planar speaker.

Commercially available flat speakers

In recent years a number of manufacturers have introduced different versions of the flat speaker. The most interesting include the Planex Sound Panel of the Fisher Radio Company and the Poly-Planar types manufactured by ERA Acoustic Corporation. The Fisher approach is said to originate as a result of a recent Argentina design while the Poly-Planar method is based on a design originally introduced by the hi-fi pioneer, Abe Cohen, back in 1966. Figure 2 illustrates cross sectional views of the conventional cone speaker as compared with these two types of flat speakers.

The Fisher types of unit uses a magnetic structure located at the center of the larger panel. This structure serves to reproduce the low and mid frequencies. To accommodate the higher frequencies, a second magnetic structure is mounted at the periphery of the panel which causes a smaller section of the panel to vibrate at the higher frequencies.

The ERA Poly-Planar design operates in a similar fashion but with some basic differences. A single magnetic driver is used to reproduce lows, mids, as well as highs. This is done by inscribed channels in the diaphragm. The width, depth, and placement of the channels are determined by the desired frequencies of operation. At low frequencies the entire panel moves as a single element. As the frequency increases the channels act to decouple increasingly smaller sections of the panel. Due to the lighter mass of the smaller sections, these act as effective pistons for the mid and high frequencies.

In effect, the panel incorporates a series of acoustical-mechanical crossover networks to duplicate the effect of a multi-speaker system. Figure 3 illustrates this action schematically. In both examples the vibrating panel is made up of expanded polystyrene material using a compacted bead structure. Since the beads are largely air, the mass is extremely low. For example, the weight of a typical ⅛" acoustic panel is less than 0.5 grams per cubic inch. In view of the high degree of rigidity of the acoustic panel, conventional "spiders" or supporting structures are not required to maintain or center the voice coil or coils in the magnetic gap.

In the Fisher structure, the acoustic panel is supported directly by an aluminum frame. In the Poly-Planar type the frame is made of a similar polystyrene plastic to provide an identical coefficient of expansion and acoustical match. The low mass of the panels used in these designs and the absence of restricting members such as spiders results in substantially greater acoustical power output for the same magnet weight as compared to the conventional cone speakers. Hence, relatively low power amplifiers can drive single or multiple speakers to maximum acoustical power output. An interesting characteristic of the flat panel is that there is minimum cancellation of sound vectors front to back; and, hence, these type of speakers can be used effectively as bi-directional reproducers.

Another important characteristic is that the smaller displacement for the acoustical panel permits a shorter voice coil throw to be used. There is, therefore, less of a burden put on magnetic flux uniformity with the result of improved linearity in translating the electrical signals into acoustic output. The right-hand photo in Fig. 2 shows two different versions of the typical Poly-Planar design. Two of the 25-watt units are incorporated as replaceable units in the ERA Acoustics panel speaker assembly. Width of the 25-watt raw speaker (Model P40) is less than 1-⁷/₁₆". The circular grooves in the panel provide for the mechanical-acoustical crossover characteristics, and the center dome is a dispersing element for the high frequencies.

MIRROR LOUDSPEAKER. The flat speaker concealed within the mirror frame causes the suspended mirror to vibrate and act as a secondary sound source.

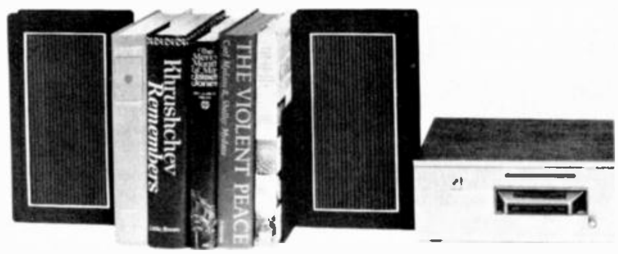
Applications

Wafer or panel type speakers have been used in both conventional applications as well as put to numerous unique uses in view of their special physical and acoustical characteristics. As with all types of loudspeakers, maximum bass and over-all response is best achieved by the use of baffling or placement in a suitable enclosure. Such baffling can take the form of a simple frame, extended "infinite baffle" or a cabinet structure.

In addition to the conventional types of enclosures, a number of interesting non-conventional approaches are feasible in view of the extremely thin aspects of the speakers. Both of the types previously described have been used for decorative applications or even wall mounting to serve the equivalent of wall art. The Fisher type has the decorative art directly cemented to the acoustical panel, and hence is not interchangeable. In the Poly-Planar design the artwork serves as a conventional grill, and hence is interchangeable. One can even match one's own drapes or personal decor!

As free-standing units the acoustical performance is quite good and compares extremely favorably with the larger acoustical enclosures. One of the drawbacks, however, of wall mounting applications is a substantial reduction in bass response due to the assymetrical loading effect when these structures are hung from a wall. Unless a substantial amount of air release is provided, such as mounting in a wall opening, full utilization of the speaker's characteristics is not possible.

In addition to the use as high-fidelity room dividers, decorative screens, and decor pieces, the flat speaker has innumerable other applications. For architectural purposes, these speakers may be mounted into ceilings or walls with these structural elements serving as infinite baffles. The thin structure permits the units to be built into furniture pieces including hassocks, cocktail tables, and the like. In the case of the table mount, the under surface of the table top is treated so as to act as a reflecting disperser to reflect the sound through a 360° horizontal pattern. The panel speaker has also been used in conjunction with mirrors and replaceable pictures. In these latter applications, the panel speaker can be mounted behind the picture or mirror surface, and the sound waves from the speaker make the mirror vibrate and act as a secondary sound source.



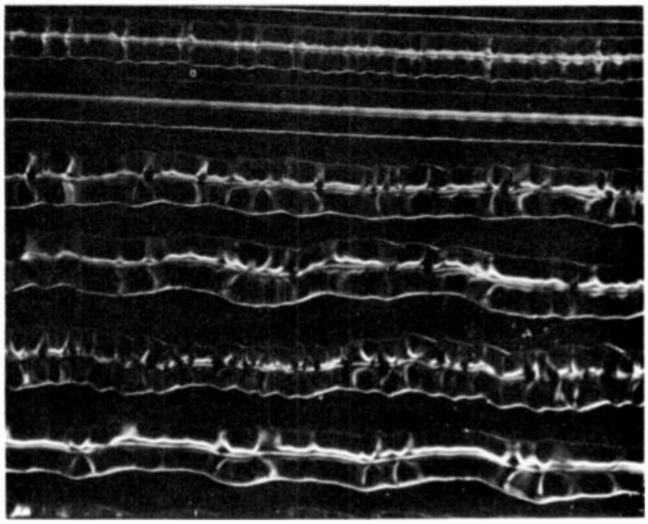
A BOOKEND SPEAKER SYSTEM using Poly-Planars to substitute for conventional bookshelf speaker systems.

The use of plastic materials in place of the conventional paper cone also makes these types of speakers well-suited to outdoor or rugged environmental applications. For example, speakers of this type have been designed for patio use hung from trees, walls, and used for a variety of similar outdoor applications. Because of the extremely thin structure they are also applicable to automobile use, such as built into the headliner of the car, used in the glove compartment, mounted in side doors, etc. A recent application is the combination of these thin speakers with a bookend structure to support books, eecords, etc., on the bookshelf. Excellent stereo reproduction can be obtained in a minimum of space and at the same time serve a useful function on the shelf.

Conclusion

The wafer or panel speaker solves or ameliorates many of the shortcomings of the cone speaker, but it is not a "cure-all" for all that ails the conventional speaker. Baffling of one type or another is still a requirement in order to obtain acceptable bass reproduction and in many instances this does not permit full utilization of the unique physical thinness of the structure. Also, wall mounting without adequate rear air release tends to deteriorate the acoustical performance. On the other hand, properly baffled, here is a worthy rival to the cone speaker. The unique physical structure, excellent acoustic characteristics, reasonable cost, one to one replaceability, all lend themselves to suggest both conventional as well as novel kinds of applications. This is a new and interesting tool for all users of loudspeaker systems. **R-E**

Getting to Know Hi-Fi Specs



A wise selection of hi-fi components requires that you know how they are rated. Understanding specs aids comparison and choice.

by KEN SESSIONS

THERE CAN BE NO MEANINGFUL DISCUSSION OF hi-fi and stereo specifications without getting around sooner or later to the IHF. The Institute of High Fidelity establishes standard tests by which certain items of hi-fi equipment can be checked and rated. The measurements are not necessarily the most valid, and the ratings bestowed on equipment are not always conservative (they tend to favor the manufacturer rather than the consumer), but the figures *do* offer at least a semblance of uniformity in the industry, and provide a legitimate means for comparing one unit against another. Before the IHF standards were adopted by most manufacturers (many still ignore them), the consumer was apt to find virtually any amplifier rated at 20 to 20,000 Hz, or an inexpensive receiver with a rated sensitivity of a fraction of a microvolt. Nonetheless, even IHF standard rating methods are not meaningful unless the method of measurement and the allowable variations are known.

Phono Cartridges

Since there is no "official" test procedure by which all cartridge manufacturers can rate their ware, each manufacturer devises his own test criteria—and the result of this is that the consumer has no way to compare objectively the performance capabilities of the various types. It may be that one cartridge has a weakness in tracking, another in flatness of frequency response. The output of another might be below normal, or the cartridge might exhibit a particularly high degree of cochannel interference (crosstalk). You can almost be assured that these are the things the manufacturers will avoid when they tout the advantages of their individual units. Nonetheless, armed with some of the basics of cartridge performance, you will know what you have a right to expect from what you buy—and you'll be in a better position to compare cartridges.

Channel balance

This specification should be observed with care, for it will tell you what the cartridge will do "monophonically"—that is, it will let you know whether or not you can expect a monophonic signal to be processed and converted to two identical electrical signals. A "perfect" figure is 0 dB, which means that when your record's program material consists of duplicate right-channel and left-channel information, the output of the cartridge will be the same for both channels—the difference between the two channels will be 0 dB. In practice, the channel-balance figure is always expressed at some value above zero; and the higher the figure, the louder the signal will be on one channel than the other.

While this might seem unimportant, be assured that it is anything but that. A 3-dB channel-balance rating will mean that when you use the turntable, you'll have to make a special balance control adjustment of your system to compensate for the difference.

And that isn't all. If you like to tape your records, you'll have to learn to adjust the tape recorder's level controls one way for discs, and perhaps another for FM taping. Anyone who has ever done any serious taping knows that the fewer variables, the better. Certainly, the audio experimenter has enough to amuse himself with without getting involved in the initial balance procedure every time he wants to listen or tape-record. If you can get a cartridge with a very small decibel figure for channel balance, you'll not regret it.

A 1 dB difference between the left and right channels is barely detectable over most of the audio spectrum—but it is detectable. A difference greater than 1 dB can become annoying.

Separation

Separation is often confused with channel balance, but there is little relationship. There is *some* relationship, though, and you should know what it is. The separation capability is expressed in decibels. When the record offers a left-channel signal, with no right-channel signal, the phono cartridge will reproduce the left channel all right, but some of that information will be passed to the right channel. Just how much signal is passed is determined by the cartridge's separation figure. The higher the number, the better the channel separation—and here's where the relationship to channel balance comes in.

Suppose the cartridge has a channel separation of 18 dB—which means a right channel signal will be measured (when none is intended) when the left channel is fed a discrete signal; but it will be 18 dB below the level of the left channel. If the cartridge has a channel-balance rating of 3 dB, that 18-dB rating could mean 15 dB when the system has been equalized. There is no standard that tells a manufacturer to compensate for the out-of-balance condition before making the separation check.

Your best bet is to deduct the channel-balance figure from the separation figure to get a good idea of what the practical separation measurement really is.

Again, that's not the whole story. An unfortunate fact is that separation is a function of frequency. A cartridge might exhibit a 25-dB separation at one point in the audio spectrum, while showing deteriorating performance above and below this frequency.

A separation measurement is usually made by playing a record with a signal recorded on only one channel. This signal is arbitrarily designated 0 dB. The output of the unmodulated channel is then measured, and is expressed in "-dB," or decibels below the modulated channel. Some manufacturers may check the entire audio spectrum, then use the best-frequency value for their separation specification. Reputable manufacturers, in general cite the frequency at which the separation measurement was made. But it is a good idea to look for several separation figures, representing measurements made at different frequencies.

Regardless of how careful you are when you buy a cartridge, even the finest will not give you the performance specified unless you use it the way the manufacturer says it must be used. Bear in mind that record grooves are recorded at an angle 45° from the horizontal plane, and the groove walls are angled 90° from each other. It stands to reason that the stylus tip must ride squarely in this precise groove. Any misalignment of the cartridge—such as a side-to-side or front-to-back tilt—will render the manufacturer's separation specification meaningless. The bottom of the mounted cartridge must be aligned with the record. That is, the axis of the cartridge body must be precisely aligned with the surface plane of the record.

Output level

To some extent, the output of a magnetic cartridge is related to separation. (The relationship is even greater with ceramic cartridges, but these are not considered because they are not typically found in a serious audio enthusiast's system.) In general, the lower the output level (usually expressed in millivolts, or thousandths of a volt), the greater the degree of separation between channels.

A function of velocity

It is natural, of course, that the output level varies according to the information on the record; otherwise there could be no "loud" and "soft" variations in the playback. Thus, a cartridge's output level must be based on some input specification that varies as a function of program level. For phonograph records, this is modulation velocity, expressed in centimeters per second. Usually, the output-level specification for a cartridge is a value reflecting but one input recording velocity; and unless the velocity is known, the value will tell you little. James Kogen cited an example of two output-level values (3 and 6 mV) for two cartridges whose outputs were the same. The difference was in the test velocity at which the output voltage readings were taken. The first measurement, he noted, was made at a peak velocity of 5 centimeters (cm) per second; the second at 6 cm/sec (peak). Since the output level is linear and proportional to modulation velocity, a meaningful figure would be one showing the level increase for each centimeter-per-second of modulation velocity.

The Shure V15 Type III cartridge has a rated output level of 3.4 mV (for each channel) with a 1000-Hz input signal recorded at a modulation velocity of 5 cm/sec peak. This works out to be just under 0.7 mV per centimeter per second. Pickering's V-15 Micro IV AME has a rated output of 5.5 mV with an input signal recorded at a modulation velocity of 5.5 cm/sec. This works out to an even 1.0 mV per centimeter per second.

What all this means

The output level tells you something about signal-to noise ratio, for one thing. A very low output means you'll have to turn your amplifier's volume control up higher to hear a record at your normal listening levels. To determine whether or not your system can tolerate one of the low-output cartridges, disconnect the input wires from the phono jacks of your preamplifier and turn the volume control up to "normal," then a bit beyond that. If you don't hear noise with no input, your system should be capable of tolerating a phono cartridge with an output as low as 0.5 or 0.6 mV per centimeter per second

If, when the volume control is at its normal setting, you *do* hear hum or noise, you should plan to either buy a high-output cartirdge or do something to get rid of the noise. Unfortunately, many of the lower-priced amplifiers are inadequately shielded in the early preamplifier stages—in which case, the choice becomes: use an inferior high-output ceramic cartridge with a good signal-to-noise ratio, or use a high-quality, low-output magnetic cartridge and suffer the consequences of bothersome hum and noise during the "pianissimo" passages.

Output level also can affect separation, as we've already noted. Check both output and separation specifications of a cartridge before you buy.

To determine what the output level is on a per-centimeter basis (which is necessary if you want to make comparisons between cartridges of different manufacture), divide the rated output voltage (in millivolts) by the modulation velocity (in centimeters per second).

Tracking force

As with every variable in the cartridge-stylus industry, there are controversies always raging as to which tracking force is best—for performance, for record wear, for stylus wear, for tracking capability. Some manufacturers will tell you that a moderate tracking force—say, two or three grams—is a necessity if the stylus is to faithfully track the groove with its vagaries of width and depth. Others say records wear off with no more than a couple of playings at pressures greater than a gram or two.

There are elements of truth to both these statements, regardless of how contradictory they may seem. It is a fact that the life of a diamond stylus can be doubled by reducing the tracking force from 1.5 grams to 0.75 gram. It is also true that record life is stretched out even further, for high tracking pressures cause delicate protrusions to be shaved off the inner walls of a record groove, particularly when the stylus is worn flat in the areas where it most frequently touches the groove walls.

A note from Shure points out that at a mere 2 grams of tracking pressure, more than 11.5 tons per square inch is added to the record groove walls over the pressure at 0.75 gram! And even at that seemingly low force (0.75 gram), the wall surfaces see the equivalent of 60,000 pounds per square inch! So it would indeed be hard to deny that reduced tracking force means increased record and stylus wear. Unfortunately, that isn't the whole story; read on and get the rest of it.

Records with extremely loud passages at some frequencies can boot a low-force stylus right off the surface of the disc. But this problem can be easily overcome by a slight 'heavying up' of the tracking force. Also, unless the turntable is of a particularly high-quality design, the arm just won't track at extremely low forces. Excessive friction in the tone arm, anywhere in the tracking range, will cause skating and jumping, the net result of which is even more stylus and record wear than would be realized with lower tracking forces.

Finally, tracking ability is threatened as the tracking force is lessened. It takes an extremely good cartridge, pickup arm, and stylus combination, matched into a unit, to provide consistently good results at pressures below a gram. If you haven't bought the best, and if your cartridge isn't rated for low-force tracking, you'll have much better results with higher forces. In general, track somewhere between the center and the upper end of the cartridge's range.

Trackability

Since this is a word that was coined by the people at Shure, you can bet they're proud of what their cartridges will do. And well they should be, for the company's Model V 15 Type III cartridge has been shown to perform remarkably well at a tracking force of 0.75 gram and below.

Shure says trackability is the measure of a cartridge's total (they emphasize the word total) performance, and it reflects the cartridge-stylus assembly's ability to follow the hypercomplex record grooves up to and beyond the upper limits of modern recording technology—over the entire audible spectrum

In the graph of Fig. 1, the shaded area

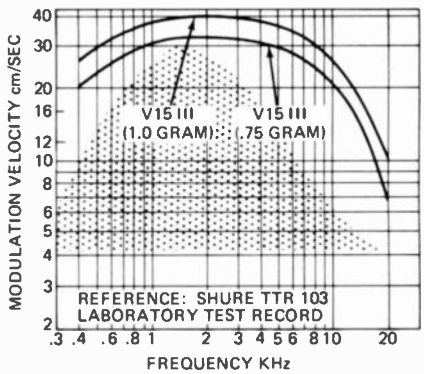


FIG.1—TRACKABILITY CURVE FOR SHURE V15 TYPE III cartridge (at ¾ gram and 1 gram stylus force). The shaded area represents the recommended theoretical limits for cutting record velocities. Modulation velocities are shown up the left edge; frequency range is registered across the bottom. The smoother the curve of the cartridge being tested and the greater its distance above the shaded area, the greater its "trackability."

represents the recommended theoretical limits for cutting record velocities. The modulation velocity (in centimeters per second) is shown to be the vertical scale at the left; frequency range is the horizontal scale. Because the upper surface of the gray area is curved, the performance of the playback cartridge must also be a curve; but it should be as far above the gray area as possible. According to Shure, the trackability of a cartridge is directly proportional to the distance above the gray area its performance is plotted. The two curves shown reflect the performance of Shure's V15 Type III cartridge—which is shown in the photo of Fig. 2—at tracking forces of 0.75 gram and 1 gram.

Needless to say, Shure points with pride to photos such as the one of Fig. 3, which is a photomicrograph of an actual record surface. The one on the left shows several gently modulated grooves and one groove

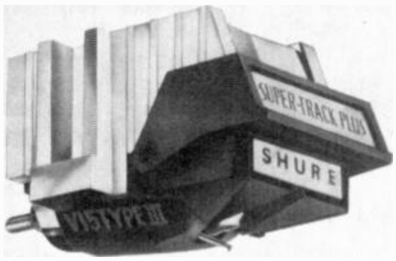


FIG. 2—SHURE'S TOP-OF-THE-LINE "V-15, Type III" magnetic cartridge, which can track at less than a gram.

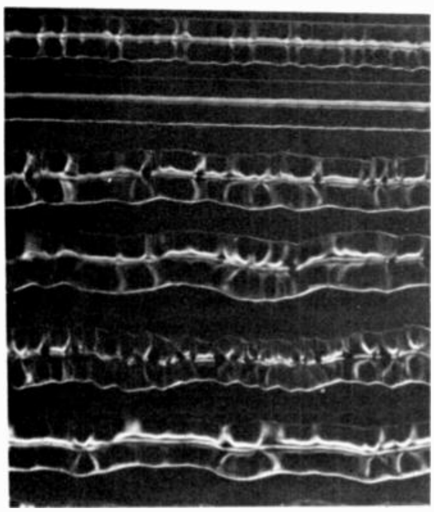


FIG. 3—THIS IS A CLOSEUP PHOTO of the surface of an ordinary phonograph record. Some of the grooves are jagged, representing a real obstacle course for a stylus; notice that one groove is unmodulated, representing a silent portion of a recording. Increasing tracking pressure to help a stylus stay in the groove can cause the fragile protrusions on a groove wall to be shaved off in places, resulting in distortion and ventual destruction of the recorded material. A high-trackability cartridge-and-stylus assembly will properly follow the errant paths of the grooves at extremely low tracking pressures. (Photo courtesy Shure, Inc.)

representing the errant, hard-to-track-modulation of a castanet. At the right are easy grooves of flutes with a sudden intrusion of maracas. It isn't difficult to see the problems faced by a speeding stylus when it hits the maracas' winding road! Neither of the two situations shown in the photomicrographs are a rarity—both were taken from ordinary recordings.

However . . . when played on an ordinary cartridge the stylus will tend to "lose control" like a speeding auto on a wet, winding road. The castanets sound raspy, while the flute and maracas sound dead as a zinc penny.

Or take silibants such as the vocalists' "s-s-s" sounds—and "th" sounds as in through and three, where mistracking produces exaggerated distortion. Here are the places where trackability is important. And while trackability can be improved to some extent by increasing the tracking force, basic consideration to stylus and record wear obviates that as a rational alternative if cartridges can be used that can give high-trackable performance at low, low pressures.

Tape decks

A reel-to-reel tape recorder (we'll call it Brand X) might show a frequency response at the 7½ inch-per-second speed of 30 to 15,000 Hz. That specification is a promise that the recorder will reproduce (or record, or both) sounds in that audio range. But getting those sounds on tape and reproducing them do not necessarily imply that the user will be able to hear them. The recording curve of the tape unit might be such that when midrange frequencies are recording at a normal level, the very low frequencies (below 100 Hz) and the very high frequencies (above 10 or 12 kHz) might be sufficiently lower in volume as to render them totally inaudible.

To have any meaning at all, a frequency-response performance specification must be qualified by a "gain-or-loss" figure. The Brand X recorder has a frequency range of 30 to 15,000 Hz—which is good. But if the low-end or the high-end response is 10 dB down, that frequency range is useless. Look at the curve of Fig. 1, which is admittedly hypothetical. It shows the performance the Brand X machine could have while still legitimately claiming the 30 to 15,000 Hz range.

Another tape recorder (Brand Y) boasts a frequency response of 50 to 10,000 Hz +3dB, which appears to be inferior to Brand X's response. It costs more, though, so the consumer wonders why the response is so "poor." Look again at Fig. 4 and you can

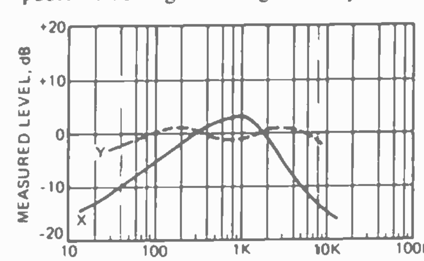


FIG. 4—THE SOLID LINE SHOWS a measured performance that would entitle a manufacturer to claim a response of 30 to 15,000 Hz. The broken line shows a better usable performance, where only 50 to 10,000 Hz is claimed.

see why. Brand Y's performance is based on usable response; the frequency range is given with a gain-or-loss qualifier.

The Institute of High Fidelity hasn't yet come up with a rating system for tape recorders. Perhaps it never will. But the fact that no universally accepted standard does exist contributes to the confusion and seemingly unjust performance-versus-price comparisons among manufacturers of a handful of less-than-quality tape machines.

Playing with curves

A well known fact among ad men and propagandists is that a curve can be used to minimize a weakness or exaggerate a strong point. For example, when you feel tempted to buy a bargain-priced phono cartridge or microphone or speaker or amplifier, you might be impressed with a performance curve such as the one shown in Fig. 5.

You know, as a matter of course, that the frequency response should be as flat as possible, and the manufacturer knows you

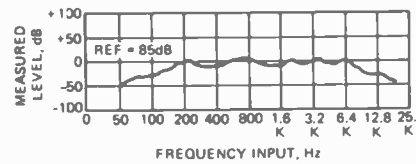


FIG.5—IF THIS CURVE LOOKS FLAT TO YOU look again. The actual usable response is from about 200 to 6 or 7 kHz. Even at that, the peaks and valleys would be annoying. This unit would be unacceptable in a serious audiophile's home audio installation.

know it. So it behooves him to show you a flat curve. The curve shown looks flat enough, so why not go ahead and buy the speaker? Look again. The speaker's response is 40 to 16,000 Hz, which is not bad. And it appears flat--also not bad. But how flat? The curve is laid out on an unrealistic graph, which shows increments of 50 dB on the vertical scale. A 50 dB variation in a speaker's performance curve would be totally unacceptable in a good-quality system, for a drop of 50 dB below the center "zero" line represents a power decrease of considerable magnitude! The total spread of the depicted graph is 50 dB. The audio signal level at 40 Hz (and at 16 kHz) is a minute fraction of the strength of the signal at 3 kHz!

Ideally, a performance curve should be laid out so that minima and maxima are shown at the upper and lower limits of the graph, like the one in Fig. 6. But these don't

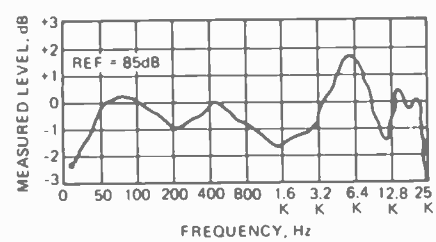


FIG. 6—THIS CURVE, FOR A VERY HIGH-QUALITY SPEAKER SYSTEM, tells you the response characteristics at a glance. The 85 dB reference (0 dB) means that the test signal was injected at normal listening level for a very low-frequency note.

"look" good, so many manufacturers avoid these at all costs. Actually, the performance of the speaker depicted in the Fig. 6 graph is very good. The quality can't even be compared to the inferior unit of Fig. 5. The speaker is meant to sell in the $150 range.

While the prospective purchaser can look at the graph of Fig. 6 and get a clear, fast, concise view of what the speaker can do, he'll probably not be given the opportunity to examine this kind of a chart. Instead, he'll be shown the one in Fig. 7, which is an actual duplicate of the manufacturer's published table. Note the flatness of this compared to the one of Fig. 6.

The object of all this? Caveat emptor. Take graphs with a great deal of skepticism. Redraw the graph in your mind, placing the minimum and maximum values at the top and bottom. Compare the performance on a point-by-point basis with similarly priced units of other manufacture. But don't be snowed by a "flat" curve.

It is difficult to generalize and be fair, but it would be even less fair to omit the simple fact that "specification" complaints among buyers of better-quality tape recorders are

(continued on page 72)

Improving Room for Better

Most living rooms and similar listening areas hi-fi. Here are details on how to dramat-

by LOUIS CHALLIS

SOME YEARS AGO, A WELL-KNOWN club asked me to cure a severe acoustical problem caused by excessive reverberation. After I had assessed the problem and made initial proposals, the club secretary asked me why I hadn't considered using a number of wires stretched across the room above head height. Such wires were cheap, but what I was proposing would cost a great deal of money.

All I had to do, he explained, was to be a good fellow and tell him where to buy those wires. He added that a member of the committee, a doctor, had recommended them as "cheapest form of acoustical treatment available." When I realized that I couldn't offer the club what they wanted, I tactfuly suggested that we were both wasting our time, and left!

Two years later I discovered the basis for the doctor's advice. The practice started in the U.S.A. about 100 years ago, when somebody—applying unusual scientific acumen—suggested that "if the stretched string of a violin, harp, or piano can transmit acoustical energy to a sounding board, then the same stretched string should be capable of absorbing acoustical energy from the air!"

Apparently the suggestion was taken seriously, and installations were made all over the U.S.A.—some using over five miles of stretched wire. Presumably, in a few cases simultaneous changes— of form or occupancy—accompanied the installations. When these occurred, the occasional improvements in acoustics were—erroneously—attributed to the wires. In any case, 30 years passed before the practice was entirely abandoned.

The study of architectural acoustics goes back many centuries—to Vitruvius, who wrote in the early years of our era but few of the early students had more than a slight understanding of the subject. Most early examples of good architectural acoustics were accidents for which neither architects nor builders could take much credit.

Some of the early concepts put forward for theater or concert hall design varied from the extensive use of wooden paneling to the use of large numbers of empty bottles placed under the stage!

Scientific method

In 1895, Clement Walter Sabine, then professor of mathematics and natural philosophy at Harvard, was asked to "do something" about the poor acoustics of the new Fogg Art Museum.

Sabine went beyond the request to "do something." He initiated a basic study of room acoustics. This started a new science, and earned for him the title of "Father of Modern Acoustics."

Professor Sabine produced a clear and concise appraisal of room reverberation (the time taken for echoes to die away). To do so, he developed a remarkably accurate measurement system based on electro-pneumatic-valve-operated organ pipes, a stop watch (later replaced with a chronograph), and his own ears.

When later asked to undertake the acoustical design for the new Boston Symphony Hall, Sabine applied the theoretical knowledge he had acquired during the previous three years to plan the first scientifically designed theater in the world. When the hall

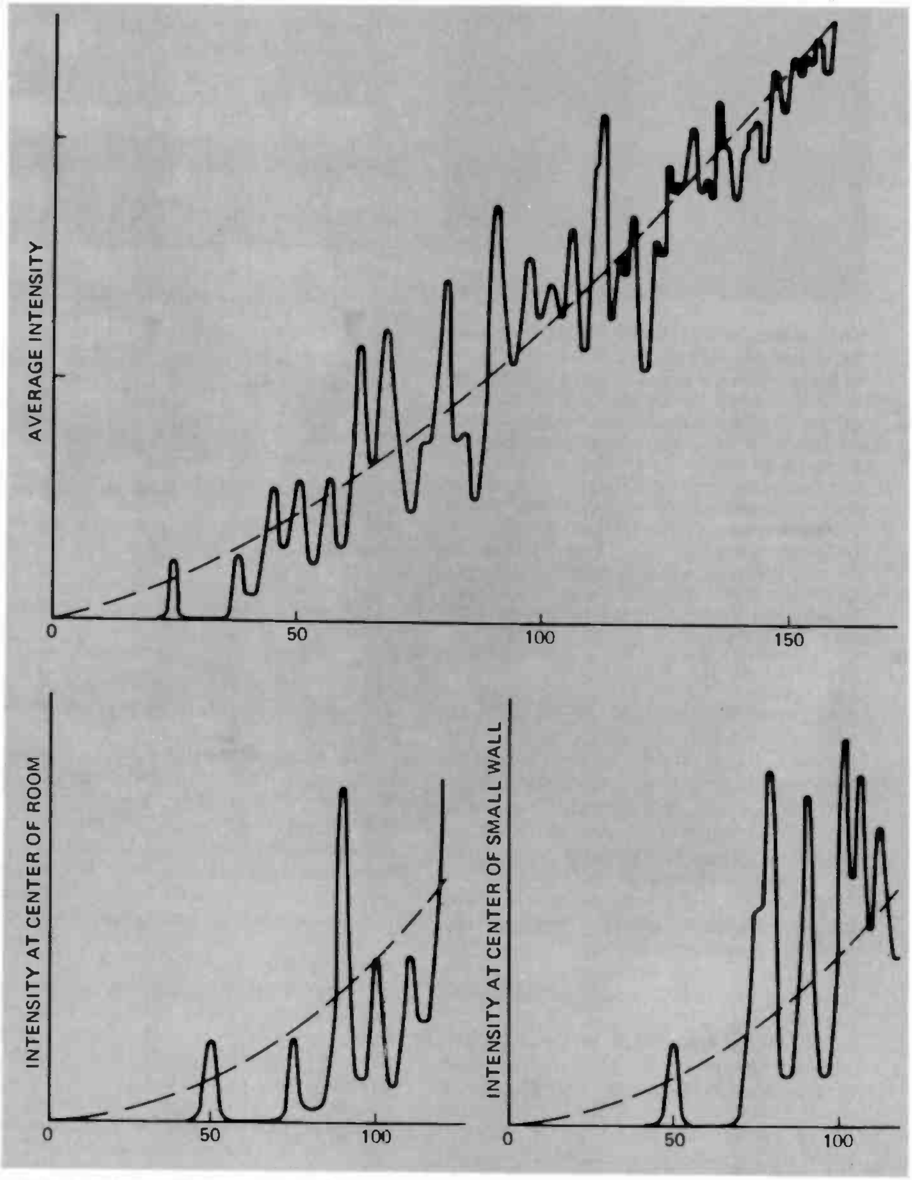


FIG. 1—SOUND INTENSITY IN ROOM 30 x 15 x 10 feet, reverberation time 1 second. Note that over fairly wide ranges (below 100 Hz.), the sound decreases all the way to zero.

This article originally appeared in the Australian magazine *Electronics Today*, Sydney, Australia and is presented here with the permission of the publishers.

Acoustics
HI-FI Sound

are very live and too reverberant for good
ically improve acoustics in your rooms.

was opened (in 1900), it was acclaimed by musicians and critics alike: and for symphony music at least, it is still one of the best auditoriums in the world.

Sabine's initial work was quaint by modern standards. His initial investigations were concerned with evaluating how cushions, curtains, drapes, and carpets affected the reverberation time of just one room. And what he found was appreciated by very few people in his day.

He provided qualitative and quantitative information on many materials, and proceeded further to develop a mathematical relationship that, with minor improvements, is still used.

Absorption characteristics

For live music, reverberation times of more than one second are required. A professional recording will have reverberant sound lasting at least that long already incorporated in it, either artificially or naturally.

The ideal listening room has a reverberation time that is short by comparison with that of the recorded material. Such a short reverberation time is not easy to obtain, not because of technical difficulties, but because most acoustical materials lack decorative appeal. It is usually necessary to rely on the acoustical properties of normal building and furnishing materials to obtain an acceptable compromise between appearance and acoustics.

A plasterboard wall, for instance, offers some low frequency absorption, as do wood floors and plasterboard ceilings.

As these materials are commonly used in single dwellings, reverberation time is often suitable at the low end of the frequency spectrum.

On the other hand, home units and apartments present a real problem (to obtain low-frequency reverberation time). They are usually constructed with brick walls, and concrete floors and ceilings. These have virtually no low-frequency absorption. Low-frequency absorption may be provided only by the windows.

Absorption in the mid-frequency range may be provided by soft furnishings. Old-fashioned armchairs, sofas, and carpets are very useful acoustical materials. But modern vinyl-covered seats—unless they have padded arms and backs—absorb very little, and parquetry floors often lead to undesirable acoustical properties.

Midfrequency range absorption is also provided by people—four people may improve the acoustics of a living room significantly. (This may help those who wish to demonstrate their hi-fi to visitors. If the room acoustics are bad—just invite more people!)

Absorption in the higher-frequency range is provided by soft pile carpet, drapes, and other materials that contain fine, loosely packed fibers.

How sound behaves

When a sound is created in a room, the sound waves are reflected back and forth between every pair of parallel walls diminishing in intensity at each reflection. They also travel in oblique paths that incorporate any or all groupings of walls, floor, and ceiling.

If the room has an irregular shape, the sound waves take every conceivable path and set up highly complex patterns called, room modes. These modes are not harmonically related as such, but are dependent only on the frequency and the room dimensions.

Such modes are a common problem in the average family living room, and may be so dominant that music played in the rooms is colored—certain frequencies are selectively favored.

A far more serious problem is that of rooms with highly reflective parallel walls without curtains, and lacking furniture or other devices to change the direction of sound waves or to absorb them.

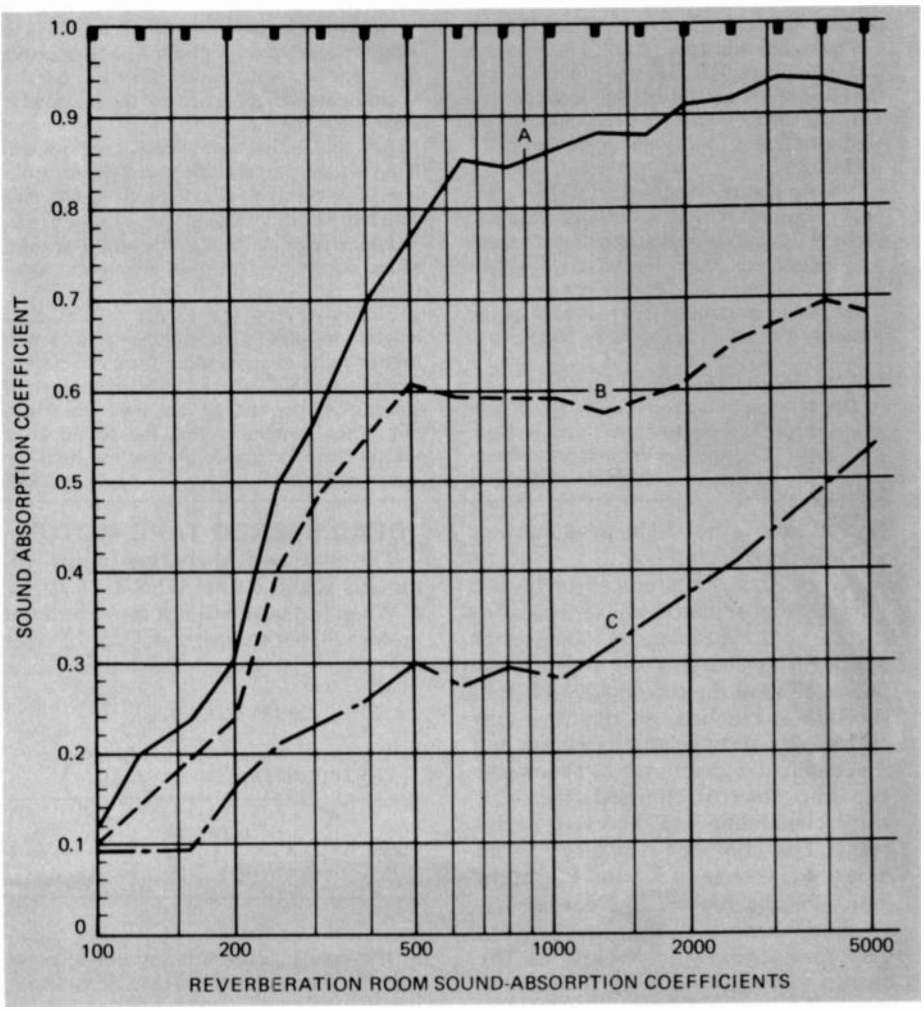


FIG. 2—ABSORPTION WOOL CURTAINS hung 6 inches from wall surface. A—Double fullness close weave with double thickness calico lining. B—Double fullness close weave wool. C—Moderate weight wool fabric without backing.

If you clap your hands between such walls, you will notice a ringing effect in which the sound waves diminish in cyclical steps. You may have noticed this in unfurnished houses or flats, or even occasionally in occupied rooms.

Technically the phenomena is called flutter echo, and results from certain frequencies (related to the dimensions of the room) setting up a decay process that is prolonged by the parallel walls.

Acoustic materials

Soft, porous fabrics and furnishings absorb a considerable proportion of the sound waves that impinge on them. This they do by converting the sound energy into heat.

Practically all building materials absorb sound to some extent, and the efficiency of this conversion is a measure of whether they may correctly be called "acoustical material" or not. Some materials are effective at all frequencies, but most are effective over a small frequency range only.

Rooms are classified as "live" when they have little furniture and furnishings, and "dead" when they have heavy-padded furniture, thick carpets, and drapes.

A "live" room or hall favors church music, choral works, and orchestral music. The sound in such a room is composed of two parts—the direct sound, and the reverberant (or reflected) sound. A listener hears the direct sound first, and the first reflections of the reverberant sound a short fraction of a second later. If the room or hall is large and live, this reverberant sound may continue for more than five or six seconds.

Five centuries ago, the average cathedral had a reverberation time of a little less than five seconds. Music of that day was composed to make use of the fullness of sound that such a reverberation produced.

Today, a reverbration time of 1.5 to 2.5 seconds is considered optimum for an orchestral concert hall, and between 0.4 and 0.7 seconds for the average living room.

The effect of room size and shape upon the quality of sound is marked, but very difficult to define without high-powered mathematics. These effects are due to the relationship between the wave length of the particular sound wave and the room size and shape. These relationships are complex, but there are a few simple guides.

ABSORPTION OF COMMON MATERIALS

Material	Percentage of sound absorbed 250Hz	1kHz
Concrete	1	4
Linoleum	2	2
Brick wall	2	4
Cotton curtains	3	10
Carpets	10	40
Heavy drapes	30	70

The wave length of sound at a given frequency can be approximated by remembering that a frequency of 1 kHz has a wave length of about 1 foot, and that wave length is inversely proportional to frequency. Thus 500 Hz corresponds to 2 feet, 100 Hz to 10 feet, and 50 Hz to 20 feet.

The principal room dimension of interest—particularly in a rectangular room—is the longest diagonal. This is the distance between a corner of the room at floor level and the diagonally opposite corner of the room at ceiling level. This will be the longest straight line in the room. For a room 15 x 30 x 10 feet it is roughly 35 feet.

For good room acoustics, this measurement needs to be at least three to four times greater than the wave length of the lowest frequency. Thus for the room with these dimensions, the maximum wave length for acceptable acoustics is roughly 10 feet. This corresponds to a frequency of about 100 Hz.

This room will have marked resonances and dips below 100 Hz, and sounds below that frequency cannot be reproduced faithfully. Apart from this, the response will be vastly different at various positions in the room.

And no matter what hi-fi enthusiasts and audio salesmen may believe to the contrary, there is no way to reproduce sounds faithfully below this lower limit. You will hear sounds certainly, but they will not be, sometimes not even remotely, a facsimile of the original. The effect is shown in Fig. 1.

How to modify your room

The average living room is usually poorly planned for listening to music, and is much too "live." The speaker enclosures are usually poorly located on either side of the windows, a fireplace, or a sideboard. Almost without exception, they face a reflective wall, creating the first problem. They are usually fixed flat against a wall "for appearance's sake," and all too often are not placed far enough apart.

For optimum sound, the speakers should be spaced between 6 and 12 feet apart, opposite a wall that has an extensive area of curtains and drapes lined with additional layers of backing cloth to increase the absorption.

Until recently, there was little or no data available for the intending user (or expert) to assist in evaluatiing or specifying curtain treatments. Most of the available data involved evaluations of muslins, terylenes, or fiberglass cloths that are not really suitable for decorating a living room. But recently a series of measurements were made for people who wished to use wool curtains for this purpose.

The results of this investigation are particularly interesting. They show that wool curtains, and especially wool curtains with backing, combine remarkably high absorption with generally acceptable appearance.

Some of these results are shown in Fig. 2, where it can be seen that medium-weight wool cloth (double fullness) together with a cotton lining (also of double fullness) has particularly good acoustical absorption.

Either of the two "best" cloths shown in Fig. 2 would enhance acoustics dramatically in most living rooms.

Although the intention of this article is to help the average hi-fi enthusiast to improve his room acoustics rather than to help the Wool Board sell its products, the message is clear.

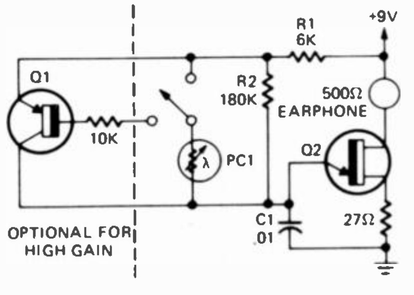
And that is that wool decorator cloth will almost totally overcome the difficult problem of excessive reflections from the rear wall behind the listeners.

The effect is to provide good frontal sound with well-controlled rear wall reflections.

Finally—if you feel kindly toward your neighbors—place your speakers on a carpet, rubber pads, or some other form of resilient mounting. This will reduce the amount of structure-borne energy that they can transmit. Then remember that the sound level that is right for you is always too loud for your neighbors. **R-E**

LIGHT-CONTROLLED OSCILLATOR

This light-controlled oscillator makes a wonderful toy for children and can be used to follow by ear, or on tape, chemical reactions, lightning flashes and other light-producing or modulating effects.



NOTE: Q1 – MEDIUM GAIN, LOW LEAKAGE, NPN TRANSISTOR.
Q2 – UNIJUNCTION TRANSISTOR
PC1 – CdS PHOTOCELL, RESISTANCE RANGE 1K TO >1 MEGOHM

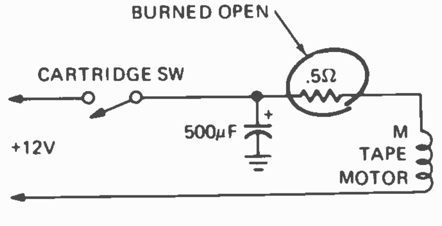
Basically, it is a photocell-controlled unijunction oscillator whose frequency increases as light intensity increases. It operates by charging C1 through the photocell until the threshold voltage of the UJT is reached. At this time current passes through the earphone and the capacitor discharges. When the capacitor has discharged, the UJT stops conducting and the cycle begins anew. The photocell resistance varies over a wide range so R1 and R2 set the limits for the highest and lowest frequencies.

A transistor (shown left of the dashed line) can be used to increase sensitivity at low light levels. C1 and R2 can be varied slightly to achieve the best frequency range.—*Edward A. Kimble*

DEAD STEREO TAPE MOTOR

The motor would not turn in this Automatic Radio model GES-8111.

When the tape will not move and the motor will not rotate, check for 12 volts



at the motor terminals. A dead motor may be caused by defective cartridge switch, speed regulator, isolation resistor and motor. A .5-ohm resistor was open in this particular model.—*Homer L. Davidson*

ELECTRONIC CASINO

Five games of chance that you can build with electronic circuits, complete with sound effects. It's an experimenter's dream. High card; one armed bandit; dice roll, roulette and coin flip.

by WALLER M. SCOTT

NOTE TO READERS
This is not a construction article! Wehave not seen an assembled version of the Electronic Casino. However, this story does contain enough information to enable a reader who expects to do a bit of experimenting to build the unit. If you do build your own version of the Electronic Casino, we'd appreciate receiving a glossy photo of the assembled unit and will publish it in our Letters column. **—Editor**

THE CASINO IS AN ELECTRONIC version of five games of chance: Dice Roll, Roulette, Coin Flip, High Card, and The One-Armed Bandit. As well as being an interesting project to build, the Casino fills the bill for personal amusement, party games, mathematical probability studies, or just an exercise to stimulate creative electronic thinking. The Electronic Casino combines digital and linear IC's, discrete and 7-segment LED displays, and unijunction transistors (UJT) with an assortment of R's and C's into an exciting audio/visual game.

The Casino is designed in modular fashion which allows easy duplication of any of the five games. As shown in the system block diagram of Fig. 1, the only parts common to all games are the power supply and audio amplifier. Each game of chance has its own "sound generator". The addition of sound to the quiet electronic operation adds realism.

All game circuits use a high-frequency oscillator (2 to 20 MHz) to generate a clock signal. The random nature of the games comes from the

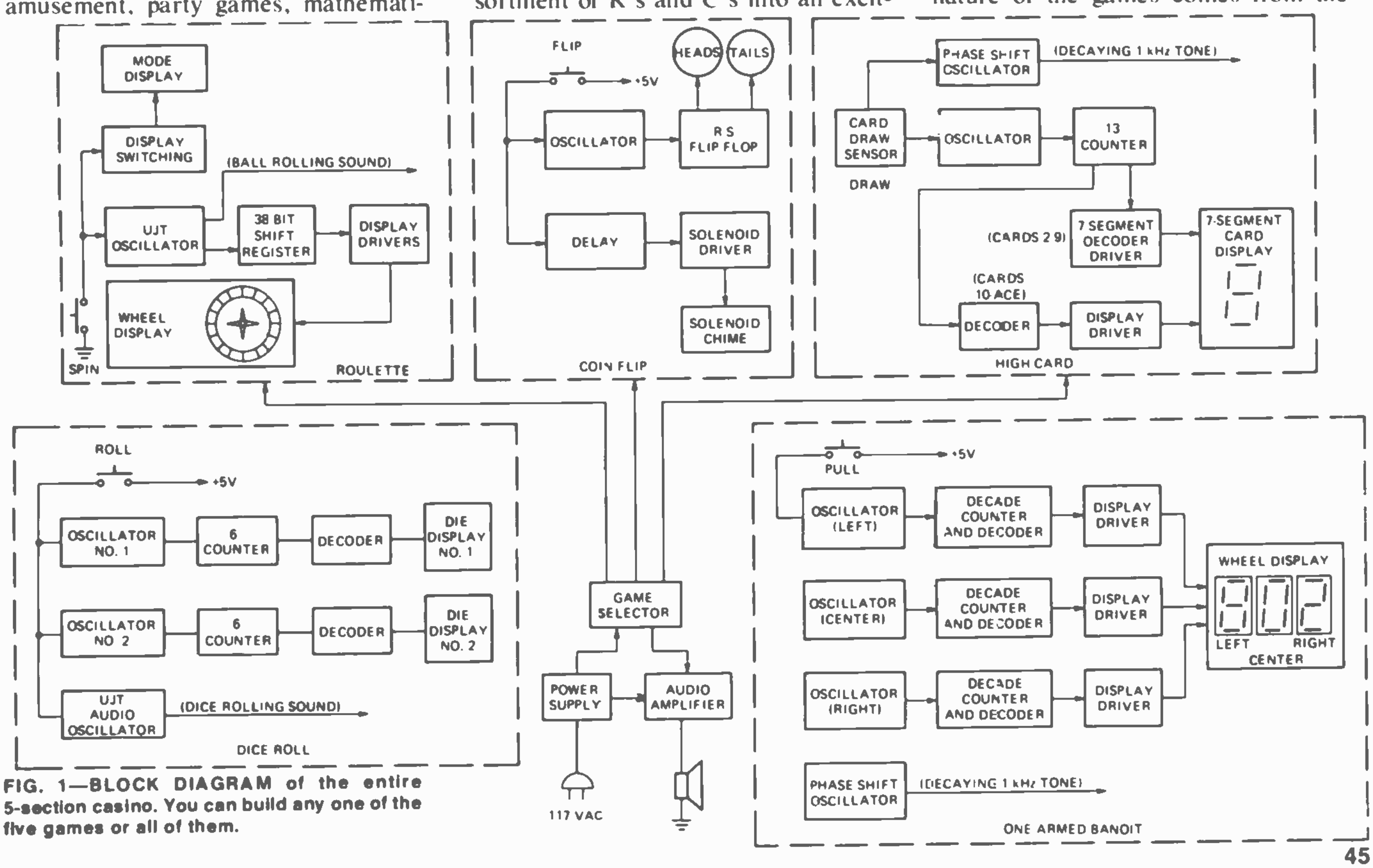
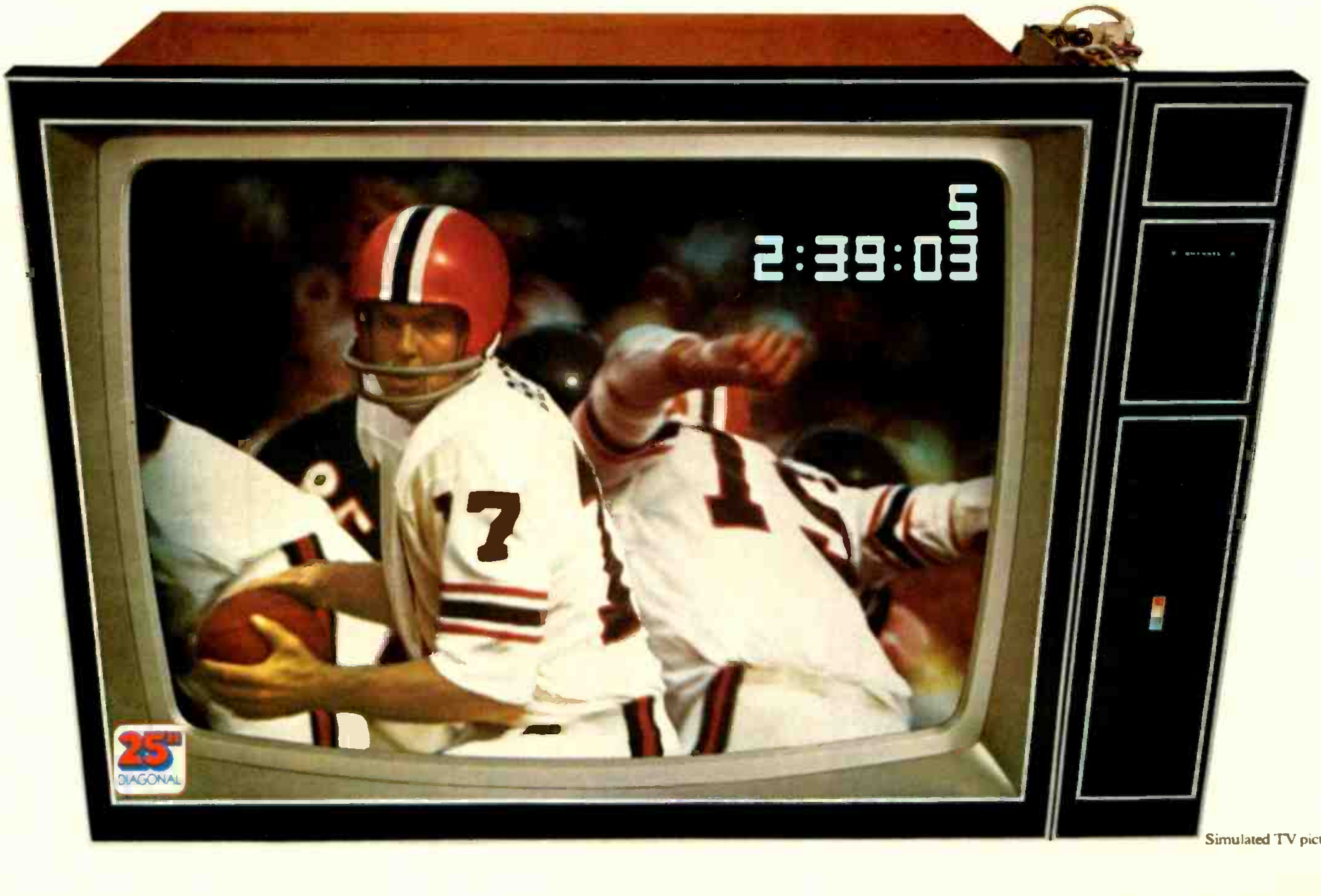


FIG. 1—BLOCK DIAGRAM of the entire 5-section casino. You can build any one of the five games or all of them.

NEW FROM BELL & HOWELL SCHOOLS...

THE REVOLUTIONARY 25-INCH DIAGONAL DIGITAL COLOR TV YOU ACTUALLY BUILD YOURSELF!



Simulated TV picture

Build and keep one of today's most advanced color TV's! It's the perfect spare time project . . . an enjoyable way to learn about the exciting new field of digital electronics!

Digital electronics is a fascinating world to explore! It's a new technology that's changing not only our clocks, wristwatches and pocket calculators, but now, color TV!

By building Bell & Howell's new big-screen digital color TV you not only learn all about this new field, first-hand, but you'll have a remarkable color TV to keep and enjoy for years! And, you'll take special pride in it because you built it yourself!

You get a color TV ahead of its time . . . with revolutionary features like:

Channel numbers that flash on the screen

Wait until the neighbors see that *your* TV has channel numbers that actually flash on the screen! You can even pre-set how long you want them to stay on before fading.

Automatic pre-set channel selector

With just the push of a button, your favorite channels come on in the sequence you pre-set. All "dead" channels are skipped over.

Digital clock flashes on the screen

Imagine pushing a button and seeing the correct time on your TV screen! The hours, minutes and seconds appear in clear, easy-to-read digital numbers.

What's more, Bell & Howell's digital color TV has all-electronic tuning, reliable integrated circuitry and a 100% solid-state chassis for a bright, sharp picture with long life and dependability.

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

You don't have to be an electronics expert to build it!

That's one of the beauties of this TV! All you need is a few simple household tools and our step-by-step instructions. You can also take advantage of our toll-free phone-in assistance service throughout the program and in-person "help sessions" held in major cities throughout the year where you can "talk shop" with your instructors and fellow students.

You also build and keep Bell & Howell's exclusive new Electro-Lab® electronics training system

Includes building the three professional instruments you'll need to test your TV and other digital equipment. You'll use the digital multimeter (pictured here), solid state "triggered sweep" oscilloscope and design console throughout the course and later, perhaps, in a full or part-time business of your own.

PLUS . . . for immediate "hands on" experience right from the start, you'll get a Lab Starter Kit, which will help you understand many of the fundamentals of electronics.

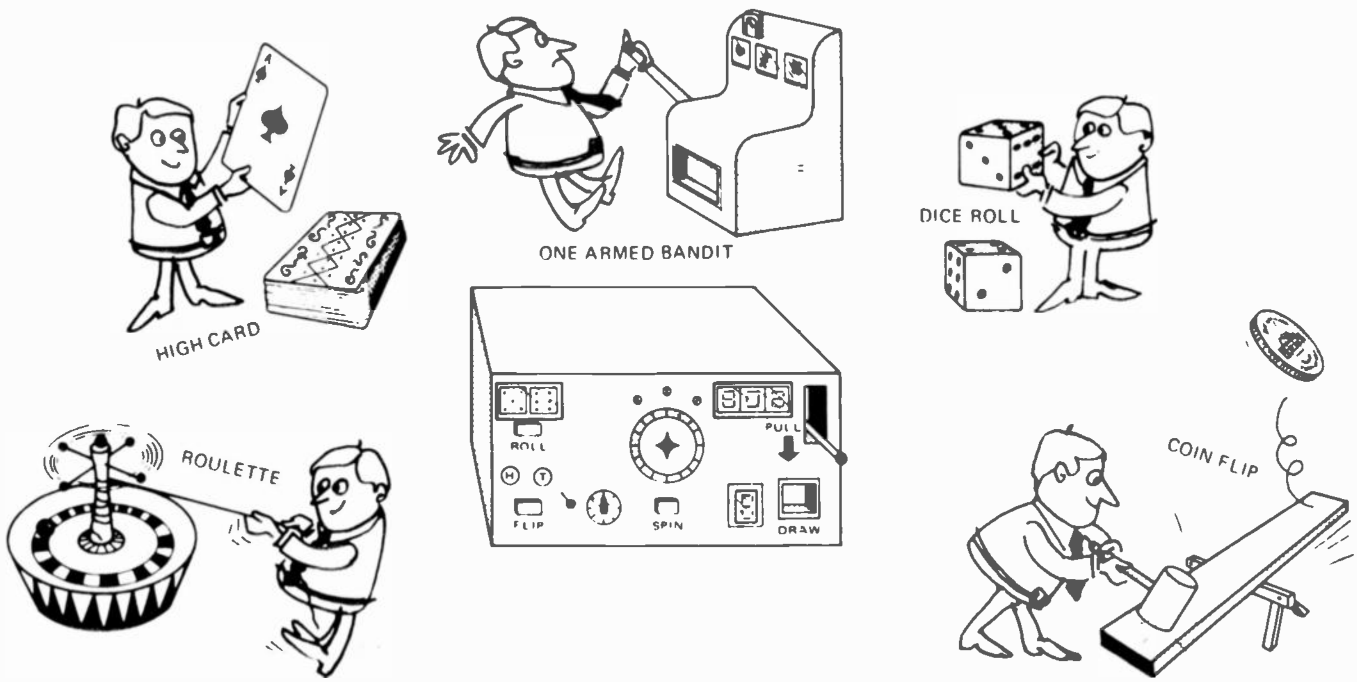
The skills you learn can lead to part-time income or a business of your own

This new digital technology opens up a world of opportunity for people with the right know-how. Let us show you how Bell & Howell Schools' new at-home program can lead to extra income part time. Or, if you're thinking bigger, we even include a complete volume on how to start a TV servicing business of your own!

Mail the postage-free card today for full details, free!

If card has been removed, write:
An Electronics Home Study School
DEVRY INSTITUTE OF TECHNOLOGY
ONE OF THE
BELL & HOWELL SCHOOLS
4141 Belmont, Chicago, Illinois 60641

600



fact that an unpredictable number of clock pulses will be generated during any given play operation. Therefore, no amount of manual dexterity on the part of the operator will allow him to defeat the random number selection. This is due to such variables as the duration of switch closure, switch contact bounce, built-in circuit delays, and the very high clock frequencies.

Power supply audio amplifier

The schematic for the Casino power supply and audio amplifier is shown in Fig. 2. The power supply consists of a full-wave bridge rectifier circuit with capacitor filter supplying an output of about +15Vdc. The +15V is fed to a +5Vdc series regulator. Adequate heat sinking should be provided for the series pass transistor, Q28.

An IC audio amplifier is used to amplify the sounds emitted by the various games. The National Semiconductor LM380N is an excellent example of a simple power amplifier requiring very few external parts. Power output is 2 watts maximum. Heat sinking is provided by soldering pins 3,4,5,10, 11, and 12 directly to the PC board ground plane. The larger the area of copper attached to these pins, the better the heat will be conducted away from the package. A socket should not be used.

The +15Vdc, +5 Vdc and audio amplifier input lines are switched with a 3 pole 5 position rotary switch. The proper connections are made to each game separately, so only one game is energized at a time.

The dice roll

As shown in Fig. 3, there are two similar circuits; one for each of the die displays yielding the normal pair of dice. Transistor transistor logic (TTL) IC's are used for the three-gate oscillator, six-counter, counter decode, and display driver. When the ROLL switch is depressed, the two control transistors, Q1 and Q2, are turned on supplying +5V to the 7400 oscillator and a reset pulse (momentary LOW) to the six-counter. A HIGH (+5V) is applied to one input of the three-gate oscillator. The output of gate 1 goes LOW. This causes the gate 2 output to go HIGH, which in turn causes the gate 3 output to go LOW. Gate 3's output is fed back to the other input of gate 1. The gate 1 output now changes state from a LOW to a HIGH and the cycle continues. The squarewave output from gate 3, a frequency of several MHz, is used as a clock signal for the six-counter. The .001-µF and 470-pF capacitors used in the two oscillators introduce different amounts of delay into the feedback signal, thus causing the two oscillators

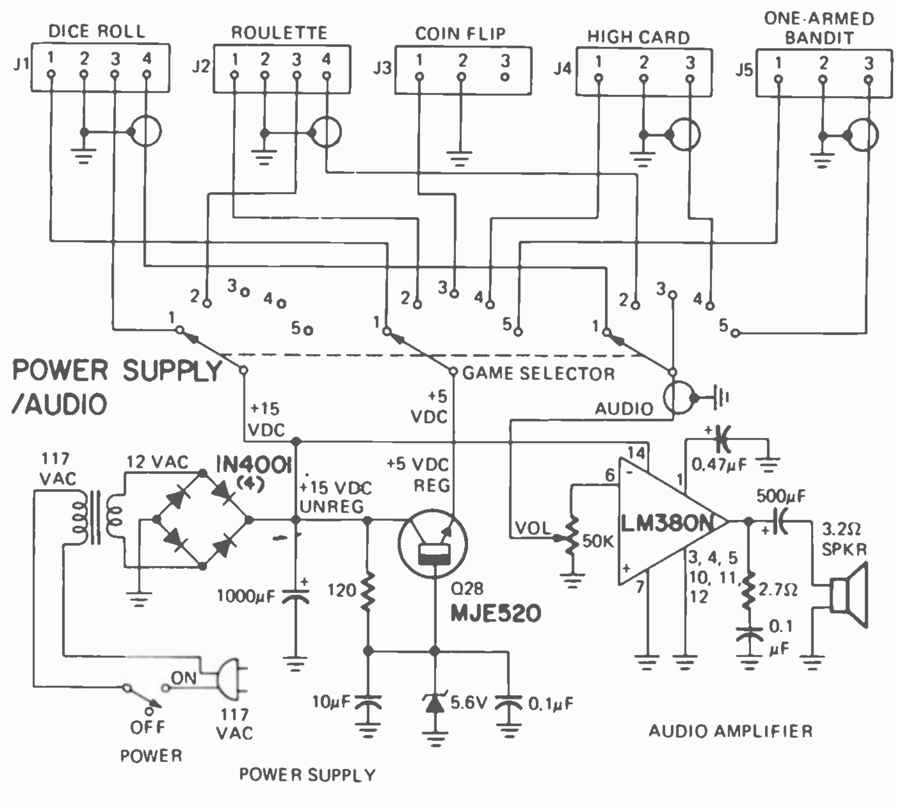


FIG. 2—POWER SUPPLY AND AUDIO AMPLIFIER for the electronic casino. Note that the circuitry is simple and rather ordinary. No special parts are used.

to run at different and unrelated frequencies.

After the switch is released, the oscillators continue to run for several milliseconds until the 25- and 50-μF capacitors discharge, adding more randomness to the operation.

All the time the oscillator is running, the six-counter has been counting clock pulses 1-2-3-4-5-6-1-2- . . . -6 etc. Out of the millions of clock pulses counted in any given operation, it will eventually stop on some number from 1 through 6, just as dice must come to rest showing one of their six sides face up.

The flip-flop outputs of the six-counter are decoded in a manner which will turn on individual dots in a display in exactly the same pattern as shown on real dice. The display is an arrangement of seven light-emitting diodes (LED's) for each die of the pair. The diode cathodes are grounded through current-limiting resistors resulting in diode currents of approximately 20 mA.

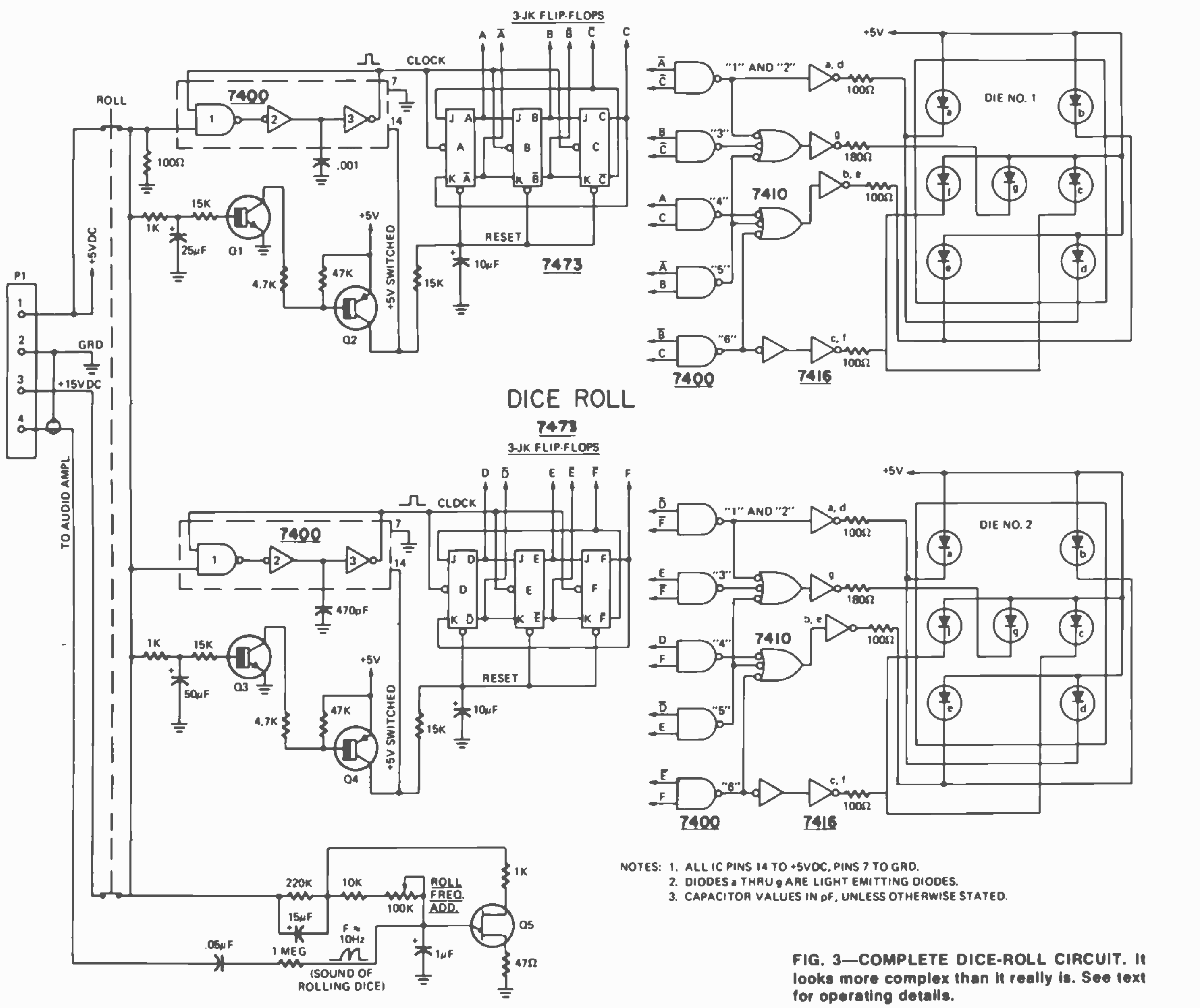
A unijunction transistor oscillator, Q5, is also turned on when the ROLL switch is depressed. It provides a sawtooth type waveform which when amplified and applied to a speaker resembles thessound of dice rolling across a table. The oscillator will only run until the 15-μF capacitor charges up. Similarly, dice stop rolling after exhausting their momentum.

Roulette

Fig. 4 shows the circuit of the Roulette game. In this game a moving spot of light (a turned on LED) is substituted for the little round ball of the roulette wheel.

When the SPIN switch is depressed, control transistor Q8 is turned on which applies +15V to the UJT oscillator. This oscillator runs at a frequency of about 100 Hz which is adjustable. The output pulse from the UJT is coupled into Q10, the clock driver, which provides clock pulses to a 38-bit TTL shift register. This shift register is composed of 19 dual JK flip-flops.

As power is first switched on to the Roulette game, a set pulse (LOW) is provided at the set input of a RS (RESET-SET) flip-flop and to the shift register. The RS flip-flop provides a HIGH to the J input of the A_1 flip-flop as a binary data "1" and a "0" is entered into the A_1—K input. After the first clock pulse (clocking of the JK flip-flop occurs on the trailing or falling edge of the clock pulse) the 1 is transferred to the A_1 output and A_2 on the next clock pulse, then B_1, B_2, . . . etc. After the first clock pulse the A_1 output sends a reset (LOW) to the RS flip-flop resetting it immediately and not allowing any more than the single binary 1 to be entered into the shift register. The binary 1 (HIGH) continues to shift down the 38-bit shift register with each clock pulse. When the 1 reaches the output of the S2 flip-flop it drives Q12 causing a RECYCLE command to reset the RS flip-flop. This starts the whole se-



NOTES: 1. ALL IC PINS 14 TO +5VDC, PINS 7 TO GRD.
2. DIODES a THRU g ARE LIGHT EMITTING DIODES.
3. CAPACITOR VALUES IN pF, UNLESS OTHERWISE STATED.

FIG. 3—COMPLETE DICE-ROLL CIRCUIT. It looks more complex than it really is. See text for operating details.

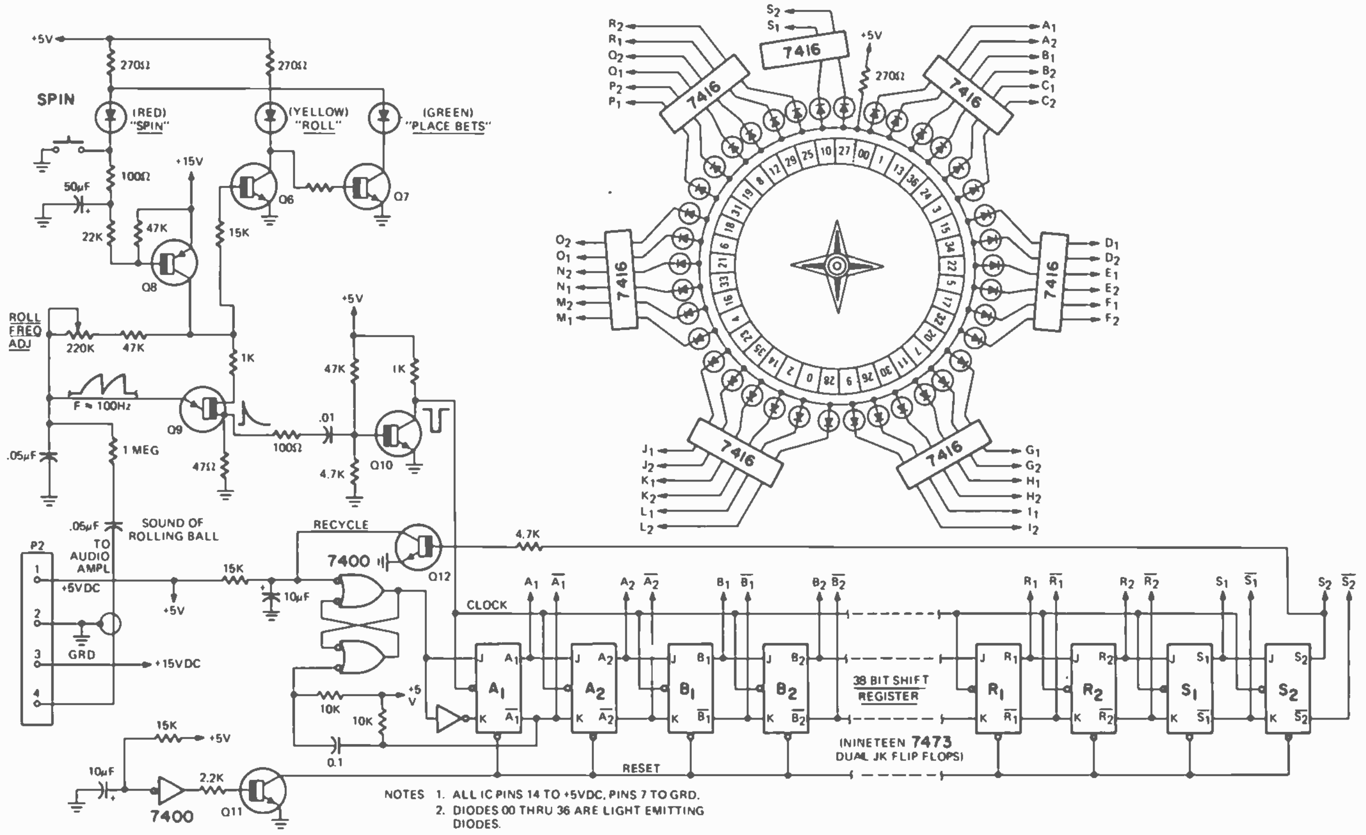


FIG. 4—(above) THE ROULETTE GAME is not nearly as complicated as it looks. There is, however, some additional information you'll need if you are going to build this unit. The base resistor for transistor Q7 is 4700 ohms. Transistor Q11 should be a type 2N2222 or equal. The A_1, A_2 through S_1, S_2 are not used.

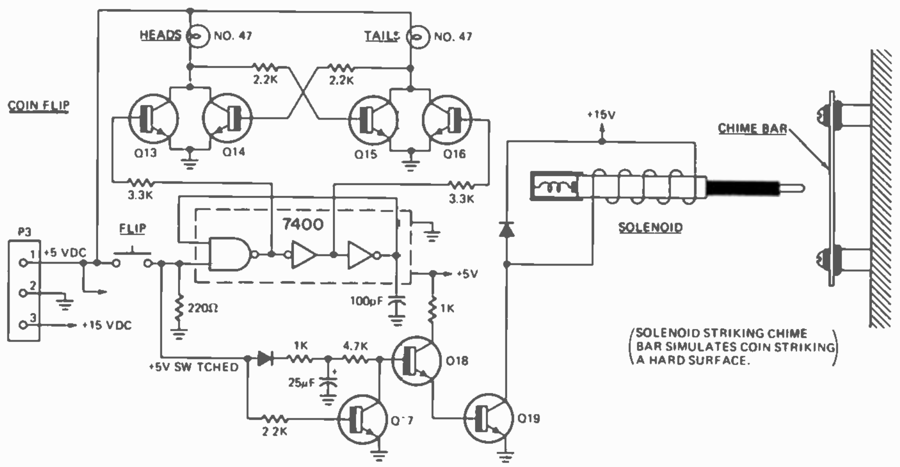


FIG. 5—(right) THE COIN FLIP. Audio is provided by the solenoid. Transistors Q13, Q14, Q15, and Q16 should be a 2N2222 or equal. The diode across the solenoid should be a 1N4001 or equal. Transistor Q19 should be a Motorola MJE520 or equal.

MISCELLANEOUS NOTES FOR THE CONSTRUCTOR

All discrete LED's (red) are Texas Instruments TIL210.

All discrete LED's (green) are Monsanto MV5222.

All discrete LED's (yellow) are Monsanto MV5322.

The seven-segment LED displays are Texas Instruments TIL303.

All small-signal diodes 1N914.

Unijunction transistors are Motorola 2N4870.

Small-signal npn transistors are Motorola MPSA20 or 2N2222, or Texas Instruments TIS84.

Small-signal pnp transistors are Motorola MPSA70 or 2N2907 or Texas Instruments TIS37.

Substitutions can be made for all of the semiconductors mentioned above depending upon availability and cost. Before making a substitution, however, take a careful look at maximum voltage and current ratings as well as minimum Beta to insure proper operation of the circuit.

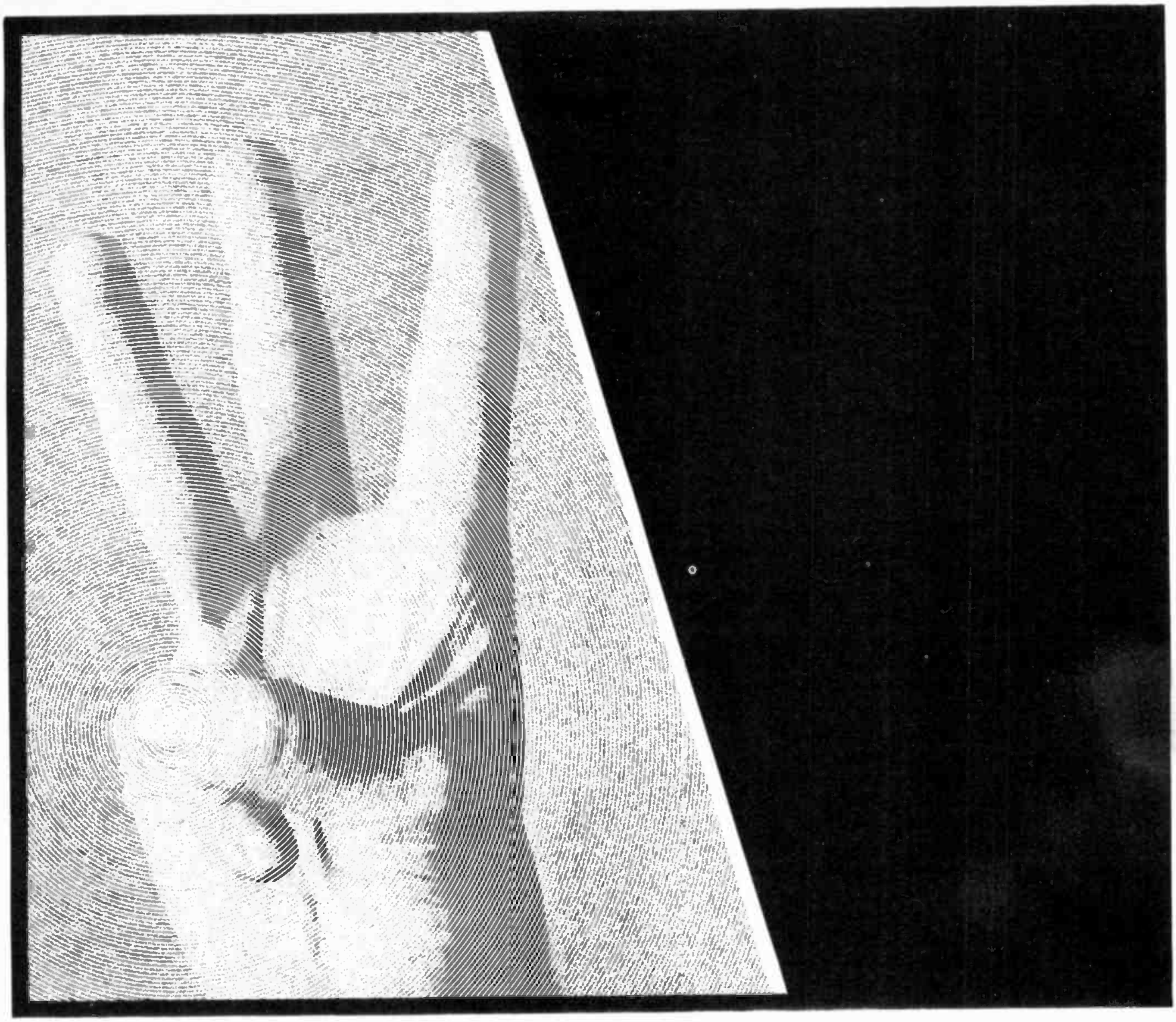
quence over again and a new binary 1 is entered.

The outputs of each of the 38 flip-flops in the shift register are used to drive (through buffer display drivers) LED's arranged in a circle forming a Roulette Wheel. Adjacent to each LED is a number corresponding to position on the wheel. As the binary 1 circulates through the shift register, the display lights the LED corresponding to its position. Travel of the "ball" is in a clockwise direction.

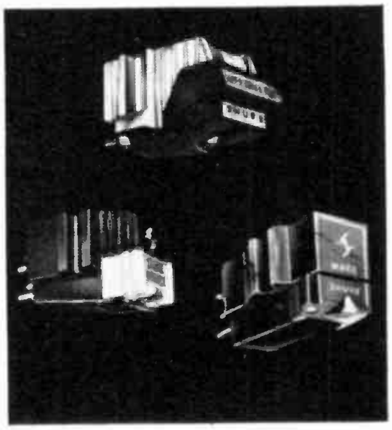
When the SPIN switch is released the "ball" will continue rolling as the 50-μF capacitor in the base circuit of Q8 charges up. As it nears +15V, Q8 will start to cut off slowly reducing the supply votage to UJT Q9 and lowering the frequency of operation until it stops oscillating and stops generating clock pulses. Thus, the "ball" stops. The sawtooth waveform on the emitter of the UJT is fed to the audio amplifier providing the sound of the ball rolling and then coming to a stop.

Three LED's provide visual indication of which mode the roulette game is in. A red LED turns on while the SPIN

(continued on page 86)



Best. Best. Best.



Permit us this momentary bit of self-indulgence, because our intentions are pure: to assist you in choosing the best phono cartridge for your hi-fi system, within the practical limitations of your audio budget. To begin, if you feel uncomfortable with anything less than state-of-the-art playback perfection, we heartily recommend the Shure V-15 Type III, a cartridge of such flawless performance it is the perfect companion to the finest turntables and tone arms available today — and those coming tomorrow. At a more moderate level of performance and price, we suggest the Shure M91ED, a superb performer second in trackability only to the Type III. Finally, for optimum performance under a budget austerity program, the yeoman Shure M44E is for you. All in all, these are three great ways to enjoy music with the kind of system you have decided is best for you.

Shure Brothers Inc.
222 Hartrey Ave., Evanston, Ill. 60204
In Canada: A. C. Simmonds & Sons Ltd.

SHURE®

Circle 19 on reader service card

Repairing Cassette Recorders

Many recorders may develop troubles that are common to others, regardless of make and model. Here are some troubles and their cures.

by GARY McCLELLAN

CASSETTE RECORDERS ARE BECOMING more popular than ever, and that means more are coming in for service. If you are now turning away these machines, you are missing out on a lot of potential profits. In practice, most of the problems that you'll encounter will be easy to fix; bad batteries, broken microphone cables, and tape jammed up in the machine head the list. Of course you'll run into more difficult problems, but with a good understanding of tape recorders—aided by the service manual of the machine you are working on—you should be able to handle these units almost painlessly.

Five popular machines, their most common problems and their repairs, are about to be presented. Hopefully, they'll be helpful to you on your next cassette recorder repair job. At the least, they may give you ideas as to where to look for the trouble. Let's look at the first example.

The Norelco 150 Carrycorder

In recent years a great many of these machines have come in with the complaint of slow fast forward or rewind. A check of the motor and the drive belt showed that the motor pulley would not turn the belt under these conditions. Simply cleaning off the belt and pulley solves most of these problems, but in extreme cases you'll have to replace the belt. These belts are made out of plastic, and they tend to stretch with age. I have seen a few cases where this belt had stretched so much that the recorder stopped working completely!

The Norelco 2401 cassette changer

This machine is one of Norelco's 1970 models. It stacks up to six tapes, and can give up to six hours of nonstop music. Recently my unit stopped changing cassettes. For want of a better place to start looking for the trouble, I checked the well where the tapes drop to be recorded or played. Running across the bottom, there is a recessed track. Riding on this track, there is a finger-like device that moves the played cassette out of the well so that a new one can take its place. Looking carefully at this finger, I happened to notice that it was jammed flat inside the track. It should have been in a popped-up position. An adjustment with a pair of needle-nosed pliers cured this one.

A Norelco 2502 changer (which is mechanically identical) came in with the same problem. The cure was the same.

The Sony Easymatic 100

One of these machines came in with no erase and poor record. A scope check of the bias oscillator showed the output voltage to be high, like there was no load on it. A new erase head was tried, the voltages dropped to normal, and the recorder worked fine again.

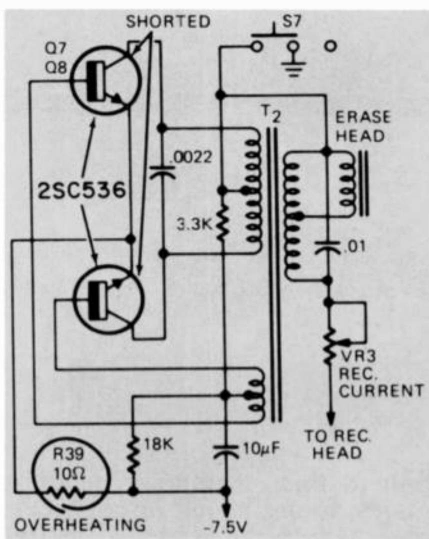


FIG. 1—BIAS-ERASE OSCILLATOR in a Sears model 8245 cassette recorder. Shorted transistors caused erase and record failures.

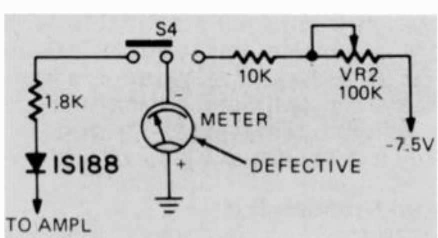


FIG. 2—METER CIRCUIT checks battery and recording level through selector S4.

The Sears 8245 recorder

This machine came in with no record or erase. I went immediately to the bias oscillator. Not surprisingly, there was no output. About this time I noticed that R39 was getting hot (see Fig. 1). The only possible chance for this to happen would be if Q7 and Q8 were drawing too much current. These transistors (2SC536's) were pulled and checked; both were shorted. I didn't have a pair of them handy, so I tried a pair of 2N706's. They worked fine, although VR3 had to be readjusted for better performance on *record*. I have since found that 2N706's work better in this circuit. The recorder was returned working perfectly.

Another one of these machines came in without the battery/level meter working. I tried a 0 to 500-μA meter in place of the original movement, and it worked fine (see Fig. 2). A new meter cured this one. Incidentally, be careful when replacing subminiature meters; they're fragile!

The GE M-8300 recorder

A salesman friend of mine brought in one of these. He complained of weak record and playback, but said that the erase was okay. With this information, I went to work. With a pre-recorded cassette playing in the recorder, I tried to trace the signal through the record/playback amplifier. Immediately one thing became clear; the gain of each stage was too low! Next the supply voltages were checked; all of these were okay. I must admit that this one had me stumped until I thought of the coupling capacitors. So I checked the input capacitor—it was open! And so were most of the others! I finally ended up by replacing all of them. That did it; the gain came back, and the recorder worked like new. It was about this time my friend mentioned that he had been leaving the recorder in the trunk of his car. It was the heat that damaged it! R-E

Add the new Sony SQA-2030 decoder / amplifier and two speakers to your present stereo system and you're into four channel. And what four channel!

Full logic IC circuits increase separation—side to side, front to back. SQ records and broadcasts are reproduced with rock- and concert-hall realism. Matrix recordings and broadcasts, other than SQ, discrete four channel tapes (with a quad deck), retain the excitement of the original performance. Even stereo records take on new depth.

And the SQA-2030 gives you something extra—a built-in stereo amplifier. It delivers 18+18 watts, RMS into 8 ohms at every frequency in the audio range (20-20,000 Hz)—plenty of power to drive your back channel speakers. It's distortion-free (THD less than 0.8%). And it's easy to enjoy. Once you've balanced your system, the SQA-2030's master volume control is about all you'll have to adjust.

Thanks to new integrated circuits,developed and manufactured by Sony, this full logic decoder, control center and stereo amplifier is housed in a cabinet about half the size of a standard receiver. It costs just $239.50.

Sony offers two other choices to go four channel. The full logic SQD-2020 has all the quality and control convenience of the SQA-2030 plus four calibrated VU meters to help you balance your system visually. If your stereo system has high power output, add a basic amplifier of equal power plus two speakers. The SQD-2020 costs $229.50.

Add full logic SQ to an existing four channel system. Or upgrade stereo to four channel (an integrated amplifier and two speakers are required).

The full logic SQD-2070 is an inexpensive choice, $89.50.

Go four channel with Sony. It's very logical. **SONY**®

Introducing the $240 full logic decoder. With an amplifier to boot.

Prices suggested retail
Sony Corp. of America, 9 West 57th St., New York, N.Y. 10019

Circle 18 on reader service card

How to Install

If TV servicing is your bag and you are

take on tape-player installations. The jobs

THIS GUIDE HAS BEEN DESIGNED TO facilitate installation of car stereo units. It is also intended to encourage service technicians who are not presently installing car stereos to consider the advantages in doing their own installations.

Installation charges are arbitrary and can be assigned at your own discretion. The following is an example of a typical installation schedule:

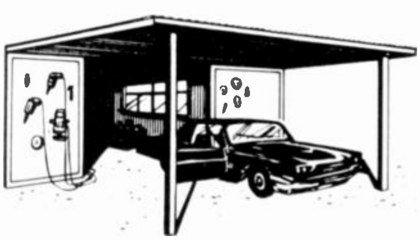
Installation with 2 speakers	$20.00
Installation with 4 speakers	$30.00
Installation of unit not purchased from installer	$10-$15 above regular price
Holes cut for speakers only	$4.00 per hole

A normal installation can be completed in one hour, so it is possible to install up to 8 units per day per man.

Using the schedule above, a technician making only 3 installations per man per day would adequately cover direct labor and material costs. All additional installations are bonuses that can greatly increase the profit picture.

Physical requirements

If you plan to do your own installations, physical limitations such as space to work in must be considered. Normally, an external

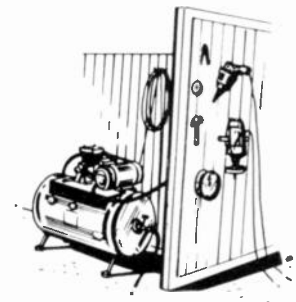


area 18′ × 18′ is sufficient for car stereo installation. The area must have access to at least one 117-volt ac outlet. It is also recommended that the area include an overhang to shield from the environment. In many eastern and northern areas, the installation center must be indoors.

Tools and equipment

The tools and equipment required for car stereo installation are as follows:

	Approx. Cost
1. Small 117-volt compressor — should be at least 1 horsepower	**$325.00**
2. ½″ drill motor	**75.00**
3. Air chisel	**90.00**
4. Air chisel ¼″ angle head	**70.00**
5. Various size chisel bits (2-4 should be enough.)	**15.00**
6. 4″ hole saw — with suitable arbor	**15.00**
7. 5″ hole saw — with suitable arbor (Note — to prevent tearing upholstery, file teeth down.)	**15.00**
8. Assorted wrenches, sockets, cutters, pliers, screw drivers, etc.	**55.00**
9. Soldering iron	**12.00**
TOTAL	**$672.00**



Our thanks to the Craig Corporation for their permission for using this material in Radio-Electronics. Both illustrations and text are based upon their brochure.

Expendable tools and materials

You must also have an adequate supply of expendable tools and materials. The following materials should cover most installation requirements:

1. **Wire, 20 to 18 gauge. (Wire supplied with unit is usually sufficient. Extra is desirable.)**
2. **Solder-rosin core.**
3. **Tape, plastic, ¾ inch width, black.**
4. **Misc. self-tapping sheet metal screws (10 x ½ inch) (10 x 1 inch) (10 x 1½ inch)**
5. **8-32 x 1, machine screws with nuts and lock washers. (Used for securing mounting brackets and occasionally for mounting speakers.)**
6. **No. 10 flat washer, plated. (Used in conjunction with item 5)**
7. **Wire nuts**

The following tools are not on the must list, but will speed and simplify installations:

1. **Reversible high-speed nut driver. Used to drive ground screws and speaker screws.**
2. **Vacuum cleaner to clean out cars of stripped wire, dirt, etc.**
3. **Miscellaneous assortment of paint for touch up — available in aerosol cans.**

Installation procedure

NOTE: Most car stereo units are designed for 12-volt negative ground electrical systems. Installations in 6-volt and/or positive ground electrical systems require special 6-12-volt and positive-to-negative ground converters.

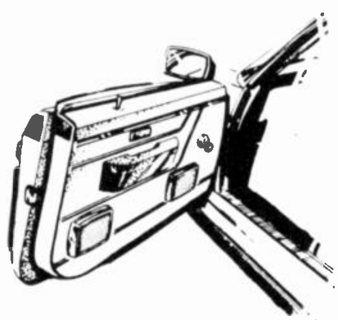
There are several converters on the market suitable for 6-12-volt and positive-to-negative ground conversion. Installation of the converter should follow the instructions included with the converter and is not described here.

Speaker installation

Generally, two speakers are adequate for good quality sound reproduction. However, in some cases where car size and/or consumer demand dictates, two additional speakers may be added. Speakers are generally mounted in the doors. Here is a breakdown of speaker combinations:

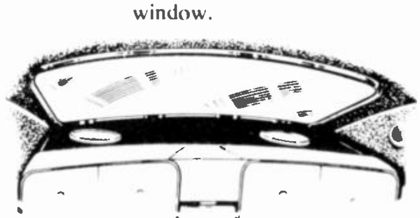
2 Speakers: 1 each in the front lower section of the front door.

4 Speakers: 1 each in the front lower section of the front door and 1 each in



the rear lower section of the front door. (In 4-door models, 1 each in lower front section in all doors.)

4 Speakers: 1 each in the front lower section of the front door and 2 in the package tray under the rear window.



In some late model cars, it is possible to mount the front speakers in the front kick panel instead of the door.

Front Door Speakers

When installing speakers in the front doors, follow these procedures:

1. Pull lower portion of door panel out enough to check door structure and locate area most receptive to speakers. Make sure area is free from window intrusion and door and window handles. In recent model cars, check to make sure speaker is out of the way of door safety panel bar.

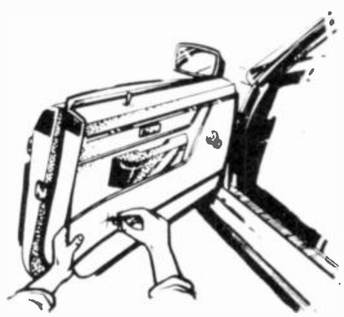
2. Carefully mark desired speaker location and push panel back against door.

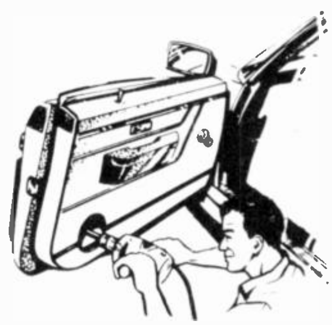
3. Cut hole for speaker in door panel using appropriate size hole. Saw/cut door panel only. Do not attempt to cut metal door.

Car Tape Players

looking for a way to raise your income,

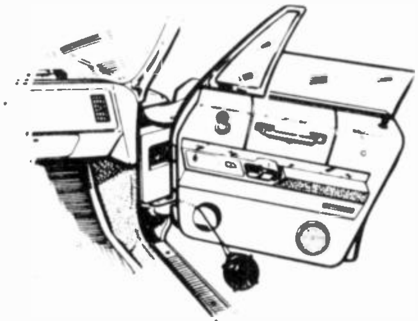
are quick and easy and the tools inexpensive.





4. If necessary, cut door metal with pneumatic air chisel.

5. Run wire through the door to the speaker before attaching the speaker to door.



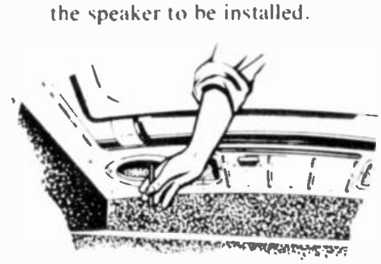
6. Mount speaker to door with supplied screws. *Wiring*—Door speaker wires should be run through the doors, kick panels, and under the dash to the unit. All wires must be securely anchored down and taped where necessary.

Rear Speakers—Door Mount
Same as above

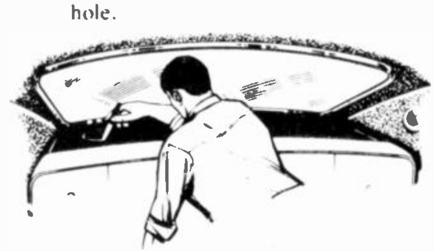
Rear Speakers–Package Tray

A. Metal Holes . . . Pre-Cut

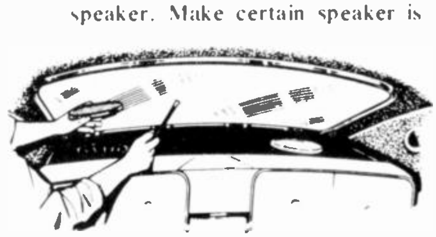
1. From underneath the rear deck, make four small punctures through the deck approximately the size of the speaker to be installed.



2. From the top of the deck, use a linoleum knife to cut and shape the hole.



3. Line up speaker cover over hole and drill holes for cover screws.
4. Use the same screws to mount speaker. Make certain speaker is



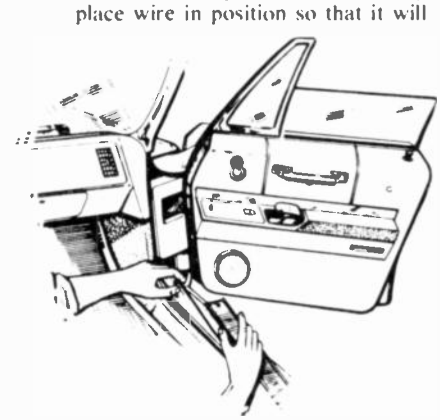
tight to prevent rattle and speaker buzz.

B. Metal Holes To Be Cut

1. Locate flat and easiest accessible position.
2. Using marking pencil, draw outline of speaker.
3. Using a pneumatic air chisel to cut hole (be careful of ripping top deck cover).
4. Complete installation as outlined above.

C. Wiring of Rear Speakers

1. After connecting wire to rear speakers, remove the rear auto seat.
2. Use fish wire (straightened coat hanger would do) to run wire from trunk to inside of auto.
3. Remove door jam plates. Carefully place wire in position so that it will



not short out when plate is replaced.

4. Remove kick panel, and run speaker wire up and under dash to complete the installation.

Exterior or Hang-on Speakers

Exterior or hang-on speakers permit installing car stereo units without having to drill holes in the door or package tray.

Installing exterior speakers requires only the securing of the speaker to the door panel or package tray with the included mounting screws. Wiring the exterior speakers is done just as for regular speakers, with door speaker wires run through the door and kick panels, and package tray speaker wires run under door jam panels and under dash.

Unit Installation

Because of size and installation variations among units, it is impossible to present specific instructions that will be applicable to all units and automobile models. Therefore, the installation instructions included with each specific unit must be carefully followed.

Perhaps the most important requirement in car stereo installation is to remove the fuse from the positive lead wire before installation. This will insure against accidental

(continued on page 96)

TECHNICAL TOPICS

Of the five circuits presented here, we have two that are test-instrument oriented. The others are a burned-out bulb indicator for motorists, a visual door annunciator and a VOX for tape recorders.

by ROBERT F. SCOTT
TECHNICAL EDITOR

MY THANKS TO THOSE OF YOU WHO told me what they would like to see in "Tech Topics" in the months to come. As it stands now, you'll be looking for simple test instruments, various types of control circuits and all the circuits I can find of photographic and automotive accessories. Also, from time to time you'll find a unique circuit that I've come up with as an answer to a reader's request. Too, you'll find me asking for help for a fellow reader. For example, Mr. Craig Pearce of Berwyn, Ill. wants a simple circuit to produce the two-tone beeping heard on European police cars or, more exactly, the sound heard on the old "Man from U.N.C.L.E." TV series. Perhaps a European reader or a "sound-effects" man can help. What about it fellows?

Automobile stoplight indicator

A burned-out stoplight is a hazard and can earn you a traffic ticket. A simple and inexpensive stoplight warning system was described in *Electronics Australia*. The heart of the device is a dry reed switch connected into the car's electrical system as shown in Fig. 1. The indicator is the car's handbrake warning light on the dashboard.

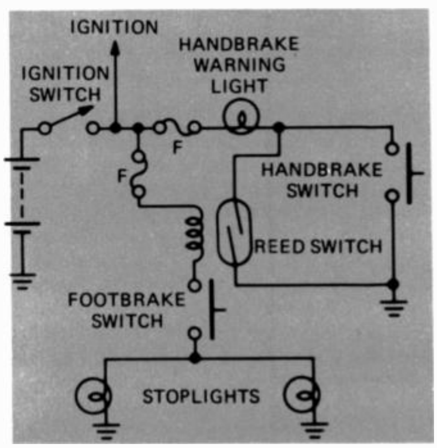


FIG. 1—BURNED-OUT STOPLIGHTS are a safety hazard that is often undetected by the driver of the car. This simple add-on circuit shows the condition of the stoplights every time you brake.

The indicator works on the difference between the pull-in and hold-in current of the magnetic reed switch. Pull-in current generally runs about three to three and a half times the hold-in current required to keep the contacts closed.

Until recently, reed switches have not been widely available, but now they are a part of every home security kit and they are readily available to experimenters. For example, you'll find them in the *Calectro Handbook*, a catalog for the electronics hobbyist and experimenter from GC Electronics.

You will have to wind the relay coil to match your car's stoplight system. The author found that 12 turns was just right for his automobile that has a 12-volt battery and uses 18–20-watt stoplight bulbs. When winding your coil, you might wind directly on the glass envelope of the reed switch or use the bobbin supplied with the switch kit. I suggest that you use the bobbin. Start with 12 turns of No. 16 to No. 20 wire.

Connect the switch into the stoplight and handbrake circuits as shown. Press the brake pedal so all stoplights come on. The indicator should come on and stay on as long as your foot is on the brake. Add a turn or two if the indicator flashes on and then goes out.

Temporarily remove one of the stoplight bulbs or break its circuit at one of the quick-connect terminals in the car's trunk. Press the brake pedal. The indicator should flash on and then go off. If the indicator stays, you have to remove a turn or so.

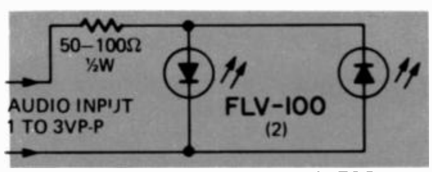


FIG. 2—VISUAL ZERO-BEAT INDICATOR is a useful adjunct to frequency calibrators and shortwave receivers. Two LED's form the null indicator in this simple circuit.

LED zero-beat indicator

If your hearing sensitivity has fallen off on the low end and you have trouble tuning your rig to zero-beat with an incoming signal or zero-beating WWV or a shortwave broadcast station, you need a zero-beat indicator.

The one in Fig. 2 from "Engineers Handbook" in *Electronics* magazine looks like it will fill the bill. It's simple and all you have to do is connect it across the speaker terminals. (A blocking capacitor was not shown, but I think you had better include one.) The circuit consists of two LED's connected in parallel with opposing polarity. The resistor protects them against overload.

Like all diodes, they conduct in just one direction and therefore will glow on alternate half-cycles of the audio signal. Both appear to glow constantly when the beat signal is around 1 kHz and higher. When the two signals are within about 20 Hz of each other, the lamps flicker alternately and slower and slower until zero-beat is reached. The LED's go out and remain out over a bandwidth of about 10 Hz.

The LED's may be Fairchild's red type FLV-100 or Monsanto MV-5091 red/red or MV-5491 red/green.

Visual door-bell indicator

This device is useful in areas where there are deaf or hard of hearing, where the ambient noise level is high or where the sound of the doorbell would be disturbing. The circuit shown was developed by G. A. French and described in *The Radio Constructor*. It is designed so the light stays on about 4 seconds after the bell stops ringing.

Fig. 3 shows the circuit arrangement when the doorbell is controlled by pushbuttons at two doors. Separate lamps identify which bell button has been pushed. To see how it works, look at the top section, say for the front door.

The system is powered by an 8-volt bell transformer. Rectifier D2 develops a constant dc voltage across the 100-µF electrolytic. Pressing the bell at the front door closes the circuit from the transformer secondary to the bell and

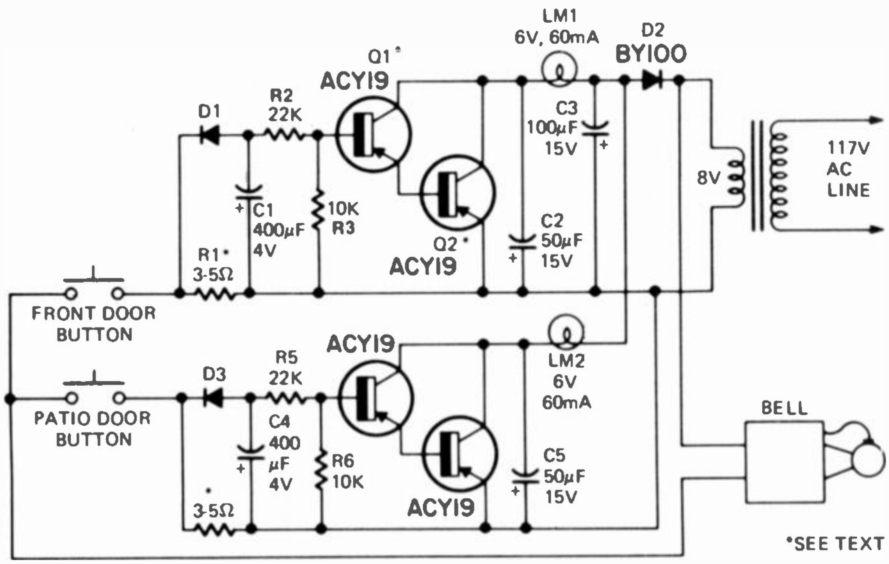


FIG. 3—HARD-OF-HEARING and persons working where ambient noise is high will find this doorbell indicator a handy device to have. It identifies front and rear doors.

develops a small ac voltage drop across series resistor R1. This voltage is rectified and charges C1 to 1.0 to 1.5 volts. Base current flows in Q1, which with Q2, forms a Darlington pair. Q2 is driven to saturation and lamp LM1 lights.

When the bell button is released, the voltage across R1 drops to zero. The charge remaining on C1 is sufficient to keep Q2 saturated for about 3 seconds. From then on, Q2's collector current drops until the lamp is extinguished.

The ACY19 transistors are European pnp germanium types similar to the HEP-253, GE-2 and SK-3004. Germanium transistors are specified because silicons have a higher base-to-emitter forward voltage drop. This would require a much higher drop across R1 to drive the Darlington pair to saturation.

Rectifier D1 can be any convenient silicon diode. D2 is a high-voltage rectifier because of the high-back emf developed when the bell is ringing. Equivalents are GE-509, HEP-159 and SK-3052. R1's value can be found by experimenting. It will be a 1-watt unit with a value of 3 to 5 ohms. Its value is selected to develop 1 to 1.5 volts dc across C1 when the bell button is pressed. R3's value is set to reduce the leakage current Q1–Q2 so the current through the lamp is below the glow level until the bell button is pushed. Reduce the value of R3 if the lamp glows when the bell button is not being pushed.

DB meter monitors phone-line levels

Ma Bell and her sister telephone companies specify the maximum signal levels that can be fed over their lines. So if we are to avoid difficulties, we must be sure the signals fed from phone patches, telephone answering devices, teletypes and similar apparatus do not exceed the limits. For this, you can use this linear decibel meter that has a range of +10 to −80 dB with 0 dB equal to 1 mW across 600 ohms. Its input impedance is 600 ohms to match the phone lines. Response is dc to 3.5 kHz.

The circuit (Fig. 4, abstracted from *Wireless World*) is built around four 741, IC op-amps. The first two are switched-gain amplifiers. The gain of the first can be set at 0, 5, and 45 dB by using the −5 and −40 dB pushbutton switches. Similarly, the second IC can be switched to 0, 10, 25 and 35 dB. The signal level in decibels equals the values of the pressed switches minus the meter reading.

IC2 feeds D1, a peak voltage of 1.1 volts for 0dB signal level. (Remember that 0 dB is a predetermined signal level used as a reference, not zero signal input.) This signal goes to the non-inverting input of IC3. A dc voltage applied to the inverting input neutralizes the effect of this voltage so the output of IC3 is 0 volts. For 10 dB—a voltage ratio of 3.16 the peak voltage applied to the input of IC3 must be 1.1 × 3.16 or 3.48 volts. The dc bucking-bias voltage applied to the inverting input reduces the signal input to the effective level of 2.38 volts. The amplifier gain is adjusted to 4.2 so the signal gives a 10-volt output from IC4

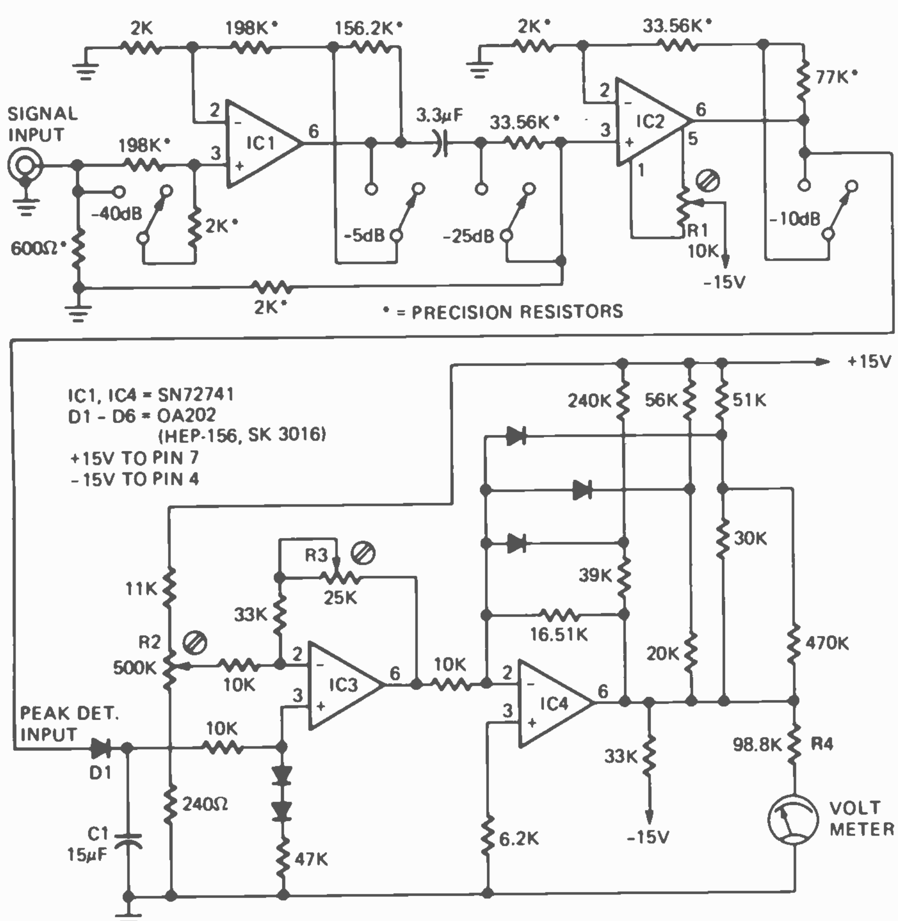


FIG. 4—DB METER uses switched-gain op-amps to provide a linear scale. Meter matches 600 ohm telephone lines and has response to 3.5 kHz. Reference 0 dB equals 1 mW across 600 ohms.

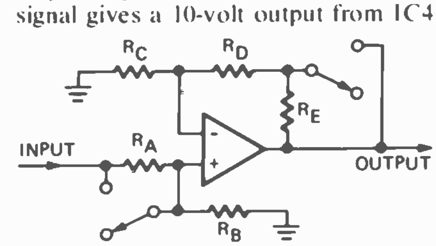


FIG. 5—BASIC CIRCUIT of switched-gain amplifier. Gain is controlled by switching R_E and R_A in and out of circuit.

and a 10 dB reading on the meter.

Fig. 5 is the basic circuit of the switched amplifier. The gain is controlled by switching R_E and R_A out of the circuit. With all resistors in circuit, gain equals

$$\frac{R_B}{R_A + R_B} \times \frac{R_C + R_D + R_E}{R_C}$$

If R_A is shorted out, the gain is

$$(R_C + R_D + R_E)/R_C$$

And if R_E and R_A are shorted out, the gain equals

$$(R_C + R_D)/R_C.$$

When R_E alone is shorted, gain is found from

$$\frac{R_B}{R_A + R_B} \times \frac{R_C + R_D}{R_C}.$$

The meter can be any type that can be driven by the IC with R4 being selected as a multiplier for 10 volts full-scale. Three trimmer resistors are used for calibration. First adjust R1 to give zero volts dc output from IC2 when no input signal is being applied. Next, apply a 0 dB, 1 kHz signal and adjust R2 for zero indication on the meter. Press the −10 dB button and set R3 for a fullscale reading. Release the −10 button and press the −5 button and reset R2 and R3 as necessary to make the meter read halfscale or −5 dB.

Automatic recorder control

A tape recorder is a handy adjunct to a two-way radio monitor receiver. The fire or police buff can record or log transmissions he is interested in. By adding the simple recorder controller shown in Fig. 6, the recorder can be turned on and off by the incoming signal. Thus, the businessman with two-way radio need not miss any calls while away from his shop or vehicle. This automatic recorder controller circuit was abstracted from *Electron*, a Canadian publication.

The controller's input is tapped off the receiver's voice-coil circuit. The 2N408 transistor is a current amplifier that energizes the relay when it is fed with an aduio signal. The relay contacts are connected in parallel with the push-to-talk switch on the microphone.

The circuit is designed so the controller can be used with either of two receivers and so the mike can be used to record comments, time, etc. on the tape. Components are not critical. The relay has a 1,000 ohm coil and spdt contacts so it can be adapted to recorders using either normally open or normally closed contacts to control the motor. C2 provides a time delay so the relay holds in for an instant after the audio from the receiver drops out. Increase the value for a longer hold-in time. **R-E**

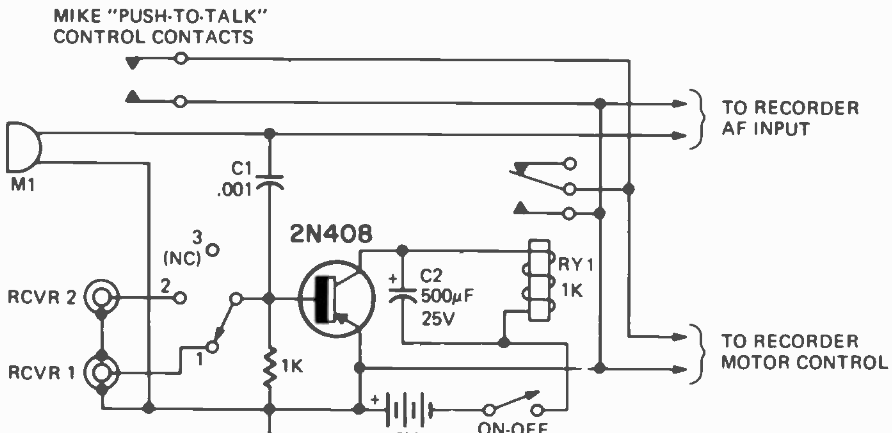


FIG. 6—TAPE RECORDER is turned on and off automatically by incoming signal on a monitor receiver. Circuit can be actuated by either of two receivers or by a mike used for recording comments or time.

ONE CHANNEL DEAD, RECORD ONLY

I've got an odd one on a Lafayette RK890A 8-track cartridge recorder. Playback and recording on the first 3 tracks, fine. However, when I record on the 4th track, the left channel is normal but the right channel is very low. The VU meter shows a low level on the bad one. Pre-recorded tapes* play *normally on the last track.—C.V., Bronx, N.Y.

OK, wait'll I dust off the crystal ball, and here we go. To change tracks, you *move the heads* up and down, right? There is no electrical switching as far as the signal is concerned. Track 4 would probably be the one with the heads closest to the chassis.

From all of the symptoms, and especially the reaction of the *VU meter* (which is right across the head, in RECORD, and works normally in all of the other three channels) it looks very much as if you have a *short* to chassis when the head is in Ch. 4 position. The very small wires to the head may be rubbing on a sharp edge.

Get a big magnifying glass and a strong light, and see if you can tell where this is taking place. You might try putting bits of plastic tape across any sharp metal edges near the wiring to the heads. Might even be able to verify this crystal-ball diagnosis with an ohmmeter on the head, moving it into Ch. 4 position manually.

NEW PRINTING OF 1927 RADIO ENCYCLOPEDIA

If you want to take a look back at what electronics was like in 1927, you can now get a new reprint of S. Gernsback's **1927 Radio Encyclopedia.** Just who is S. Gernsback?

Sidney Gernsback (1876—1953) was the older brother of Hugo Gernsback, the founder of **Radio-Electronics.** He was editor of *Radio Review*, and the *Radio Listeners' Guide And Call Book*. He also wrote *A Thousand and One Formulas, Wireless Course In Twenty Lessons*, and *Experimental Electricity Course* in addition to the Radio Encyclopedia that was originally published in 1927.

You can order your copy in paperback for $9.95 or hardcover for $12.95 from Vintage Radio, Apt. R, Box 2045, Palos Verdes Peninsula, Calif. 90274.

R-E's Substitution guide for replacement transistors

PART XIII

compiled by

ROBERT & ELIZABETH SCOTT

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

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

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

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

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

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

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

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

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

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

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
2N2835	NA	T-642	NA	NA	IRTR-50	PTC 120	HEP-642	NA	RT-127	ECG 131	WEP-642	NA
2N2836	RS276-2006	T-232	GE-25	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP-232	ZEN 326
2N2837	RS276-2023	T-52	GE-67	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-127	ECG 106	WEP-717	NA
2N2838*	RS276-2023	T-52	GE-67	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 106	WEP-717	NA
2N2841	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2842	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2843	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2844	NA	NA	NA	NA	NA	NA	HEP803	NA	NA	NA	NA	NA
2N2845*	RS276-2023	T-52	GE-20	ICC-52	TR-20	PTC 136	HEP-52	SK 3025	RT-102	ECG 129	WEP-735	NA
2N2846	NA	T-714	GE-18	NA	TR-25	PTC 144	HEP-S3001	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2847	RS276-2023	T-52	GE-17	ICC-52	IRTR-25	PTC 121	HEP-52	SK 3025	RT-102	ECG 123A	WEP-735	NA
2N2848	NA	T-714	GE-18	NA	IRTR-25	PTC 144	HEP-S3001	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2849	NA	T-714	NA	NA	IRTR-25	PTC 144	HEP-S5000	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2850	NA	T-714	NA	NA	TR-87	PTC 144	HEP-S5000	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2851	NA	T-714	NA	NA	TR-87	PTC 144	HEP-S5000	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2852	NA	T-714	NA	NA	TR-87	PTC 144	HEP-S5000	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2853	RS276-2018	T-243	GE-4	ICC-243	TR-87	PTC 144	HEP-243	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2854	NA	TS-3020	GE-28	NA	TR-87	PTC 144	HEP-243	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2855	RS276-2018	T-243	GE-4	ICC-243	TR-87	PTC 144	HEP-243	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2856	RS276-2018	T-243	GE-4	ICC-243	TR-25	PTC 144	HEP-243	SK 3024	RT-114	ECG 128	WEP-243	NA
2N2857*	NA	T-56	GE-17	NA	NA	PTC 133	NA	NA	RT-113	ECG 108	WEP-56	NA
2N2858	NA	NA	NA	NA	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N2860	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 102	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2861	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2862	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2863	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S3011	NA	NA	NA	NA	NA
2N2864	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S3010	NA	NA	NA	NA	NA
2N2865	RS276-2011	T-56	GE-17	ICC-56	TR-24	PTC 133	HEP-56	SK 3019	RT-113	ECG 161	WEP-719	ZEN 104
2N2868	NA	T-232	GE-63	NA	NA	PTC 144	HEP-S3010	NA	NA	ECG 121	NA	NA
2N2869	RS276-2006	T-232	GE-25	ICC-232	RT-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP-232	ZEN 326
2N2870	RS276-2006	T-232	GE-25	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP-232	ZEN 326
2N2873*	RS276-2003	T-3	GE-1	ICC-3	TR-17	PTC 109	HEP-3	NA	NA	ECG 160	WEP-56	ZEN 301
2N2874	NA	NA	NA	NA	NA	NA	HEP-S3010	NA	NA	NA	NA	NA
2N2875	NA	TS-3031	GE-69	NA	NA	NA	HEP-246	NA	NA	NA	NA	NA
2N2876	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2877	NA	TS-3020	GE-66	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2878	NA	TS-3020	GE-66	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2878	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2880	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2881	NA	NA	NA	NA	NA	NA	HEP-242	NA	NA	NA	NA	NA
2N2883	NA	T-56	GE-17	NA	NA	PTC 133	HEP-75	SK 3039	RT-113	ECG 108	WEP-56	NA
2N2884	NA	T-56	GE-17	NA	NA	PTC 133	HEP-714	SK 3039	RT-113	ECG 108	WEP-56	NA
2N2886	NA	T-714	GE-18	NA	TR-25	PTC 125	HEP-53	NA	NA	NA	NA	NA
2N2887	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2888	NA	NA	NA	NA	NA	NA	HEP-R1304	NA	NA	ECG 5524	NA	NA
2N2889	NA	NA	NA	NA	NA	NA	HEP-R1306	NA	NA	ECG 5525	NA	NA
2N2890	NA	T-714	GE-18	NA	NA	PTC 125	HEP-714	NA	NA	NA	NA	NA
2N2891	NA	T-714	GE-18	NA	NA	PTC 125	HEP-S5004	NA	NA	NA	NA	NA
2N2892	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2893	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2894	RS276-2023	T-52	GE-20	ICC-52	IRTR-20	PTC 136	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2895	NA	T-243	NA	NA	NA	PTC 144	HEP-S0005	SK 3024	NA	ECG 128	NA	NA
2N2896	NA	NA	NA	NA	NA	NA	HEP-S0005	NA	NA	NA	NA	NA
2N2897	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S0004	SK 3024	NA	NA	NA	NA
2N2898	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2899	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2900	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S0007	NA	NA	NA	NA	NA
2N2901	NA	T-56	GE-11	NA	TR-21	PTC 136	NA	NA	NA	NA	NA	NA
2N2902	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2903*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2904	RS276-2021	T-708	GE-21	ICC-708	TR-12	PTC 141	HEP-708	SK 3025	RT-115	ECG 129	WEP-242	NA
2N2905	RS276-2021	T-708	GE-67	ICC-708	TR-12	PTC 141	HEP-708	SK 3025	RT-115	ECC 129	WEP-242	NA
2N2906	RS276-2023	T-52	GE-21	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2907	RS276-2023	T-52	GE-67	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2908	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2909	NA	T-706	GE-27	NA	IRTR-78	PTC 144	HEP-S3010	NA	NA	NA	NA	NA
2N2910*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0004	NA	NA	NA	NA	NA
2N2913*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-729	NA	NA	NA	NA	NA
2N2914*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0007	NA	NA	NA	NA	NA
2N2915*	NA	NA	NA	NA	NA	NA	HEP-S729	NA	NA	NA	NA	NA

NA = NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N2916*	NA	T-728	NA	ICC-728	NA	NA	HEP-728	NA	NA	NA	NA	ZEN 114
2N2917*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0007	NA	NA	NA	NA	NA
2N2918*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0007	NA	NA	NA	NA	NA
2N2919*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2920*	NA	TS-0007	NA	ICC-S0007	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2921	RS276-2009	T-722	GE-10	ICC-722	IRTR-24	PTC 121	HEP-722	SK 3124	RT-113	ECG 108	WEP-56	ZEN 110
2N2922	RS276-2009	T-722	GE-10	ICC-722	IRTR-24	PTC 121	HEP-722	SK 3124	RT-113	ECG 108	WEP-56	ZEN 110
2N2923	RS276-2009	T-723	GE-62	ICC-723	IRTR-24	PTC 121	HEP-723	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 111
2N2924	RS276-2009	T-724	GE-62	ICC-724	IRTR-24	PTC 121	HEP-724	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 112
2N2925	RS276-2009	T-725	GE-62	ICC-725	TR-21	PTC 121	HEP-725	SK 3019	RT-102	ECG 123A	WEP-735	NA
2N2926	RS276-2013	T-726	GE-62	ICC-726	IRTR-51	PTC 115	HEP-726	SK 3018	RT-102	ECG 123A	WEP-735	ZEN 113
2N2927	RS276-2021	T-51	GE-67	ICC-51	TR-88	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N2928	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 102	HEP-3	SK 3123	NA	ECG 160	WEP-637	ZEN 301
2N2929	NA	T-2	NA	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2930	NA	T-250	GE-2	NA	TR-05	PTC 102	HEP-629	SK 3010	RT-118	ECG 100	WEP-254	NA
2N2931	RS276-2016	T-54	GE-11	ICC-54	IRTR-21	PTC 136	HEP-54	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N2932	RS276-2016	T-54	GE-11	ICC-54	IRTR-21	PTC 136	HEP-54	SK 3124	RT-102	ECG 123A	NA	NA
2N2933	RS276-2016	T-54	GE-11	ICC-54	TR-25	PTC 136	HEP-54	SK 3124	NA	ECG 123A	NA	NA
2N2934	RS276-2016	T-54	GE-11	ICC-54	IRTR-25	PTC 136	HEP-54	SK 3124	RT-102	ECG 123A	NA	NA
2N2935	RS276-2016	T-54	GE-11	ICC-54	IRTR-21	PTC 136	HEP-54	SK 3124	RT-102	ECG 123A	NA	NA
2N2936*	NA	T-736	GE-20	NA	N	PTC 136	HEP-S0004	NA	NA	ECG 123A	NA	NA
2N2937*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3004	NA	NA	NA	NA	NA
2N2938	RS276-2009	T-50	GE-20	ICC-50	IRTR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A	NA	ZEN 100
2N2939	NA	NA	NA	NA	NA	NA	HEP-S3011	NA	NA	NA	NA	NA
2N2940	NA	NA	NA	NA	NA	NA	HEP-S3022	NA	NA	NA	NA	NA
2N2941	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2942	NA	T-2	GE-51	ICC-2	TR-17	NA	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2943	NA	T-2	GE-51	ICC-2	TR-17	NA	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2944	RS276-2023	T-52	GE-67	ICC-52	TR-20	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2945	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2946	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2947	NA	TS-3020	GE-66	NA	NA	NA	HEP-S3020	NA	NA	NA	NA	NA
2N2948	NA	T-247	GE-19	NA	NA	PTC 119	HEP-S3020	NA	NA	NA	NA	NA
2N2949	RS276-2018	TS-0001	GE-63	ICC-S3001	NA	PTC 123	HEP-0001	SK 3024	NA	NA	NA	NA
2N2951	RS276-2009	T-53	GE-63	ICC-53	TR-24	PTC 136	HEP-53	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 102
2N2952	RS276-2009	T-50	GE-63	ICC-50	TR-21	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2953	RS276-2005	T-254	GE-9	ICC-254	TR-14	PTC 109	HEP-254	SK 3004	RT-120	ECG 102	WEP-631	ZEN 305
2N2954	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0004	NA	NA	NA	NA	NA
2N2955	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2956	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2957	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2958	RS276-2007	T-53	GE-18	ICC-53	TR-24	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 102
2N2959	RS276-2009	T-53	GE-18	ICC-53	TR-24	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 102
2N2960	RS276-2009	T-53	GE-18	ICC-53	TR-24	PTC 123	HEP-53	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 102
2N2961	RS276-2009	T-53	GE-18	ICC-53	TR-24	PTC 136	HEP-53	NA	RT-102	ECG 123A	WEP-735	ZEN 102
2N2962	NA	NA	NA	NA	NA	NA	HEP-636	NA	NA	NA	NA	NA
2N2963	NA	NA	NA	NA	NA	NA	HEP-636	NA	NA	NA	NA	NA
2N2964	NA	NA	NA	NA	NA	NA	HEP-253	NA	NA	NA	NA	NA
2N2965	NA	NA	NA	NA	NA	NA	HEP-253	NA	NA	NA	NA	NA
2N2966	NA	T-250	GE-2	NA	TR-06	PTC 102	HEP-2	NA	RT-126	ECG 100	WEP-254	NA
2N2967	NA	NA	NA	NA	NA	NA	HEP-50	NA	NA	NA	NA	NA
2N2968	NA	T-52	GE-21	NA	TR-30	PTC 131	HEP-51	SK 3118	RT-126	ECG 106	WEP-52	NA
2N2969	NA	T-52	GE-21	NA	TR-30	PTC 131	HEP-52	SK 3118	RT-126	ECG 106	WEP-52	NA
2N2970	NA	T-52	GE-21	NA	TR-30	PTC 131	HEP-51	SK 3118	RT-126	ECG 106	WEP-52	NA
2N2971	NA	T-52	GE-21	NA	TR-30	PTC 131	HEP-52	SK 3118	RT-126	ECG 106	WEP-52	NA
2N2972*	NA	NA	NA	NA	NA	NA	HEP-729	NA	NA	NA	NA	NA
2N2973*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2974	NA	T-53	GE-20	NA	NA	PTC 136	HEP-729	NA	NA	NA	NA	NA
2N2975*	NA	NA	NA	NA	NA	NA	HEP-S007	NA	NA	NA	NA	NA
2N2976*	NA	NA	NA	NA	NA	NA	HEP-729	NA	NA	NA	NA	NA
2N2977*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2978*	NA	NA	NA	NA	NA	NA	HEP-729	NA	NA	NA	NA	NA
2N2979*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2980*	NA	NA	NA	NA	NA	NA	HEP-S0007	NA	NA	NA	NA	NA
2N2981*	NA	NA	NA	NA	NA	NA	HEP-S0001	NA	NA	NA	NA	NA
2N2982*	NA	NA	NA	NA	NA	NA	HEP-S0001	NA	NA	NA	NA	NA
2N2983	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2984	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2985	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2986	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA

*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

VTR problems set straight

How VTR with defects affects your color picture

by JACK DARR
SERVICE EDITOR

TO A READER'S QUESTION IN THE Dec. 1972 issue, I answered (Slightly edited) "Those odd horizontal streaks you see in the picture are due to a problem in the Video Tape Recorder (VTR) at the TV station." Whereupon, the roof fell in on me! I got letters, long-distance calls, etc. from irate VTR engineers, and even from the Telco people. All of them said, in effect, "You're crazy! A *properly operated* VTR will never do that!" (Emphasis mine).

To be as plain as possible, that is exactly what I was saying: a properly operated VTR won't do it. A dirty, improperly adjusted, incorrectly operated VTR definitely WILL! The next sentence in most of these letters was "You'll never see this kind of trouble on a TV station or network. The FCC won't allow it!" Right again. However, I *have* seen every one of these troubles, not only on local TV stations but on certain network shows, with my own bloodshot baby-blues! Loss of color sync; horizontal sync, a complete wipeout of the picture, as well as the "streak every 4 inches" symptom! I will admit that there was a mixup in the photos that were printed with the original Question! One of them wasn't correct.

Also! I did not correctly identify the precise VTR troubles that caused these symptoms. Much detailed correspondence with some very helpful and highly competent people helped to clear this up. Chief among these, I should like to thank Mr. James O'Neal of New Haven, Conn. a VTR Engineer, and Mr. Eric Address, Chief Engineer of E.J. Stewart, Inc. of Broomall, Pa. Mr. O'Neal, in particular, was nice enough to take time to simulate all of these errors, photograph them, and allow us to use the pictures. So, I hope this will "set the record straight."

Distortions and Their Causes.

Now then: the sawtooth look in a picture should be called "Skewing". Fig. 1 shows the unmistakable symptoms. This distortion results from improper tape-to-head contact. It used to be quite common in the early machines. Now, it's automatically corrected, by special circuitry, which makes a correction for *each* horizontal line! Fig. 2 shows the error signal de-

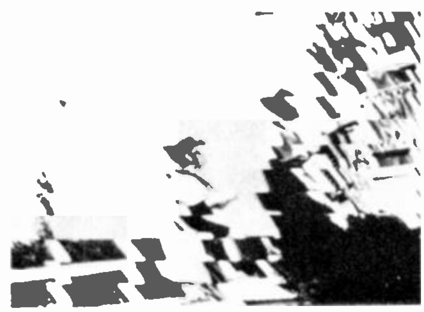


FIG. 1—VIDEO TAPE PLAYBACK with a large amount of "skewing" geometric distortion. The video signal feeding the monitor in this photo was obtained at a point in the tape system before any time element compensation had taken place.

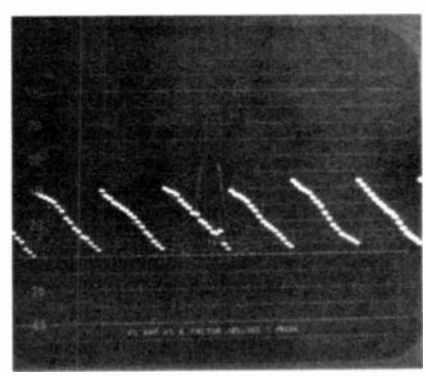


FIG. 2—OSCILLOGRAM OF ERROR SIGNAL developed by the time element compensation device for correction of skew shown in Fig. 1.

veloped by the time-compensator for the pattern of Fig. 1: this was disabled in order to mis-adjust the machine to make the photo. The late models also have an automatic guide servo to set the "head penetration" or guide-position automatically.

Fig. 3 shows a color-bar pattern with a very severe velocity error, deliberately introduced. Here, the color bars

(continued on page 68)

All photographs courtesy of James O'Neal New Haven Conn.

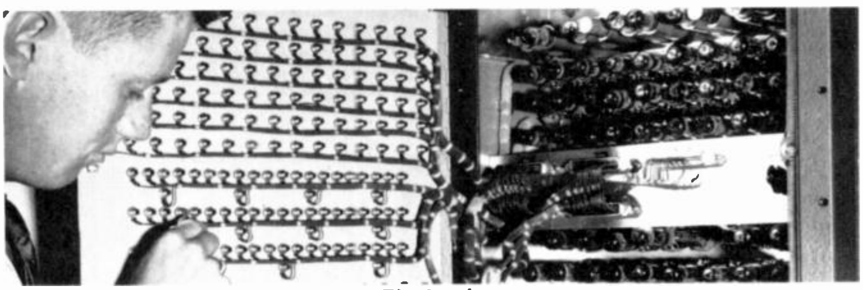
This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included, we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

Feel at home on jobs like these:

NTS builds your confidence with more solid training in Solid-State

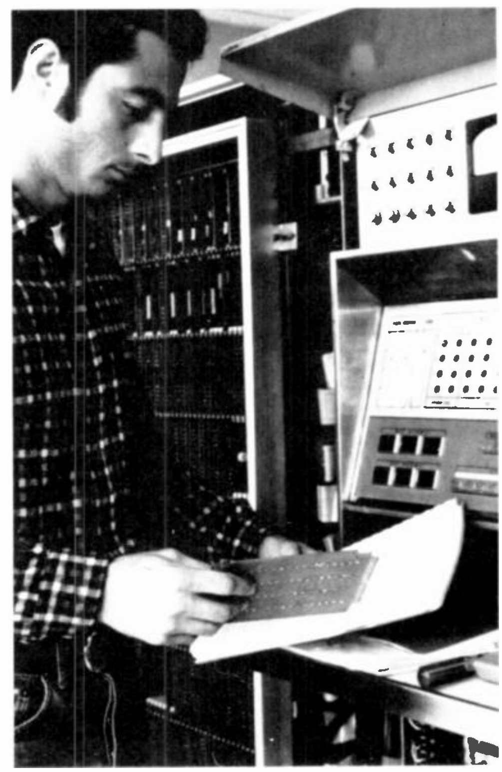
NTS Training on professional solid-state equipment prepares you for many careers — in many consumer, commercial and industrial fields. If television is your chosen field, you could join a first class TV repair center, start a shop of your own, or specialize in industrial applications of television such as security system installation. And other electronic fields are continuing to grow, revolutionizing industry and communications, even reshaping our own lives. Opportunities are opening in home entertainment areas, commercial audio systems, mobile communications, computer servicing, industrial controls and many other service technician areas. Yes, this is truly "The Age of Electronics." Your NTS training and the equipment you receive prepare you for these exciting careers wherever electronic technicians are needed. Start now! Build your confidence along with new skills in electronics. You may start earning extra money even before you graduate! Check your course on the card or coupon and mail today! No obligation. No salesman will call.



Master Technician: Communications Electronics

Master Technician: Industrial Electronics

Master Technician: Home Entertainment Electronics



Master Technician: Computer Electronics

Classroom training at Los Angeles

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

Approved for Veteran Training

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

NTS guide to careers in Electronics

Please rush Free Color NTS Guide To Careers In Electronics and Sample Lessons, plus information on course checked below. No obligation. No salesman will call.

National Technical Schools
Technical-Trade Training Since 1905
Resident & Home Study Schools
4000 So. Figueroa St.
Los Angeles, Ca. 90037

- ☐ Master Course in Color TV Servicing
- ☐ Color TV Servicing (For Qualified Technicians)
- ☐ Master Course in B&W TV & Radio Servicing
- ☐ Master Course in Electronic Communications
- ☐ Practical Radio Servicing
- ☐ FCC License Course
- ☐ Master Course in Electronics Technology
- ☐ Automation & Industrial Electronics
- ☐ Computer Electronics
- ☐ Basic Electronics
- ☐ Audio Electronics Servicing
- ☐ Audio Technology for Qualified Technicians

Dept. 206-034

NAME ____________________ AGE ____

ADDRESS ____________________

CITY ____________________

STATE ____________ ZIP ______

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

☐ Check if interested ONLY in Classroom Training at Los Angeles.

SERVICE CLINIC
(continued from page 63)

are straight, although a very severe color-shift is taking place. Note the absence of error in the first grey bar (left), and in the reference-white area, below.

In Fig. 4, here we finally see a very good example of the "bad single head" or unequalized-head error. Actually, Mr. O'Neal had a hard time getting this photo! The head itself isn't bad; he finally had to remove all of the high-frequency equalization from his preamp. The resulting HF loss dropped the chroma level, and gave a perfect simulation of this type of problem.

I will once again agree with the gentlemen who properly called me to account on the first item. You won't see these types of problems in a properly operated, clean VTR. You may see them now and then; more frequently if you watch some of the smaller TV stations (It's getting harder and harder to get good engineers for $35.00 a week! Most of the trouble is a simple lack of experience in this split-second switching, and so on.)

These conditions are almost always intermittent. They can be the result of minor errors; VTR not quite up to speed on cue; momentary loss of head-contact, etc. In the larger TV stations and networks, a backup (duplicate) tape is kept synced and rolling on another VTR! If any trouble occurs, this is instantly switched to "Air", so fast that viewers often cannot see it!

There may be "emergencies", too. I once watched a whole hour of tape, with a complete loss of color sync, and lousy sound! However, this was the only recording available of the college football game, so they went ahead with it (and then ran for cover!)

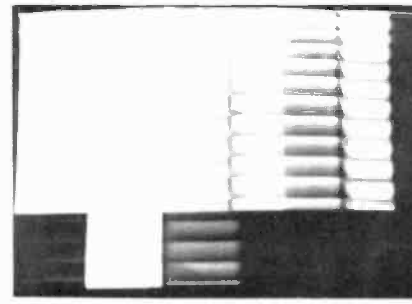


FIG. 3—EXTREMELY SEVERE "VELOCITY ERROR" introduced into the tape system for photographic purposes. Individual color bars are straight even though a severe color shift is occurring. Note also the absence of error in the first "grey" bar and white 100% area at the bottom.

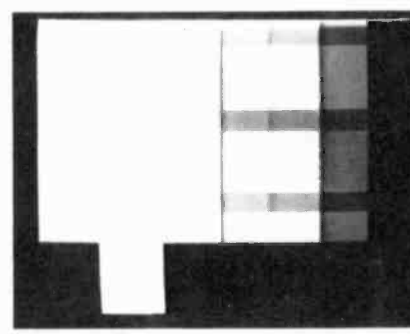


FIG. 4—BANDING DISTORTION produced by a bad head or unequalized head. (Head was actually in good condition. All high-frequency equalization was removed from head preamp and the resulting high frequency loss dropped chroma level.) The wide diagonal band was produced by the camera shutter and not visible on the monitor.

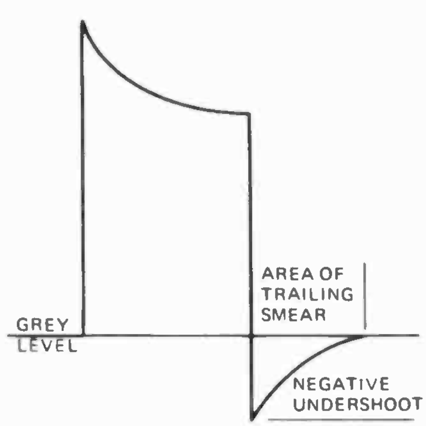


FIG. 5—TRAILING SMEAR on black-to-white transition is caused by amplifier with this type of response to square waves.

Black Streaking To The Right.

While we were at it, Mr. O'Neal

cleared up another very common reader question—the "black streaks to the right of light-colored letters on a dark background". If this is NOT present at all times in the TV receiver, or on all stations, this can be due to video problems at the TV station. The major cause is very poor low-frequency response *somewhere* in the TV system. The most likely cause is misadjusted frequency compensation in the camera-tube-pickup preamplifier. Partial or complete loss of clamping in any clamped amplifier stage can do it.

The "white-to-black", or vice-versa, transition in a picture should be a perfect square wave, with very short rise and fall times. Fig. 5 shows a square wave with a negative undershoot, also very poor low-frequency response, as shown by the overshoot and tilt on top. This type of response would produce the trailing smear symptom in a picture. In highlight areas, this isn't noticeable; in any scene with an abrupt transition from light to dark, or vice versa, it is.

However, neither of us is absolving the TV receiver from possible guilt. If some of the low-frequency compensation in its video amplifier is defective, it can definitely show such symptoms. If this is true, then it would show up on a fixed pattern, such as color bars, "shading patterns", and so on (unless, of course, it was intermittent! With the world what it is, this is always possible!) In any case, the receiver should be thoroughly checked out before blaming the TV station for all troubles!

I have said and I reiterate, that I am not making a blanket condemnation of TV operating engineers! The worst thing I said was that some of them may not have enough experience yet. It isn't hard to make mistakes. I know of one case where a radio engineer read almost half of a 15-minute newscast into a very dead mike, simply because he forgot to push the mike switch down! I wouldn't mention any names, of course. (At least, not any of the ones the station-manager called me when he came running in screaming "You're off the air! You're off the air!" These couldn't have been broadcast in any event; not and keep our license!) **R-E**

reader questions

ODD DARK SPOT

This Heathkit B/W TV, a GR-104A, has an odd problem: there's a dark spot about 5" in diameter in the center of the screen. There's also a bending that gradually goes up the screen; the horizontal hold is very touchy. Are

these problems all related?—L.B., Sulphur La.

Very likely! This type of "multiple-symptom" condition is often due to a filter capacitor in the dc power supply. If one of these is below normal capacitance, or has a high power-factor, you can get a whole gang of weird feedback loops, and you can see all kinds of things at once.

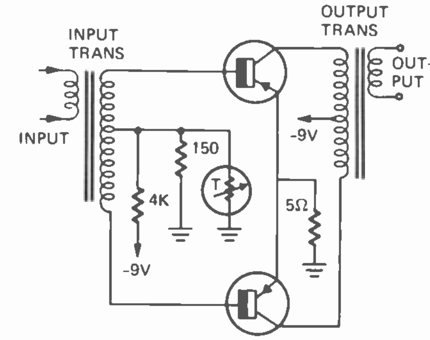
Scope the dc power supply lines, or bridge good capacitors across any that you suspect.

SHORT LIFE TRANSISTORS

The output transistor in this Mayfair FT-1024B tape recorder keep burning up. The original 2SB178's had been replaced, and the replacements also burnt up. I replaced these, and now the new ones fry if I leave it more than about 60 seconds.

The base voltage is too high; −0.8 volt instead of the listed −0.1 volt. Collector voltage starts to drop as soon as it's turned on, and keeps dropping. Checked resistors, etc.; no luck. I'm baffled.—T.L. Berkeley Calif.

I think your high base bias is the key to the whole thing! This is far too much forward bias, and as the transistor is driven into conduction, things will get worse. Note that this stage is clamped by a voltage-divider network from the −9 volt-source (see diagram). This is composed of a 4,000-ohm resistor and a 150-ohm resistor with a small thermistor shunted across it. Base goes to the junction, through the secondary winding of the transformer.



25B178

"Leave us now analyze" the situation. If the ground-leg of this voltage divider *increased* in value, this would make the base voltage go up. (Which it is doing.) You have replaced both of the resistors, so this leaves us only one thing to suspect—that thermistor. I believe you'll find that this is either open (unlikely) or not properly soldered! (Very likely). Taking off part of this *parallel* circuit makes the net resistance go up which would give you just the kind of reaction you have. I have found quite a few small amplifiers like this, with thermistors open due to poor solder joints. Same results: pow goes the output transistors.

UHF TUNER PROBLEM?

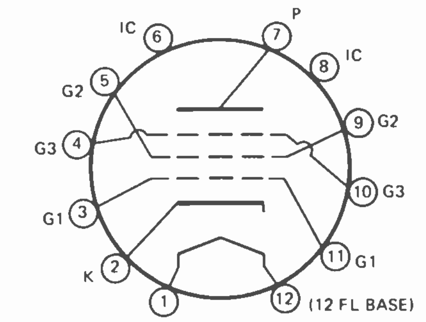
The uhf stays on for about 30 seconds, then fades away. Turn back to vhf, and it will repeat the same action. I've subbed all tubes, and substituted another uhf tuner; same old thing. Why the same symptoms?—J.M., Evanston, Ill.

Educated (??) guess: since you get the same symptoms with two uhf tuners, this problem could be in the "Channel 1" (40-MHz i.f. amplifier) of the *vhf tuner*. Test: jump the vhf output of a working tuner, in another set, into the *uhf input* of the vhf tuner in this set. See if this shows the same symptoms. If so, then dig into this one strip, position, etc. Something is "loose" in there.

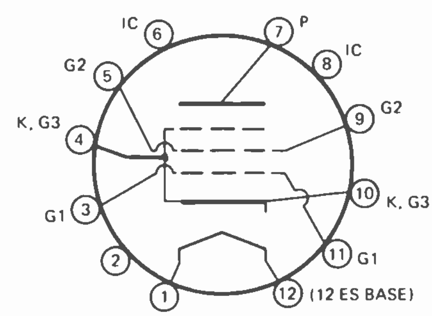
REPLACEMENT FOR 21HJ5

It's very hard to get some of the odd tubes you find in older black & white sets! Right now, I'm hunting for a replacement for a 21HJ5, used as horizontal output, in a 16M3 Admiral. —R.J., Michigan City, Ind.

This is a Compactron; you might check with the nearest GE Distributor to see if they have this one listed. If not, check through the GE Tube Manual. I see quite a few 21-volt, 600 mA types, in this category. Most of them would require rewiring of the socket, although the tube characteristics look very much the same.



21HJ5



21HD5

A 21HD5 tube looks pretty good. Same mutual conductance, current ratings, etc. Only the cathode would need rewiring: it's connected to different pins. Just watch out for *internal* connections and jumpers, which could cause shorts.

NO RASTER, HV OK

After I fixed some other things, I had this GE CB chassis working very well. Put it back in the cabinet, and it won't light up! Plenty of HV. Voltage on 12HG7 video output plate is about 50 volts high. Won't change as the brightness control is turned. Where to look?—H.S., Vincennes, Ind.

Right where you are now! That excessive 50 volts on the 12HG7 plate is normally enough to bias-off the picture tube cathode, and kill the raster! Trace the circuits of this tube: check to see if the cathode circuit has been accidentally opened as you were replacing it in the cabinet. (I did the same thing the other day! Knocked a loose wire off! Glad it happened in the shop and not in the customer's home!)

CRAWLING CATHODE CURRENT

This Sears 528.81201 has had me in a spin for days. The 40KD6 cathode current slowly rises from 210 mA to over 400 mA. High voltage rises to 30 kV, regulation won't work, and finally

(continued on page 106)

(continued from page 41)

extremely rare. Excellent frequency response has been attainable to tape recorders for quite some time, and there is little need for manufacturers of notable reputation to publicize them. There are some frequency-response considerations that should still be borne in mind, however.

If possible, when shopping for a tape recorder, try to determine whether the frequency-response rating applies to play or record (sometimes the specification covers both). A recorder with a +3 dB variation over the audible range can lose up to half its output power at the top (or bottom) end of the audible spectrum during the record mode. If the playback mode is specified

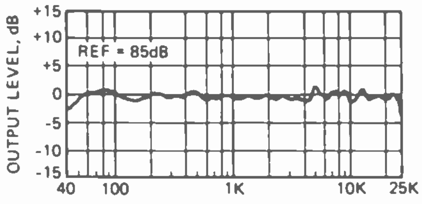


FIG.7—THIS CURVE REPRESENTS THE ACTUAL PERFORMANCE of the speaker system used for the data in Fig. 6. The speaker is a high-quality, fairly expensive model, and the curve looks—and is, relatively—flat. Still, an overview of performance would be easier if the vertical scale were expanded as in the previous table.

similarly, the half-power signal can deteriorate still further on playback, giving a net loss of 6 dB in one area of the spectrum while perhaps having a net gain of the same amount in another. The total signal difference *could* be a total of 12 dB when a uniform signal is applied over the complete audio range. The most satisfactory method for determining record-play quality of a tape deck is to A-B the unit, comparing the playback against the source signal. Better recorders do tend to have separate recording and playback heads, which makes it easy to run this test.

The top-name tape deck manufacturers seem to have the frequency-response problems solved. Often, even the slightest imperfections during the record mode are compensated for in playback, so the overall result is a very flat and very faithful replay of the material you put on the tape.

Total Performance

Today, top-name manufacturers concentrate on other areas such as lessened distortion from flutter and wow, improved cross-talk performance, and the inclusion of special desirable features. The Revox deck, for example (Fig. 8), can handle 10-½ inch reels. If you don't mind the hassles of using half-mil tape, this means that you can get as much as four hours of 7½-ips music on each side.

Or take the Teac. You won't even have to ask about the frequency response—it's up there. So the company concentrates on features. Teac's 3300 doesn't come cheap, but it performs. Like the Revox, it can handle the big reels that were once the exclusive domain of the professional studio-type decks. The unit incorporates all the features that today are becoming "standard equipment" on those "Very Best" models, and

FIG. 8—THE REVOX REEL-TO-REEL tape recorder has capability of handling 10-½ inch reels and comes with a torque-changing switch to allow smooth handling of either these larger reels or the smaller 7-inch types.

includes a few other niceties as well—like hyperbolic heads, damped tension arm, and that very handy front-panel bias switch that lets you adjust the tape bias.

The Akai deck in Fig. 9 crams about as many features as you could ask for in a fairly-high-performance, moderately priced unit. The remarkable machine combines reel-to-reel, cassette, and cartridge recorders into a single unit—and it can transfer, internally, programs from the reel to either the cartridge or the cassette.

Dokorder features bidirectional recording and automatic reversing—nothing new, of course, but nonetheless desirable. It's big "special thing" is design. The Model 9100 comes mounted in a slant-front cabinet

FIG. 9—THE AKAI X-2000SD CAN RECORD or play back all three varieties of tape —cassettes, individual reels, and cartridges. Unit also provides transfer from the reel to either the cartridge or cassette without external connection to an amplifier or control system.

topped with a pair of easily accessible control panels. Not surprisingly, the manufacturer likes to refer to it as a "miniature recording studio."

The point of all this is simply to say that frequency response and low distortion are facts of life these days on good equipment. A wide-frequency recording and playback range that is flat is a goal that may be attained in a variety of available machines. Once you've established the basic performance capabilities of a deck you're interested in buying, start comparing the features it offers against other competitive makes. You won't lose by it. *(continued on page 84)*

Why a Sylvania home training program may be

your best investment for a rewarding career in electronics

1 LEADER IN ELECTRONICS TRAINING

Over the years, Sylvania Resident Schools have trained thousands of men and women for key positions in the electronics field. Now, through Sylvania Home Training, you can receive the same high-quality career training at home. In your spare time. While you hold your present job. Remember, this training is designed with one purpose in mind — to give you the background you need to land the electronics job you really want!

2 AUTOTEXT TEACHES YOU ELECTRONICS RAPIDLY, EASILY.

AUTOTEXT, offered exclusively by Sylvania, is the proven step-by-step method of home training that can help you learn the basics of electronics quickly and easily.

3 CASSETTE SYSTEM

This innovative learning-by-hearing approach is a special option that adds an extra dimension to AUTOTEXT. It's almost like having an instructor in your own home. As you play the cassette tapes, you'll have an instructor guiding you through your AUTOTEXT lessons. Explaining the material as you read it. Going over schematics with you, reinforcing the basic electricity and electronics study materials with you. Everything you need to know to get you started towards a highly regarded position as an electronics technician — all in an easy-to-understand, conversational tone.

4 SPECIALIZED ADVANCED TRAINING

For those already working in electronics or with previous training, Sylvania offers advanced courses. You can start on a higher level without wasting time on work you already know.

5 PERSONAL SUPERVISION THROUGHOUT

All during your program of home study, your exams are reviewed and your questions are answered by Sylvania instructors who become personally involved in your efforts and help you over any "rough spots" that may develop.

6 HANDS-ON TRAINING

To give practical application to your studies, a variety of valuable kits are included in many programs. In Sylvania's Master TV/Radio Servicing Program, you will actually build and keep an all solid-state black and white TV set, and a color TV set. You also construct an oscilloscope which is yours to keep and use on the job.

7 FCC LICENSE TRAINING — MONEY BACK AGREEMENT

Take Sylvania's Communications Career Program — or enter with advanced standing and prepare immediately for your 1st, 2nd, or 3rd class FCC Radio Telephone License examinations. Our money-back agreement assures you of your money back if you take, and fail to pass, the FCC examination taken within 6 months after completing the course.

8 CONVENIENT PAYMENT PLANS

You get a selection of tuition plans. And, there are never any interest or finance charges.

SEND ATTACHED POSTAGE PAID CARD TODAY! FREE DESCRIPTIVE BOOK YOURS WITHOUT OBLIGATION!

If reply card is detached send this coupon

SYLVANIA TECHNICAL SCHOOL
Home Study
909 Third Avenue
New York, N.Y. 10022

Please send me FREE illustrated career catalog. I understand that I am under no obligation.

Name ______________________

Address ______________________

City ______________________

State ______________ Zip ______

Age ______________________

Veterans: Check here ☐ 758-403-0

SYLVANIA TECHNICAL SCHOOL

In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

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.

FOUR-CHANNEL RECEIVER, *model SA-8000X,* features built-in facilities for directly decoding or demodulating all four-channel mediums. Has plug-in adaptability for discrete four-channel broadcasts of the future.

Contains built-in demodulator for CD-4 discrete four-channel discs, and Acoustic Field Dimension (AFD) Control System permits ad-

justment to any matrix system. Can accommodate all auxiliary four-channel sources, including discrete four-channel tape equipment, reel-to-reel, and cartridge. Separate level control four each channel (plus master gain control), four-channel /two-channel speaker outputs, expanded tape monitor, and dubbing facilities. Total harmonic distortion: 0.5%; signal/noise ratio (IHF): 70dB; FM sensitivity (IHF): 1.9µV; capture ratio (FM): 1.8 dB; $499.95. **—Technics by Panasonic,** 200 Park Avenue, New York, N.Y. 10017

Circle 31 on reader service card

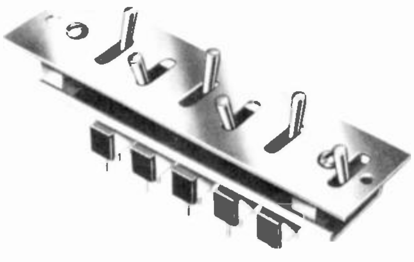
VOM, *model LT-70,* protects against polarity reversal and overload. Reads as low as 0.25 V full scale, and 250 µA on normal readings for measurements of small solid-state dc voltages and currents. Scales are included for measuring back currents as low as 75-µA to check diode and transistor quality.

Sensitivity: 20,000 ohms/Vdc; 8000 ohms/Vac; resistances: up to 40 megohms. Nine current ranges: dc—75µA to 2.5A, and ac—2.5A. Voltage ranges: from 0.25V to 1000V, dc (10 steps), and 10V to 250V ac (3 steps). Output in 10V range is −20 to +22 dB, ac, and in

50V range, ac, +20 to +36 dB. Powered by two 1.5V (UM-3) batteries and one 22.5V (BL-015) battery. 5-¾" x 4" x 2-¼"; approximately 2 lbs.; $34.95 (complete with set of heavy duty test leads and set of alligator clip adapters). **—Leader Instruments Corp.,** 151 Dupont Street, Plainview, N.Y. 11803.

Circle 32 on reader service card

SWITCH MODULE, *"Rapid Reset,"* permits instant reset of multiple ganged toggle switches. It is possible to create an array of up to 15 switches, using one- or two-pole double throw switches per station. A reset level (mounted



right or left) simultaneously throws all switches back to their original positions. Application of toggle switches in an array like this provides a current carrying capacity of up to 6A. Available only on a custom basis; price is regulated by length of module, and type and quantities of switches required. **—Alco Electronic Products, Inc.,** 1551 Osgood Street, North Andover, Mass. 01845.

Circle 33 on reader service card

CB TRANSCEIVER, *model CB-23CH,* has 23 channels and operates at full 5 watts. Low noise, double conversion superhet, with total delay switching, supplies dual conversion and clear cutting when working back and forth between transmit and receive positions. Noise

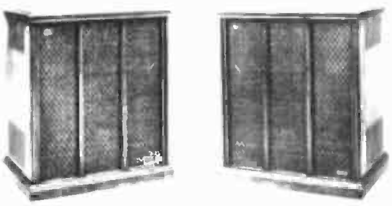
limiter uses series-type gate that has clipping level of approximately 50%.

Zener protection and regulation circuit stabilizes performance for negative or positive ground dc voltage input between 11 and 16 volts. Incoming signal strength and rf noise can be read by "S" meter/modulation indicator. Local /distance switch allows sensitivity control in low noise areas or under high ambient noise conditions. Modulation is 95%; audio amplification is 3.5 watts out 2" x 6-½" x 7"; 4 lbs., $139.00 **—American Trading Corp.,** 29245 Stephenson Highway, Madison Heights, Mich. 48071.

Circle 34 on reader service card

STEREO SPEAKER SYSTEM *Leslie Plus 2*, combines basic principles with electromechanical devices and electronics to solve the standing wave problem. When connected and balanced properly, listener can experience live ambient quality of a live performance.

Consists of two complete, hi-fi loudspeaker systems that have built-in solid-state power amplifiers whose impedance and damping factors are matched to the speakers themselves. Amplifiers are rated at 50 watts, rms; capable of

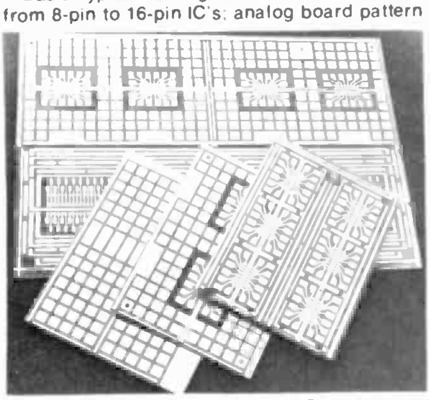


70 watts rms power output levels, and more. Both loudspeaker systems have patented devices, one of which disperses low-frequency energy in a way that eliminates standing wave conditions. The other causes a continuously random phase shift that disperses middle- and high-frequency energy in a way that eliminates standing wave problem at those frequencies. Can be used with existing stereo speakers and is compatible with all recorded program material including SQ, CD-4, and QS —**Electro /CBS Musical Instruments,** 56 West Del Mar Blvd., Pasadena, Calif. 91105.

Circle 35 on reader service card

INSTANT BREADBOARD. Circuit designer can assemble a circuit without drilling or inserting components. Circuit is soldered to pre-etched patterns of large lift-resistant two-ounce copper land areas of unit. Four basic breadboard patterns permit component interconnection for analog and digital circuits.

Basic types are: digital board that handles from 8-pin to 16-pin IC's; analog board pattern



that includes 8-pin to 16-pin IC's; discrete board pattern that favors circuity that uses all discrete components; digital-analog board pattern that includes 8-pin, 16-pin, and 24-pin IC socket configurations. All socket patterns are pre-drilled to prevent solder short circuits between pins. $2.45 to $9.80 (1-9 quantity). —**Instant Instruments** Inc., 306 River Street, Haverhill, Mass. 01830.

Circle 36 on reader service card

DESOLDERING KIT, *model 500K*, contains Endeco model 500 desoldering/resoldering iron, eight different sized tips, stand for the iron, and cleaning tool. I.D. of tips range from .025 to .090. Iron features safety indicating light

Circle 61 on reader service card

in handle, flexible burn-resistant neoprene two-wire cord set, and cool unbreakable polycarbonate handle. Twelve piece kit, $21.55. —**Enterprise Development Corp.,** 5127 East 65th Street, Indianapolis, Ind. 46220.

Circle 37 on reader service card

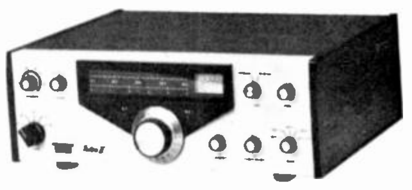
FOUR-CHANNEL RECEIVER KIT, *model AR-2020.* 25 watts IHF, 15 watts continuous, per channel into 8 ohms. FM receiver section features two IC's and two ceramic filters in i.f. for selectivity greater than 60 dB. Phase lock multiplex demodulator offers 40 dB typical channel separation at less than 0.5% distortion. Preassembled FM tuner provides 2µV sensitivity and a 2 dB capture ratio.

Individual front panel controls on all four

channels plus master volume control. Pushbuttons for mono, stereo, discrete four-channel, matrixed four-channel program sources. Rear panel input sockets for phono, tape, tape-out, plus two sets of auxiliary inputs—one for stereo source, the other for four-channel. Solid-state components and modular circuit layout; kit builder assembles one board at a time and installs them in chassis. $249.95 (includes cabinetry). —**Heath Company,** Benton Harbor, Mich. 49022.

Circle 100 reader service cards

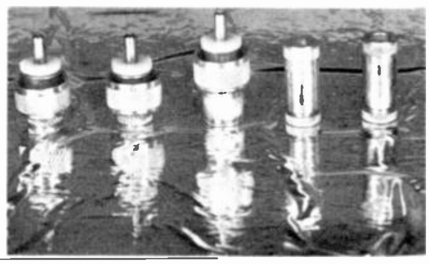
TRANSCEIVERS, *Triton I* & *Triton II,* cover all amateur bands from 3.5 to 30 MHz. Featrures include: instant band change, instant break-in, offset tuning, ALC, pulsed crystal calibrator, and optional 150Hz CW filter. Solid-state; has



12Vdc circuit. *Triton I* ($519.00) is specified at 100 watts input; *Triton II* ($606.00) is specified at 200 watts, CW or SSB. —**Ten-Tec Inc.,** Highway 411 East, Sevierville, Tenn. 37862.

Circle 38 on reader service card

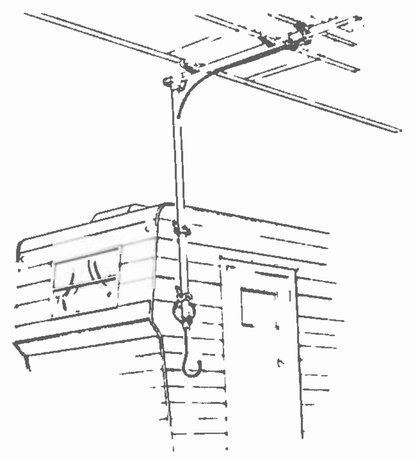
COAXIAL CONNECTORS, *Nos. F3-126 thru F3-130.* Solderless coaxial connectors are used



to connect or splice coaxial cable for CB, ham radio, or cable TV. Insures constant impedance for troublefree TV reception with no color distortion. Eliminates dangers of soldering coaxial cables; reusable; for use with RG-58/U, RG-59/U, and RG-8/U coaxial cable. —**GC Electronics,** 400 South Wyman, Rockford, Ill. 61101.

Circle 39 on reader service card

TV ANTENNA KIT, *Travelon TOTE-5K* is designed for travel trailers, mobile homes, campers, and boats. Pulls in strong distortion-free pictures on channels 2 through 83, plus FM. Periodic design provides high gain and flat response needed for color reception. All elements are made of heavy gauge aluminum with



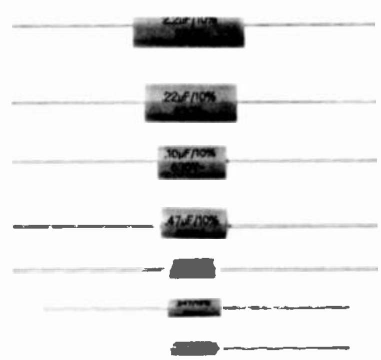
weather-resistant finish that permits them to hold up even in salt air and other corrosive atmospheres.

Kit includes the antenna and 5' gold alodyned mast, 15 feet of color-axial cable with factory-assembled connectors, antenna matching transformer, TV set matching transformer U-V splitter, neoprene grromment to take the lead-in through skin of the vehicle, and all necessary mounting hardware. $39.75. —**Jerrold Electronics Corp.,** 200 Witmer Road, Horsham, Pa. 19044.

Circle 40 on reader service card

FILM CAPACITORS, *series YM.* Wrap-and-fill metalized polyester film capacitors are available in standard voltages of 250 Vdc, 400 Vdc, and 600 Vdc. Capacitance range is .0047-µF to 4.7-µF, with capacitance tolerances of 5%, 10%, and 20%. Operating temperature range is −40°C to +85°C with no derating.

Non-inductively wound, the ends of these



capacitors are sealed by epoxy resin and the leads are welded to the foil. Units have self-healing characteristic. —**International Components Corp.,** 10 Daniel Street, Farmingdale, N.Y. 11735.

Circle 41 on reader service card

MARINE RADIOTELEPHONE, *Del Mar 225,* has full 25 watts rf output that assures solid signals at maximum range in marginal reception areas (set is switchable to 1 watt for in close conversations). Twelve channels cover marine vhf band—intership, emergency, and ship-to-

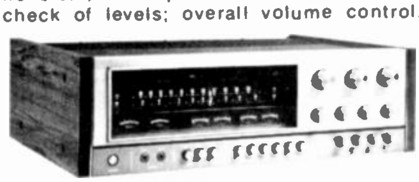
shore. Weather information is available on two toggle-switch-selected channels.

Double conversion receiver has sensitivity to weak signals and takes advantage of ignition and static noise reducing properties of FM. Panel adjustable squelch eliminates background noise in the absence of signals. 2-3/4" x 8" x 9"; 4 lbs. —**SBE,** 220 Airport Blvd., Watsonville, Calif. 95076.

Circle 42 on reader service card

FOUR-CHANNEL RECEIVER, *KR-9340*, delivers 40 watts per channel rms continuous power in four-channel, or 44 watts per channel in two-channel (8 ohms, 20-20 kHz). Features separate built-in decoders for SQ and RM matrixed discs, decoder/demodulator for CD-4 quadradiscs, and provision for two four-channel tape decks (with tape-to-tape dubbing).

Four-channel controls include four individual tone controls for bass-and-treble front, bass-and-treble rear; three balance controls for left-and-right front, left-and-right rear, and front/rear; four separate VU meters for visual check of levels; overall volume control.



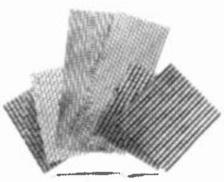
Double-switching demodulator circuit in MPX cancels all unwanted signals to achieve channel separation at all frequencies. Sensitivity (IHF): 1.8 μV; selectivity: 50 dB; signal-to-noise: 65 dB; stereo separation: 40 dB at 1 kHz, 20 dB at 10 kHz; $749.95. —**Kenwood,** Dept. P, 15777 South Broadway, Gardena, Calif. 90248.

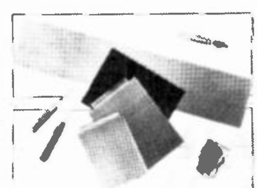
Circle 43 on reader service card

CB TRANSCEIVER, *Rebel 23+*. 5-watt rig uses a 12-crystal synthesized circuit to provide 23-channel operation in both receive and transmit modes. Features include: adjustable squelch, built-in automatic noise limiter, improved microphone, and amplifier circuits.

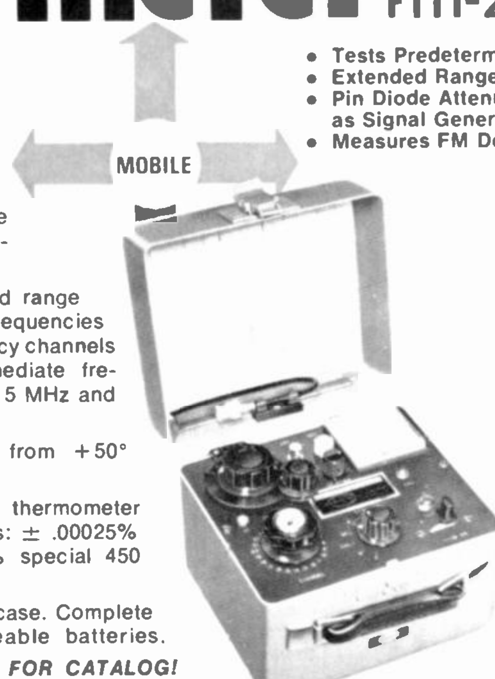
Silver and black control panel includes PA/CB switch, illuminated S/rf meter, and large channel selector. Unit has built-in speaker and external speaker and PA jacks; comes with all crystals, built-in microphone and all mounting hardware; may be installed in vehicles with positive or negative ground. —**Fanon/Courier Corp.,** 990 South Fair Oaks Avenue, Pasadena, Calif. 91105. **R-E**

Circle 44 on reader service card





Circle 62 on reader service card



Circle 63 on reader service card

new literature

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 over.

TEST AND MEASUREMENT DEVICES *No. 4200.* 40-page catalog lists over 1,500 types, styles, sizes, and ranges of panel meters, more than 100 meter relays, and a variety of general and special-purpose test equipment. New products include: reed frequency meters, pyrometers, percent-load meters, loadmeter relays, 360 digital vom, photo tachometer, illumination level meter, insulation testers, and general purpose oscilloscope. — **Simpson Electric Co.**, 853 Dundee, Elgin, Ill. 60120.

Circle 45 on reader service card

A BETTER WAY TO SEE SOUND, *CATALOG No. 7173* contains sound level meters, dosimeter, integrator, calibrators, and accessories. Provides detailed physical and electronic specifications (dimensions, weights, decibel ranges, performance parameters, operating characteristics, environmental considerations), and carries tables that show typical sound pressure levels generated by various industrial and other operations. — **Triplett Corp.**, Dept. SLM, Bluffton, Ohio 45817.

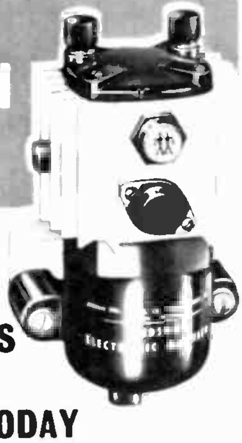
Circle 46 on reader service card

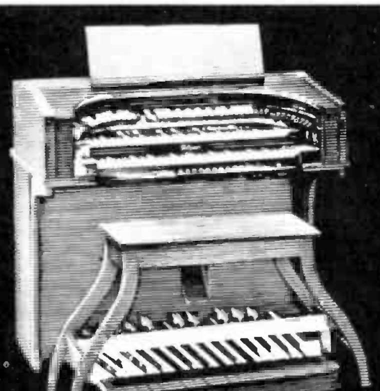
Write direct to the manufacturers for information on items listed below:

1974 ENGINEERING MANUAL & PURCHASING GUIDE, *No. 740.* 363-page catalog features engineering drawings of all electrical components. Physical dimensions are given to permit design of electronic packages before components are purchased. Electrical properties of all items are included on each. Contains drawing and specifications of semiconductors, IC's, LED's, tubes, relays, timers, plugs, switches, connectors, coils, books, power supplies, tools and many others. **$1.00.—Allied Electronics,** 2400 West Washington Blvd., Chicago, Ill. 60612.

MAIL-ORDER CROSS-CANADA SALES CATALOG. 64-page catalog features Sinclair line of high-fidelity amplifiers and tuner modules as well as speaker kits by Philips Dcforest, Marsland, Radio Speakers of Canada and Goodmans of England. Other hi-fi lines include Audionics, Garrard, JVC, AR, Shure. Test equipment, hobbyist/experimenter parts and service parts include Eico, Mallory, EV, International Rectifier, Weller, Clarostat, Sams, Sprague and many others.—**Gladstone Electronic Supply Co. Ltd.**, 1736 Avenue Road, Toronto, Ontario, Canada M5M 3Y7. **R-E**

Circle 64 on reader service card





GETTING TO KNOW SPECS

(continued from page 73)

FM receiver specs

FM receivers come in a variety of configurations— some as part control-center and amplifier combinations, some with discrete four-channel sound or the built-in capability of interconnection to a four-channel decoder. This subsection will deal with the specifications for FM receivers as such; the information is applicable to all FM receivers, whether included as part of a tuner-amplifier or a complete four-channel sound system. Specifications involving amplifiers or amplifier portions of systems are covered under the subhead of "Amplifier Specifications." Four-channel information, whether it involves the receiver or the amplifier, is covered under the subhead "Quad Specifications."

Capture ratio

Many of the better receivers have, among the myriad other specifications, a capture-ratio figure, expressed in decibels. With AM, this specification means less than nothing. With FM it *could* mean something, but often as not it doesn't.

When two AM signals are on the same assigned frequency, the result (when both can be detected on a single receiver) is intermodulation and a "heterodyne," or whistle, the frequency (pitch) of which represents the spectrum distance between the two signals. When two FM stations are operating on one frequency, the stronger of the two will predominate by "capturing out" the weaker. The result will be the same as if the weaker station wasn't there at all —though the capturing signal will be somewhat weaker than it would be if the interference didn't exist.

Relative signal strength is measured in decibels. One signal may be several decibels weaker or stronger than another. The capture ratio, given in decibels, will tell you how much stronger the dominating station must be over the other station to effect 100% capture. Bear in mind that 3 dB represents a doubling of power, so a receiver with a 3 dB capture ratio means that one signal must be twice as powerful as another before capturing will take place.

Unfortunately, like so many other specifications, this is not the whole story. The IHF standard for measurement calls for receivers to be tested with a reference capturing signal of 1 millivolt (1 mV). Communications-type FM receivers are accustomed to signals as low as one tenth of one microvolt, which is but a mere one ten-thousandth of the 1 mV specification.

In practice, stations are rarely of the 1mV strength. In rural areas, signals are typically no more than a few hundred microvolts. And it is doubtful that there is any spot in the entire country where two stations could be interfering with each other when one has a signal strength of 1 mV. The FCC is careful to assign stations so interference is unlikely. It is inconceivable to think of two signals interfering when one of the two is a full millivolt.

Sometimes the signal from one station's transmitter will find more than one path to the receiving antenna—particularly in mountainous areas, where signal bounce is likely. But even here the reflected signal is rarely strong enough to cause problems if the direct signal is as strong as the IHF specification for the test.

Another unfortunate fact is that the capturing ability of a receiver is not a linear function. With a stronger signal of 100 microvolts, there may be no capturing at all in a receiver with a rated capture ratio of 1.5 dB. There simply is no way to tell what the usable capture ratio might really be by examining the manufacturer's capture-ratio figure—simply because some receivers tend to show degraded performance as the signals get weaker, while others show marked improvement in the ratio as the signals diminish in strength.

If you live in a suburban or rural area, not in proximity to any radio station, you'll be interested in the usable capture ratio— but the figure the manufacturer gives will be meaningless to you. Your best bet if you're receiver shopping will be to make in-store comparisons by tuning in fairly weak signals that seem extra close to other signals (actually on the same frequency, but when one signal is modulated with loud music, the station spreads to cover a wider portion of the dial, giving it the appearance of being on another frequency). You'll see no correlation betwee actual capturing ability in practice and the published capture-ratio figure if you're listening to low-strength signals.

Sensitivity

When you tune an FM receiver to a spot between stations where you can hear no signals, you *will* hear *something*: noise. FM's peculiar characteristic is that an incoming signal acts on existing noise by suppressing it. The amount of suppression is dependent on the strength of the incoming signal. Regardless of how sensitive an FM receiver may be, the signal is worthless unless it quiets the existing noise sufficiently for you to enjoy the program material of the transmitting stations. Thus, the sensitivity specification is another meaningless one unless a "quieting" specification is included (in decibels).

Stated another way, a receiver that boasts a sensitivity of 1.5 μV may be able to pull in a measurable signal at that level, but that is no indication that you'll be able to hear such a signal. However, a receiver whose sensitivity is rated at 1.5 μV for 30 dB of quieting tells you that a signal at that voltage level will actually suppress the existing noise by 30 dB—which is indeed a usable figure, though few music lovers would enjoy listening to music with noise only 30 dB down.

The institute of High Fidelity has set up a standard for measuring sensitivity of FM receivers, but this one has its holes too; the most significant is the fact that the measurement is based on a signal only 30 dB above the suppressed noise. R-E

COMING NEXT—
THE FEMTOWATT

If you liked this story of hi-fi specs, you'll want to read Len Feldman's article on the Femtowatt in the April issue. It explains a new method of looking at some hi-fi specs and is currently up for approval by the Institute of High Fidelity. Make sure you get the April issue of **Radio-Electronics**. It goes on sale March 19.

LETTERS

(continued from page 16)

FCC WARNING

This is in regard to a recent article which appeared in the September 1973 edition of **Radio-Electronics** describing a TV Typewriter which operates into a standard television receiver.

The Commission set forth the technical standards governing such equipment, termed Class I TV Devices, in a recent proceeding in Docket 19281. I have enclosed copies of related actions pertinent to these devices for your information. Please note that Class I TV Devices must be type-approved by our Laboratory Division to demonstrate that the equipment as a type complies with our Rules. The procedures to be followed to obtain type-approval are specified in Section 2.561 et seq., and the filing and grant fees specified are $50 and $250, respectively.

HERMAN GARLAN
Federal Communications Commission
Washington D.C.

The most effective procedure we can use to notify our readers of the potential violation that the TV Typewriter might exhibit would be to publish your letter in the earliest possible issue of ***Radio-Electronics.*** *We have no other way of contacting readers who may be currently building the TV Typewriter. As this piece of equipment is not a manufactured item (but rather home-made), we would like to let our readers know whether or not type-approval is still required. We would also like to specify the maximum power of a type-approved device of this type that is acceptable.*

Until your letter arrived, we were not aware of the possible conflict with the Rules. But we will do our best now to advise our readers of the potential problem.

LARRY STECKLER
Editor, Radio-Electronics

. . . . The Commission does not differentiate between equipment produced commercially and devices which are fabricated by an individual (home-made), accordingly, both types of equipment are subject to our regulations.

We appreciate your willingness to cooperate in this matter and if I can be of assistance to you in the future, please contact me.

HERMAN GARLAN
Federal Communications Commission
Washington, D.C. R-E

ELECTRONIC CASINO

(continued from page 52)

switch is depressed. Also, a yellow LED is turned on indicating the "ball" is rolling. When the switch is released, the SPIN LED goes out and the ROLL LED stays on until the "ball" stops.

Coin flip

In Fig. 5 a version of the old heads or tails game is shown. Depressing the FLIP switch starts a three-gate TTL oscillator (similar to that used in the dice game) which sends out-of-phase signals to both inputs of a cross-coupled flip-flop composed of Q13—16.

When the FLIP switch is released the flip-flop will be in either the HEADS or TAILS state turning on the appropriate indicator lamp. While the oscillator is running, the 25-uF capacitor is the base circuit of Q18 charges up. Q18's base is clamped to ground so that it can not turn on, by Q17. At the instant the FLIP swtich is released Q18 is turned on by the stored charge in the 25-µF capacitor and drives Q19 which in turn drives a solenoid. The plunger of the energized solenoid strikes a chime bar resulting in the clanging sound of a flipped coin striking a hard surface.

The circuit for and the description of the one-armed bandit and the high-card game will appear next month. R-E

TV WHISTLE DETECTOR

Some color TV sets produce an annoying squeal or whistle that may not be audible to the Old Timer and some senior service technicians or the Young Squirts whose hearing has been "bombed-out" by overexposure to too much loud rock music. So, before many technicians can handle complaints of squeals and whistles, we have to hear them or find a way to detect them so we can pin-point the source.

An article in the *GTE Sylvania Service Notebook* points out that the source is usually sympathetic vibration originating in the horizontal deflection circuit. The problem is identifying the source when you can't hear the whistle.

For this, the author developed a detector probe that is nothing more than a remote-control ultrasonic transducer (Sylvania 12-23768-1) mounted in one end of a ⅞-inch ID metal tube. The other end of the tube is flattened (Fig. 1) to

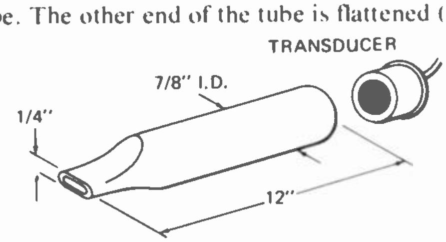


Fig. 1

make it directional. The tube is shock proofed with layers of plastic tape. A plastic tube can be used, instead, when fitted with a cone shaped head to make it directional (Fig. 2).

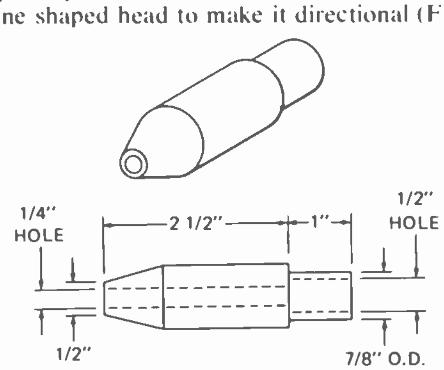


Fig. 2

The transducer output is fed into a scope's direct vertical input, using 0.1 or 0.2 V/cm sensitivity. The 15,750-Hz whistle can be seen on the screen even when it cannot be heard. The directional probe becomes a pointer to pinpoint the trouble source.

If you have an old remote receiver you can pad down one of the tuned circuits to reach 15,750 Hz and eliminate the need for maximum scope amplification. The author mentions using a RC-11 remote receiver. He replaced the 680-pF tuning capacitor on the "volume-down" tank circuit with a .003-μF unit so the coil could be retuned to 15,750 Hz. Signal for the scope was tapped off the 18-ohm common emitter resistor. R-E

electronic logic

The Panasonic experimental system has two variations. One uses an up-down counter that steps through the stations one at a time. The second system is similar but direct channel dial-in from a local or remote keyboard is used.

Fig. 1 is the logic diagram for the simpler sequential version. Figs. 2 and 3 show the schematics of the two IC's used in the system. A fairly simple remote transmitter-receiver system is needed to duplicate the local function of the up-down local switches. In the random selection keyboard system a more complex serially keyed ultrasonic tone system replaces the fixed front panel keyboard.

The series of potentiometers R1 through RU4 in Fig. 1 are the varactor presets to select the received stations. There are 16 pots; the first 12 for vhf stations and 4 for uhf. At the heart of the system are the four flip-flops shown at the left of the figure with their dual output lines scanning the length of the decoder matrix. The dots connecting the horizontal flip-flop outputs and the decoder

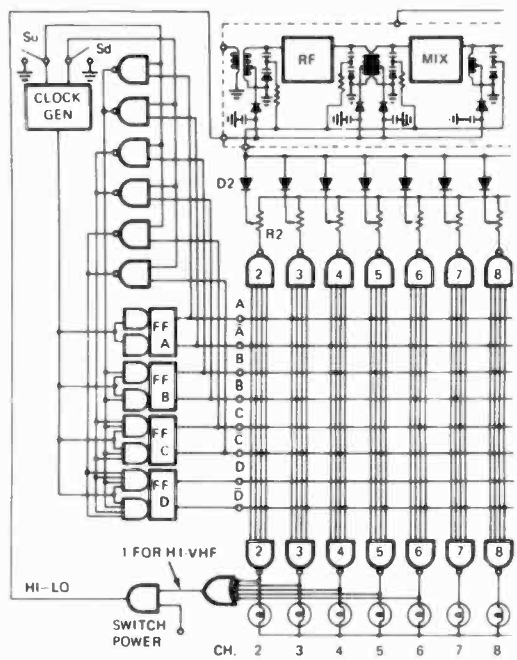


Fig. 1

Schematic diagram

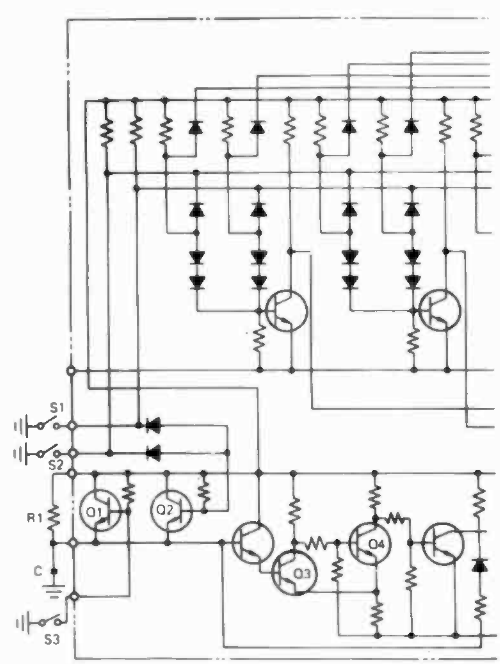


Fig. 2

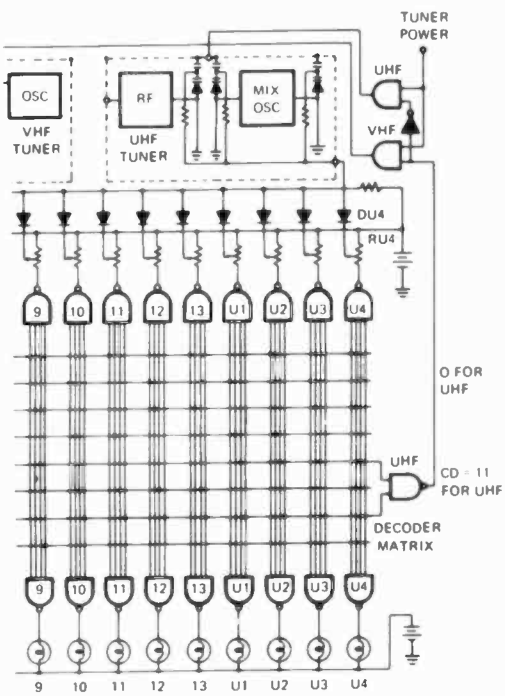
for TV tuning

gate inputs represent isolation diodes to prevent sneak paths within the matrix.

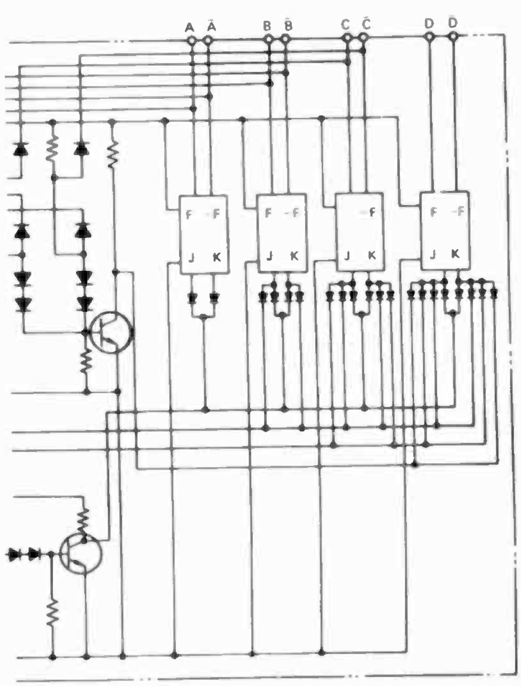
When an output such as A is low its complement $\bar{A}$ is high and vice versa. The four flip-flops with the series of six 2-input NAND gates above them form the up-down counter. The logic is such that when the up switch S_u is grounded, the flip-flops count through a binary sequence in one direction and when the down switch S_d is grounded the sequence is reversed.

If the binary number stored in the counter is initially 0000, the upper and lower Channel 2 triple-input NAND gates are selected. 0000 means that flip-flops A through D all have 0 outputs and 1 complemented outputs. Note that the inputs to the Channel 2 NAND gates are connected by dots to the $\bar{A}\,\bar{B}\,\bar{C}\,\bar{D}$ outputs. Since these outputs are all high with a 0000 count the Channel 2 gates are activated.

(turn page)



of the channel memory (MK8014)



When the upper Channel 2 gate is selected, its output is low because of the inversion represented by the small circle on the gate output, grounding the lower end of the Channel 2 pot R2. Since the wiper of the selected pot is now the lowest in potential of any of the poteniometers only its corresponding diode, D2, conducts connecting the Channel 2 wiper to the varactor tuner inputs.

As the up-down counter cycles through its other states the other channels are selected in the same way.

In addition to providing for the basic channel tuning some means must be made for applying power to the appropriate vhf or uhf tuner and for switching between the low (2-6) and high (7-13) vhf channels.

The inverted input OR gate connected to the Channel 2 through 6 indicators does the high-low vhf switching. When any one of these stations are selected and its corresponding display output is low, the switching input to the vhf tuner is held low and the

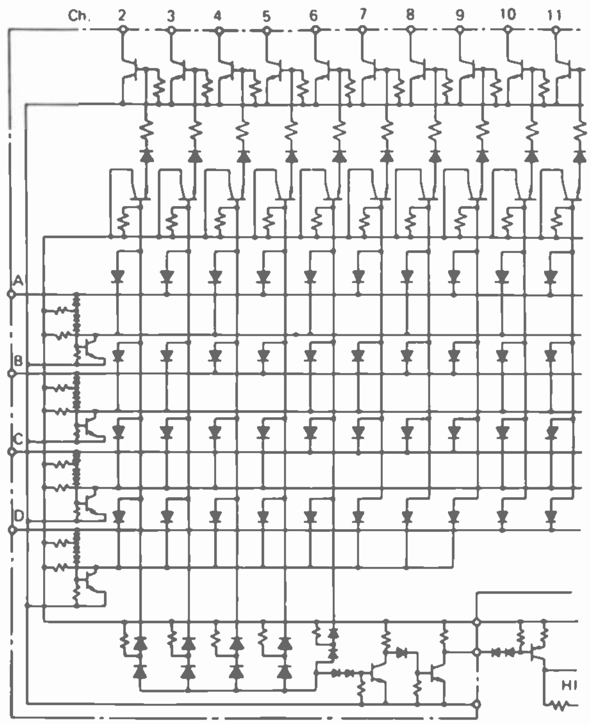


Fig. 3

Schematic diagram of

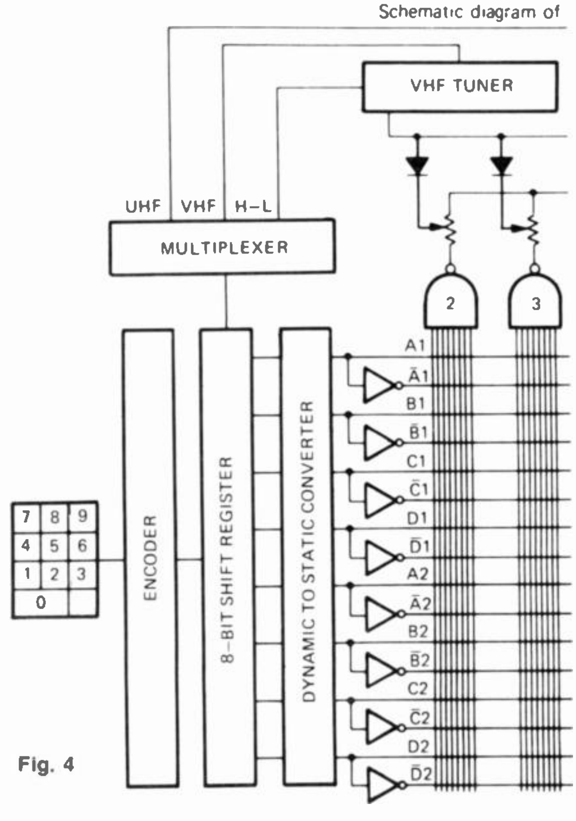
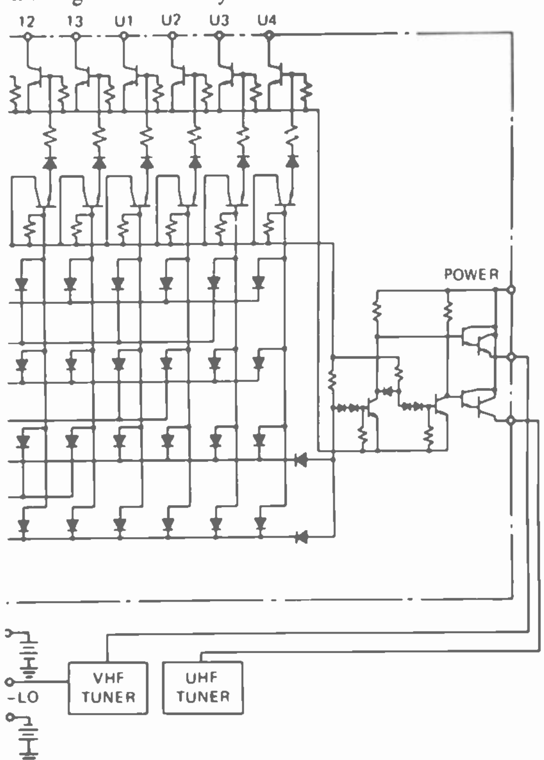


Fig. 4

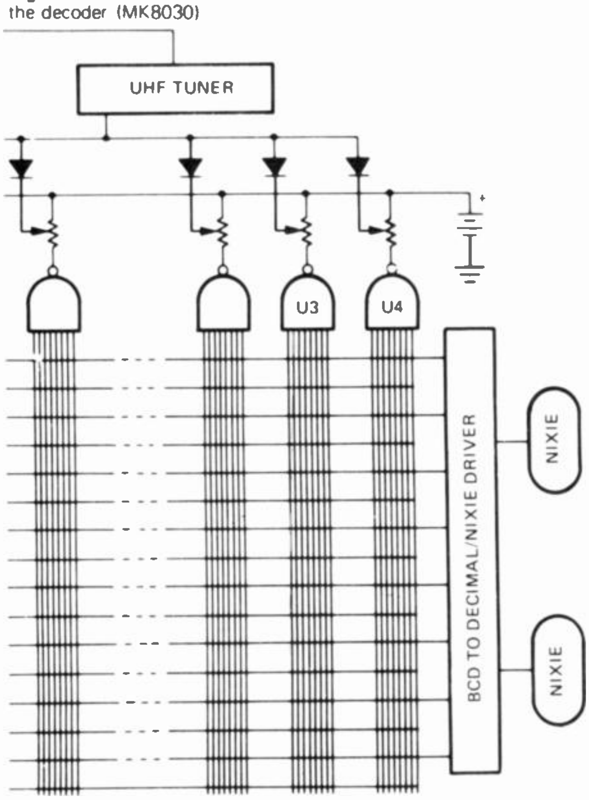
low-vhf tuning function is selected. All other channel choices will result in the high-vhf tuning.

Fig. 2 is the schematic of the channel memory IC, an MK8014. The lower left portion is the clock oscillator. Each of the three gates in the upper left along with the base connected diodes performs the identical function of each of the three pairs of dual input NAND gates associated with the up-down counter of Fig. 1. In Fig. 3, the MK8030 decoder IC contains the actual diodes represented by dots in Fig. 1. On the top are the 16 output transistors. They are used for both operating the channel display lamps and selecting the pots, a variation from the original scheme. The uhf-vhf bandswitching circuitry is on the right of Fig. 3 and the high-low vhf selection circuitry is at the bottom of the diagram.

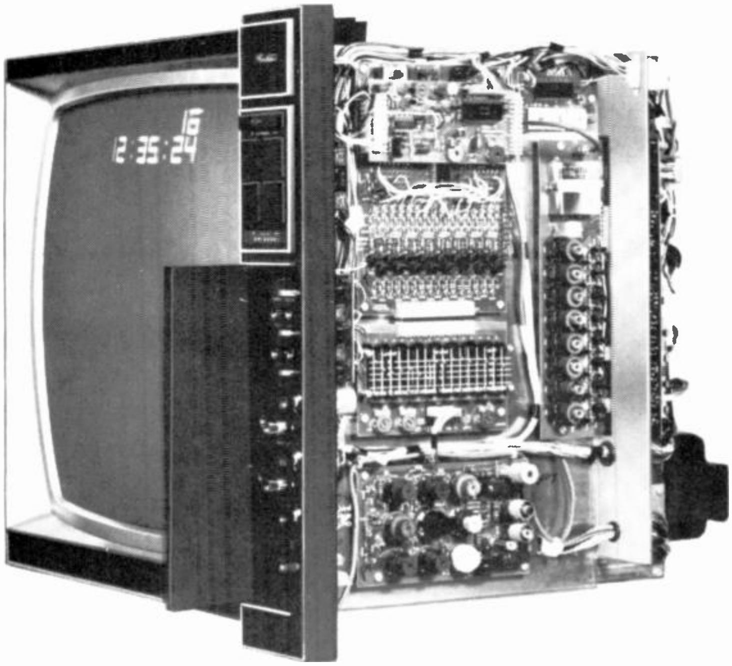
Fig. 4 is the block diagram of the fancier system where the ten-key decimal keyboard is used to key through an encoder and shift register to directly control the matrix. **R-E**

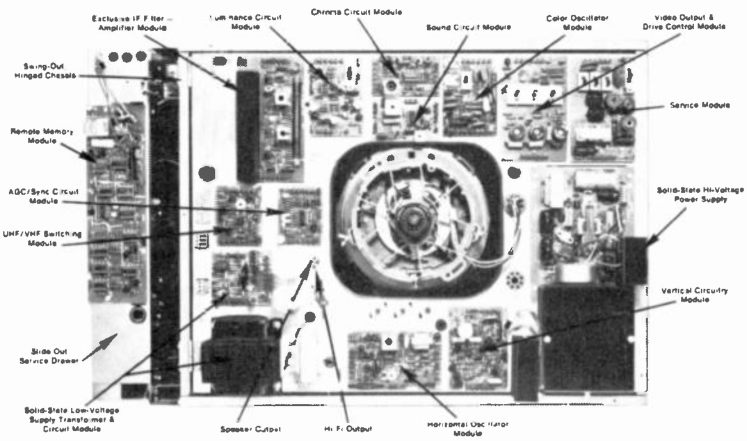


the decoder (MK8030)



The all-new digital-design

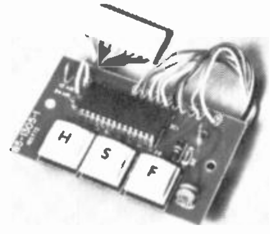




Eleven-Function Touch-Tune Remote Control for the Heathkit GR-2000... 79.95*

This all solid-state ultrasonic system utilizes 13 integrated circuits, 28 transistors to give you wireless arm-chair control of on and off, volume, VHF/UHF channel selection, up or down color intensity, and tint. Plus, a touch of the volume button automatically recalls the digital readout to the screen. Kit includes receiver for in-chassis mounting and hand-held transmitter. Operates from 20-feet away from set.

Kit GRA-2000-6, 4 lbs. **79.95***

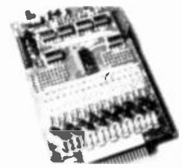


Optional Digital Clock for your GR-2000

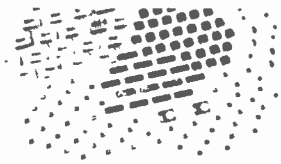
In just a couple hours' time you can build the GRA-2000-1 Digital Clock Accessory. Everything mounts on one small board that plugs into the readout board in the GR-2000 service drawer. That's all there is to it. Clock circuit board has slow, fast and hold pushbuttons for setting time, jumper wire for selecting 12 or 24-hour format. You set your on-screen display for hours and minutes, or hours, minutes and seconds using the programming circuitry on the channel readout board. Order with your GR-2000, or add it on later, if you prefer.

Kit GRA-2000-1, Digital Clock Accessory, 1 lb. **29.95***

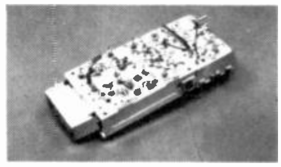
It offers you these important advances in technology, quality, and performance:



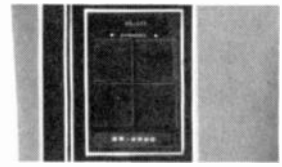
Programmable Channel Selection through digital up-down counter with computer-like programming board.



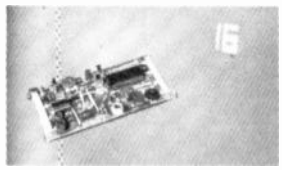
100% Solid-State Design — the picture is the only tube-type device.



Silent All Electronic Tuning with new combination UHF/VHF Varactor Tuner located inside the chassis — completely shielded.



Touch Tuning at front panel (or remote) — touch to change channels up or down — hold in to sweep all channels.

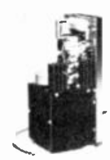


On-Screen Channel Readout — big, bright 1½" numerals for both UHF and VHF.

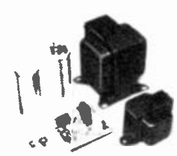
On-Screen Clock Readout gives time in 4 or 6-digit format, 12 or 24 hour time.

Fixed Filter IF totally eliminates instrument IF alignment forever.

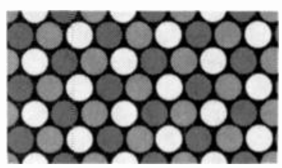
19 Integrated Circuits simplify kit building and permit ultra-sophisticated technology with long-term reliability.



Solid-State Hi-Voltage Supply in tripler configuration for efficiency and long life.

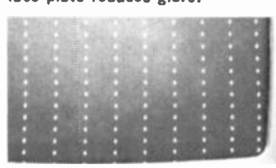


Solid-State Low-Voltage Supply has short-circuit proof integrated circuit regulators.



New Deluxe Black (Negative) Matrix Picture Tube — fully illuminated color dots with black background matrix for greater brightness and contrast — new, etched, face plate reduces glare.

New Vertical Sweep Design gives better picture interlace, improved picture detail; complementary power transistors eliminate output transformers for better linearity.



True Digital Design Dot Generator makes picture convergence easier and more precise.

Twelve Wiring Harnesses — prefabricated, connectors installed, pre-stripped, ready to solder — this TV is easier to build.

INSTALLING CAR TAPE DECKS

(continued)

shorting and possible damage to the unit and/or speakers during installation.

Noise suppression

Alternator Noise—Although a noise filter is provided in the tape player, it is sometimes necessary to provide an additional external choke (4-mH inductance) to suppress severe alternator noise which shows up as a high-pitched whine that varies in pitch with the speed of the engine.

1. Cut hot lead between fuseholder and connecting plug, and strip insulation from ends.
2. Connect 4-mH choke between cut ends of hot lead. Insulate connections with electrical tape, and secure choke by tape or sheet-metal screw to under-dash structure to prevent rattles.
3. Use shielded cable in extreme cases where the choke coil will not eliminate alternator noise.

Weak Response in Left or Right Channel

Check: a) Pigtail—make sure prongs are making connection.
b) Hot lead wire to weak speaker may have shorted against door metal.
c) Playback tape head—small amount of dust may distort one or both sides—clean tape playback head.

Unit Does Not Run

Check: a) Fuse—check both unit fuse and automobile fuse (fuse box).
b) Ground connections must be firm on clean metallic surface.
c) Hot wire—check for any breaks or shorts.

There you have it. A complete guide to the installation of automobile tape players. Use it as ready reference and start picking up some of this "extra" business. R-E

next month

APRIL 1974

- **Build An Electronic Security Alarm**
  Easy-to-build alarm system provides many important features to help you protect your loved ones and your property.

- **Using Calculator IC's**
  Details on the inner workings of today's calculator chips—their operating principles and what you need to know to use them.

- **All About Transformers**
  A comprehensive overview of transformer theory, construction and applications.

- **Build An Infrared Viewing System**
  Use invisible infrared light to get a new view of familiar objects. Build the detection gear yourself.

PLUS:
Appliance Clinic
Replacement Transistor Guide
Step-By-Step-Troubleshooting
Jack Darr's Service Clinic

APRIL ISSUE ON SALE MARCH 19, 1974

new books

Transistor Radio Servicing Made Easy, 3rd Edition by Wayne Lemons. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46268. 160 pp. 8¼" x 5¼". Softcover $4.50 ($5.40 in Canada).

This third edition is actually a new and completely up-to-date book that guides the technician or hobbyist through transistor radio servicing from the antenna to the speaker. Both AM and FM radio circuits, using bipolar and field effect transistors, are explained. The text discusses practical facts you should know about transistrs, the repair and method of repairing, problems, service techniques, tracking and alignment, tools and equipment, tricks and short cuts and where to get parts. A profitable resource for anyone who wants to get into transistor radio servicing.

1-2-3-4 Servicing Transistor CB & Two-Way Radio by Forest H. Belt. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 256 pp. 8¼" x 5¼". Softcover $5.25 ($6.30 in Canada).

Both Citizen's band and commercial mode 2-way radio are becoming increasingly popular. This new easy-to-read book applies the popular 1-2-3-4 servicing methods. The author explains the four distinct divisions: sections, stages, circuits and parts. Then he analyzes the four important servicing steps: diagnose, locate, isolate and pinpoint. If you're a student, licensed technician or interested layman, you will understand CB and 2-way radio when you finish this book.

Simplified Electronics Measurements: How to Get More From Low-Cost Test Equipment by John H. Fasal. Hayden Book Co., Inc., 50 Essex Street, Rochelle Park, N.J. 07662. 144 pp. 8¾" x 5¾". Softcover $4.25.

A true on-the-job tool for the hobbyist, technician or engineer, this guide describes and illustrates the principles, construction and calibration of many inexpensive devices and accessories that will extend the performance of ordinary test equipment. It covers a broad array of devices such as meter amplifiers, capacitors, bridges, scope calibrators and more. This guide offers you a deeper understanding of the hows and whys of your equipment so you can try your own hand at extending its use without sacrificing accuracy.

Four-Channel Sound by Leonard Feldman. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 144 pp. 8¼" x 5¼". Softcover $4.50 ($5.40 in Canada).

Four-channel sound is here to stay. An increasing number of manufacturers are starting to sell matrix systems. Discrete discs are being so d and a new high-frequency cartridge has been developed and several corporations have proposed four-channel FM broadcasting systems to the FCC for approval. Both two and four-channel receivers and four-channel headphones have recently come onto the market. Whether you were thinking about purchasing a four-channel system, converting to one or just desiring to learn about it, this book has the information you need. The author covers four-channel sound from the reasons for it, to the selection of the equipment. Matrix techniques and discrete four-channel discs are discussed at length. Complete chapters are devoted to four-channel FM broadcasting, four-channel sound on tape, discrete records and matrixing techniques. An appendix acquaints the reader with new terms associated with this growing field of four-channel sound.

5 Minute Electronic Projects by Len Buckwalter. Howard W. Sams & Co., Inc., 4300 West 62 St. Indianapolis, Ind. 46268. 96 pp. 8¼" x 5¼". Softcover $3.95 ($4.95 in Canada).

Here in one book is a group of easy-to-build inexpensive electronic projects. Wired together and driven by dc voltage, these simple circuits can flash lamps, sound tones and speakers, convert the sun's energy into mechanical motion or perform scores of more sophisticated tasks like transmitting the voice by radio to a receiver across the room or counting seconds by an electronic tick. There are no high voltages to cause electrical shock or complex schematics to follow — just dozens of fun projects.

Transistor-Transistor Logic by George Flynn. Howard W. Sams & Co., Inc., 4300 W. 62 St. Indianapolis, Ind. 46268. 176 pp. 8¼" x 5¼". Softcover $5.50 ($6.60 in Canada).

TTL today is the dominant form of semiconductor logic. Numerous families of TTL devices exist; some are compatible with others, some are not. Most major semi-conductor manufacturers in the United States make devices in one or more of the TTL families. This book provides an understanding of how the various devices are used to do many things — from frequency synthesis to data communications to computer design. It starts with a basic introduction to the devices: gates, flip flops, counters, shift registers — and goes on from there, including a chapter on TTL applications.

R-E

Digi-Key
DIGI KEY CORPORATION

Quality Electronic Components

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Temp. range, -40°C + 85°C Tolerance: -10 + 50% for more than 4.7 ufd, -10 + 75% for 4.7 ufd or less

Value	1	10-99*	100-200*	Value	1	10-99*	100-200*
1 ufd/50V	14c	12c	11c	100 ufd/16 V	19c	15c	14c
2 2 ufd/50 V	14c	12c	11c	100 ufd/25V	24c	18c	17c
3 3 ufd/35V	14c	12c	11c	220 ufd/16 V	24c	18c	17c
4 7 ufd/35 V	14c	12c	11c	220 ufd/25 V	35c	25c	24c
10 ufd/16 V	13c	10c	9c	330 ufd/16 V	35c	25c	24c
10 ufd/25 V	14c	11c	10c	330 ufd/25 V	44c	35c	32c
22 ufd/16 V	14c	11c	10c	470 ufd/16 V	37c	30c	27c
22 ufd/25 V	15c	13c	12c	470 ufd/25 V	49c	39c	35c
33 ufd 16 V	15c	12c	11c	1000 ufd 16 V	49c	39c	35c
33 ufd/25 V	17c	13c	12c	1000 ufd/25 V	75c	60c	55c
47 ufd 16 V	17c	14c	13c	2200 ufd/16 V	75c	60c	55c
47 ufd 25 V	19c	15c	14c	*10 pcs per capacitance value			

½ & ¼ WATT CARBON COMP. RESISTORS

5 each of the 85 standard 10% values (2 2-22M) ½ W Resistors (425 pcs)
Sorted by value $12 set 2-4 are $11 set 5-9 are $10/set
5 each of the 70 standard 10% values (10-5 6M) ¼ W Resistors (350 pcs)
Sorted by value $12 set 2-4 are $11 set 5-9 are $10 set

DIGITAL TTL

7400N	32c	7446N	$1 30	7496N	$1 20
7401N	32c	7447N	$1 30	74107N	55c
7402N	32c	7448N	$1 35	74121N	70c
7403N	32c	7450N	32c	74122N	72c
7404N	35c	7451N	32c	74123N	$1 11
7405N	35c	7453N	32c	74141N	$1 61
7406N	52c	7454N	32c	74150N	$1 56
7407N	52c	7459N	32c	74151N	$1 20
7408N	36c	7460N	32c	74153N	$1 58
7409N	36c	7470N	36c	74154N	$2 25
7410N	32c	7472N	40c	74155N	$1 46
7411N	35c	7473N	52c	74156N	$1 17
7413N	63c	7474N	52c	74157N	$1 56
7416N	50c	7475N	85c	74158N	$1 56
7417N	50c	7476N	60c	74160N	$1 95
7418N	35c	7480N	74c	74161N	$1 95
7420N	32c	7482N	$1 02	74162N	$1 95
7423N	75c	7483N	$1 58	74163N	$1 95
7426N	36c	7486N	60c	74164N	$1 95
7430N	32c	7489N	$4 50	74165N	$2 48
7437N	51c	7490N	85c	74166N	$2 03
7438N	51c	7491N	$1 37	74180N	$1 20
7440N	32c	7492N	85c	74181N	$3 38
7441N	$1 45	7493N	85c	74182N	$1 17
7442N	$1 20	7494N	$1 20	74192N	$1 80
7445N	$1 62	7495N*	$1 20	74193N	$1 80
Discounts offered in quantities				74198N	$2 78
of 100 pcs TTL in mixed lots				74199N	$2 78

LINEAR INTEGRATED CIRCUITS

NE555V MiniDIP	$1 00	723C DIP	$1 15
NE565A DIP	$3 57	741C MiniDIP	60c
NE567V MiniDIP	$3 5?	747C DIP	$1 10
N5558V MiniDIP	95c	748C MiniDIP	60c
709C MiniDIP	44c	Quantity Discounts	

1 AMP SILICON RECTIFIERS

IN4001	50 PIV	10 $1 00	100 $ 7 00	1000 $ 60 00
IN4002	100 PIV	9 $1 00	100 $ 8 00	1000 $ 70 00
IN4003	200 PIV	8 $1 00	100 $10 00	1000 $ 85 00
IN4004	400 PIV	7 $1 00	100 $11 00	1000 $ 95 00
IN4005	600 PIV	7 $1 00	100 $12 00	1000 $105 00
IN4006	800 PIV	6 $1 00	100 $13 00	1000 $115 00
IN4007	1000 PIV	5 $1 00	100 $14 00	1000 $120 00

MOLEX IC SOCKET PINS

100 $1 00	200 $1 80	300 $2 60	500 $4 20
700 $5 80	1000 $8 20	ea addn	1000 $7 50

D:SPLAY DEVICES

5 Volt 7 Segment Tube	$3 75
Display Kit (Tube + 7447 + 7475 + 7490)	$6 15
	3 $17 50
7 Segment LED (MAN 1 Type)	$3 50
Display Kit (LED + 7447 + 7475 + 7490 + Resistors)	$6 50 3 $18 00
7 Segment LED (MAN-4 Type)	$3 50
Display Kit (LED + 7448 + 7475 + 7490 + Resistors)	$6 50 3 $18 00

Also available are Transistors IC Sockets Slide Switches Reed Relays Heat Sinks and more!
Send for FREE CATALOG or Mail Readers Service Card

C O D ORDERS ACCEPTED FOR SAME DAY SHIPMENT
CALL 218-681-6674

Orders Less Than $10 00 Add 25c — Others Postpaid

DIGI-KEY
Box 126 **Thief River Falls, MN 56701**

Circle 91 on reader service card

market center

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). $1.00 per word . . . minimum 10 words.
NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) 70¢ per word . . no minimum.
FIRST WORD and NAME set in bold caps at no extra charge. Additional bold face at 10¢ per word. Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for May issue must reach us before March 1.

WANTED

"CASH" paid for unused teletype parts and assemblies. **"PHILMAR"**, Box 96, Morrisonville, N.Y. 12962 518-561-3479

QUICK cash . . . for electronic equipment components, unused tubes. Send list now! **BARRY,** 512 Broadway, New York, N.Y. 10012, 212 Walker 5-7000

WANTED: Used metal detectors, manuals, schematics; antique radios. **MUSEUM OF ELECTRONICS,** Box 4127-P, Huntsville, Ala. 35802

WANTED used complete picture tube rebuilding unit for television repair shop. **JAPAN ELECTRONICS**, 636 Taraval, San Francisco, Calif. 94116

FULLY skilled English TV repairman, 41, married, 3 kids, seeks work U.S.A. or Canada. Knowledge German makes. Passed RCA exam. Fluent Spanish Write: **JIM HANDLEY**, Generalisimo 37, Alcobendas, (Madrid), Spain.

PLANS & KITS

ELECTRONIC organ kits, keyboards and many components. Independent and divider tone generators. All diode keying. IC circuitry. Build any type or size organ desired. Supplement your Artisan Organ, 35c for catalog. **DEVTRONIX ORGAN PRODUCTS,** Dept. B, 5872 Amapola Dr., San Jose, Calif. 95129

FREE catalog. Most unusual electronic kits available. Wind accessories, surf, wind synthesizers, wind chimes, many others. **PAIA** Electronics, Box B14359, Oklahoma City, OK 73114.

WALL-SIZED TV . . . Build a TV projector for under $15.00. Free details: **MACROCOMA,** Box-FCE, Washington Crossing, Pa. 18977

ELECTRONIC ENGINEERING & INSTRUCTION

TV tuner repairs—Complete course details, 12 repair tricks. Many plans. Two lessons, all for $1. Refundable. **FRANK BOCEK,** Box 3236 (Enterprise), Redding, Calif. 96001.

EDUCATION & INSTRUCTION

DEGREE Program in Electronics Engineering. Our 27th Year! Free literature. **Cook's Institute,** Dept. 14, Box 10634, Jackson, Miss. 39209.

SHORTCUTS to success! Highly effective, profitable short courses. (75 choices). Study at home. Diploma awarded. Our 27th year. Free literature. **CIEE-E,** Box 10634, Jackson, Miss. 39209

BUSINESS OPPORTUNITIES

START small, highly profitable electronic production in your basement. Investment, knowledge unnecessary. Postcard brings facts. **BARTA-AC,** Box 248, Walnut Creek, Calif. 94597

BUILD your own speaker systems. Lowest wholesale prices on famous brands. Write for 176 page catalog. **McGEE RADIO COMPANY,** 1901 McGee Street, Kansas City, Missouri, 64108

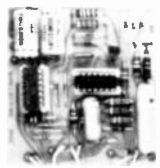
TUBES

SAVE money on parts and transmitting-receiving tubes, foreign-domestic. Send 25c for Giant Catalog. Refunded first order. **UNITED RADIO COMPANY,** 56-R Ferry Street, Newark, N.J. 07105

RECEIVING & industrial tubes, transistors. All brands-biggest discounts. Technicians, hobbyists, experimenters—request free giant catalog and save! **ZALYTRON,** 469 Jericho Turnpike, Mineola, N.Y. 11501

DO YOU OWN A LOW COST SCOPE?

IMPROVE IT!
$20.00



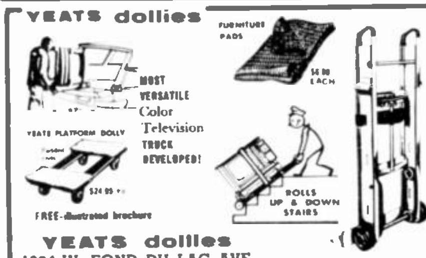
PROFESSIONAL RESULTS
BUILD AND ADD AN "EASY TO USE VISTA KIT"
ALL SOLID-STATE, USING THE LATEST OP-AMP IC'S PARTS, CONTROLS, ALL SEMI-CONDUCTORS, CIRCUIT BOARD AND INSTRUCTIONS INCLUDED
VISTA TRIGGER SWEEP GENERATOR
PREPAID U.S A & CANADA
PHOTOLUME CORPORATION
BOX 139 NEW YORK N Y 10016

"GROUNDED" OUTLET TESTER

New GT-20 Tester tells if your AC Outlets are safely grounded or properly wired. Simply plug it in & read coded neons. Ideal for home, shop, campers, electricians, maintenance men, etc. $7.95 PREPAID. Two prong adapter $.75.

ALCO BOX 1348-RE-FM Lawrence, Ma. 01840

YEATS dollies



YEATS dollies
1324 W. FOND DU LAC AVE.
MILWAUKEE, WIS. 53205
YEATS Model No. 5 $76.50

INTERNATIONAL ELECTRONICS UNLIMITED

TTL

7400	$ .25	7447	$1.45	74123	$1.15
7401	.25	7448	1.50	74125	.69
7402	.25	7450	.29	74126	.95
7403	.25	7451	.32	74141	1.25
7404	.29	7453	.32	74145	1.25
7405	.27	7454	.45	74150	1.25
7406	.55	7455	.32	74151	1.05
7407	.53	7460	.30	74153	1.45
7408	.29	7461	.30	74154	1.75
7409	.29	7464	.45	74155	1.35
7410	.25	7465	.45	74156	1.50
7411	.35	7470	.50	74157	1.50
7413	.95	7472	.45	74161	1.65
7415	.50	7473	.55	74163	1.80
7416	.50	7474	.55	74164	2.95
7417	.50	7475	.95	74165	2.95
7420	.25	7476	.55	74166	1.95
7421	.32	7478	.89	74173	1.95
7422	.32	7483	1.25	74175	1.95
7423	.37	7485	1.20	74176	.95
7425	.39	7486	.55	74177	.95
7426	.35	7489	3.25	74180	1.15
7427	.39	7490	1.25	74181	4.25
7430	.25	7491	1.40	74182	1.10
7432	.30	7492	1.05	74190	1.65
7437	.50	7493	1.05	74192	1.65
7438	.55	7494	1.10	74193	1.65
7440	.25	7495	1.05	74194	1.65
7441	1.25	7496	1.05	74195	1.15
7442	1.15	74100	1.65	74196	1.35
7443	1.25	74105	.55	74197	1.15
7444	1.30	74107	.55	74198	2.50
7445	1.25	74121	.65	74199	2.50
7446	1.45	74122	.55		

Low Power TTL

74L00	$ .40	74L51	$ .40	74L90	$1.75
74L02	.40	74L55	.60	74L91	1.50
74L03	.40	74L71	.60	74L93	1.75
74L04	.40	74L72	.60	74L95	1.75
74L06	.40	74L73	.80	74L164	2.95
74L10	.40	74L74	.80	74L165	2.95
74L20	.40	74L78	.80	85L52	2.95
74L30	.40	74L85	1.25	86L75	2.95
74L42	1.75	74L86	.95		

High Speed TTL

74H	$ .40	74H21	$ .47	74H60	$ .45
74H01	.40	74H22	.47	74H61	.45
74H02	.40	74H30	.40	74H62	.45
74H04	.45	74H40	.40	74H72	.60
74H08	.45	74H50	.45	74H74	.70
74H10	.40	74H53	.47	74H76	.70
74H20	.40	74H55	.47		

8000 Series TTL

8054	$ .45	8200	$ 2.95	8554	$ 2.95
8060	.30	8210	3.95	8570	2.95
8091	.69	8214	1.95	8600	1.15
8092	.69	8219	1.95	8810	.95
8093	.69	8220	1.95	8812	1.25
8094	.69	8230	2.95	8822	2.95
8121	1.05	8280	.95	8830	.69
8122	1.05	8288	1.05	8831	2.95
8123	1.75	8520	1.45	8832	2.95
8130	2.50	8551	1.95	8836	.69
8182	1.75	8552	2.95	8880	1.50

ALL DIP PKGS.

Specify spec. sheets required with order. Add $ .50 per spec sheet for items less than $1.00 ea.

CMOS

74C00	$ .85	74C76	$1.70	74C162	$3.25
74C02	.85	74C107	1.50	74C163	3.25
74C04	.95	74C151	2.90	74C164	3.50
74C10	.85	74C154	3.50	74C173	2.90
74C20	.85	74C157	2.25	74C192	3.25
74C42	2.15	74C160	3.30	74C195	3.00
74C73	1.70	74C161	3.25	80C97	1.50
74C74	1.50				

4000 Series – RCA Equivalent

CD 4001	$ .65	CD 4012	$ .65	CD 4023	$ .65
CD 4002	.65	CD 4013	1.50	CD 4025	.65
CD 4009	1.00	CD 4016	1.50	CD 4027	1.35
CD 4010	.65	CD 4017	2.95	CD 4030	.65
CD 4011	.65	CD 4019	1.35	CD 4035	2.85

MOS

MM1404	1024-bit dynamic shift register	$2.25 ea.
MM5013	1024-bit dynamic shift Register/Accumulator	2.25 ea.
MM5240	2560-Bit Character Generator (ACA or AA)	4.95 ea.
MM5241	3072-Bit Static Read only Memory (ABV)	7.95 ea.

Memories

1101	256 bit RAM MOS (2501)	$2.50 ea.
1103	1024 bit RAM MOS	7.95 ea.
5260	1024 bit RAM 16 pin Low power consumption	7.95 ea.
7489	64 bit RAM TTL	3.25 ea.
8223	Programmable ROM	6.95 ea.

MARCH SPECIALS

OPTO ISOLATORS

MCD 2	Diode	$ .99 ea.
MCT 2	Transistor	.99 ea.

TTL dip pak

7400	Quad two-input gate	5 for $1.00
7483	4-bit binary full adder	1.00 ea.
7493	4-bit binary counter	.95 ea.
74123	Retrig. mono. multivib w/clear	1.05 ea.
8123	Tri-state 9322, multiplexer	1.50 ea.

Linear circuits

351	(75453) Dual peripheral driver minidip	3 for $1.00
723	Voltage regulator	3 for $2.00

18 PIN CALCULATOR KIT

- MM5736 – 18 pin calculator chip – four function – 6 digit
- A pair of 3-in-1 dip paks (6 digits) LED Similar to DL-33
- One 75492 Hex Digit Driver

Data supplied on above items. You supply switches, resistor, keyboard and battery for complete calculator

$11.95/kit

Linear

LM300	Pos V Reg (super 723)	TO-5	$ .95 ea.
LM 301	Hi performance AMPL	TO-5 or MINI-DIP	.45 ea.
LM 302	Voltage Follower	TO-5	.95 ea.
LM 304	Negative Voltage Regulator	TO-5	1.25 ea.
LM 305	Positive Voltage Regulator	TO-5	1.25 ea.
LM 307	Op AMP (super 741)	TO-5 or MINI-DIP	.45 ea.
LM 308	Micro Power Op Amp	TO-5 or MINI-DIP	1.25 ea.
LM 309H	5 V Regulator	TO-5	1.25 ea.
LM 309K	5 V 1A Regulator	TO-3	1.95 ea.
LM 310	Voltage Follower Op Amp	TO-5	1.45 ea.
LM 311	Hi perf. Voltage Comparator	TO-5 or MINI-DIP	1.25 ea.
LM 319	Hi Speed Dual Comparator	DIP	1.56 ea.
LM 320	-5.2 V Negative Regulator	TO-3	1.95 ea.
LM 320	-12 V Negative Regulator	TO-3	1.95 ea.
LM 320	-15 V Negative Regulator	TO-3	1.95 ea.
LM 339	Quad Comparator	DIP	1.95 ea.
LM 340T	Positive Voltage Regulator (6V, 8V, 15V or 24V)	TO-220	2.25 ea.
LM 370	AGC/Squelch AMPL	TO-5 or DIP	1.29 ea.
LM 372	AF-IF Strip detector	DIP	.85 ea.
LM 373	AM/FM/SSB Strip	DIP	3.60 ea.
LM 376	Pos. Volt Regulator	MINI DIP	.65 ea.
LM 380	2 Watt Audio Regulator	DIP or MINI-DIP	1.75 ea.
LM 382	Low Noise Dual Pre-Amp	DIP	2.25 ea.
LM 560	Precision Voltage Regulator	DIP	.96 ea.
LM 703	RF-IF Amp	MINI-DIP	.59 ea.
LM 709	Operational AMPL	TO-5 or DIP	.39 ea.
LM 711	Dual Differential Comparator	DIP	.39 ea.
LM 723	Voltage Regulator	DIP	.75 ea.
LM 739	Dual Hi Performance Op AMP	DIP	1.25 ea.
LM 741	Comp. Op AMP	TO-5 or MINI-DIP	.45 ea.
LM 747	Dual 741 Op AMP	TO-5 or DIP	.95 ea.
LM 748	Freq Adj 741	MINI-DIP	.45 ea.
LM 1303	Stereo Pre-Amp	DIP	.95 ea.
LM 1304	FM Multiplex Stereo Demod.	DIP	1.50 ea.
LM 1307	FM Multiplex Stereo Demod.	DIP	.95 ea.
LM 1458	Dual Comp. Op. Amp.	MINI-DIP	.75 ea.
LH 2111	Dual LM211 Volt. Comparator	DIP	2.95 ea.
LH 3065	TV-FM Sound System	DIP	.75 ea.
LM 3075	FM Det. – LMTR and Audio Pre-Amp	DIP	.85 ea.
LM 3900	Quad Amplifier	DIP	.50 ea.
LM 3905	Precision Timer	MINI DIP	.75 ea.
LM 7524	Core Memory Sense AMPL	DIP	1.95 ea.
LM 7525	Core Memory Sense AMPL	DIP	.95 ea.
LM 7535	Core Memory Sense AMPL	DIP	.95 ea.
LM 9601	Retriggerable One Shot	DIP	.95 ea.
LM 75451	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75452	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75453	(LM 351) Dual Peripheral Driver	MINI-DIP	.69 ea.

Specify TO-5, DIP or MINI-DIP Package

Specify Spec. Sheet Required with order. Add $ .50 per spec sheet for items less than $1.00 ea.

Phase Locked Loops

NE 560	Phase Locked Loop	DIP	$2.96 ea.
NE 561	Phase Locked Loop	DIP	2.95 ea.
NE 562	Phase Locked Loop	DIP	2.96 ea.
NE 565	Phase Locked Loop	DIP	2.95 ea.
NE 566	Function Generator	MINI DIP OR TO-5	2.95 ea.
NE 567	Tone Decoder	MINI DIP OR TO-5	2.96 ea.

Specify TO-5, Dip or Mini-Dip Package

Calculator Chips

5001 LSI (40 pin) Add, subtract, multiply & divide 12 digit
- Data supplied with chip .... $6.95 ea.
- Data only-Refundable w/purchase .... 1.00 ea.

5002 LSI Similar to 5001 except designed for battery power
- Data supplied with chip .... $8.95 ea.
- Data only-Refundable w/purchase .... 1.00 ea.

5005 LSI (28 pin) Full four function memory. 12 digit display and calc. 7 segment multiplexed output
- Data supplied with chip $10.95
- Data only-Refundable w/purchase .... 1.00 ea.

Digital clock . . . on a Chip

MM 5311 (28 pin) Any readout 6 digit BCD with spec. sheet	$11.95 ea.
MM 5312 (24 pin) Any readout 4 digit ipps BCD with spec. sheet	8.95 ea.
MM 5313 (28 pin) Any readout 6 digit ipps BCD with spec. sheet	10.95 ea.
MM 5314 (24 pin) LED-incandescent readout 6 digit with spec sheet	10.95 ea.
MM 5316 (40 pin) Normal alarm, snooze alarm, sleep timer 12 or 24 hr. operation with spec. sheet	15.95 ea.

LED

MV108 Visible red SUPER SPECIAL	$ .25 ea.
MV50 type red emitting	.25 ea. 5/$1.00
MV5020 type Large red	.35 ea. 3/$1.00
ME4 Infra red TO18	.69 ea.
MAN 1 The original	3.95 ea.
MAN 3 type	1.95 ea. 3 or more 1.49 ea.
MAN 4 type	2.75 ea. 3 or more 2.50 ea.
Data-Lite 707 (MAN 1 repl)	3.25 ea.

Opto Isolators

MCA 2 30	Darlington	$ .95 ea.
MCD 2	Diodes	1.95 ea.
MCT 2	Transistor	1.45 ea.

Untested IC's

UNTESTED MOS

MM1403	1024 bit dynamic shift register	DIP	.65 ea.
MM1404	1024 bit dynamic shift register	DIP	.65 ea.
MM5013	1024 bit dynamic shift register/accum.	DIP-TO-5	.55 ea.
MM5016	512 bit dynamic shift register	DIP-TO-5	.25 ea.
MM5019	Dual 256 bit mask prog. shift register	TO-5	.25 ea.
MM5050	Dual 32-bit static shift register	TO-5	.35 ea.
MM5054	Dual 64/72/80 bit static shift register	DIP	.35 ea.

MOS Shift Registers 2500 Series
2502 2506 2509 2510 2511 2518 2519 2521 2522
Untested seconds 4/1.00

Grab Bag Specials
15 Assorted TTL's (dips) $1.00/bag
25 Assorted DTL's (dips) $1.00/bag

ON ORDERS OVER $25.00 DEDUCT 10%

Satisfaction guaranteed. All items except as noted are fully tested. Minimum order $5.00 prepaid in U.S. and Canada. Calif. residents add sales tax. Orders filled within three days from receipt.

INTERNATIONAL ELECTRONICS UNLIMITED
P.O. BOX 1708R
Monterey, Calif. 93940

Circle 92 on reader service card

U.S. GOV'T ELECTRONIC SURPLUS

• Nationally Known-World Famous SURPLUS CENTER offers finest, most expensive, Government Surplus electronic units and components at a fraction of their original acquisition cost.

IBM COMPUTER POWER SUPPLY

• (ITEM #22-934-XYZ) Expensive, regulated unit. Fine for college labs, research co's., service shops, etc. Pure DC over a wide range of voltages. DC output voltages 6, 12, 48, etc. Wide range of AC voltages available.

• Finest transformers, filters, transistor load regulation system. Independent of line voltage fluctuations. Contains five separate rectifier systems. Unit is furnished without small "regulating card" which can be easily made or can be by passed. Data and circuit diagrams furnished. 30" x 12" x 10". (125 lbs.)

Cost Gov't Over $500.00 — **$26.95**

ONCE-IN-A-LIFETIME SPECIAL

BURGLAR-FIRE ALARM SYSTEM

• (ITEM #1135-A) -- Dual alarm system gives warning of fire or break-in. Operates on 115-VAC. Control unit, 2 kidde flash fire, 2-mercury column, 1 door window actuators, alarm bell, 100 ft. wire, instructions. 8½" x 7½" x 1". (7 lbs.)

$39.95

STANDARD DIAL TELEPHONE

• (ITEM #715) -- Standard, commercial telephone same as used throughout U.S.A. Attractive polished black, like new condition. Use as extension phone to private systems or connect several phones together for local intercom system. Full instructions are furnished. Wt. 9 lbs.

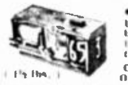
Original Cost $24.50 — **$8.79**

STEP-BY-STEP TELEPHONE SWITCH

• (ITEM #738) -- Amazing "up-and-around" switch. Great experimental item. When used with two-wire telephone dial will select any number from 0 to 100. Make intercom or private system. Use to turn on remote lights, start motors, etc. Complete with contact bank. 13" x 6" x 5". (16 lbs.) Cost Over $90.00 — **$8.95**

• Telephone dial for use with above switch (when purchased at same time as switch). Order as (ITEM #700 A). Only — **$1.97**

MAGNETIC DIGITAL COUNTER (12 to 18-VDC)



• (ITEM #21-959) -- Use to count electrically. Use to count number of times door is opened after business is closed, to show changing prices, laboratory uses, etc. Will count 1 for each pulse and will transfer 10th count to next unit. 4½" x 1¾" x 1½". (1½ lbs.)

Orig. Cost Over $19.00 — Each **$1.99** — Three For **$4.99**

200 AMP., 50 VOLT, SILICON DIODE

• (ITEM #22-963) -- A Four Star Buy! New, leading make. Heavy duty units excellent for use in 12 or 24-volt fast chargers, high current power supply systems, etc. 2½" x 1½" x 1½". ¾"—16 SAE mounting threads. (1 lb.)

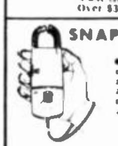
List Over $15.00 — **$4.98**

AC PROGRAM TIMING CLOCK

• (ITEM #158) -- Zenith 115-VAC unit. Use for periodic signaling, work breaks, classes, turn on radio, etc. Adj. clips permit ON-OFF switching any time in 24-hour period. Also has "skip a day" feature. Can be multiple programmed. 15 amp. contacts. 8½" x 6½" x 4". (8 lbs.)

Cost Gov't Over $30.00 — **$15.75**

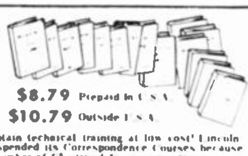
SNAP AROUND VOLT-OHM-AMMETER



• (ITEM #21-944) -- Measures AC current without opening the line. Simply press handle and snap the probe around the conductor. Reads currents from .25 to 125 amps. Reads voltages to 300, reads ohms up to 500. Test motors, appliances, etc. Three current ranges, two voltage ranges. With case, test leads. 7½" x 3" x 1¼". (2 lbs.)

$39.95

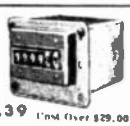
SPECIAL SALE Correspondence Course in ELECTRICAL ENGINEERING



$8.79 Prepaid in U.S.A.
$10.79 Outside U.S.A.

• (ITEM #9-181) -- Obtain technical training at low cost! Lincoln Engineering School has suspended its Correspondence Courses because of rising costs. A limited number of Electrical Engineering Courses are available, but without the examination grading service. The course consists of 15 lesson books, each with associated exams and standard answers. Book describing prize winning Home Experimental laboratory Bench furnished at no extra cost.

RUNNING TIME METER

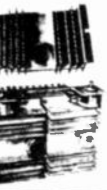


• (ITEM #2188) -- Record number of operating hours of electric lights and electrical devices such as refrigerators, furnaces, etc. Records total hours, tenths and hundredths up to 9,999.99 hours. For 115-volt, 60-cycles. Size 4⅝" x 3" x 2½". Shipping weight 2 lbs.

$4.39 Cost Over $29.00

COMPUTER TRANSISTORS ON HEAT SINKS

IBM Computer Quality Units



• (#22-928) -- Unit consists of one 150-watt power transistor on heavy, ribbed, aluminum heat sink. Many experimental uses. (1 lb.)

Cost Gov't Over $10.00 — **$1.98**

• (#22-918) -- Unit consists of two 150-watt power transistors, 2 pots, several diodes, capacitors, resistors, etc. on heavy, ribbed aluminum heat sinks. Ideal for use as motor speed control. (4 lbs.)

Cost Gov't Over $15.00 — **$4.91**

ALL ITEMS SHIPPED F.O.B. LINCOLN, NEBR. Order Direct From Ad. Money Back Guarantee.

SURPLUS CENTER
DEPT. RE-034 LINCOLN, NEBR. 68501

COMPUTER KEYBOARD W/ENCODER $35
Another shipment just received. Alpha numerics keyboard excellent condition. Once again we expect an early selout. Price of $35 incudes prepaid shipment in the US and shipment made within 24 hours of receipt of order.

JUNK KEYBOARDS as above, "as is" for parts $7.00

COMPLETE MEMORY SYSTEM $150
Measures 12 × 7 × 1 inches. Utilizes TTL IC's. 10240 memory cores. 9 installed sense amps, addressed as 1024 locations. I/O lines include 9 data-in, 9 data-out, 10 address-in, powering status and control. Only 40 systems on hand. Schematics included.

#DCU $150 pp

AUTOMOBILE REVERB $7.00
Brand new fully assembled, ready to install in your car to give 3rd dimension concert hall effect. Complete with instructions, rear seat speaker, grill, wires, plugs.

#05 $7.00

8 TRACK STEREO TAPE DECK $14.00
With built-in stereo pre-amp, 115 volt drive motor, channel indicator lamps. Unused, original boxed, less cabinet. Customize your stereo music center with one of these tape decks.

#46 $14.00

Please add postage for above.
JOHN MESHNA JR.
PO Box 62, E. LYNN, MASS. 01904

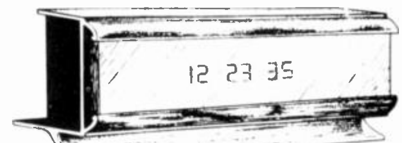
Circle 93 on reader service card

C·MOS

74C00	.60	CD4001	.60
74C02	.60	CD4002	.60
74C04	.85	CD4009	.95
74C10	.60	CD4010	.95
74C20	.60	CD4011	.60
74C42	2.75	CD4012	.60
74C73	1.65	CD4013	1.25
74C74	1.25	CD4016	1.25
74C76	1.65	CD4017	3.20
74C95	3.20	CD4019	1.45
74C107	1.65	CD4022	3.10
74C151	3.00	CD4023	.60
74C154	4.50	CD4024	3.25
74C157	2.35	CD4025	1.25
74C160	3.25	CD4027	1.75
74C161	3.25	CD4030	1.25
74C162	3.25	CD4035	3.10
74C163	3.25		
74C164	3.50		
74C173	3.20		
74C192	4.75		
74C193	4.75		
74C195	3.15		

Buy 10 IC's – 10% discount
Buy 100 IC's – 20% discount
All IC's tested and guaranteed

DIGITAL CLOCK KIT!



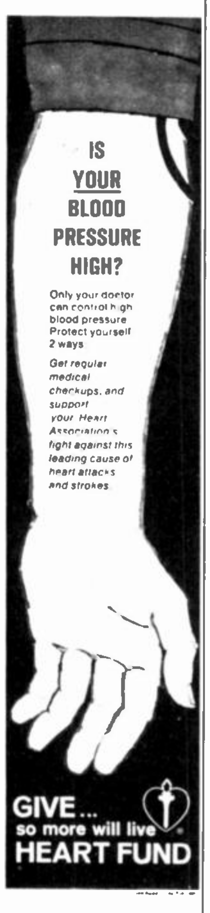
SPECIAL **29**[95]

Full 6 digit LED display - 12/24 Hr 50/60 Hz operation! Handsome aluminum case approx 2" x 5" x 1½". All components, PC board, with complete instructions for easy assembly.

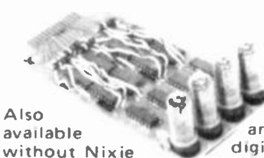
Orders over $10.00 POSTPAID. Under $10.00 add 50c. California ADD TAX

BILL GODBOUT ELECTRONICS
BOX 2673, OAKLAND AIRPORT, CA 94614

Circle 94 on reader service card



BURROUGHS DIGITAL COUNTERS



BURROUGHS Series C2506 decade counters with memory. Available with 4,5,6 or 7 digits. NIXIE tube readouts. Complete 25 Mhz counter, all you need is a power supply, 200 Vdc, and 5.0 Vdc (Vcc). This a basic unit for digital instruments such as frequency counters,clocks, thermometers,DVMs etc. With 6 pages of data.

Also available without Nixie tubes;write for information.

STOCK NO.F5134	4 digits (C2506 4)	29.50
STOCK NO F5135	5 digits (C2506 5)	36.00
STOCK NO.F5136	6 digits (C2506 6)	42 50
STOCK NO.F5137	7 digits (C2506 7)	49.50

DUAL VOLTAGE,HIGH CURRENT VARIABLE POWER SUPPLY KIT

We supply the following parts, to make a dual D.C. power supply with the following ratings: 0 to 42 volts D.C. at 5.0 Amps., and 12 volts D C at 5 0 Amps Switch, line cord, pilot light,transformer,Variable Autotransformer, 2 bridge rectifiers, 2 high capacity electrolitic capacitors. (Meters and cabinet not supplied.)

STOCK NO. J5166 Parts Kit $22.50, 2/39.00

TUNG–SOL DIGIVAC FLUORESCENT READOUT TUBE.

Tung-Sol DT1704B 7 segment fluorescent 9 pin miniature readout tube. Character size .360x570. Height 1¾". Fil. volts 1.6 AC or DC. Segment voltage 12 to 50 volts, 25 volts typical. Electrically identical to G.E.Y4075 & Y-1937. Readout colr is green, but can be filtered to any color. We supply a socket for each tube, and many pages of application data.

STOCK NO.F5140 $2.65 ea. 2/5.00 6/14.00

Include sufficient postage. Excess will be refunded. Send for free new 56 page catalog. Minimum order $5.00.

DELTA ELECTRONICS CO.
BOX 1, LYNN, MASSACHUSETTS 01903
Phone (617) 388-4705

Circle 95 on reader service card

Circle 96 on reader service card

FOR SALE

LOGIC probes from $9.95. Free catalog. **ELECTRO INDUSTRIES,** 4201 Irving Park, Chicago, Ill. 60641

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

CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **RELCO**—A25, Box 10563, Houston, Tex. 77018

TRANSISTOR curve tracer, $10.95, guaranteed one year. **APPALACHION TECHNICAL**, Box 8512, Asheville, N.C. 28804

KEYBOARDS. Brand new. Full ASCIL decoder in base, $34.50. Intersil 8038 VCO function generator, $5.75. Voltage regulators 7805, 7812, 7815, 7912 or 7915, $2.50. All ppd. Latest flyer for 8c stamp. **TRI-TEK, INC.,** P.O. Box 14206, Phoenix, Ariz. 85063

BUGGEDD??? . . . Dectors locate hidden transmitters. Literature 25c. **SECURITY**, Box 671RE, Westwood, New Jersey 07675

RADIO & TV tubes 36c each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, Calif. 92105

CANADIAN'S free catalog LED's, IC's, transistors, SCR's diodes, parts. **CORONET ELECTRONICS,** 649A Notre Dame West, Montreal 101, Que., Canada

NEW! Record, dub, edit, mix, fade, monitor. Eliminate "jungles" of tangled wires with Dubie Tape Aid control for 1 to 3 tape decks. **DUBIE TAPE AID CORP.,** Dept. D, 2305 N. Penn., Oklahoma City, Okla. 73107 (405) 524-858

FREE catalog. Electronic parts bargains. J.K. PRODUCTS, P.O. Box 527R, Norris, Tenn 37828

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

FREE catalog lists resistors, tubes, transistors, rectifiers, condensers, tools, tuners, etc. etc. **HYTRON HUDSON,** Dept. RE 2818 Kennedy Blvd., Union City, N.J. 07087

GIANT 126 page Canadian surplus catalog. $1.00. **ETCO ELECTRONICS**, Dept. RE, Box 741, Montreal, Canada.

SEMICONDUCTOR and parts catalog. J. & J. **ELECTRONICS**, Box 1437, Winnipeg, Manitoba, Canada

ELECTRONIC music synthesizer. Printed circuit boards and kits. Satisfaction guaranteed. Free information. **UNDERWATER LABORATORIES**, Box 25066, Northgate Station, Seattle, Wash. 98125

ELECTRONIC slot machine type game. Plans $5.00. **KAB**, 1923 Fern, Royal Oak, Mich. 48073

POLICE radar. Hard to get supplies. **ELECTRONIC SPECIALISTS**, 171 S. Main, Natick, Mass. 01760

MANUALS for Govt. surplus radios, test sets, scopes. List 50c. **BOOKS**, 7218 Roanne Drive, Washington, D. C. 20021

DIGITAL electronics! Complete schematics, parts lists, theories—Discrete Component Digital Clock. $3.00. Increase technical competence, hobby skills —Complete course in Digital Electronics is highly effective, $10.00. Free literature. **DYNASIGN,** Box 60R2, Wayland, Mass. 01778

NEW FM deviation meters $75.00. Free information. Write **ECM,** 412C N. Weinbach, Evansville, Indiana 47711.

DIFFERENT, **unusual gadgets employing numerical readouts: Plans catalog free! GBS**, Box 100R, Greenbank, WV. 24944

TWENTY disc, or 10 bar magnets. $1.00. **MAGNETS**, Box 192-E, Randallstown, Md. 21133

LOUDSPEAKERS - BOSE 901 replacements. $7.98 postpaid. Quantity discounts. Money back guarantee. **AURATONE**, Box 580-2B, Del Mar, Calif. 92014

SLA-3 7 segment LED readouts .77" numbers. 45 Ma/seg. **$7.95**

MINIATURE TRIM POTS
5K, 10K, 20K, 25K, 50K, 100K, **$.75** **3/$2.00**

MULTI-TURN TRIM POTS
Similar to Bourns 3010 style
3/16" × 5/8" × 1¼"
50, 100,500, 2000, 5000, 10,000 and 20,000 ohms.
$1.50 ea. **3/$4.00**

PRINTED CIRCUIT BOARD
4½"×6½" double sided fiber-glass board, 1/16" thick, unetched **$.60 ea. 5/$2.50**

NIXIE TUBES
Similar to Raytheon 8650 tubes, with socket & data sheet **$2.25 3/$6.00**

TIS 73 N FET	$ .60
2N4891 UJT	$ .50
ER 900 TRIGGER DIODES	4/$1.00

VERIPAX PC BOARD
This board is a 1/16" single sided paper epoxy board, 4½"×6½" (standard veripax), DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connections. Is also etched for 22 pin connector. **$5.25**

FLV 100 Visible LED	$ .59
ME-4 IR LED	$ .59
MV5026 Vis. LED	$ .59
MT-2 PHOTO TRANS.	$ .80
MCT-2 OPTO-ISOL.	$ .90
MCD-2 OPTO-ISOL.	$ .90
Green GaP OSL-16 LED	$ .90
Red GaP OSL-3 LED	$ .60
Hi intensity VIS. Red with reflector	$ .60
MCA 2-30 photo darlington relay	$ .90
14 PIN DIP SOCKETS	3 $1.00

Silicon Power Rectifiers

PRV	1A	3A	12A	50A
100	.06	.11	.30	.90
200	.07	.16	.35	1.25
400	.09	.20	.50	1.50
600	.11	.25	.70	1.80
800	.15	.35	.90	2.30
000	.20	.45	1.10	2.75

Terms: FOB Cambridge, Mass. Send check or Money Order. Include Postage. Minimum Order $3.00

TRANSISTOR SPECIALS

2N3772 NPN Si TO-3	$1.25
2N1137B PNP GE TO-3	$ .95
2N3137 NPN Si TO-5	4/$1.00
MPS3393 NPN Si TO-92	4/$1.00
2N3866 NPN Si TO-5	$ .75
2N5324 PNP GE TO-3	$1.50
2N404 PNP GE TO-5	4/$1.00
2N3767 NPN Si TO-66	$ .70
2N2222 NPN Si TO-18	5/$1.00
2N3055 NPN Si TO-3	$1.00
2N5296 NPN Si TO-220	$ .50
2N6109 PNP Si TO-220	$ .55
2N4898 PNP Si TO-66	$ .60
MJ2252 NPN Si TO-66	$ .90
2N3638 PNP Si TO-5	5/$1.00
2N2218A NPN Si TO-5	4/$1.00

C/MOS (DIODE CLAMPED)

CD 4001	$ .65
CD 4009	$1.50
CD 4010	$ .65
CD 4011	$ .65
CD 4013	$1.60
CD 4025	$1.50
CD 4016	$ .65
CD 4030	$ .65

CAPACITORS
6V 30 UF TANT. 5 $1
20V 4.7UF TANT. 5/$1
12V 10UF ELECT. 5/$1
50V 100UF ELECT $.40
25V 30UF ELECT 4/$1.00

DATA-LIT 707 LED readouts **$2.75**
MAN-3 LED READOUTS $1.75
MAN-4 LED READOUTS $2.50

Full Wave Bridges

PRV	2A	6A
200	.95	1.25
400	1.15	1.50
600	1.35	1.75

1103 1024 bit RAM	$ 7.25
NEC 6003 2048 bit RAM	$10.95
1101 256 bit RAM	$ 3.25
8225 64 bit-read-write RAM	$ 3.50

5311—Clock Chip. 6 Digit BCD hold count. Output Strobe $11.95
5314—Clock Chip. 6 Digit hold count. Output Strobe $9.95

Conductive Elastometer low profile calculator keyboard. A 2¾" × 3¾" × ½" flex key. 19SK-6 keyboard having 0-9, •, K · C buttons with off, on switch. **$6.50**

Injection laser—a single diode 6W. 25A GaAs unit similar to RCA 40859 **$10.95**

Dual tapered CdS photo cell used for optical alignment with a single plane lens. (Not included). $ .95

ASC II ENCODED TERMINAL KEY BOARDS $60.00

TTL IC SERIES

74L00	.50	7475	1.00
7400	.28	7476	.75
7401	.28	7480	.70
7402	.28	7483	1.25
7403	.28	7486	.50
7404	.33	7490	1.50
7405	.30	7491	1.30
7407	.50	7492	1.30
7408	.32	7493	1.30
7410	.28	7495	1.30
7411	.32	7496	1.10
7412	.45	74107	.75
7413	.85	74121	.70
7416	.50	74123	1.10
7417	.50	74125	1.50
7420	.28	74126	1.50
7422	.32	74151	1.25
7426	.35	74154	1.95
7427	.55	74157	1.50
7430	.28	74164	2.20
7437	.60	74165	2.20
7438	.55	74173	2.20
7440	.28	74176	1.95
7441	1.50	74177	1.95
7442	1.50	74192	1.75
7445	1.50	74193	1.75
7446	1.50	74195	1.25
7447	1.50	75451	1.00
7448	1.50	75452	1.00
7450	.28	75491	1.10
7451	.33	8211	1.50
7470	.50	8220	1.50
7472	.50	8520	1.75
7473	.60	8520	1.75
7474	.50	LM 351	1.00

LINEAR CIRCUITS

LM309K 5V 1A regulator	$2.25
536 FET input oper amp	$3.25
537 Precision 741	$2.50
560 phase lock loop	$2.95
561 phase lock loop	$2.95
565 phase lock loop	$2.95
567 Tone decoder	$2.95
703 RF—IF amplifier	$ .80
Dual 709	$ .95
709C operational Amp	$ .47
723 Regulator	$ .75
741 operational Amp	$ .47
747 Dual 741	$1.75
LM 308 oper amp	$1.50
101 oper amp	$ .75
741A oper amp	$ .47
320—5V reg.	$1.75
320—15V reg.	$1.75
748 oper amp	$ .95
LM 300H—Vol. reg.	$1.25
LM370—AGC squelch oper. amp	$1.25
LM 380—2 W audio amp.	$1.75
555—2µS-2hr timer	$1.40
558—dual op. amp.	$ .88
531—hi slew op. amp	$2.96
501—video amp.	$1.25

Similar to 8038C IC Voltage controlled oscillator, as featured in Oct. 73 P.E. they have sine, square and triangular outputs good to IMHz. Two of them can be used to make an FM generator...$9.95

	TRIACS			SCR'S		
PRV	1A	10A	25A	1.5A	6A	35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	.20	2.20
600	1.70	2.30	3.00			3.00

Send 20c for our Spring catalog featuring Transistors and Rectifiers; 325 Elm St., Cambridge, Mass.

SOLID STATE SALES
Post Office Box 74D — Somerville, Mass. 02143 — Tel. (617) 547-4005

NEW! CONVERT TV TO 6 FT. WIDE SCREEN!

Easy Do-It-Yourself Kit
Project a giant **5'x6' picture** onto wall or screen. B&W/Color. Kit contains detailed plans, Inst., and Precision Lens System. Only $12.95 ppd., or write for Free illustrated details.
Guaranteed to Work!
The Macrocoma Co., Dept. FC Washington Crossing, PA 18977

BUILD A "SPACE-AGE" TV CAMERA!!

ONLY KNOWN SOLID-STATE CAMERA IN KIT FORM! Also available factory assembled • Ideal for experimenters, industry, education, etc. • High quality performance backed by over seven years of lab and field testing • Fully Guaranteed • Completely self-contained • Connects to any TV set without modification • Easy-to-follow assembly manual • Model XT-1A, Series D complete with vidicon $149.40 PP anywhere in USA & Canada (less vidicon tube $116.95 pp). Many other kits, parts and plans also available.
PHONE or WRITE for CATALOG...DIAL 402-987-3771
BOX 453-RE ***ATV Research*** DAKOTA CITY, NEBR. 68731

PARTS! CORNELL TUBES!
FREE Send For CORNELL'S New Color Catalog FREE 48 Pgs. New Items
33¢ per tube IN LOTS OF 100
36¢ per tube
ORDER FREE IF NOT SHIPPED IN 24 HOURS!
4215 E UNIVERSITY AVE. SAN DIEGO, CALIF. 92105

F.C.C. EXAM MANUAL


PASS FCC EXAMS! Memorize study— "Tests-Answers" for FCC 1st and 2nd class Radiotelephone licenses. Newly revised multiple-choice questions and diagrams cover all areas tested in FCC exams - plus "Self-Study Ability Test." $9.95 postpaid. Moneyback guarantee.
COMMAND PRODUCTIONS P.O. BOX 26348 — E
RADIO ENGINEERING DIVISION • SAN FRANCISCO, CALIF. 94126

A NEW INSTRUMENT TO USE WITH YOUR SCOPE

MULTITRACER
Use with your present Oscilloscope to trace Resistors, Capacitors, Transformers, Diodes, Transistors, Zeners, Trigistors, most Semiconductors; IC's, etc. • Also shows continuity, in-circuit and go/no-go checks. • Complete with diagrams and instructions. No internal scope connections. • For medium or small production runs or for hobbyist, experimenter, engineer, or ham.
ONLY $19.95—CHECK OR MONEY ORDER
WHY PAY MORE?
BOX 14, LESCO ELECTRONICS, SKOKIE, ILL. 60076

DIGITAL:THEORY,DESIGN, CONSTRUCTION
LOGIC NEWSLETTER ©
SAMPLE COPY $1.00
LOGIC NEWSLETTER
POB 252
WALDWICK, N.J. 07463

Circle 96 on reader service card

READERS QUESTIONS

(continued from page 71)

the breaker trips. Grid drive remains normal at 200V p-p, but the grid voltage goes from -62V dc to -42V dc. All tubes, the flyback, etc. have been changed. No help. Does this with picture tube second anode unhooked, too. Any ideas?—D.B., Bremerton, Wash.

The crystal ball tells me that this must be something related to that change in grid bias on the 40KD6. This drop in bias would let the tube "stay on" too long, thus making the output *rise*, and the current rise with it.

I'd suspect the high-voltage adjust circuitry, which in this set is a grid bias control, with a VDR, fed by a pulse from the flyback. It *should* hold the output and current *down*, but it seems to be working backward. It is supposed to develop a higher *negative* voltage if the output tries to go above normal. However, you're getting a *less negative* voltage on the 40KD6 grid. Check the bias across that VDR, also the pulse height. I don't have the exact figure, but this should develop about a -100 volts at this point.

LOSS OF HEIGHT

The raster on this Zenith portable is only about 2 inches high, and "ripply". Changed the tube, changed a vertical linearity control which was open, and so on. Now everything checks fine but it won't work!—H.M., Gainsville, Fla.

Under the circumstances I'd check the *yoke*. We have had a good deal of assorted yoke troubles lately.

Open the yoke circuit, find the center tap, and check the two halves for *balance*. While the resistance won't tell you too much, it must be the same for each half. Any unbalance is a sign of trouble. Look for signs of arcing, etc.

"JIG SMEAR" IN MONITOR TV

We have a small TV receiver that we're using as a monitor. We've remoted the picture tube from the cabinet, and housed it about 36 inches away. The picture lost detail and seems to have a horizontal smear. Controls are working, but the picture just isn't as crisp as we want. What can we do about this?—S.L., Barrie, Ontario.

This is very apt to be what I have christened "Jigsmear". It is caused by the added shunt capacitance of the extension cables in the video circuits. You see the same thing when operating a color TV chassis on a test jig. It reduces the high-frequency response of the picture tube by shunting these signals to ground, etc.

Possible cure would be to isolate the pix cathode lead from the rest by a couple of inches minimum. **R-E**

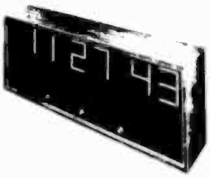
ADVERTISING INDEX

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

READER SERVICE CARD NO.		PAGE
27	ACS, American Circuits and Systems, Inc.	73
	Amperex	69
	Bell & Howell Schools	46-49
9, 10, 17	B & K Division of Dynascan Corp.	16, 32
3	British Industries (BIC VENTURI)	2
79	Brooks Radio & TV Corp.	97
83	Castle TV Tuner Service, Inc.	Cover-IV
88	Center for Technical Development	91
20	Channellock Inc.	68
14	Chemtronics, Inc.	26
16	CIE, Cleveland Institute of Electronics	28-31
84	Continental Speakers Corp.	70
	CREI, Division of the McGraw-Hill Continuing Education Center	18-21
6	Crown International	12
76	Data Precision Corp.	96
11	Delta Products, Inc.	17
30	Digital Concepts	79
24	Dynaco	72
64	Edlie Electronics	82
82	Edmund Scientific Co.	110
80	EICO, Electronic Instrument Co.	98, 99
74	Electronic Distributors, Inc.	86
	EMC, Electronic Measurements Corp.	88
81	Fluke	98
78	Fordham Radio Supply Co.	96
85	GC Electronics	89
7	General Electric Co.	13
75	Grantham School of Electronics	87
	GTE Sylvania Electronic Components	24-25
100	Heath Co.	92-95
	ICS School of Electronics	15
77	Indiana Home Study Institute	96
28	International Components Corp.	78
63	International Crystal Mfg. Co.	81
73	Jensen Tool & Alloy	86
67	Judson Research & Mfg. Co.	84
2	La Salle Extension University	1
26	Leader	73
66	Lectrotech, Inc.	83
4	Mallory Distributor Products Co.	5
13	MITS, Micro-Instrumentation Telemetry Systems, Inc.	23
25	National Camera Co.	73
	National Technical Schools	64-67
	NRI Training	8-11
71	OK Machine & Tool Corp.	85
87	Oneida Electronics Mfg. Co. Inc.	88
68	PAIA Electronics	84
1	PTS Electronics, Inc.	Cover-II
70	Quietrole Co.	85
	RCA Electronic Components Semiconductors	Cover-III
86	Rye Industries	99
15	Senheiser Electronic Corp.	27
69	Schober Organ	84
19	Shure Bros.	53
18	Sony Corp. of America	55
12	Southwest Technical Products	22
23	Sprague Products Corp.	71
	Sylvania Technical Schools Home Study Division	76-79
21	Tab Books	90
29	Tescom, Corp.	79
65	Telematic	83
22	Tri-Star Corp.	70
5	Tuner Service Corp.	7
61	TV Tech Aid	80
62	Vero Electronics	81
72	Vintage Radio	86
8	Winegard	14

(Market Center Advertisers' Index on page 108)

GIANT NIXIE CLOCK KIT



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

☐ Giant Nixie Clock Kit $99.50

TESLA COIL KIT

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

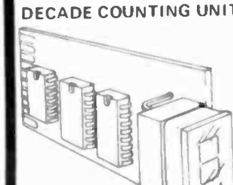
Tesla coils are patterned after the design of Nikola Tesla (1857-1943) an American electrical genius who built versions many feet tall. His dream was to light and power entire cities with energy radiated from such coils – but no luck!

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

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

☐ Tesla Coil Kits $7.50

DECADE COUNTING UNITS WITH READOUTS



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

7490 Basic 10 MHz counter. Used in frequency counters and events.

74196 Same as 7490 except presettable 50 MHz unit. Used where higher speed and/or presettability is required.

74192 Bi-Directional Counter, 32 MHz operation. Has two input lines, one that makes the unit count up, the other down. Uses include timers, where the counter is preset to a number and counts down to zero, monitoring a sequence of events, i.e., keeping track of people in a room by counting up for entries and down for departures.

7475 Adds latch capability. Used in counter so displays continue displaying frequency while new frequency is being counted for uninterrupted display.

7447 Basic decoder module. Drives basic seven segment display which is included for all modules.

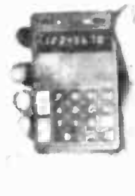
NEWEST DCU!

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

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

☐ 910 K 7490-7447 Counter $9.25
☐ 910 LK 7490-7475-7447 Counter $10.25
☐ 911 LK 74196-7475-7447 Counter $11.25
☐ 912 K 74192-7447 Counter $10.25
☐ 913 K 74192-7475-7447-7485 Universal DCU $15.50

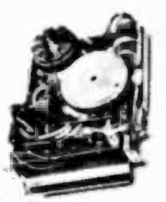
CLOSEOUT – CALCULATOR KIT



B and F was one of the first (if not the first) to introduce an under $100.00 calculator. Now that all the giant corporations have introduced theirs, we feel it's time to move on to new kits and let the "Biggies" slug it out. We have enough parts for about 200 more calculators, which we are closing out at $54.50 each. Floating point eight digit display, constant capability, sealed elastomer keyboard, molded ABS case, uses (4) standard AA cells, 14 hour battery life.

☐ Pocket Calculator Kit $54.50

STEREO TAPE CARTRIDGE PLAYER



High quality tape cartridge player has built in preamps, and requires only 115V 60Hz for motor and 12 volts for electronics to operate, four light indicators indicate channel selected. Output compatible with amplifier "Auxiliary" imputs. Here is the inexpensive high fidelity way to play those tape cartridges for your car player in your home.

☐ Stereo Tape Cartridge Player $15.00

REVERBERATION UNIT & SPEAKER

Useful in conjunction with music synthesizers, organs, and to add "presence" to music. This complete reverberation unit requires only a source of 12 Volts to operate, might also be useful for other acoustic delay experiments. Includes high quality oval ceramic magnet speaker, brand new, originally made to sell for $24.50, now at a price you would pay for the speaker alone.

☐ Reverb Unit $6.95

SLIDE RULE CALCULATOR

Casio Root-8S

New Low Price! Casio Root 8-5 features all four basic functions plus square and square root. Useful for engineering and physics students, now available at low price of regular calculators.

☐ Casio Root 8-5 Calculator .. $75.00

QUARTZ CRYSTAL CHRONOMETER

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

Fits into a standard 2⅝" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e., replacing battery in car). This clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligible power drain. The low price is only possible because of a new one chip MOS clock. Operates from 12-24 Volts D.C. An accessory unit which mounts on the back adapts the unit to 2-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

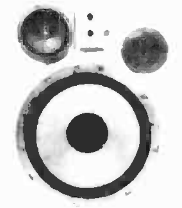
☐ Quartz Chronometer, Kit Form $69.50
☐ Quartz Chronometer, Wired $99.50
☐ 24 Volt Adapter $10.00

NICAD BATTERIES

No need to tell you the uses of these sealed Nickle-Cadmium batteries in all kinds of portable equipment. All brand new except the 0.5 ampere hour, which is removed from new equipment, guaranteed perfect.

Type	Volts	Amps	Price	Size
☐ 1.25NCB0.5	1.25	0.5	.50	1 1/4" diam x 5/8"
☐ 1.25NCB0.6	1.25	0.6	1.00	Lg. AA
☐ 24NCB0.6	24	0.6	11.80	1 1/2" x 1 1/2" x 11"
☐ 8NCB0.6	8	0.6	5.00	5/8" diam x 11"
☐ 18NCB	18	0.5	7.50	3" x 3" x 4"

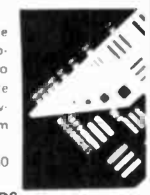
LOUDSPEAKER SYSTEM COMPONENTS



We have made an excellent purchase of an excess inventory of a local manufacturer's speaker systems, although we are not allowed to mention the mfg.'s name, the specs should make it self-evident. The woofer is a 12" free-edge (acoustic suspension) unit, with 2" voice coil and a No. 2 magnet. The mid-range is a 5" sealed back speaker and 3½" flare dome tweeter for best high frequency dispersion. Crossover between woofer & mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided. The level controls provide frequency response to suit room acoustics, with realism that will delight even the most critical listener. Response – 25 to 250K + Hz., Power – 40 watts RMS. Impedance – 8 ohms. Sh. Wt. 12 lbs.

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

RESOLUTION TEST CHART



These 2" x 2" glass plate test charts are excellent for testing enlargers, microscopes, scanners, etc. Original cost to manufacture was over $60.00. Complete plate is covered with test patterns. Several types available may vary slightly from illustration. A rare bargain.

☐ Resolution Test Plate $2.50

COMPUTER GRADE CAPACITORS

We have a large inventory of computer grade caps, difficult to get now because of an aluminum shortage. Priced at a fraction of O.E.M. cost. Here are a few of the most popular types, our catalog contains complete listing, excellent for Hi-Power audio amp supplies.

☐ 15,000 MFD @ 10V .... $ .60
☐ 66,000 MFD @ 6V $1.00
☐ 3,100 MFD @ 75V $1.00
☐ 3,750 MFD @ 75V $1.50
☐ 74,000 MFD @ 10V $1.50
☐ 140,000 MFD @ 6V $2.00

MUSIC SYNTHESIZER PARTS

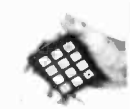
We have obtained some surplus keyboards and other parts from a Mfg. of synthesizers. Received too late to list. Write dept MSP for list.

UNIVERSAL METER KIT

In this kit we give you the one and three quarter inch meter, as picture, with new scales to paste over the present scale to make this a 1, 6, 10, 60 volt voltmeter or similar range milliameter. Also included, are the appropriate resistors to make any of these ranges. Full instructions are included. A few of these would be handy to have for all kinds of construction projects, so save by buying four.

☐ UMK Kit .... $3.00 each
4 for $10.00

TELEPHONE TOUCH-TONE KEYBOARD



Built by General Telephone, this keyboard uses 2 poles and seven busses, for touch-tone keying. Never before at this low price. Size 3" x 2½" x 1".

☐ Telephone KB $4.75

AM/FM RADIO CHASSIS

Quality A.C. powered AM/FM radio. Useful for construction projects. Order now, these usually don't last long.

☐ AM/FM Radio $5.75

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

CATALOG: Check reader's card or write.

POSTAGE EXTRA ON ALL ABOVE ITEMS

CHARGES WELCOME!

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

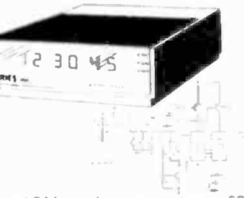
B.&F. ENTERPRISES Mass. 01960
Phone (617) 531-5774
119 Foster Street
Peabody, Mass. 01960

Circle 98 on reader service card

MARKET CENTER

	Alco Electronics Products, Inc.	100
	ATV Research Corp.	104
97	Babylon Electronics	106
	Barta	108
98	B & F Enterprises	107, 109
99	Brigar Electronics	108
	Command Productions	104
	Cornell Electronics	104
95	Delta Electronics	102
91	Digi-Key	100
94	Bill Godbout Electronics	102
	Gregory Electronics Corp.	108
92	International Electronics Unlimited	101
	Lakeside Industries	108
	Lesco Electronics	104
	Logic Newsletter	104
	Macrocoma	104
93	Meshna Electronics, John Jr.	102
	Photolume Corp.	100
96	Polypaks	103, 105
	Solid State Sales	104
	Surplus Center	102
	Valparaiso Technical Institute	108
	Yeats Appliance Dolly Sales Co.	100

NEW LOW COST DIGITAL CLOCK/ALARM/ CALENDAR CLOCK KIT



This is an updated version of our popular low price clock kit. In addition to the former features which were a decorator walnut case, six digit blue-green display, the clock now features 28/30/31 day calendar, 12/24 hour clock and 24 hour alarm, snooze alarm, 50/60 Hz Operation, setting any counter (time, alarm, calendar, and clock radio) is quite easy, since a separate control of the hour and minutes digits has been provided. The setting of any counter does not affect the contents of any other counter

☐ New Clock/Alarm/Calendar Clock Kit. Available Jan., 1974. Send $10.00 deposit to insure early shipment. Will be shipped C.O.D. for balance of $59.50 to make up full purchase price of $69.50.

☐ "OLD" Clock Kit. Uses 5311 Clock Chip does not have Alarm/Calendar features indicates hours, minutes, seconds. Available now $47 50

UNIVERSAL DIGITAL CLOCK – TIMER – STOPWATCH ALARM KIT

This new kit has so many features and applications, we hardly know where to start. To summarize the applications

*The unit can be used as a conventional clock either from internal batteries, or from the AC adapter. Makes an excellent travel clock

*The alarm feature can be set at any time, and will generate a tone with an external speaker

*The unit can be used as a stopwatch, either registering hours, minutes, or seconds, up to 23 59 59, or minutes, seconds, and 1/60 seconds up to 24 minutes, to an accuracy of 1/60 second

*The unit can be used as a timer, to trigger an external device at a preset time.

☐ This unit will be available as a complete kit in Jan 1974. To get one of the first, and take advantage of our lower pre-issue price, send $10.00 deposit, will be sent COD for balance. Total kit price will be $69.50 including pillow speaker as shown. AC power adapter $4.75 additional

☐ Available now, all parts, but no circuit board or detailed instructions $59.50

CLOCK CHIPS – INCLUDES NEW DIGITAL CLOCK/CALENDAR ALARM CHIP

These large scale integrated (LSI) chips eliminate literally thousands of components or hundreds of chips in the construction of a clock. For most applications only a single supply and a minimum of components are required.

☐ 7001 Chip – Features 28/30/31 day calendar, 12/24 hour clock, 24 hour clock, 24 hour alarm, snooze alarm, 6 digit display, direct drive to luminescent anode tubes or LED segments, single transistor interface with Sperry displays. Segment and digital outputs can be "wire or D" to share calculator displays $14 75

☐ MM5314 Chip – Features 6 digit seven segment output, operates from 50 or 60 Hz input, use for Minitrons LED's, Luminescent or Sperry displays $9 75

☐ MM5311 Chip – Same as 5314 but with additional BCD outputs, ceramic pkg $12 50

FUNCTION GENERATOR CHIP, TYPE 4038

This chip gives simultaneous sine, square, sawtooth, and triangular outputs. Great for music synthesizers, or voltage controlled function generators and oscillators.

☐ Function Generator Chip $7 75

LUMINESCENT 7 SEGMENT NUMERIC READOUTS

Bright Blue Green display Tube. Very pleasing to the eye. Tube exhibits fast display speed and easy to read characters of 0.57"H x 0.36"W, with decimal point. Complete with instructions to make a decade counting unit or a 6 Digit Clock. Tubes are manufactured by TungSol, part number 1705

☐ 7SDD-1705 READOUT $1 70
6 for $8.50
10 for $14 00

one of the world's largest manufacturers, has sold us his surplus of multiple digit clusters with one bad digit per cluster. They were for use in the calculator, DVM, and other products. The remaining digits are guaranteed perfect in all respects and are intensity graded (marked on the back with letters A thru F) and matched, so that several strips can be combined and still result in a perfect match. These monolythic GaAsP displays require as little as 7 mW per digit, are highly readable at arm's length, and lend themselves well to hand-held portable applications.

Applications include hand-held calculators, digital thermometers, stopwatches, darkroom timers, DVM's, clocks and watches, or any other product requiring low cost, low power, long lifetime indicators.

The unit is common cathode, set up for multiplexed operation. Two decimal point styles are available; center decimal for PN 7804/05, and right decimal for PN 7814/15, as illustrated. The following configurations are available, where "8" represents a perfect digit, "X" a non-functioning digit:

X8888	7405-1 or 7415-1,	X888	7414-1
8X888	7405-2 or 7415-2,	8X88	7414-2
88X88	7405-3 or 7415-3,	88X8	7414-3
888X8	7405-4 or 7415-4,	888X	7414-4
8888X	7405-5 or 7415-5,	X88X	7556-1

All products are available at the following price rate:

1 – 24 digits ... $1.875/digit
25 – 99 digits ... $1.50/digit
100 – 499 digits ... $1.25/digit

Higher quantity price on request.

For the following applications we recommend the following configurations.

Pocket calculators: 7405-1 & 7405-5, which results in X88888888X, eight consecutive perfect digits @ $1.875 = $15.00.

Recommended Calculator chips:

Nortec 4204 @ $19.75 ($15.00 when ordered with displays). Caltex 5005 @ $9.75 ($7.50 when ordered with displays).

Clocks: 7405-3 & 7556-1, which results in 88X88X88X, six perfect digits at $1.875 = $11.25.

Recommended clock chips:

National MM5314 @ $9.75 ($7.50 ordered with displays). National MM5316 @ $19.75, includes alarm, ($15.00 ordered with displays).

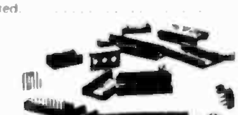
For only hours and minutes, order 7405-3 only.

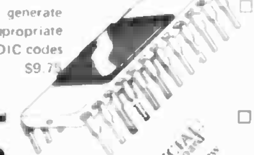
Digital thermometers, DVM's, stopwatches, darkroom timers, frequency counters, etc., order 7415-1 or 7415-5 for four digits ($7.50) or 7414-1 or 7414-4 for three digits ($5.60). Use Solitron CM 4102AE 3½ digit counter decoder @ $19.00, ($15.00 ordered with displays).

Schematics for calculators, clocks and counters using these components free with order.

ALPHANUMERIC DISPLAY

☐ This is a 5x7 (35 Dot) Dot Matrix which will generate alphanumeric characters when used with an appropriate generator such as the 2513. All 64 ASCII or EBDIC codes can be generated $9.75





LAST MINUTE SPECIAL: 1/16 inch copper clad board single side phenolic brand new individual tissue wrap. 8X10 inches... 2 for $1.00; 16X20 inches $2.00

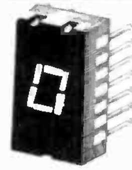
I.C SOCKETS

Mfg by T.I., Cinch, high quality, most gold plated. Use for SSI, MSI, and LSI chips.

☐ 14 Pin Solder Tail	3 for $1 00
☐ 14 Pin Wire Wrap	2 for $1 00
☐ 16 Pin Solder Tail	3 for $1.25
☐ 16 Pin Wire Wrap	2 for $1 25
☐ 24 Pin Solder Tail	2 for $1.25
☐ 28 Pin Solder Tail	2 for $1.50
☐ 40 Pin Solder Tail	$1.00 each
☐ 10 Pin Round for to-5 style	3 for $1.00
☐ 3 Pin Transistor Sockets	10 for $1.00

COSMOS & MISC. CHIPS

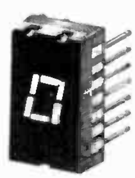
☐ Harris 256 Bit Programable Read only memory	$2 50
☐ 2501 256 Bit RAM	$2 50
4000AE Dual 3 Input NOR & INV	$ .99
4001AE Quad 2 Input NOR.	$ 99
4002AE Dual 4 Input NOR	$ .99
4006AE 18 Stage Shift REG	$4.99
4007AE Dual Comp Pair	$ .99
4009AE Hex Buffer, Inv.	$2.19
4010AE Hex Buffer, NON-Inv.	$2 19
4011AE Quad 2 Input NAND	$ 99



0.3 HEIGHT L.E.D. NUMERIC DISPLAYS

Always a good seller, we are now offering these displays at the lowest price ever. Use for clocks, counters, and other applications. We have previously sold these for as much as $6.75 per digit.

☐ 0.3 inch height red LED $2.25
6 for $12.00



0.3 HEIGHT GREEN L.E.D. NUMERIC DISPLAY

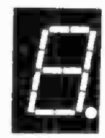
This is the first time we have had green LED's at an economical price.

☐ 0.3 inch height green LED $3.95
6 for $21.00

0.3 HEIGHT YELLOW L.E.D. NUMERIC DISPLAY

Vary your display colors for coding or Variety

☐ 0.3 inch height yellow LED. $3.95
6 for $21.00



GIANT 0.750 INCH HEIGHT RED L.E.D. NUMERIC DISPLAY

This is one of the largest LED Displays made. Used in applications where the displays must be read at greater than average distances, or for commercial and advertising purposes.

☐ 0.750 inch LED Numeric Readout $5.75
6 for $30.00

LOWEST PRICE EVER ON DISCRETE L.E.D. LAMPS

These high quality red LED's are useful for Logic and Computor readouts, as Pilot Lights, or at this low price, they can be grouped together to build your own Giant size Alphanumeric Readouts.

☐ Discrete LED's .... 10 pcs. $1.75
100 pcs. $15.00
1000 pcs. $125.00
5000 and up $ .10 each

GREEN L.E.D. LAMPS

☐ Same as above, but Green .... 3 for $1.00
100 for $30.00 — 10 for $4.00
1000 for $250.00

YELLOW L.E.D. LAMPS

☐ Same as above, but Yellow .... 2 for $1.25
10 for $5.00

RED WITH BUILT-IN RESISTOR

☐ Same, but no resistor required for 5 Volt operation .... 2 for $1.00
10 for $4.00

CALCULATOR CHIPS

☐ Nortec 4204 – Eight Digit, floating point, constant operation single supply operation, very low power consumption $19 75
($15.00 with purchase of 7400 series LED's.)

☐ 5001 – Twelve Digit, fixed decimal point, no constant, may be used for six digit display $9.75
($7.50 with purchase of 7400 series LED's.)

3½ DIGIT COUNTER CHIP

This chip is useful in building dim's DPM's and small counters, provides multiplexed seven segment output for LED displays, Solitron 4012 or Equivalent. $19.00
($15.00 with purchase of 7400 series LED's.)

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

CATALOG: Check reader's card or write.

POSTAGE EXTRA ON ALL ABOVE ITEMS

CHARGES WELCOME!

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

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

Circle 98 on reader service card

NEW

AC & BATTERY POWERED SUBBER™

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

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

A NEW APPROACH to agc system analyzing!

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

- Works with any 40MHz receiver . . . color or black and white . . . solid state, tube or hybrid.
- High level, low impedance output furnishes signal usable at input of final i.f. stage.
- Special output circuit works equally well into first I.f. input of late model, link coupled systems and older, low "C" bandpass coupled systems.
- Antenna input and i.f. output electrically isolated; no "hot" chassis hazards.
- No need to disconnect supply leads from suspected tuner being tested. Substitutes the VHF tuner and tests the UHF tuner.
- Tunes all 12 VHF channels, has preset (memory) fine tuning on all channels.
- Higher overall gain than previous models with wide range gain reduction control of 60db.
- Completely self contained and battery operated, uses popular batteries available everywhere. Simple battery replacement; battery compartment in rear of custom molded case.
- Reduced current consumption extends battery life to as much as double that of previous models. Bright LED indicator warns when unit is ON.
- Use on the bench or in the home . . . anywhere.
- Comes complete with extension cables, batteries and instructions.

Specifications

Inputs:	300 ohms balanced VHF antenna terminals, electrically isolated. 75 ohms 40 MHz amplifier (Ch. #1) RCA phono jack.
Sensitivity:	30 microvolts. Input signal handling capability; over 100,000 microvolts.
Output:	40 MHz TV i.f.: bandwidth 6 MHz. "Mastermatchcoupler" output circuit with matched cable to furnish usable signal for all input circuits. Termination is RCA phono jack, electrically isolated.
Tuning Range:	All 12 VHF TV channels, plus Ch. #1 40 MHz amplifier position for testing UHF tuners. High stability of 40 MHz amplifier permits two Mk.IV Subbers to be cascaded for high level 40 MHz output signal from any VHF channel.
Tuning:	Preset (memory) fine tuning.
Gain Control:	Gain reduction 60 dB.
Power supply:	18 volts. Uses two 9v transistor batteries.
Size & Weight:	6.5"x 6.5"x 3.25" exclusive of control knobs and handle. 1.5lbs complete with batteries.
Accessories:	"Mastermatchcoupler" output cable with RCA phono jack termination. "Mastermatchcoupler" output cable with alligator clip terminations. UHF tuner test cable.

Contact your distributor.

TV TUNER SUBBER™ Mark IV *(Battery model)* ***net $45.95***

TV TUNER SUBBER™ Mark IV-A *(120 VAC + Battery model)* ***net $54.95***

All battery only models of the SUBBER may be factory modified for 120VAC use. Contact your distributor for details and cost.

CASTLE TV TUNER SERVICE, INC.

5715 N. Western Ave., Chicago, Illinois 60645 • Phone: (312) — 561-6354

In Canada: Len Finkler Co., Ontario

Circle 83 on reader service card