MINICOMPUTERS What They Are and What They Can Do

Four-Channel Sound What, How and When

Legal Booby Traps in Tape Recording

JOBS FOR LASERS

BUILD:
- Preamp for 2 or 4 Channels
- An Alarm System for your Car
- Transistor Curve Tracer

TEST REPORTS:
- Audiotex 30-5104 Speaker
- Telex Communication
- Leader Field Strength
- Triplett 990 VOM Multiplier
- Mura Temperature Probe
Kit for kit, text for text, dollar for dollar, your best home training buy is NRI

NRI “hands on” method gives you as much as 2 years of on-the-job experience. Pick your field and enroll now!

After over 55 years of training men for Electronics in their homes, NRI knows that theory alone is not enough. That’s why NRI concentrates so heavily in the development of special training equipment. Your hands must be trained as well as your head, and NRI gives you both kinds of training in a manner no other school can match.

You get your hands on professional parts and demonstrate theory you read in NRI’s unique “bite-size” texts. You build designed-for-learning Electronic circuits and complete, operating equipment. You use what you build to prove out what you read. Electronics comes alive in the most valuable, practical manner. You experiment with the same kinds of solid-state and transistorized and tube circuits you’ll find on the job—not hardware or breadboard hobby kits.

NRI prepares you for your choice of careers in Color TV Servicing, Communications, Industrial Electronics and the growing field of Computer Electronics. Many NRI graduates start earning $5 to $7 an hour extra soon after they enroll, fixing home Electronic equipment for friends and neighbors in spare time. NRI’s remarkable teaching method simplifies, organizes, dramatizes subject matter so that any ambitious man, regardless of his education, can effectively learn and profit from the Electronics course of his choice—and NRI gives you 15 training plans to choose from.

Over three-quarters of a million men have enrolled with NRI since 1914. Proof of the value and experience you get when you choose NRI for your Electronics training... proof of why NRI continues to be the country’s largest Electronics home-study school. Discover for yourself how easy it is to move into Electronics and move up in a rewarding career. Mail the postage-free card for the new NRI Catalog. There is no obligation. No salesman will call on you because NRI does not employ salesmen. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

If postage-free card is missing, write to:
NATIONAL RADIO INSTITUTE
Washington, D.C. 20016

GET FACTS ABOUT GI BILL
If you have served since January 31, 1955, or are in service now, check GI line on postage-free card.
...first and only school to include training equipment designed from chassis up for your education

Earn $5 to $7 an hour spare or full time in COLOR TV SERVICING
It's easy to learn as you build, stage-by-stage, the only custom designed Color TV receiver engineered specifically for training purposes. You grasp a professional understanding of all color circuits through logical demonstrations never before presented. The end product is a superb Color TV set that will give you and your family years of viewing pleasure. NRI gives you the option of selecting either Color or black-and-white training equipment.

There's glamour, success awaiting Technicians in COMMUNICATIONS
NRI gives you the experience you need to qualify for jobs in TV broadcasting stations, or operating and servicing mobile, marine, aviation communications equipment. You build and use a solid-state voltmeter; perform experiments on transmission lines and antenna systems, even build your own 25-watt, phone-cw amateur transmitter band. In all NRI Communications courses, you must pass your FCC exams—or you get your money back.

Fill technical jobs without a degree in INDUSTRIAL ELECTRONICS
NRI's Electronics Technology course gives you completely specialized training kits engineered for business, industrial and military Electronics fields. On completing this training, competent technical ability can be instantly demonstrated by you. As you learn, you actually build and use your own training center in solid-state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, even the latest integrated circuits are included in your home training program.

Prepare quickly for a high pay career in COMPUTER ELECTRONICS
This may well be the most unique and exciting educational aid ever developed for home training—a digital computer with memory you build and use to learn organization, trouble shooting, operation and programming. It performs the same functions as commercial computers you encounter on the job. Lessons stress computer repair. You perform a hundred experiments, build hundreds of circuits. Your own solid-state voltmeter is included among the ten training kits you receive.

OVER 50 YEARS OF LEADERSHIP IN ELECTRONICS TRAINING
JUNE 1972
FEATURE ARTICLES

12 LEGAL BOOBY TRAPS IN TAPE RECORDING Marshall Lincoln
The tape recorder is a handy device, but there are times when you are not allowed to use it.

26 FOUR-CHANNEL SOUND William Cowfield
What is quadraphonic sound? How is it produced? When can you expect to hear it for yourself?

32 MINICOMPUTERS—WHAT THEY ARE AND WHAT THEY CAN DO David L. Heiserman
Applications for these increasingly popular instruments

35 COLOR TV PROJECTION SYSTEM

40 NEW THERMAL VIEWER HAS CIVILIAN USES A detector array of lead selenide provides an image which can be seen on a phosphor screen.

46 KODAK ENTERS VIDEO RECORDER/PLAYER MARKET

47 JOBS FOR LASERS John R. Collins
A roundup of applications for various types.

64 SINGLE SIDEBAND FOR THE CB'ER John T. Frye
How SSB can help the CB'er as it did the ham.

THE SCENES

68 COMMUNICATIONS SCENE Richard Humphrey
Harbor police: communications afloat.

84 TEST EQUIPMENT SCENE Leslie Solomon
Digital instruments: what, why and who.

97 SURPLUS SCENE Alexander W. Burawa
The small-parts market
CONSTRUCTION STORIES

41 BUILD A VERSATILE SEMICONDUCTOR CURVE TRACER John Keith
Indispensable for checking or matching devices.

51 VEHICLE ALARM SYSTEM Frank J. DiElsi
Uses no key and is easy to install.

58 BUILD A DISTORTIONLESS PREAMPLIFIER James Bongioino
Perfect component for four-channel sound.

83 TV SIGNAL SPLITTER C. R. Lewart
When you use more than one set.

PRODUCT TEST REPORTS

76 TELEX MODEL CS-7 COMMUNICATIONS HEADPHONES
77 AUDIOTEX MODEL 30-5104 SPEAKER SYSTEM
78 TRIPLETT MODEL 990 MAINTENANCE IN A CASE
80 LEADER INSTRUMENTS TV FIELD STRENGTH METER
81 MURA THERMY TEMPERATURE PROBE
82 KURZ-KASCH AUTO-PROBE

DEPARTMENTS

6 EDITORIAL Milton S. Snitzer
Engineering enrollments down sharply

8 LETTERS

23 NEWS HIGHLIGHTS

88 NEW LITERATURE

89 ELECTRONICS LIBRARY

94 NEW PRODUCTS

READER SERVICE CARD ON BACK COVER
ENGINEERING ENROLLMENTS DOWN SHARPLY

Because of a substantial dropoff in enrollments last fall, there are 26,000 fewer engineering students now than there were a year ago. This figure is from a study just completed by the Engineering Manpower Commission of the Engineers Joint Council. The survey covered almost 300 institutions offering bachelor's or higher degrees in the various engineering fields.

The decline hit all levels from beginning freshmen to doctoral candidates. Half the total drop occurred in the freshman class, which was 18 percent smaller in 1971 than in 1970, and 25 percent smaller than in 1967. The sophomore class was also hit, with a decrease of 10 percent. Junior and senior enrollments were lower by about 2 percent.

The reason for the dropoff is obvious. Primarily it is due to a fear of not being able to get a job when the training is completed. There have been a large number of layoffs in the engineering field so that it is no longer as glamorous as it used to be.

With all the talk these days about conserving our natural resources, it seems to us that the figures given above indicate a serious loss to all of us—a loss in technical manpower. Some will say that the overall effect is a good one since now only those who are seriously interested in engineering will be the ones to choose this as their profession. No longer will students go into engineering simply because it is the thing to do.

Despite the reduced levels of engineering recruiting and hiring in 1970 and 1971, new engineers generally fared better than graduates in most other disciplines, according to Dr. Robert J. Raudebaugh, President of Engineers Joint Council. Also, long-range projections by the U.S. Department of Labor continue to show a need for large numbers of engineers in the next decade.

We seem to be perpetually on a swinging pendulum of supply and demand. In the last year or two, the supply in certain areas has exceeded the demand, but now we see signs of an equalization. Perhaps in the near future the demand will again exceed the supply. The difference in the rates is what really hurts one side or the other.

In any case, it is safe to predict that the supply of engineers will start to drop while the demand in new areas for them increases. We seem to be more and more a country that is service-oriented as well as product-oriented. This bodes well for technical people who will be required to serve these areas.
Put More “GO POWER” into Your Electronics Career —

**MOVE AHEAD**

from TECHNICIAN to

**ASSOCIATE ENGINEER**

by studying at home with

GRANTHAM SCHOOL OF ENGINEERING

“the college that comes to you”

The GRANTHAM educational program in ELECTRONICS ENGINEERING is designed to upgrade electronics technicians to the engineering level, mostly by home study.

While you continue your present employment, you can really learn electronics engineering and earn an ACCREDITED DEGREE.

GRANTHAM's strong-foundation correspondence program in electronics engineering leads to non-obsolescent skills — to skills based on reasoning — and leads to the DEGREE of Associate in Science in Electronics Engineering (the ASEE Degree). Completion of this program will prepare you for positions normally filled by college-graduate engineers, and for many other electronics careers open to men with the proper training.

This accredited degree program for experienced technicians consists of four correspondence courses of 100 lessons each — an overall total of 400 lessons — followed by a two-week graduation seminar held at the School. Upon completion of the four correspondence courses, you are awarded a diploma in Electronics Engineering. Then, upon completion of the two-week graduation seminar, you are awarded the ASEE Degree.

**What's in Your Future— The Same Old Job, or Success in Electronics?**

Where will you be five years from today? Are you headed for real advancement in electronics, or in a rut? The experience you have is valuable; it gives you a head start toward a better future. But to get ahead and stay ahead, experience must be supplemented with more education in electronics and such allied subjects as mathematics, physics, computers, and engineering design.

**Accreditation and G.I. Bill Approval**

Grantham School of Engineering is accredited by the Accrediting Commission of the National Home Study, is approved under the G.I. Bill, and is authorized under the laws of the State of California to grant academic degrees.

For complete details, mail postcard or coupon.

**Grantham School of Engineering**

1505 N. Western Ave., Hollywood, Calif. 90027

Telephone: (213) 469-7878

Please send me your free Bulletin which explains how the Grantham educational program can prepare me for a degree in electronics.

[ ] I am a beginner in electronics.
[ ] I have a little experience with electronic equipment.
[ ] I am an experienced electronics technician.

Name ____________________________________________

Address __________________________________________

City __________ State ______ Zip __________
Test new circuit ideas... I.C. circuits... discreet components... at no risk! Money back guarantee!

$17.25

All you need are #4 mounting screws... just plug-in components... like 14 watt resistors, ceramic capacitors, diodes, I.C.s, transistors and more... and your circuit's built! No special patch cords needed! Components interconnected with any solid No. 22-26 gauge wire.

And you can try it with absolutely no risk for 5 days. If not satisfied, just return your EL Socket and receive a full refund. Trying is believing. How can you go wrong? Order your EL Socket now!

- Nickel/silver plated terminals — very low contact resistance
- Low insertion force
- Mounts with #4 screws
- Initial contact characteristics beyond 10,000 insertions
- Vertical, horizontal interconnecting matrices
- Accommodates wide range of wire and component leads from .015"-.032"

Send check or M.O. today!

EL INSTRUMENTS, INC
61 First St., Derby, Conn. 06418
Telephone: 203/735-8774

CIRCLE NO. 18 ON READER SERVICE CARD

OUR ETCHING AND DRILLING GUIDES

I don't know why you run etching and drilling guides with the construction projects you publish. I don't think anyone really uses them. Since you usually give sources for the printed circuit boards in your construction articles, why bother with the guides?

Marvin Jones
Topeka, Kan.

We would like to hear from readers as to how many of you use the etching and drilling guides we print and what your feelings are on the use of such patterns in our projects.

HOSPITAL SAFETY COMMENTS

CHALLENGED

For a short article on hospital electrical equipment, "Medical Electronic Equipment And Hospital Safety" (Jan. 1972) was quite good. However, a definition of leakage current would have been helpful to readers. Many people still do not understand that leakage current is still current and must obey Ohm's law.

My second comment concerns the last two paragraphs in the article. I don't know where you got your information or which hospital you visited, but the situation is nowhere near what you describe. Most hospitals have few, if any, technical personnel on their staffs. They provide only rudimentary in-service education on medical electronics and its proper use. I suppose you conclude optimistically to give the reader some sense of security. I would only say that we are far from the blissful picture you paint.

Burton R. Klein
Director, Medical Electronics Dept.
Tufts-New England Medical Center
Boston, Mass.

Forgive an overexuberant editor who was responsible for the last two paragraphs. However, while our picture may have been a bit too blissful, the picture you paint appears a bit too dark.

THEY DON'T MAKE 'EM LIKE THEY USE TO

Recently, while cleaning out my basement, I came across an old Gilfillan radio of 1934...
vintage. Of course, I had to plug it in to see if it still worked. Its performance was magnificent! At night, with only a couple of feet of wire, it pulled in BCB from all over the country—spaced only 10 kHz apart no less. Its 175-kHz i-f apparently was responsible for the receiver's excellent selectivity, and the tuned circuit ahead of the converter stage kept image response to a minimum.

This leaves one obvious question: Why don't the radio manufacturers build receivers like this nowadays? With the exception of the expensive German-made all-band receivers, there is apparently no AM radio offered with the performance of my 1938 Gilfillan. Answer please?

MONTY BANCROFT
Sun Valley, Calif.

That's a question you will have to ask the manufacturers. Right now, they are sinking all their efforts into the FM medium which traditionally is less prone to interference and offers better fidelity as a result of its wider bandwidth.

THE NOSTALGIA CORNER

Your new Surplus Scene column reawakens memories of my first visits to the New York surplus scene back in 1947. I recall that, by category, Canal Street was "junky," but it was well worth a visit to prowl around ceiling-high stacks of BC-375's and dynamotors. One great find was the control box for the C-1 autopilot, encrusted with switches, pots, and jeweled pilot lights. Cortland Street and environs (Radio Row to the initiate) was much more sophisticated with such nearby surplus titans as C&G, Leotone, TAB, North Radio, Eddie, Newark, and others—all now vanished into oblivion to make way for the World Trade Center towers. Their display windows, containing neatly labeled signs, were enough to tempt any electronics enthusiast as well as to accomplish instant bankruptcy.

Now, that unique area is vanished. I still get Eddie catalogs, but from the sterile isolation of distant Levittown on Long Island. If there are still any of the "old gang" around, I would like to know about them.

FREDERICK W. CHESSON
Waterbury, Conn.

CLEARANCE SALE

I am offering for sale a complete set of Popular Electronics from 1954 through 1971 for $110. Every issue is in mint condition, all have covers, and none has torn pages. At $110 postpaid, that comes to less than 50c per issue.

JOSEPH WEGNER, JR.
P.O. Box 362
Glendale, CA 91209

Interested readers please write directly to Mr. Wegner.

The Kleen Machine.

Records and dust.

If you enjoy one, must you suffer the other?
Not with the new Bib Groov-Kleen.
Groov-Kleen is the most effective method yet devised for removing the dust and dirt that accumulate on record surfaces.
Simple to use and install, Groov-Kleen reduces record and stylus wear and improves reproduction without the use of any groove fouling liquids.
Handsome in crafted in chrome and aluminum with black accents, Groov-Kleen has a built-in arm rest and an adjustable counterweight to reduce drag and minimize speed variations.
Available directly or from your nearest dealer.
Only $7.50.
The MOD-KIT series kits described were designed for both the beginning and advanced hobbyist. The building block approach allows each module to be used again and again in many different applications. MOD-KITS are easy to assemble, electrically compatible as a group, and contain the features most often needed by the experimenter.

Connectors are provided so that you never need to solder input/output wiring to the PC boards. Sockets are included for the integrated circuits and display to prevent accidental soldering damage. The simplified construction information, "hidden" added features, and industrial grade components all contribute to the wide acceptance and popularity enjoyed by the MOD-KIT series.

We have invested a large amount of time and money to the production of each kit for a very selfish reason: we want you to buy another one.

Crystal Frequency Standard

This versatile frequency standard kit has a buffered master crystal oscillator and 9 simultaneous output frequencies which span 0.1 Hz to 10 MHz. All retain the ±0.025% stability of the oscillator. Oscillator has zero-beat control and requires a 5 V supply. Outputs are TTL compatible. Module measures 2" x 3.5". G-10 board. Crystal included.

CRO-1D .............................................. $21.95

Digital Power Supply

A virtually indestructable power supply for TTL, RTL, and DTL logic. Output variable from 3.3 to 5 V at 2.2 amps. Basic 6 amp regulator "loafs" at rated output. Automatic short circuit and overload protection. Monolithic regulator has 1% regulation and 10 mV ripple. Requires only a transformer. All components shown included. G-10 board is 3" x 3.5".

DPS-2A ............................................... $10.95
TR-500 ................................ Transformer 5.95

BCD Display Counter

World's smallest 5 decade counter/display. Counts to 1,000,000 with LED display. Requires only 5 V and any number may be cascaded. Teaches BCD counting and display. Bought by experimenters and schools throughout U.S. Measures only 2" x 3.5" x 0.5" high. Modern TTL circuitry and 100 year life LED displays.

MOD-1 ................................................. $18.95
LED Counter/Display Modules
These subminiature counter display modules have a decade counter, latch, 7-segment decoder and LED display. All functions brought out to contact fingers which fit standard 18 pin PC connector. PC board measures 1.25" x 3". Modules mount on 0.5" ctrs. and any number may be cascaded. 5 V operation.

LR-110 ........ 20 MHz .................. $15.95
LR-110H ....... 70 MHz .................. 16.95
LR-110UD ...... Up/Down ................ 18.95

PCC-18 ......... connector ............... .95

Counter/Display Driver Modules
The NR-3 series universal decade counter/display drivers are compatible with nearly all 7-segment displays which require up to 15 V and 40 mA per segment. Modules are 1" x 3.5". Units may be cascaded. G-10 boards supplied with sockets for "Numitron" displays. Other models available, see 1972 catalog. Supplied less display.

NR-3 ........... 20 MHz .................. $ 8.95
NR-311 .......... 70 MHz .................. 9.95
NR-3UD ......... Up/Down ................ 10.95

Analog Power Supply
This analog supply will power even complex op-amp circuits. Tracking dual-polarity outputs are continuously variable from 0 to ± 15 V. Built-in current limiting may set at 25 to 200 mA per output. Regulation is better than 0.1% and ripple less than 3 mV. Components conservatively rated for long life. Requires only a transformer.

APS-5A .......... $13.95
TR-200 .......... Transformer .............. 2.95

Write for Free 1972 Catalog
Linear & Digital IC's
State-of-the-art LSI chips
Memory devices
Connectors & Switches
Diodes & Transistors
Light emitting diodes
Liquid crystal displays

Environmental Products
BOX 406 Lafayette, IN 47902 Ph: 317-743-1893
CIRCLE NO. 19 ON READER SERVICE CARD

JUNE 1972
Legal Booby Traps in Tape Recording

BY MARSHALL LINCOLN

THE tape recorder has given the world a handy, portable, and accurate secretarial service for both business and pleasure. Its versatility and usefulness, however, have given rise to a number of legal and ethical questions which ultimately influence how, where, and when it can be used.

Questions facing tape recorder owners include such gems as: May we use our recordings for anything we wish without limitations? To what other electronic equipment may we connect our recorders without causing the law to look upon us? Are there any special limitations placed on private citizens in the manner in which we use our recorders (limitations which do not apply to certain privileged groups)?

For those of us who own them, tape recorders have become part of our everyday lives; so, it is easy to overlook the fact that their use can create legal pitfalls. Some of these pitfalls may seem trivial at times, but it is good policy for each of us to be aware of circumstances which can bring the unwary under the scrutiny of the law.

Recording Phone Conversations. Let us take the case of a tape recorder being used as an “automatic notebook” for taking accurate notes of lectures, interviews, business calls, etc. When you are talking face to face with someone and openly using a tape recorder, there can be little doubt that the conversation is being taped. But in the absence of face-to-face confrontation, as in the case of a telephone conversation, are you free to record? Many tape recorder owners will be shocked to learn that they are not free to arbitrarily record telephone conversations.

The Federal Communications Commission’s rules state that you cannot record phone conversations without prior arrangement with the telephone company! Another little known fact that may add to your astonishment is that the ruling does not apply to radio and TV broadcasters who are permitted to ignore the rule which applies to everyone else. This startling contradictory situation has its roots in a series of meetings held a few years ago between the Bell Telephone System and FCC officials. The meetings resulted in the drawing up of FCC Public Notice 60591, FCC Docket 6787, AT&T Tariff 263, and later, FCC Docket 18601. They state that a private citizen may record his own telephone calls only if his phone is connected to his recorder via a “coupling arrangement” containing a beeper rented from and installed by none other than Ma Bell. (The beeper generates an audio tone every 15 seconds or so to alert anyone on the line to the fact that the conversation is being taped.) In return for satisfying this requirement, you must (of course) pay the company a monthly service charge for use of the coupling arrangement.

A much simpler and superior way to record phone conversations is with an inductive coupler or telephone pickup coil, a low-cost item which can be purchased from any radio or tape recorder dealer. Inductive pickups have the advantage that they do not create interference on the telephone line since no physical connection is made to the phone wires. But when telephone recording methods were being considered by the FCC, Bell Telephone was categorically opposed to inductive pick-ups (which they could not control) while the FCC had no objections to their use.

The FCC pointed out that inductive couplers would eliminate any need for recorder salesmen to make special arrangements with the phone company whenever they
MORE OF A JOB, MORE TRAINING: The Navy can guarantee you your job (there’s over 70 to choose from) or the Navy can guarantee you get to a school where you’ll learn one.

MORE CHOICE—NEW 3 YEAR ENLISTMENT: You can come in for 6 years or 4 years or now, 3 years.

MORE GUARANTEES: You can be guaranteed East or West Coast and choice of sea duty or airman recruit work.

MORE TRAVEL: See Africa. See Europe. See Japan. Join the Navy and see the world. (It’s still true.)

MORE BREAD: New guys now earn $288 a month. (Congress gave us a raise.)

MORE HAIR: You can wear a beard (nicely trimmed) if you want to. It’s a Naval tradition; it’s also a brand new Navy.

MORE FREEBIES: Besides free travel and free education and that $288 a month, you get free food and free clothing and free housing and free health care and 30 paid vacation days per year.

TO GET A LITTLE MORE:

1. CALL THIS NUMBER:
   800-424-8880
   It’s toll free and a real, live Navy recruiter will answer all your questions 24 hours a day, seven days a week. (In Washington, D.C., call: 433-2000.)

2. OR SEE YOUR NAVY MAN.

3. OR SEND IN THIS COUPON.

   Send To: Captain Donald E. Oglevee
   Building 157, Fourth Floor,
   Washington Navy Yard,
   Washington, D.C. 20390

   I want to know more about:
   □ Training and Education
   □ Travel and Adventure
   □ Increased Pay
   □ How I can enlist now, but not report for duty for six months
   □ I don’t want to wait. Call me now!
   My phone No. (________________.)

   NAME________________AGE____
   ADDRESS________________________
   CITY_________STATE____ZIP____
Johnson put it all together.

- low band and high band channels in any combination
- base and mobile operation with built-in power supply
- auto-scan with push-button "lock out" plus manual "lock in"

**new Duo-Scan™**

$169.95

Eight VHF FM channels, in any combination of high and/or low band, keep you on top of all the action. Operates mobile or base with performance features previously found only in professional public safety radio equipment. Two ceramic filters give unsurpassed adjacent channel rejection. Integrated circuit symmetrical limiting makes it really quiet. 0.4 µV sensitivity lets you hear what others miss. Powerful transistor audio produces clear, undistorted sound. The new Duo-Scan puts it all together, for just $169.95 (less crystals).

**E.F. JOHNSON COMPANY**

**WAASECA, MINNESOTA 56093**

CIRCLE NO. 24 ON READER SERVICE CARD

wished to demonstrate their equipment. The telephone company took the position that the opposition to the inductive pick-up was based on the fact that it wanted to insure the privacy of its customers' calls. It insisted that some sort of signal must be put on the line to warn everyone that the call was being taped and made the claim that an inductive pick-up could not be used to do this (in fact, it can). The FCC finally yielded to the phone company's arguments.

The record of the FCC proceedings shows no trace of any consideration being given to a simple requirement that a person making a recording must tell the party on the line that he is taping for purposes of accuracy or other legitimate reason.

More discrimination was on the way. In a later ruling, the FCC agreed to allow broadcasting stations, but no one else, to dispense with beepers. Broadcasters merely have to state that the call may be recorded or broadcast. At times, they do not even have to do that.

There is another wrinkle to Ma Bell's story: Beeper are not used on those recorders she rents to her customers. These recorders automatically answer business calls during hours when an office is closed, recording messages from the caller. The phone company contends that no beepers are needed because its "tariffs" specify them only for recording two-way telephone conversations. Actually, the FCC rule applies to all parties (with the broadcaster exception).

Once upon a time, broadcasters were required to use beepers because they were not permitted to connect their telephones to their transmitters. When FCC rules were amended to permit broadcasters to connect regular phone calls into their transmitters (a fringe benefit of the Carterfone Case of a few years ago), it meant that stations might not actually record calls before broadcasting them. So, they did not use a beeper because the rule specifically applied to recordings made from telephone lines.

The new FCC rule on this matter states that broadcasters may either record for broadcast or to directly broadcast telephone conversations with the only warning being a simple announcement at the beginning that the conversation may be taped or broadcast. In some cases, such as when the caller dials an "open-mike" number, the broadcasters are not even required to make the announcement. The FCC reasons that
In 1968 almost every stereo enthusiast knew:

1. You couldn't reproduce bass notes through small speakers.
2. All the sound should come from the front of the speaker and none should be directed rearward toward the wall.
3. A speaker should never have associated electronics such as an active equalizer.
4. All good speakers should have crossovers, woofers and tweeters.
5. All speakers should be designed to give flat frequency response on axis.

By 1972 almost every stereo enthusiast has heard the BOSE 901.

A speaker which violates every one of the concepts above. Born out of 12 years of university research,* the 901 has become the most highly reviewed speaker, regardless of size or price.

Today we have a theoretical basis that explains why these concepts limit the performance of conventional speakers. But no theory can tell you how much better a new design will sound. To appreciate this, ask your dealer for an A-B comparison of the BOSE 901 with the largest and most expensive speakers he carries.

*For those interested in the 12 years of research that led to the design of the 901, copies of the Audio Engineering Society paper "ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS," by Dr. A. G. Bose, are available from BOSE Corporation for fifty cents.

You can hear the difference now.

BOSE
Natick, Mass. 01760
it may be assumed the public will know
their voices may be recorded or broadcast
because they dialed the number.

This convenience has been a great boon
to broadcasters since they can dispense with
the beep tone which they may consider an-
noying on the air. However, the FCC has
not allowed individual citizens the same
convenience of simply stating at the start
of a call that it will be taped for their own
use.

Recording from a Receiver. You can
record anything you wish from a radio
or TV receiver tuned to any frequency
in the spectrum without first having to
obtain permission from anyone. However,
the nature of the transmission taped de-
termines how you may use your recordings.
Any radio or TV public information or
entertainment broadcast is public domain
and can be recorded and played back
for anyone who wishes to hear it. But
if you record from a commercial channel
(police, fire, aircraft, mobile telephone,
etc.), you are forbidden under the FCC's
"Secrecy of Communications" regulation
from playing the recording for anyone
else. Furthermore, you are enjoined from
even repeating the contents of any trans-
mission heard.

Recording Live Performances. At live
performances—especially concerts given by
well-known performers—you can run into
a whole series of prohibitions designed to
prevent you from using your recorder. For
one thing, musical and vocal performers
nowadays are plagued by bootleg record
companies which secretly tape perfor-
manences and sell record copies to an
unsuspecting public. The performers, need-
less to say, receive no compensation what-
ever from the bootleggers. (Some shady
bootleggers get in as members of the
audience with a small battery-powered
recorder hidden on their persons. They use
the recorders to make their "master tapes."
The quality of the recordings possible from
these small tape recorders may not be first
class, but it is passable for hard rock and
other loud music. Too, if the buyer has
never heard a live performance by a given
performer or group, he has no real way of
determining whether or not the selection
was bootlegged.)

The hard-nosed attitudes of performers'
agents and theater managers toward any-
one they see carrying a tape recorder into
a live performance is understandable.
They are protecting their interests and the
interests of the performers. Hard to
understand, however, are the union rules
which forbid any recordings to be made
unless a whole gang of union electricians
is on hand (always assuming, of course,
that you have received permission to make
recordings). These rules are in union con-
tracts; so, there is nothing a theater
manager can do about the situation.

When you plan to take a recorder to a
live performance, remember that you are
treading on dangerous ground. If you are
cought with a recorder at a performance,
chances are good that you will be hustled
out the nearest exit. It would be better
(and safer) to check with the theater
manager before walking in with a tape
recorder. If you are convincing in the
telling of why you want the recording,
there is always the remote possibility that
permission will be granted—but don't
count on it.

OLYMPICS COMMUNICATIONS

Almost 300 meters high, this tower
at Munich Olympics grounds will serve
as a symbol of the Games as well as
a radio and TV link to the rest of
the world. Siemens is providing many
new communications lines including a
relay to the satellite earth station.
for AM for FM for TV for CATV

...the 54 series from Telequipment

10 mV/cm DEFLECTION FACTOR
200 ns/cm SWEEP RATE
VERSATILE TRIGGERING

On your bench, in the field, or built into your system, if you require a 10-MHz oscilloscope, look no further. One of the 54 Series from Telequipment is designed to meet your needs.

Telequipment products are marketed and supported in the U.S. through the TEKTRONIX network of 56 Field Offices and 32 Service Centers. The instruments are warranted against defective parts and workmanship for one year. For a demonstration or more information, call your nearby Tektronix Field Engineer or use the coupon below.

U.S. Sales Prices FOB Beaverton, Oregon

JUNE 1972
10 Reasons why RCA Home Training is your best investment for a rewarding career in electronics:

Performing transistor experiments on programmed breadboard — using oscilloscope
LEADER IN ELECTRONICS TRAINING

When you think of electronics, you immediately think of RCA...a name that stands for dependability, integrity, and pioneering scientific advances. For over half a century, RCA Institutes, Inc., a subsidiary of RCA, has been a leader in technical training.

2 RCA AUTOTEXT TEACHES ELECTRONICS FASTER, EASIER, ALMOST AUTOMATICALLY

Beginner or refresher, AUTOTEXT, RCA Institutes' own method of programmed Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

3 WELL PAID JOBS ARE OPEN TO MEN SKILLED IN ELECTRONICS

RCA Institutes is doing something positive to help men with an interest in electronics to qualify for rewarding jobs in this fascinating field. There are challenging new fields that need electronics technicians...new careers such as computers, automation, television, space electronics where the work is interesting and earnings are greater.

4 WIDE CHOICE OF CAREER PROGRAMS

Start today on the electronics career of your choice. On the attached card is a list of "Career Programs", each of which starts with the amazing AUTOTEXT method of programmed instruction. Look the list over, pick the one best suited to you and check it off on the card.

5 SPECIALIZED ADVANCED TRAINING

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

6 PERSONAL SUPERVISION THROUGHOUT

All during your program of home study, your training is supervised by RCA Institutes experts who become personally involved in your efforts and help you over any "rough spots" that may develop.

7 HANDS-ON TRAINING

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in many programs. Each kit is complete in itself. You never have to take apart one piece to build another. They're yours to keep and use on the job.

8 FCC LICENSE TRAINING—MONEY BACK AGREEMENT

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

9 CONVENIENT PAYMENT PLANS

You get a selection of low-cost tuition plans. And, we are an eligible institution under the Federally Insured Student Loan Program.

10 RCA INSTITUTES IS FULLY ACCREDITED

RCA Institutes is an accredited member of the National Home Study Council. Licensed by N.Y. State—courses of study and instructional facilities are approved by the State Education Department.

VETERANS: TRAIN UNDER NEW GI BILL

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

If reply card is detached, send this coupon today.

RCA INSTITUTES, INC.
DEPT. 694-206-O
320 W. 31 ST.,
NEW YORK, N. Y. 10001

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

Name________________________________________ Address__________________________ City__________________________ State_________ZIP______ Age__________
Veterans: Check here ☐

Construction of Multimeter.

CIRCLE NO. 33 ON READER SERVICE CARD

Construction of Oscilloscope.

Temperature experiment with transistors.

JUNE 1972 21
Introducing the expensive digital multimeter that doesn’t cost a lot.

The B&K Precision Model 281. A solid-state, lab-quality portable instrument that measures AC/DC voltage, current and resistance.

The state-of-the-art Model 281 shows readings on a large, clear, 2½-digit numeric display. It also has positive over-range and reverse-polarity indication. There’s no need to switch leads. You can reverse polarity at the flick of a switch.

Model 281 readings are faster and more accurate than analog-type meters. Unlike hard-to-see needle indicators, you can read the large, illuminated numerals—including the decimal point—from a distance.

Featured are 26 ranges: five DC voltage, 100mV to 1000V, with 1% accuracy and 10 megohms input impedance; five AC voltage, 100mV to 1000V RMS, five DC current, 100mA to 1A; five AC current, 100mA to 1A; and six resistance, 10 ohms to 10 megohms.

With built-in protection, the 281 can’t be harmed by overload. And for safety’s sake, it has a three-line AC grounded cord.

Everything about the 281 says expensive—except the price.

Call your B&K distributor.

Or write Dynascan Corporation.

Very good equipment at a very good price. $169.95

Product of Dynascan Corporation, 1801 West Belle Plaine Avenue, Chicago, Illinois 60613

CIRCLE NO. 7 ON READER SERVICE CARD
New Marine Anti-Collision Radar

A new fully automated radar data plotter has been installed on the Norwegian M/S Island Venture. The new equipment—called Digiplot by its developer, Iotron Corp.—graphically displays present and future positions of radar echoes potentially threatening a ship. Using a 16-in. cathode ray tube, the system is contained within a waist-high console installed alongside the ship's conventional radar. The course and speed of any target selected by the operator is displayed in digital form.

Columbia SQ 4-Channel System Adds More Licensees

A growing number of firms are coming out with products using the Columbia SQ matrix system for obtaining 4-channel sound from phono records. Kenwood Electronics is one of the most recent licensees to introduce such 4-channel equipment. In addition to Kenwood, other audio equipment manufacturers who have become licensees include: Sony, Sherwood, Harman-Kardon, Masterwork, Lafayette Radio, Radio Shack, Metrotec, and Instroteck Corp.

Students' Proposals for Skylab

Proposals for space experiments and demonstrations have been submitted by 3409 U.S. secondary school students for flight consideration aboard the Skylab manned space laboratory scheduled for launching next April. Called the Skylab Student Project, the program is designed to stimulate interest in science and technology by directly involving students in space research. A limited number of student proposals from the 25 national finalists will be chosen for flight by NASA.

New Compact Satellite Navigation Receivers for the Navy

The Navy has ordered from Magnavox 32 sets to be used on special purpose surface ships. The receivers will be used with the Navy Satellite Navigation System, better known as Transit. The system consists of several navigation satellites in circular polar orbit about 600 miles above the earth along with a network of ground stations which predict and record the satellites' constantly changing orbits. Due to the large size and great cost of the receiving equipment, the primary users until recently have been Polaris subs and a few surface ships. The new receivers and computers are two feet square and weigh only a few hundred pounds compared with the thousand pounds for the previous receiving gear.

Satellite Earth Stations in Red China

A satellite communications earth station supplied to the Peoples' Republic of China by RCA Global Communications went into commercial operation recently to handle TV and other communications services between China and the U.S. The station, installed near Shanghai in only 30 days, provided live TV coverage of President
Nixon's visit there. The station is operating with the new Intelsat IV satellite located above the Pacific and links Shanghai with the Jamesburg, Calif. earth station. Another earth station, installed by Western Union International, is located in Peking. This station has been working flawlessly to provide the same type of coverage. Other ground station news is the recent signing of a contract between ITT and the Greek Postal, Telephone and Telegraph Administration for a second earth station in Greece. The first ground station works with the Atlantic Ocean satellite while the second one will work with the Indian Ocean satellite.

**TV Audio is Seen by the Deaf**

Millions of TV viewers were unaware that subtitles were shown along with the pictures in a recent ABC network show. Scores of deaf students at Gallaudet College in Washington, D.C. were reading the dialog as they watched the show. The event showed how captions could be transmitted without disturbing the picture in any way. The system, called TV Time, devised at the National Bureau of Standards, sends the caption in electronic code on the bottom line of the TV screen which can be translated into visual messages on the picture of specially adapted receivers.

**Computer Diagnosed Electrocardiograms**

Hospitals may now have electrocardiograms completely diagnosed by computer in as little as two minutes through a new emergency service being offered by Cro-Med Bionics Corp. The system uses a computer to provide a detailed EKG diagnosis which can be used by any physician. At the same time that a hard-copy tracing of the patient's EKG is taken, the impulses are recorded on magnetic tape and transmitted by telephone to the company's computer center in New York. The diagnosis is then sent back to the hospital by telephone or teletypewriter.

**Facsimile Via Phone Lines**

A facsimile system that reduces the cost of transmitting newspaper and magazine pages to distant printing plants by as much as 80 per cent has been introduced by Litton Industries Datalog division. By compressing words and pictures on a printed page into digital pulse groups, the new system allows high-speed transmission of reproduction quality facsimile over low-cost telephone lines. Currently, full-page newspaper and magazine facsimiles are transmitted over expensive wide-band communication channels. Bandwidth required for the new system in about 3 kHz compared to the 48 kHz required for wide-band transmission.

**Electronics for Law Enforcement**

A new two-way radio system that automatically reports a patrol car's status has been installed by the Jefferson Parish, Louisiana, Sheriff's office. Radio interrogation of the vehicle produces an instantaneous response showing the vehicle's identity and its status. The system substitutes number codes for a variety of routine radio messages now relayed by voice. In addition to exchanging digital and voice messages, the new system, developed by RCA, can be used by the radio dispatcher to blow the horn of the patrol car when the officer is out of the vehicle. In a related development, an RCA computer has been credited by Camden, N.J. police authorities with increasing criminal arrests by 10 percent.
It's old enough to vote. You haven't seen one like it since 1954. Now you've got to service it.

No sweat. PHOTOFACT gives you complete service data on 87,000 different radio/TV circuits... including Rip Van Winkle, here.
Sams Photofact is the most comprehensive Radio/TV/Audio circuit source in the world. Photofact supplies complete service information on over 87,000 models produced since 1946—color and b-w TV, AM and FM radios, stereos and record changers. Plus service data on auto radios and tape players, CB radios, modular hi-fi and tape recorders. Quite a package!

And more data keeps coming. Every month, Photofact produces new Photofact data containing easy-to-follow service information on up to 65 of the latest chassis.
This data includes the manufacturers' own printed board callout numbers, detailed circuits, photos, standard notation schematics, replacement parts lists and descriptions, etc., etc., for each model. It'll save you hours of time and frustration.

And it's available in two ways: (1) Photofact-of-the-Month Club members receive regular monthly deliveries of the latest data; (2) or you can purchase whatever service data you need as you need it from your local electronic parts distributor.

The cost? A bargain either way. Photofact-of-the-Month Club members pay just $13.50 a month—a $56.00 a year saving for the entire service package. And if you need a Photofact on Rip Van Winkle, above, the price is only $3.

1. Ask your Sams Distributor. or...
2. Fill out this coupon for membership in the Photofact-of-the-Month Club... get service data on up to 65 new chassis every month, delivered in 6 handy file folders... plus monthly "Bonus" certificate coupons toward a file cabinet of your choice.
In order to understand 4-channel sound, we must first understand what "high fidelity" means. According to Webster, it means "the reproduction of sound with a high degree of faithfulness to the original." For decades, this re-creation of a live concert performance in your home has been the goal of the audio industry. The whole chain of hardware—from the microphones which recorded the sound to the speakers that reproduced this sound in your living room—has been improved to the point where there is practically no difference in the live and recorded sound. But, do we now have true "high fidelity?" Not yet. The audio industry had actually arrived at this point, using a single channel of sound (monophonic), back in the late 1950's.

Fig. 1 is a simplified illustration of how an orchestra was recorded. Sometimes multiple microphones were used in a session, but they were mixed down to a single signal which eventually made its way into the listening environment of your home.

But, there was still something missing from the concert-hall environment. Stereo was developed in the late fifties and increased the "concert-hall" feeling considerably. As Fig. 2 shows, an orchestra was no longer beamed to the listener from a single point but was dispersed across a line stretching between two speakers in a virtual curtain of sound. The orchestra now had breadth. The violins seemed to come from the left side, the percussion from the middle, and the brass from the right—or however the conductor actually arranged his musicians. The recorded orchestra was now beginning to sound like its live counterpart.

However, one still did not have the illusion of "being there." The problem lay in the strange world of psycho-acoustics. This pertains to how our ears and brain interpret sound. In a concert hall, we are immersed in the sound coming from all directions: the direct sound from the orchestra on stage; the reflected sound bouncing off the side walls, the ceiling, and the rear wall; and the sounds of the audience clapping, talking, coughing, or moving in their seats. All of these sounds are present in the hall during a live concert.

Acoustic engineers have always been con-
A STATUS REPORT ON QUADRAPHONIC SOUND—TELLING WHAT IT IS, HOW IT IS PRODUCED, AND WHEN YOU CAN EXPECT TO HEAR IT

BY WILLIAM CawLFEld
Ampex Corporation

Concerned with the "liveness" or "ambiance" of a particular hall. You may not be aware of this ambiance until it is no longer present and you are sitting in the acoustically different environment of your living room.

Four-channel sound was conceived as a means of fooling your brain into thinking you are at a live performance. It is an illusion of being there and not the real thing—but still a very good illusion indeed. See Fig. 3.

There has been some grumbling that the audio industry has just "created another gimmick." That all it is concerned with is to obsolete your present equipment and sell more speakers. This is simply not true.

Fig. 2. Two-channel (stereophonic) recording and playback is shown in this diagram.

Some people say, "Give me an excellent stereo rather than a good 4-channel system any day." The same thing was being said about stereo a decade ago: "Give me excellent mono rather than good stereo." These statements can sometimes be traced to an individual's concern over the "nuts and bolts" of his equipment rather than the total sound field generated by his system. They can also be traced to a reluctance to change.

The entire electronics industry is a dynamic one because of change; and each change has improved the overall enjoyment for the consumer. From radio to television, from black-and-white television to color TV, from tubes to transistors, from wire to magnetic tape—each step has caused some problems, but they were easily overcome.

The advent of 4-channel does not mean that 2-channel sound is obsolete any more than color killed black-and-white television. Price and convenience will still make 2-channel stereo an important part of the audio scene for the foreseeable future.

Achieving 4-Channel Sound. Let us now look at the various ways of achieving 4-channel sound. The most straightforward method is called "discrete." This is a copy of the master tape which consists of the two tracks of music that was fed to the microphones near the orchestra and two tracks picked up by microphones placed out in the hall itself—generally toward the rear. These four channels of music are recorded onto a tape and reproduced in your home by means of a tape player that is equipped...
to pick up the four channels of music and send them through four amplifiers to four speakers (Fig. 4).

In this way, the orchestra comes to you from the front speakers while the rear speakers recreate the ambiance of the hall. You are literally there. You are immersed in the hall and, depending on your seating preference, you can adjust the front and rear balance and put yourself in the front row, a middle row, or way in the back.

The use of four channels has spun off another interesting byproduct. This is in the field of pop music which was never performed in a concert hall, but rather in a studio. Thus, the four channels can be used to surround the listener with singers or instrumentalists in the group.

Is this true high fidelity, as defined by Webster? Well, probably not, but increasing your enjoyment of the music is what it's all about. What one person enjoys may not be the same as what you like. One person likes jazz while another likes classical music. It is all a matter of personal preference. If someone likes to feel immersed in the orchestra, is it better or worse than sitting in front of the orchestra? Musical enjoyment, like art, is a very personal thing.

It is interesting to speculate whether some "purists" who look with disdain at this surround concept of 4-channel sound really know how most recordings are made today. One finds that most stereo discs are, in reality, two mono channels. The music, like a film, is "created" in the editing room where segments are blended, cut, over-dubbed, slowed down, or speeded up to create a complete product. The whole orchestra may not even record in the same room or on the same day. Echo or reverberation is added during the mixing.

It is the author's feeling that it does not make any difference whether the complete product is sent into your home out of two channels or four. Neither concept is "purer" than the other. If the effect is more pleasing with four channels, then you should receive four channels. At times, 4-channel sound with the rear channels containing the ambiance material is pleasing, while at other times the surround-sound effect of being immersed in the music is preferable.

The most popular tape format for discrete 4-channel sound is the 8-track cartridge system. Its advantages are many, including the fact that, being a continuous loop, you never have to rewind after hearing the program; and, because of the immense popularity of the 8-track format, prerecorded material will be more readily available. It is too soon to know what the reel-to-reel market will do, but it is assumed that the only demand for the reel-to-reel format, until discrete records or FM broadcasts become available, will be from the live-recording hobbyist. The cassette, because of track-width restrictions, will probably go the way of records and FM broadcasts by achieving 4-channel sound through the use of a "matrix" system—for the next few years at least.

**The Matrix System.** The matrix method
of achieving 4-channel sound consists of encoding four channels of information into two channels by mixing them together in a complex phase and amplitude relationship. See Fig. 5. These two channels of information can then be pressed into a normal stereo record, broadcast over an FM-stereo station, or recorded onto a 2-channel stereo tape. When you play these two channels of music through the proper equipment, including a "matrix decoder," the two channels will be restored somewhat to the original four channels. The degree of restoration and the cost to the customer are the problems being debated in the industry.

Various companies have introduced matrix decoders. When all the marketing superlatives have been stripped away, the various systems have only two ingredients to work with—one is the coefficients and the other is phasing. The coefficients are the terms in the formulas that specify how much of each channel is mixed or separated from another. The phasing is an attempt to gain more distinctness between the channels. A commonly used phase shift is 180 degrees. The more complicated matrix circuits use 90-degree phase shifts.

One of the first major matrix systems was introduced by Electro-Voice. The heart of the unit is an IC chip that contains all the resistors, capacitors, and transistors that will decode by the proper coefficients and detect signals 180 degrees out-of-phase. It is the most popular matrix decoder because E-V made the IC available to all manufacturers at small cost to encourage the adoption of its system. There is an encoder available to record companies and FM stations who wish to encode 4-channel music into two channels.

This system looked as if it would capture the market until CBS announced another matrix system that was claimed to be better. The problem was that it utilized different coefficients than E-V and 90-degree phase shifts. This 90-degree phase shifting is sometimes described by CBS as the mechanical movement of the record stylus tracing these signals. The stylus will create a clockwise or counterclockwise helix as it moves along the groove. The Columbia system, called "SQ," is licensed to Sony, Harman-Kardon, Sherwood, Masterwork, Lafayette, Metrotec, and Radio Shack at the present time—and probably to others by the time you read this. Columbia, Capitol, and Vanguard have all announced record releases under this system.

Sensing a battle of non-compatible systems and acknowledging the strength of Columbia’s record library, E-V has announced that a new chip will soon be available containing coefficients compatible with the CBS SQ system and that the circuit will have additional components to detect 90-degree phase shifting. This latter development now provides two systems that are compatible.

Sansui offers another matrix decoder that features 90-degree phase-shift circuits. Sansui’s main push so far is the use of its decoder as an enhancer of stereo recordings. This circuit, like Electro-Voice’s, detects signals that are at various phase relationships with each other, and directs these signals into appropriate channels where they eventually emanate from four speakers to create a total sound field in the listening room. Originally, the missing link was an encoder. This encoder is now available, but may be changed—as various record companies, especially Columbia, begin pouring out discs encoded in the SQ format—so as to have similar coefficients in order to be compatible.

Everyone claims his idea is the best and this is actually good for any dynamic industry. However, sometimes the difference between two systems is so minute that there are no practical differences. This, then, brings us to the word “compatible.” The

Fig. 4. The discrete four-channel systems keep the individual channels separate.
author feels that if a recording is made with a solo trumpeter placed in the right-front channel and a drummer in the left-rear channel, any decoder that places them in the proper locations is compatible with the encoder used at the studio. And this is true regardless of whether the coefficients and phase angles used are identical or slightly different.

Again, psycho-acoustics come into play as to what we perceive as being a good reproduction of live performance. The degree of separation between channels from a matrix system is much less than with a discrete system. There is more blending of the channels in a matrixing which some people actually prefer to the distinctness of the discrete tape system.

However, if more apparent separation is desired, a circuit can be added after the matrix decoder to enhance the 4-channel effect. This generally consists of a logic circuit that controls the gain of the four channels. When it detects an instrument that is louder in one channel than the rest, it will boost its level somewhat and reduce the levels of the other channels a bit. This gives the illusion that the instrument is located closer to that particular corner of the room than it was before the logic circuit took over.

These elaborate matrixing systems, some featuring this gain-riding logic circuit, will be more expensive and only appeal to the sophisticated music lover.

The matrix system has advantages over the discrete other than the fact that it can be used for 2-channel records, tape, and FM-stereo. This feature is that you can convert many existing stereo systems to 4-channel quite easily. The only requirement is that you can place this matrix decoder into your amplifier circuit before the final stage. This hookup requires having either separate amplifier, tuner, and phono components, or a tape-monitor jack on the amplifier. Some companies have placed special jacks on the backs of their music-playing systems which will accept matrix decoders.

The matrix decoder can sometimes be used to enhance normal 2-channel stereo music. The decoder will attempt to split it into four parts by analyzing phase and amplitude relationships and a "synthesized" 4-channel sound is created. This has led some people to confuse the main purpose of matrixing, which is to encode from four channels down to two and back to four. With this spinoff use of creating four out of two channels, the effect is quite pleasing. Because of the limited library of 4-channel music at present, you will find that most of the time the decoder is being used as a synthesizer.

Another method of bringing 4-channel sound into your home has been introduced by JVC of Japan. RCA and Panasonic have announced that they will be supplying records and equipment for this system. The method is not true discrete nor a matrix, as previously described, but a system in between. The four channels of a master tape are combined in a special formula and a coding signal is generated. This method is similar to the multiplex system used today in FM stereo. The coded signal is pressed onto the record as well as the multiplex and when played back the two signals combine to create four individual channels of information. Because of the better separation this system provides over the matrix method, it has been called a discrete system.

One drawback at present is that the record system must be able to handle frequencies as high as 45,000 Hz. This is not a major problem for a sophisticated phono cartridge to handle. The magnetic cartridge has this capability within sight. The problem will arise when this response is needed in an inexpensive ceramic cartridge.

You may ask why this is important when you own a sophisticated system? Well, the
The music industry must produce records that will be purchased in the hundreds of thousands. In order to have a large selection of records from which to choose, this mass market must exist. A large choice of selections simply cannot be provided for a small, specialized market. If the RCA-JVC system is to survive, some improvements—which, incidentally, RCA and JVC have said will be made—must occur. First, the need to produce an inexpensive ceramic cartridge for the mass market must be met; second, the problem of not being able to play this 4-channel record on a normal stereo machine without destroying the high-frequency coded signal must be overcome; and finally, the durability of the disc must be improved.

The catch is that even if all these things are done, the system may not be practical. To use this system on FM will require years of testing before the FCC will sanction it. This would then make the RCA-JVC system work only for discs, not FM or tape. So, at the present time, the E-V or CBS matrix system, which can be used today on any format without FCC approval, would seem to give the matrix a favorable edge.

**Four-Channel Converters.** Many consumers today want to try 4-channel sound in their homes, but are not quite sure if they will like the effect or what system to go into. They are taking a “building block” approach. This involves the purchase of a small “black box” converter sold by many companies now, but originally conceived by Dynaco. See Fig. 6.

All that is required as an investment is the converter and two more speakers. If, at a later date, you decided to go further by investing in a matrix decoder and/or discrete tape player, the speakers have already been purchased and the matrix decoder or tape player will then require just another stereo amplifier. The only casualty in this build-up approach was the original inexpensive “black box.”

The converter takes advantage of a very simple concept. Many times during a recording session, sounds that are 180 degrees out-of-phase with the rest of the music will be recorded on the tape. This is generally not a problem when listening through a normal stereo system and, therefore, no efforts are made to eliminate these signals. Many records or tapes out in the field have this “hidden music” on them. Through the use of a simple resistive network across the two positive terminals of the stereo amplifier, the out-of-phase sound is recovered and fed to the rear speakers. Some of the ambiance of the live recording appears at the forward microphones out-of-phase and so, in this hookup, the recorded ambience will be accentuated in the rear speakers. A solo instrument or singer that appears equally in the left- and right-front speakers will be canceled out of the rear speakers. In this way you will be surrounded by music and yet instruments will seem to come from various parts of your listening room.

The system does not have the accuracy of the true matrix system but it is a simple way to get started if you are not quite sure you will like the effect. Also, because it does not require any hookups before the amplifier but is merely connected to the existing speaker terminals, this conversion can be done by anyone.

So, in the months to come, you will see many different methods of obtaining 4-channel reproduction. If you know what the various methods involve, you will find it less confusing. If you know how far you want to go, how much existing equipment you want to keep, and how much distinctness in the separation of channels you want, you will find equipment for your purpose now—and in the very near future—available on your retail dealer’s shelves.

![Fig. 6. This is a derived or ambiance recovery system using a four-channel converter.](image-url)
Minicomputers
What They Are and What They Can Do

A LOOK AT APPLICATIONS OF THE INCREASINGLY POPULAR SMALL-SIZED COMPUTER
BY DAVID L. HEISERMAN

ANYONE who is familiar with the meaning of such mod terms as "miniskirt" and "minibike" can conjure up at least a vague notion of what is meant by the term "minicomputer." In simple terms, a minicomputer is a small computer—at least as far as size is concerned.

The sale prices of minicomputers are not very small, but neither is the present rate of sales. Even with price tags for the bread-box-size computers ranging from $6000 to $25,000, more than 10,000 of them have found their ways into new kinds of electronic instrumentation since 1968. More than half of these were sold during 1970, and the rate of sales will most likely double again in 1972.

There must be something revolutionary about minicomputers which cost more than a new Cadillac but still sell faster than candy bars at the movies. They must offer

Digital Equipment Corp. minicomputer with host of input/output blocks uses airport runway data measured photo-electrically to obtain visual range.

POPULAR ELECTRONICS Including Electronics World
the buyer something unique and useful. Any little instrument that can keep more than 70 computer manufacturers—many of them flourishing new companies—turning out minicomputers at full capacity is bound to have a powerful impact on modern business, industry, and technology.

Minicomputers are basically stripped-down versions of the large general-purpose machines. In fact, many of the well established computer firms make their minis from a small selection of the most important circuit boards and components used in their large computer products. Some minis have a few more “accessories” than others; a few have larger memories, operate faster, and can handle more sophisticated tasks. But all minicomputers behave like their larger counterparts. Only the prices and data-handling capacities are “mini.”

Stripped-Down Computers. One of the first things minicomputer engineers strip away from big computer designs to make a mini is the number of bits that appear in each instruction or data word. Whereas the large computer typically handles up to 36 bits of information per word, minis generally take on between 8 and 16 bits per word. It is possible to parallel several minis or use some programming tricks to extend the word length, but for most minicomputer applications, 16-bit words are long enough.

Another cut is in the size of the ferrite memory core. Large computers have storage space for millions of bits of digital information. Most minis come equipped with a memory capacity of 4000 16-bit words. The user can, however, buy extra 4000-word memory modules to expand storage capacity to 32,000 words.

The third major cut in sophistication is in the mini’s programming capability. Any computer’s internal workings operate on a complicated sequence of “1” and “0” binary codes. It is possible, and sometimes necessary, to program a minicomputer by feeding it a program written in the awkward binary form. A set of switches and lights allows the user to “converse” with the mini in binary language.

Since binary language is awkward for most people, manufacturers now include an assembly program in their minicomputers. This fixed program lets the user instruct the computer via standard typewriter symbols and words. The user still has to feed in one instruction for each tiny step the circuits must take, but the built-in assembly program makes custom programming a simpler and speedier process.

Newer minicomputers take the programming one step further. Many models currently available have compiler language such as FORTRAN, ALGOL, and BASIC fixed into their memories. These sophisticated programs take a simple input command—such as “add”—and translate it into the dozens of separate binary commands the machine needs for carrying out the operation.

Like the custom programs, built-in assembly and compiler programs take up valuable memory space and thus add to the cost and complexity of the minicomputer. The FORTRAN program, for example, takes up a full 4000-word memory module in most cases. If the user wants a 4000-word capacity for his custom program, he must outfit a mini with at least an 8000-word memory, 4000 to do the real work and another 4000 to make programming easier.

Because memory space in a minicomputer is precious, users seldom try to store more than one custom program at a time. Whenever a program change is wanted, new instructions are fed in via punched cards.
paper or magnetic tape, or a teletypewriter keyboard. This type of reprogramming can be troublesome and time consuming; so, most minis operate in a dedicated mode (one-program) application.

Within the limits imposed by the small size of the memories and arithmetic units, a mini can perform just about any type of task a large general-purpose computer can handle. Although a mini might spend its entire lifetime performing only one of several different types of tasks, the user has a virtually unlimited number of tasks from which to choose.

Considering its small size, rugged construction, and relatively low cost, a minicomputer is far more suitable for most on-the-spot data acquisition, control, and data processing operations than is any large computer.

Gathering The Data. Many scientific and industrial processes require the gathering of large amounts of data from many different sensing devices over a very short period of time. Using a minicomputer data acquisition system, data can be gathered from hundreds of sensors virtually instantaneously with the results printed out on a teletypewriter.

A mini can take care of all the data manipulations as fast as the sensors can provide the information. It can calculate averages, smooth out random fluctuations, look for critical readings, and construct graphs and tables in less time than it takes a man to jot down a single set of readings.

A single centrally located computer could take over the work of dozens of minis scattered around a large plant or lab facility, but the cost of a single large system is far greater than that of ten of the more expensive minis. Too, a user can buy minis a few at a time and spread out their cost as opposed to the large initial outlay for a single general-purpose computer.

Most kinds of sensors (thermocouples, pressure sensors, strain gauges, etc.) generate analog signals. A minicomputer, a digital device, employs input amplifiers to scale the analog voltages to the proper levels and analog-to-digital (A/D) circuits to translate the analog signals into digital form. These input devices and the mini and peripheral equipment make up the building blocks for a complete minicomputer data acquisition system.

Under the control of an acquisition program stored in the mini’s memory, the system samples data from each sensor, assigns binary codes, and stores the data in another part of the memory. If the program calls for data manipulations, the computer pulls the appropriate data out of the memory and performs the assigned operations. Using a display program, the mini can print out the results on a piece of paper, display it on a CRT screen, or store it on punched cards or magnetic tape.

Minicomputer data acquisition systems do more than just gather and print out data. They also manipulate the data, putting it into a form that is more useful to the human operator and other machines.

Process Control Applications. The only real difference between using a mini for data acquisition and in control applications is that, in the latter, emphasis is on controlling other machines rather than gathering data from them. Minicomputers are so well suited for process control applications that they are beginning to take over from punched-tape machine controls.

Instead of taking instructions from a moving punched tape, the mini quickly calls up rapid sequences of control instructions from its memory. By means of a preset program, it can control motors and valves in machinery as simple as a punch-press or in systems as complex as NASA’s Lunar Excursion Module.

Just as most sensing devices produce analog signals, a goodly number of the devices a mini must control operate on analog volt-
ages. This means that D/A converters and power amplifiers must be used between the mini and the devices it controls. Using a building-block approach, an engineer can assemble just about any kind of custom minicomputer control system he desires.

Traditional Mini Roles. Minicomputers demonstrate their most unique capabilities in industrial data acquisition and process control applications where no other computing device has been able to meet, effectively and economically, so many different kinds of challenges. So, it is easy to overlook some of the more traditional jobs they can perform.

In an engineering office, for example, a mini can carry out most design and analysis problems engineers encounter. With a small mini close at hand, there is no need to wait in line for time at a big computer, and there is no need to struggle with the schedules and peculiar operating characteristics of commercial computer time-sharing services. The minicomputer is available at all times; and, since most users buy their minis outright, there are no running-charges to deal with.

These advantages apply to business offices as well. Office users of minicomputers include those who must process a lot of information daily but would have insufficient running time to justify the cost of a large computer system. In business data processing applications, minis can operate in conjunction with any of the traditional computer input and output devices, including punched card and magnetic tape equipment.

Throughout most of the 25-year history of modern computer technology, engineers have placed emphasis upon developing faster computers which can handle more information with more efficiency. With the coming of large-scale integrated circuits (LSI's), this trend is reaching a new plateau. There will always be a demand for larger and more sophisticated computer systems, but there is a greater and more immediate need for computers at the minicomputer end of the scale.

COLOR TV PROJECTION SYSTEM

A NEWLY developed color video projection system that can project color TV images on a large screen was demonstrated recently to the press. Using a simple optical projection system, the image from a 12-in Trinitron CRT was projected onto a screen measuring 30 by 40 inches. Developed by Sony Corp., components of the new system are expected to go on sale in the U. S. this fall. (See News Highlights column for May.)

Projected TV images were viewed in a darkened room. Picture quality was excellent. The "Sony Color Video Projection System," as it is called, can project pre-recorded programs from a video player, or it can project programs taken off the air with the aid of an additional TV tuner/adapter.

Price of the video projector will be around $2000. The special curved screen will cost an additional $250. The screen has high reflection efficiency and good contrast. Price of the video player is just under $1000, while the selling price of the TV tuner/adapter, although not established as yet, is expected to be around the price of a color TV receiver.

It is expected that the first uses of the new system will be in the commercial area, in schools, or in public places, such as airports, hotel lobbies, or exhibition halls. Later the system may find use in the home where the screen could be mounted on a wall.

The 12-in. Trinitron, the heart of the projector, uses new, highly efficient phosphors and is operated at a high brightness level.
Join the high-paid electronics technicians who got their start through NTS Home Training.

Your home can become your own private classroom-workshop. NTS sends you everything you need to learn valuable technical skills in electronics. You get easy-to-grasp lessons, comprehensive kit manuals, large fold-out charts, and more. Plus the finest professional equipment available today. It's all included in your tuition, yours to keep.

Your equipment is sent to you in kit form, matched to lesson material. With the NTS Project Method, you start with simple projects, then move from basics to more complex concepts. You discover how electronic principles work by performing practical, fascinating experiments. Learn at your own pace.

You quickly become expert in the actual equipment and methods you'll use on the job. And soon you're ready to cash in on the tremendous opportunities in the expanding, exciting world of electronics!

If your field is television, you might decide to join a first-class TV repair center. Or start a shop of your own. Or specialize in industrial applications of television. Once you master an area of electronics, the direction you take is really up to you. And you'll be able to use the test instruments you built yourself!

It all begins at home, with NTS Project Method Training. Find out how fast and easy it is to learn skills that pay off. Check card or coupon today for your free full-color NTS Catalog and complete details. No obligation. No salesman will call.

NTS COLOR AND B&W TV SERVICING


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

Learn sophisticated solid-state circuitry as you build this B&W TV receiver. Course covers the full range of home entertainment electronics.
New solid-state
315 sq. in. color TV

NTS COMPUTER ELECTRONICS
Build and operate the exclusive NTS Compu-Trainer! Loaded with integrated circuits, it teaches you the how, what, and why of computers faster, more thoroughly. You perform all wiring and patch-cording. No short-cuts. No pre-wired circuit boards. Also receive an FET Volt-Ohmmeter and a 5" wide-band Oscilloscope.

NTS AUTOMATION/INDUSTRIAL ELECTRONICS
Systems automation is the future of industry—and you can play an important role! Enter the age of electronic controls by training on the NTS Electro-Lab—a complete workshop. Also receive a 5" wide-band professionally rated Oscilloscope. Build five industrial controls to regulate motor speed, temperatures, pressure, liquid level and much more.

NTS ELECTRONIC COMMUNICATIONS
Gain the prestige and earning power of owning an FCC First Class Radio Telephone License! Two exciting courses in the fields of transmitting and receiving. Experiment with an amateur phone 6-meter VHF transceiver, NTS’ exclusive 6-transistor solid-state radio, and a fully transistorized volt-ohmmeter.

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

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

NTS AUTOMATION/INDUSTRIAL ELECTRONICS
Build the exclusive NTS Compu-Trainer!

NTS ELECTRONIC COMMUNICATIONS
Gain the prestige and earning power of owning an FCC First Class Radio Telephone License!

CLASSROOM TRAINING AT LOS ANGELES
You can take classroom training at Los Angeles in sunny Southern California.

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

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

Name
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.
IF YOU really want to see a black cat in a coalbin at midnight, the Night Vision Laboratory of the Army Electronics Command has developed just the thing for the job. It is the Thermoviewer, a handheld thermal viewer (AN PAS-7) whose civilian applications may well exceed its primary military use of detecting and recognizing personnel targets at night.

Handheld Thermoviewer detects objects by observing temperature differences.

The Thermoviewer has already been successfully used to detect loose rock that might cause mine cave-ins and to study earth surface temperatures in geological surveys. Other potential uses include detection and mapping of thermal pollution in water and a variety of medical applications—such as detecting cancerous tissue beneath the skin and studying burned tissue.

Weighing only 6 lb, the Thermoviewer can be handled as easily as a pair of binoculars. It is powered by a belt-mounted rechargeable battery pack capable of 12 hours of continuous operation.

Images are created by sensing temperature differences between the object being viewed and its background. The Thermoviewer has a detector array of lead selenide, thermoelectrically cooled to almost $-160\degree$ F. The array is scanned electronically to create an image on a phosphor screen visible through the eyepiece. The principle used is not new, but previous equipment was heavy, bulky, and took 20 minutes to create a visible image. The Thermoviewer, however, works in real time, creating images instantaneously. Furthermore, it needs no outside illumination for creating the image.

Since the Thermoviewer detects only differences in temperature, it can be used in either darkness or daylight. It can also be used to see through light fog or haze because it works at a longer wavelength than that of visible light.

In its significant civilian use to date, the Thermoviewer was used by the U.S. Bureau of Mines in conjunction with the Night Vision Laboratory to find hazardous loose rock behind apparently solid mine walls, and by the Remote Sensing Geophysics Group of the U.S. Geological Survey in making a detailed study of conditions which affect surface temperatures of the earth.

Phillips Broadcast Equipment Co. of Mahwah, N.J. was selected to build 20 models of the Thermoviewer for the Army and civilian agencies.
BUILD A VERSATILE SEMICONDUCTOR CURVE TRACER

CREATES CHARACTERISTIC CURVES FOR MOST SEMICONDUCTORS

BY JOHN KEITH

Semiconductor characteristic curve tracers have been used very little by experimenters and hobbyists because many people are just not familiar with their operation. Then too, commercial units are expensive. However, a curve tracer is almost indispensable when you need to know the characteristics of the semiconductors you have on hand, especially when you are looking for a pair of matched devices for a particular application.

A curve tracer automatically displays the voltage-current parameters of a semiconductor device by varying one parameter while measuring another. Although this can be done manually, it is a slow, tedious job requiring many individual plots. An automatic tracer, used in conjunction with an oscilloscope, can display a family of curves in a matter of seconds. For example, the collector current curves of a transistor are created by applying the selected collector-to-emitter voltage through a load resistor and varying the base current. A voltmeter connected across the collector resistor will show a variation in indicated voltage as the base bias is varied. Obviously, a selection of different values of applied base bias currents will be needed to plot a “family” of curves such as those seen in transistor manuals.

The low-cost automatic curve tracer described here is straightforward in design, easy to use, and makes an excellent addition to any workbench.

Details of Circuit Design. Timing in the curve tracer circuit is set by the frequency of the ac power input. After it is rectified, the input is a 120-Hz half sine wave with a maximum value of about 20 volts as shown in Fig. 1A. This voltage is used as the collector-emitter supply (V_{ce}) for the transistor being tested, with the upper limit determined by a potentiometer. The V_{ce} supply is also used for the horizontal sweep on the external scope while the collector-emitter voltage drop (across a resistor) is applied to the scope’s vertical sweep.

During the time of one 120-Hz sweep, the base bias current to the transistor under test is held at a selected constant value by a built-in “staircase” generator that changes
Fig. 2. Power supply and delay circuit of tracer. Regulated supply insures stable operation. The sweep start control is adjusted to remove any curve instability.
the bias current during each sweep interval to display a family of four curves. The staircase generator is synchronized to the power line frequency as shown in Fig. 1B. Figure 1C shows the scope curves for each value of base bias, and the final composite family of curves.

As shown in Figs. 2 and 3, a delay circuit consisting of Q4, Q5 and Q6 provides a variable delay to insure that the staircase switches at exactly the same time as the VCE trace starts. This prevents "clutter" in the display.

Integrated circuit IC1 provides a binary four count which is applied to Q7, Q8, and Q9 through a diode gating network to produce the staircase bias levels. These are summed in Q10 whose emitter is always at one of four voltage states: 0, 3, 6, or 9 volts. These voltages are determined by the divider made up of R22 through R26; and they are preset by R8, R23, and R25.

The voltage staircase is coupled through one of three series bias resistors—R29, R30, or R31, selected by S4. This provides bias current values of 30, 60, and 90 microam-
peres; 100, 200, and 300 microamperes; and 300, 600, and 900 microamperes. Each has an automatic zero voltage preceding it.

To add versatility, the polarities of $V_{cc}$ and the base bias are independently selected by $S_6$ and $S_5$, respectively. This permits the analysis of both junction and insulated gate FET's, as well as conventional npn and pnp transistors.

**Construction.** The curve tracer can be built on a perf board or a printed circuit board (Fig. 4). The board and other components can be mounted as shown in the photograph of the prototype. There is nothing critical about the layout, except that the horizontal and vertical scope termination wires should be kept away from other leads.

**Calibration.** With the circuit complete and power turned on, check that pin 11 of $IC1$ is at 3.6 volts dc. Connect the dc voltmeter to the emitter of $Q_3$ (ground to minus side of $RECT1$), and adjust trimmer $R_8$ for 10.5 volts.

To check the staircase generator, connect an oscilloscope to the emitter of $Q_{10}$, making sure that $S_2$ is in the AUTO position. When the existence of the staircase wave has been confirmed, remove the scope and place $S_2$ in the MANUAL position. Reconnect the dc voltmeter (10-volt scale) to the emitter of $Q_{10}$. Operate pushbutton $S_3$ until the voltmeter indicates approximately 9 volts. (There should be four discrete voltage levels indicated as $S_3$ is operated.) With the voltmeter indicating approximately 9 volts,
adjust R8 for exactly 9 volts. Operating S3 once should cause the voltage to drop to zero, and operating S3 once more should bring the needle up near the 3-volt mark. Adjust R25 to obtain exactly 3 volts. The next operation of S3 should produce a 6-volt indication which is set by R23. The zero is automatic. Retest S3 to indicate 0, 3, 6, and 9 volts at the emitter of Q10. When S2 is placed in the AUTOMATIC position, the voltage will be an average 4.5 volts.

For most purposes, the base currents developed by these voltages can be assumed to be correct. However, it is actually one of these voltages minus the base-emitter drop of the transistor under test. For accurate calculations (if needed), the exact base currents can be found from the staircase voltage minus $V_{BE}$ divided by $R_{23}$, $R_{30}$, or $R_{31}$.

**Operation.** Connect the vertical, ground, and horizontal outputs to the proper terminals on the oscilloscope and set the scope for external horizontal input. To calibrate the scope graticule, place the CAL switch (S7) to the 10V position, set $V_{BE}$ control ($R_{33}$) to minimum, and place $V_{BE}$ polarity switch on +. Rotate $R_{33}$ until the horizontal scope trace curves up. At this point, $V_{BE}$ equals 10 volts (determined by diode $D_4$). Adjustment of the scope horizontal gain enables calibration in volts per inch. Setting S7 to the 1-mA position and adjusting the scope vertical control permits calibration in milliamperes per inch.

Insert a known good transistor in socket S01 and set polarity switch S6 accordingly (+ for npn; − for pnp). Place switch S2 on AUTO and select the desired base currents with S4. A family of four curves will be displayed on the scope. If you are using an ac-coupled scope, the curves will center about the zero axis; however, with a dc scope, the display will be more stable. Adjust $R_{15}$ for a stable display.

I really don’t think this is the way we should be deciding which of our designs is best for the project.
KODAK ENTERS VIDEO RECORDER/PLAYER MARKET

USING SUPER 8 MOVIE FILM

INSTEAD OF MAGNETIC TAPE

BY AUBREY HARRIS

THE video recorder/player has been in the news fairly often during the past few years; and with good reason, since quite a few big-name companies are involved in its development. Now, there is yet another entry. This time it is Eastman-Kodak Company. The recording medium is, quite logically for them, Super 8mm color film.

The Kodak Videoplayer system is by far the lowest cost recording system yet announced. This is because the camera used can be a simple, inexpensive Instamatic movie camera as opposed to regular color TV cameras (required for color videotape systems) priced in the range of $5000.

Kodak’s system operates as follows. Super 8 is exposed in a movie camera in the same manner as it normally would be for projector showing. Once exposed, the film is sent off for processing and, on its return from the lab is fitted into a plastic cartridge, reel and all. The cartridge is then placed in the Videoplayer which automatically threads and starts playing the film. From here, the Videoplayer is connected through its built-in r-f modulator to the antenna terminals of a conventional TV receiver to display the picture.

The Videoplayer has certain unique features. First is that the film is moved continuously as opposed to the intermittent 24 frame/second motion of a standard projector. Continuous motion is less damaging to the film and sprocket holes than is intermittent motion.

The video information is generated by a flying-spot scanner and photomultiplier tube system. In a flying-spot scanner, a plain unmodulated TV raster generated by a cathode ray tube is optically focused onto and projected through the film frame. On the other side of the film are an optical beam splitter and photomultiplier tubes. An advantage of this kind of scanner is that there are no image registration problems.

Special steps have been taken to produce a 60 field/second TV waveform from the 24 frame/second film rate. The method used is known as “Two-Three” scanning where one frame is scanned twice by the TV raster, while the next film frame is scanned three times.

The player unit will reproduce sound recorded on a magnetic stripe on the Super 8 film. The sound also passes through the modulator, emerging from the audio section of the TV receiver. Magnetic sound recording can be accomplished in the camera or in a sound-recording projector. It cannot be accomplished in the Videoplayer.

The cost of the Videoplayer is estimated to be in the neighborhood of $900, with availability sometime in 1974. This is a comparable figure for many of the presently available ½” color VTR’s.

Another of the advantages of Kodak’s system is that the medium can readily be edited and spliced using existing equipment, and copies can be made easily in the labs. There is also complete interchangeability between all Super 8 projectors, films, and the Videoplayer cartridges. Furthermore, the films are not “standard-conscious.” This last is in contrast to video tapes and EVR films which must be played only on the standard on which they were recorded.

Kodak’s Videoplayer also has a few disadvantages. There is the delay for processing between taking pictures and viewing them. A one-hour film, after processing, costs $100-$120, whereas a one-hour ½” videotape costs only $20-$30 and is reusable whereas the Super 8 film is not.
LEADING clothing manufacturer has announced a revolutionary advance in the making of wearing apparel: the cutting of cloth by laser beam. Developed by Hughes Aircraft Co., the laser beam cutting system is installed in the clothing factory of Genesco, Inc., Fredericksburg, Va. The system consists of a computer, a cutting head, a fabric conveyor, and a laser.

In operation, the conveyor rolls out a single layer of cloth from a bolt, the laser is automatically turned on, and the cutting head begins to trace what may be a very complex pattern over the cloth. The laser itself is stationary, but its beam is directed to the cutting head by silicon mirrors. The computer controls the movements of the head and also manipulates the mirrors so that the beam follows the head's gyrations. Gold-plated aluminum mirrors inside the cutting head focus the beam on the cloth in a pinpoint of intense energy.

The laser can and does cut to a tolerance of the width of a single thread, much more neatly than can conventional tools. Each garment is tailored for size and style according to instructions stored on magnetic tape. This precision system assures that every size 40 will be the same as every other size 40, with no errors to be corrected in the sewing room. When the cutting is complete, the conveyor moves the material along, the cut pieces are removed, and another section of fabric enters the cutting area.

Laser Developments. The Hughes-designed cloth cutting system came into being little more than a decade after Dr. Theodore H. Maiman, a scientist working at the Hughes Research Laboratories, developed the first successful laser. It was a remarkably fast transition from the research laboratory to the factory.

The fascinating possibilities for utilizing the intense beam of coherent laser light were immediately apparent to the scientific world. Intensified research efforts following the initial breakthrough led to the discovery of hundreds of different kinds of lasers. Among the most widely used today are solid-state lasers using ruby, glass, or yttrium aluminum garnet and gas lasers containing argon, krypton, carbon-dioxide, or a helium-neon mixture. Much experimental work is still in progress and other (possibly better) types of lasers may be developed in the future. Chemical lasers, for example, show promise of providing power far beyond anything now possible.

New laser materials may be sought for purely economic reasons since rare materials or gases are more expensive than are their more commonplace counterparts. The amount of power which can be practically extracted from a given system is also a factor. It is not feasible, for example, to make a ruby crystal large enough to yield the amount of power that can be readily provided by a CO$_2$ laser. Another consideration is the fact that different laser materials provide light of different wavelengths. This can be a critical factor when considering practical applications because wavelength determines how the beam will react with the materials it contacts.

A laser beam striking a substance may be reflected, transmitted, or absorbed. If a laser is to perform actual work, as in cutting cloth, the beam must be absorbed. A material which absorbs light of one wavelength, however, will transmit a beam with a different wavelength. For example, germanium is often used to make lenses for infrared lasers, although it is opaque to light in the visible range. Much experimen-
Precise Measurements. Unlike conventional light sources, a laser beam will travel in a very narrow beam over long distances with little dispersion. A laser beam is available for reference at any distance in front of a laser. This characteristic led to the early uses of lasers for reference lines. In the aircraft industry, a 200' beam gives far greater precision in the alignment of tools and jigs than could the old tight-wire method. Tunnels several miles long are now built with deviations of less than 3/8" at any point. On a smaller scale, some plumbing firms use lasers in establishing grade when installing sewer pipe.

Lasers, like radar, can be used to measure distances. Because the wavelength of light is shorter than that of a radar beam, a laser gives far greater accuracy. Oil companies make laser measurements of distances of up to 15 miles with accuracies of 1" when installing pipelines. When used in airplanes for mapping, a laser can distinguish between curb and street levels.

A complex system employing the accuracy of a laser is the new aircraft tracking system developed by Sylvania to assess the in-flight performance of the new DC-10 jet transport. Completely self-contained in a transportable van, the system is controlled by a single operator. A low-power infrared laser beam, originating from the van, illuminates a reflector mounted on the flying aircraft. The reflected beam is returned to detectors in the van which determine the azimuth, elevation, and range at rates of up to 100 measurements per second. The data is recorded on magnetic tape for computer analysis; the results assist engineers in evaluating avionic, aerodynamic, and acoustic functions of the airplane by providing highly precise information on aircraft location at altitudes of up to 60,000 feet.

Micromachining. The delicacy with which they can be manipulated recommends lasers for precision work in the micromachining of small electronic components and circuits. Solid-state yttrium-aluminum-garnet (YAG) lasers have found wide acceptance for these operations.

YAG lasers are usually Q-switched to increase their effectiveness. This involves detuning the laser's resonant cavity by some means while a great amount of energy is pumped into the cavity. Resonance is suddenly restored and the laser releases all of its energy in a single pulse which may last for less than a microsecond. A YAG laser for micromachining produced by Coherent Radiation, for example, has an average power of only 6 watts but can deliver a peak power of up to 4000 watts in 500-nanosecond pulses.

Applications in Electronics. In the production of such electronic components as resistors and capacitors, it is usually not feasible to deposit films to the necessary accuracy. Q-switched YAG lasers are widely used to trim them to precise specifications by vaporizing the excess metal. Because of the short pulse duration, this can be done without damage even with heat-sensitive substrates.

Reflecting mirrors sweep the laser beam over the metallic film of the component while instruments monitor the changes in its value. The components can be trimmed separately or, since the laser makes no physical contact, as part of a functioning circuit. The process may be controlled by a computer for high-volume production, yielding up to 10,000 resistors an hour with tolerances exceeding 0.1 percent.

Until recently, the frequencies of quartz crystals were adjusted either by removing some of the quartz with a diamond tool or by adding fine depositions of silver. However, these methods are slow since they do not readily lend themselves to automation. Now a YAG laser can be used to adjust the frequency of a quartz crystal. The crystal is placed in an oscillator circuit and its frequency is monitored during the trimming process. The film is vaporized in successive spots until the desired frequency is reached, at which point the apparatus automatically shuts off. The crystal is not harmed because the pulses are of short duration and the quartz is transparent to the 1.06-micron wavelength of the YAG laser; so, the beam passes through the crystal without heating it. A quartz crystal can be tuned in this manner in a fraction of a second.

YAG lasers are also used for scribing the
Laser fabric cutter (above) was developed by Hughes for Genesco, a large apparel concern. Carbon dioxide laser (below), with emission in the far infrared, has many industrial applications. Output is 250 watts continuously or 25 kilowatts if it is switched. (Photo courtesy Coherent Radiation.)

Above, quartz tubing is cut with Sylvania carbon dioxide laser. Below, jet of oxygen is used on Coherent Radiation laser to supply extra power for cutting titanium sheet.
silicon wafers used as substrates for semiconductors, a job conventionally performed with diamond scribing tools which are relatively slow and subject to wear. A Q-switched YAG laser, on the other hand, can scribe a silicon substrate to a depth of 2.5 mils at a rate of 2 in./second with practically 100 percent yield.

A highly precise YAG laser system developed by Sylvania is used by a manufacturing plant of the Bulova Watch Co. for regulating the frequency of tiny balance wheels for timepieces. Balance wheels are machine-stamped in large quantities, leaving excess weight which must be trimmed away to regulate them accurately. The output of a YAG laser is directed through a series of lenses into a beam splitter which produces two equal-intensity beams pulsed at a 100-μs rate. The dual-beam optical system enables the laser to drill out equal amounts of excess material from opposite sides of the wheel, thereby maintaining balance. The process takes only a minute with the laser, compared to 20 minutes if done manually. Also, the laser method yields ten times better accuracy.

**Carbon-Dioxide Lasers.** The development of the CO₂ laser was a great advance for industrial utilization of lasers. Most lasers convert excitation energy to light output at less than 1 percent efficiency. The CO₂ laser converts with a 15-percent efficiency. The average power output of most lasers is measured in milliwatts to a few watts; the CO₂ laser can generate several hundred watts of average power. Finally, the output of the CO₂ laser is in the far infrared (10.6 microns) which is totally absorbed by many classes of materials including most metal oxides, glass, quartz, plastics, and natural organic materials such as wood, fur, and natural fabrics.

The considerable power provided by CO₂ lasers led to new applications in areas where conventional techniques were inadequate or inefficient. To illustrate, the industries which produce boxes and cartons are highly automated. Their cartons are cut and glued at great speed. However, the making of dies for the machines which do the cutting and gluing is a manual task requiring the services of skilled craftsmen. A jig, or single-piece die, is the most stable type; but it is difficult for a diemaker to execute the number of interior cuts required in the die with the necessary accuracy. So, most diemakers compromise on stability and make block dies consisting of a number of pieces.

To overcome this problem, Coherent Radiation developed an automated diemaking machine consisting of a CO₂ laser mounted on a mechanical table and guided by numerical control equipment. A drawing of the die is prepared and information on the dimensions and sequence of cuts is transferred to a plastic tape by means of an automatic typewriter equipped with integral tape punching and reading facilities. This can be done speedily. (The tape for a flip-top box can be prepared in a little more than an hour.) Once the tape has been made and the plywood die blank placed on a bed of steel rods, the operation is completely automatic.

The most challenging task for lasers is the cutting of very hard materials like quartz tubing and tough materials like carbon steel. The extra power needed is supplied by using a coaxial oxygen source. The oxygen converts the laser power, measured in hundreds of watts, to an effective power of about 40,000 watts. As in the oxygen-acetylene welding torch, the chemical reaction induced by the laser-beam/oxygen combination produces most of the energy needed for the cutting process. The laser beam heats the metal to a high temperature so that the metal will react to the oxygen, and the gas jet blows the waste away.

**Looking Ahead.** Despite the great strides already made in bringing the laser into practical use, it is likely that the surface has barely been scratched. Experiments show that the laser beam can be used for communication, where it is estimated that ten trillion (10¹⁸) separate messages could be placed on a single laser beam with a diameter of 1 mm. This is equivalent to all the communications taking place at one time the world over.

A number of problems exist before the laser's potential for communication can be realized. But whatever it takes to solve them, the potential exists and will most certainly be exploited with maximum effort.

A second rich prospective use for lasers is in the area of holography, or lensless photography which stores and projects true three-dimensional images. Applications for entertainment (TV and motion pictures) and commercial data storage and retrieval are limitless.
KEYLESS SYSTEM OFFERS THREE OPERATIONAL MODES

BY FRANK J. DIELSI

WITH automobile thefts increasing—in spite of the best efforts of Detroit in providing locking steering columns and buzzer warning systems on the ignition—it is apparent that a reliable alarm system is necessary to protect not only the vehicle but its contents as well.

Most available alarm systems require the installation of an outside “pick proof” lock with an additional key that has to be carried around and separate switches installed at each door, the trunk, and the hood. Unfortunately, many of these systems are still vulnerable because the vehicle battery can be disconnected simply by reaching under the car and cutting the cable.

The alarm system described here eliminates all of these problems. It is operated by the switch on the door which turns on the dome light or by switches on the hood and trunk if present. Installation is very simple since only one wire of the car’s electrical system has to be modified. The alarm has a self-contained battery that is continuously trickle-charged, and the arming switch can be hidden in any convenient location in the car. When armed, the alarm disables all other electrical systems in the car including the starter, ignition, and lights; but it does not draw any current until triggered. To prevent triggering the alarm by the driver, an adjustable 3- to 8-second time delay is used, allowing ample time to arm the system before leaving the car and disarm it upon returning. It would take much longer than that for an intruder to analyze the system and find the switch—even if he knew that the car was protected by an alarm. Since most trunk and hood lights are operated by tilt switches, the car can also be protected against any unauthorized hoist and tow if the switches are set to trigger at a slight tilt from horizontal.

The driver also has the option of 3 modes of siren operation to suit different

JUNE 1972
situations. In mode A, when the door, hood, or trunk is opened, after the initial delay, the siren sounds for 60 seconds and then goes on and off at approximately 7-second intervals until the door is closed, the arming switch is turned off, or the batteries are exhausted. If the door is closed after the siren starts, it sounds for 60 seconds only and then stops and is ready to sound again when a new threat occurs.

In mode B, after the initial delay, the siren sounds for 60 seconds only and then stops whether the door remains open or is closed. If the door is closed, the alarm resets. This mode is suitable for parking in crowded areas where a 60-second siren is sufficient to frighten off an intruder without creating excessive noise.

In mode C, after the initial delay, the siren sounds continuously until the arming switch is turned off or the batteries are exhausted, whether the door remains open or closed. If the owner is within hearing range, mode C can be used.

How It Works. The system (see Fig. 1) was designed for use with a negative-ground battery system, but it can be changed for use with a positive ground by reversing the polarities of all the diodes and the auxiliary battery.

Thermostatic relays are used because they are simple and inexpensive. They are hermetically sealed in an inert gas to assure long life; and they are temperature compensated and unaffected by mechanical vibrations.

When the arming switch (S1) is on and a door is opened, the heating element of K1 is put in series with the car battery through the door (or trunk or hood) switch. If the car battery is disconnected, power is supplied by the auxiliary battery. After the delay interval, the normally open contacts of K1 close and K2 is energized. Relay K2 locks in through one set of contacts and supplies voltage to the siren through the other set. If terminal 6 is connected to 5 (mode A) the heater of K3 is energized. After 60 seconds, the contacts of K3 open to de-energize K2, turning off the siren and the heater of K3. When the heater of K3 cools (about 7 seconds), its contacts close, energizing K2, the siren and K3's heater. Since the heater hadn't completely cooled, the contacts will again open in about 7 seconds. This cycle continues until the door is closed to turn off K1. Relay K2 remains locked in until the contacts of K3 open to reset the alarm.

In mode B, terminals 6 and 7 are connected together. After K1 and K2 are energized, K3 will operate after 60 seconds to de-energize K2. If K1 is still on, the K3 heater will stay on, keeping K2 and the siren off. If the door is closed, the K1 contacts

**PARTS LIST**

B1—Eight rechargeable alkaline D cells
D1,D3—HEP151 diode
D2,D4,D5—HEP154 diode
F1,F2—10A, 3AG fuse and holder
K1—12V, normally open, 2-second delay thermostatic relay (Amperite 12N02)
K2—Dpdt, 12V dc relay (Line MK02D or similar)
K3—12V, normally closed, 60-second delay thermostatic relay (Amperite 12C60)
R1—50-ohm, 2-watt potentiometer (Ohmite CLU5001 or similar)
R2—27-ohm, 2-watt resistor
S1—Dpdt, 20A slide or toggle switch
Misr.—Battery holders, suitable chassis (Bad CU729HG or similar), octal sockets for K1 and K3, 8-terminal barrier strip, 12-volt siren, mounting hardware, wire, etc.

**Fig. 1. Alarm system has three modes of operation for different parking situations. Connection to vehicle's system is shown by the broken line.**

POPULAR ELECTRONICS Including Electronics World
Fig. 2. Circuit can be mounted in any enclosure which will fit conveniently in vehicle. The arrangement shown here used 4 x 5 x 6 in. box. Hide the unit as carefully as possible and try to conceal wiring.

Construction. The complete unit, including the 8-cell auxiliary battery can be enclosed in a 4" x 5" x 6" box as shown in Fig. 2. The layout is not critical and can be changed to suit the space and mounting conditions of the car. The two stud-mounted diodes (D1 and D3) are mounted with insulating washers on a ½-in. aluminum panel that also holds the sockets for relays K1 and K3. Switch S1 should be connected to terminals 1 and 2 with No. 12 (or larger) wire and to terminals 3 and 4 with No. 16 wire.

Installation. Hide the alarm unit as well as possible and disguise the wiring so that it looks like normal car wiring. The original car horns are not recommended for the alarm because their location makes them very vulnerable. Two small sirens can possibly be hidden in different locations instead of one large siren.

To test the auxiliary battery, remove fuse F1 and turn on the alarm with the door open.

The only part of the car's normal wiring that has to be changed is the single wire that connects the battery to the headlight switch, ignition switch and fuse block. This wire can usually be found at the bulkhead connector or tie point on the horn relay. The normal connections to the alternator voltage regulator and starter solenoid should remain on the battery side of the alarm system.

JUNE 1972
"At ComSonics we encourage all our technicians and engineers to enroll with CREI. Know why?"

WARREN BRAUN, President, ComSonics Inc., Virginia Engineer Of The Year, ASE International Award Winner, CREI Graduate
CREI's experts know the future. The changing years. Changes are expected. Continuing education for our employees is important. CREI's new course in Cable TV is an example. The CATV industry is expected to grow 250% in the next three years. I know the opportunities in Cable TV. I designed one of the first CATV systems in 1950. But technical advances are constantly changing the field. And since CREI's experts know most of what's going on in all areas of Electronics, I know that CREI can give my men some of the important, specialized training they'll need to maintain our position in Cable TV and our reputation in Electronics.

"As President of ComSonics, I see changes taking place in our Electronics business every day. We're in closed circuit TV and acoustical engineering...and pioneered in Cable TV. CREI gives my men the knowledge they need to work in new areas...CREI's new course in Cable TV is an example. The CATV industry is expected to grow 250% in the next three years. I know the opportunities in Cable TV. I designed one of the first CATV systems in 1950. But technical advances are constantly changing the field. And since CREI's experts know most of what's going on in all areas of Electronics, I know that CREI can give my men some of the important, specialized training they'll need to maintain our position in Cable TV and our reputation in Electronics.

"We've interviewed many technicians and engineers for jobs in the past year and had to reject them because their knowledge is archaic and out-of-date. A man is of no value to us if he doesn't keep up-to-date."

Some of the biggest names in electronics buy CREI courses for their own employees. CREI's students and graduates prove themselves on the job. They move ahead of the pack by earning promotions and salary increases.

The Future Belongs To You

You've been in Electronics long enough to know that the field is changing more rapidly than ever. New industries, like Cable TV, are born almost overnight. But surveys show that three out of four men now working in Electronics aren't technically qualified to work in these new areas. Clearly, the future will belong to the man who gets the right education now.

Start Learning At Home

But what you learn depends on which school you choose. Here's why CREI is among the best.

With the CREI program you study at home. At your own pace. There are no classes to miss, no work to make up. Each lesson is explained in clear, easy-to-read language. That's why many men do far better in home study than they ever did in school...even if they've been out of school for years. And the study habits they learn from CREI are sustained through life.

As a CREI student, you'll be assigned to an experienced instructor who will grade your assignments and offer constructive comments and criticism. If there's a special problem, the instructor will work with you until you understand it fully. You'll receive personal attention from your instructor because he deals with each student individually—as a class of one.

What Will I Learn?

You'll be learning the latest in advanced technology, geared to specific industry programs. Both theory and practical material are presented to meet all phases of job-related training needs.

CREI courses are written for the man who knows basic Electronics, but whose advancement depends on keeping his technical know-how current. You choose what you want to learn. You study subjects which help you grow and advance in your present job and which relate to your career objectives. CREI offers you the opportunity to continue your education throughout your working life.

Constantly Up-Dated Courses

Because of rapid changes in Electronics, CREI courses are constantly being revised and up-dated by professionals who work in Electronics every day. New developments are included as quickly as they occur. Right now, CREI students are getting the latest up-to-the-minute information on such things as Cable TV, LSI chips, microminiaturization, lasers and masers, telemetry systems, servomechanisms, and data links. If it's new in electronics, CREI—and you—will know about it!

Developed By Top Scientists And Engineers

CREI maintains a full-time advisory faculty of some of the top names in Electronics. Each is a specialist in his own field, an expert who plans and develops CREI lesson material. After each expert submits his course plan, it is carefully reviewed and written by the CREI educational staff. Then each course is broken down into individual lessons. And they make certain each lesson is clear and self-explanatory. Just the right length for easy understanding and effective study.

How Can I Qualify?

If you've read this far, your interest in getting ahead in Electronics is evident. Send for our famous book on how to prepare for tomorrow's jobs in Electronics—the book that has helped thousands of men just like you get ahead. For your free copy, simply mail postpaid card today.

CREI-A Division of the McGraw-Hill Continuing Education Company
Dept. E1206C 3939 Wisconsin Ave., Washington, D.C. 20016

Please mail me free book describing CREI Programs. I am interested in:
   College Credits for CREI Study
   oSpace Electronics
   oElectronic Engineering Technology
   oComputers and Industrial Electronics
   oNuclear Engineering
   oNon-Technical Course in Computer Programming
   oCATV Engineering

Name ___________________________ Age ______
Address ________________________ State _______ Zip Code ______
Employed by _______________________
Type of Present Work ______________ G.I. Bill ______

APPROVED FOR TRAINING UNDER NEW G.I. BILL

CREI, a Division of the McGraw-Hill Continuing Education Company
THE ADVENT of four-channel stereo need not necessarily obsolete your present hi-fi system. Regardless of which four-channel system is finally agreed on as a standard, we feel that it’s a safe bet that the conventional two-channel front end will remain and the four-channel decoding will take place after this stage. Therefore, it is more important than ever that the two-channel front end be of the best quality available. In essence, what you need is a noise-free, distortionless, nonoverloading amplifier that will follow the RIAA curve faithfully.

The phono preamplifier whose schematic is shown in Fig. 1 (only one channel is shown) comes as close to this “perfect” preamp as the state of the art permits. It is virtually impossible to overload this unit with
any cartridge presently available (at any frequency). The gain at 1 kHz is 42 dB (125 times) which means that even the most sensitive of cartridges may be used. But along with this high gain, the noise level is 0.7 μV referred to the input (63 dB below 1 mV). Since some audio measurements laboratories state noise as so many dB’s below 10 mV, this unit has a figure of −83 dB below 10 mV, which makes it a very quiet operator.

The output level is about 12 volts rms; and below 4 volts output, the distortion is just about unmeasurable, rising to 0.1% at the 12-volt output. This high level of output is available across the audio bandwidth of 20 to 20,000 Hz. The feedback loop maintains the frequency response flat to within ±0.5 dB of the ideal RIAA curve. There is also a switch to change the feedback loop to provide a flat response for use with an optional microphone input.

Construction. The foil pattern shown in Fig. 2 covers both channels of a stereo pair. The component indications are the same for both channels, with R18, C10, D1 and D2, and S1 common to both channels.

The schematic of the power supply for the amplifier is shown in Fig. 3. It would appear at first glance to be somewhat elaborate but it is essential that the system be free of hum since the amplifier gain at 60
Hz is almost 60 dB. For the same reason, transformer \( T_1 \) is a fully shielded toroid. In addition to the \(-43\) volts used in the amplifier, the supply also provides \(-47\) volts for powering other circuits. The regulator will handle up to 100 mA. The foil pattern and component layout for the power supply are shown in Fig. 4 on page 62. The printed circuit boards for power supply and preamp are available as mentioned in the Parts Lists.

With only the power supply operating, connect a voltmeter between terminal \( K \) and ground. The indicated voltage should be \(-47\) volts. If it is a little higher, connect a 40,000-to-60,000-ohm resistor across \( R_{23} \) to bring the voltage down to \(-47\). If you have a sensitive millivoltmeter, check to see that the noise at this terminal is below 200 \( \mu \)V. There should be no ripple at all when the output voltage of the supply is viewed on a scope.

Before mounting either the power supply or the preamp in the chassis, interconnect the two boards, with terminal \( L \) of the supply to terminal \( C \) of the preamp, and terminal \( J \) of the supply to \( B \) on the preamp.

**Fig. 2.** The foil pattern shown below is for both channels of the preamp. Component layout is shown at right.
Preamp board and power supply should not be mounted in chassis before conducting tests as described in text.

Common ground, making this the only chassis connection. The ground wire to the power supply should be removed and a ground wire run from the power supply point J to the selected input jack.

Fig. 3. The power supply circuit is more elaborate than some but this is essential to proper preamp operation.

**PARTS LIST**

**POWER SUPPLY**

- C11—500-µF, 70-volt electrolytic capacitor
- C12—10-µF, 16-volt tantalum capacitor
- C13—10-µF, 35-volt electrolytic capacitor
- C14—1000-µF, 50-volt electrolytic capacitor
- D3-D6—1N2070 diode
- D7—16-volt, 1-watt, 2% zener diode
- I1—117-volt neon lamp
- Q4—2N5087 transistor
- Q5—2N3053 transistor
- R19—430-ohm, 2-watt, 5% resistor
- R20—2000-ohm, 10% resistor
- R21R24—2700-ohm, 5% resistor
- R22R26—100,000-ohm, 20% resistor
- R23—6200-ohm resistor (see text)
- R25—220-ohm resistor
- S01—117-volt chassis mount receptacle
- TI—Shielded toroid transformer; 50V at 100 mA

Misc.—Pilot lamp holder, line cord, rubber feet, (4), suitable chassis (Bud CU-482), heat sink for Q5 (Wakefield 296-4), terminal strip, mounting hardware, etc.

Note—The following are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216: Transformer TI, #17221-1 for $13.00 plus postage and insurance for 1 lb.; preamplifier PC board, #LL118 for $3.15; power supply PC board, #LL119 for $2.45; complete kit of parts for $39.95, plus postage and insurance for 5 lb.
Mount the shielded transformer on the chassis, and place the heat sink on transistor Q5 of the power supply. The physical arrangement of the other chassis components and connectors is not critical.

Operation. To use the preamplifier in your present stereo system, simply plug the turntable signal cables into the input jacks (J1) and run the output jacks (J2) to the AUX inputs of your amplifier. Don't forget to phase all the ac plugs to get the lowest hum. If you find that you need a ground on the turntable chassis, run a wire from it to the mounting screw closest to the preamplifier input jack that was selected as the common ground.

PROJECT EVALUATION
HIRSCH-HOUCK LABORATORIES

The preamplifier does just about what the designer claims for it. Gain measurements, in general, were within 0.5 dB of the author's claims and show a loss of only 1.4 dB at 20 Hz relative to the extrapolated RIAA curve. Phono overload occurs at a very safe 110 millivolts, and the clipping level from the output is 14.7 volts, something of a record in our experience.

Distortion is really negligible, typically 0.013 to 0.03% over most of the useful range of the amplifier (even up to 10 volts output). The measurement of 0.31% at 125 millivolts output was partly hum and partly noise, but both were extremely low. The combined hum/noise output was about 100 microvolts.
NEW Solid-State Heathkit Color TV — the best TV kit ever offered


Kit G-900, 900-96...$599.95*
Kit G-900-6, remote control...$79.95*

NEW Heathkit Solid-State Ignition Analyzer

Analyzes standard, transistor, or capacitive discharge systems on 3, 4, 6, or 8 cyl. engines to find plug, points, wiring or distributor parts, incorrect dwell time, coil, condenser, transistor or CD circuitry problems. Built-in tach, 0-1000 & 0-5000 rpm ranges for carb. adjustments. Constant width patterns, primary or secondary, parade or super-imposed, plus expanded. Optional /20C supply for road checks, $24.95.*

Kit C-1015...$129.95*

NEW Heathkit 8-Digit Calculator

Adds, subtracts, multiplies, divides, chain or mixed functions and constant. Floating or selectable 7 position decimal. Plus, minus, and overflow indicators. Overflow protection of most significant 8 digits. Clear-display key to correct last entry. Standard keyboard. American LI circuitry. Bright 1/2" red digits. 120 or 240 VAC operation. Desktop black & white cabinet, 3/5" h x 6" w x 10 1/4" d.

Kit IC-2008...$129.95*

Heathkit Catalog

Build and save on over 350 kits

Your free 1972 Heathkit catalog describes more kits than ever over 350...all designed to give you fine performance and save you money when you buy and when you use. Choose solid state color TV, stereo, marine, automotive, test instruments, amateur radio, shortwave, home appliances, and more! Send for your free copy today.

NEW Heathkit Digital FM Tuner

Another Heathkit "first" in consumer electronics. Pure digital computer design including digital frequency synthesizer tuning employing phase-lock techniques. FET varactor FM RF front end, digital discriminator and readout result in performance specs and tuning convenience that already are the talk of the audio world: channel frequency accuracy better than 0.005%; less than 1.8 uV sensitivity; distortion levels of 0.1%; selectivity and IF rejection better than 95 dB; image & spurious rejection better than 90 dB; S/N ratio better than 65 dB; separation better than 40 dB. One of a kind, the AJ-1510 "computer tuner" is the only tuner offering you 3 distinct tuning modes, keyboard, computer-type punch cards (up to 31), plus automatic band scanning with variable speed and stereo-only capability. The 55 ICs, 50 transistors and 50 signal diodes mount on 10 modules with 7 plugging into a master board for optimum computer modularity & ease of assembly. Join the computer generation of audio equipment — order your AJ-1510 today.

Kit AJ-1510, tuner only...$339.95*
Kit AJ-1510, cabinet...$24.95*

NEW Heathkit 4-Channel Amplifier

Brings you 200 versatile watts for discrete or matrixed 4-channel sound, mono or stereo. Built-in matrix circuitry decodes matrixed 4-channel recordings or broadcasts, lets you use your existing stereo equipment as well as enhancing your present stereo records and tapes. As discrete 4-channel media grows the AA-2004 is ready...with four amplifiers producing 260 watts into 4 ohms (4x65), 200 watts into 8 ohms (4x50), 120 watts into 16 ohms (4x30), and controls for every source, mode and installation. Amplifier sections are controlled in pairs with one complete stereo system for left and right front speakers and another for left and right rear — so it can be used to power two complete 4-channel systems (up to 8 speakers) or, four separate-source mono systems if desired. Easy circuit board assembly.

Kit AA-2004, amplifier only...$349.95*
Kit AA-2004, cabinet...$24.95*

NEW Heathkit Solid-State FET VOM

Dual FET portable multimeter with lab grade accuracy, 10 megohm input and the ranges you really need: DCV and ACV ranges, 0.1 to 1000 v, ± 2% accuracy. 6 DC & AC current ranges, 10 microamps. to 1 amp. 7 resistance ranges, 1 (10 ohm center) to X-Meg. 9 dB ranges, -40 to +62.1%. precision metal-film dividers. 4½", 100 uk, ruggedized lautband meter, diode & fuse protected. Battery check. Kit IM-104, less batteries...$79.95.*
Single Sideband for the CB'er

"MAC," Barney said to his employer working at the bench beside him, "I want to ask you about the olden days."

"Do tell, Sonny." Mae answered, laying aside the diddle stick he was using to adjust a sound trap on the color chassis in front of him and affecting the cracked falsetto voice of old age; "how come and how 'olde?"?

"While I was eating at Burger Chef this noon, a young guy with a whip on his car noticed my ham call license plates and pulled up beside me and began peppering me with questions about the relative merits of single sideband as compared to amplitude modulation. He was an avid CB'er and was thinking of going SSB."

"Well, you should have been a gusher of information. After all, you're yakking it up on SSB all the time."

"That's just the point. Hams had already switched to SSB when I got my ticket. I've never operated anything but SSB and a little FM on two meters. On the bands I work, you hear very few AM stations. I felt like the man who, when asked how his wife was, answered 'Compared to what?'"

"Did you confess you didn't know?"

"Are you kidding? A ham never admits ignorance to a CB'er. I told him I had to get back to work but that I'd see him at the same place tomorrow and give him the scoop. I knew you have been an avid short-wave listener ever since you heard Marconi send his first message, and I figured you could fill me in."

"Thanks a bunch! But aren't you taking a chance in asking a senile old man for information? It just so happens, though, that I was listening during the time the big changeover from AM to SSB occurred on the ham bands, and I heard the pro and con of both systems debated heatedly over and over again. I will not be surprised if CB follows along much the same pattern in the next few years."

"I gather AM didn't give up easily."

"You gather correctly. There was a great deal of bitterness and name calling when the first few SSB stations came on the air. AM operators sneeringly referred to the new signals as 'Donald Duck' and 'slop bucket' modulation. The SSB boys retaliated with scornful references to 'Ancient Modulation.' Each group accused the other of putting out broad, interfering signals, and each group deliberately interfered with the other."

"Then the two types of modulation aren't very compatible."

Advantages of SSB. "Not very—at least not on the ham bands when you're receiving unwanted SSB signals on an AM receiver, and vice versa. But before we go into the 'why' of that, let's talk about the claimed advantages of single sideband. The first is talk power, and this adds up to a whopping 9 dB. Here's how.

"A very efficient 5-watt AM-CB transceiver might produce a 4-watt carrier without modulation. On a panoramic receiver which displays r-f voltage on the vertical axis of a scope tube and frequency on the horizontal axis, this carrier would be a single vertical line rising from the base line at the carrier frequency. We can adjust this line to a convenient one-unit length with the receiver controls. Now if we modulate this carrier 100% with a 1000-Hz sine wave, we see two other vertical lines, each ½ unit in length, spring up on either side of the carrier signal at a distance of 1 kHz from it. The carrier line remains unchanged. However, if we simultaneously examine the modulated envelope of our signal, we find..."
Not everybody needs a concert grand piano, nor does everybody need the best cartridge Shure makes to enjoy his kind of music on his kind of hi-fi system. Eventually, you'll want the renowned V-15 Type II Improved, the peerless cartridge for advanced systems and ample budgets. But, if your exchequer is a little tight, consider the M91E, widely acclaimed as the second best cartridge in the world. With a sharply circumscribed budget, all is far from lost. Choose any of the four models in the M44 Series, built for optimum performance in the easy-to-take $18-25 price range. Write for a complete catalog:

Shure Brothers Inc.,
222 Hartrey Ave., Evanston, Illinois 60204.

Circle No. 37 on Reader Service Card
CRUISING the water around New York City from Long Island Sound to New Jersey's Sandy Hook is an elite group of the City's Finest with its own vhf/FM communications system. The system is separate from the New York Police Department's radio network; and that makes the NYPD Harbor Patrol Unit very happy.

Restructuring the Bands. The Harbor Patrol Unit's good fortune came about when the Federal Communications Commission was restructuring the vhf/FM marine band and enlarging it from 18 channels to 39. Fitting those 39 channels into the same space in the radio spectrum formerly occupied by 18 channels was a big problem for the FCC.

Following the guidelines laid down by the International Telecommunication Union's World Administrative Radio Conference held in the fall of 1967 in Geneva, the FCC accomplished its task by reducing the channel-spacing from 50 kHz to 25 kHz. So there'd be no chance of "crosstalk" between channels it cut the FM "swing" from ±15 kHz (the so-called "wide-band FM") to ±5 kHz ("narrow-band FM").

In the process, the two "guard" bands on either side of channel 16 (156.8 MHz), the national distress, safety and calling frequency, became much too large. The low-side guard band was changed from 156.725-156.775 MHz to 156.7625-156.7875 MHz; the high-side from 156.825-156.875 MHz to 156.8125-156.8375 MHz. This meant that channels 15 and 17—not used up to now because of their proximity to channel 16—were available for assignment.

The FCC, therefore, made channel 15 (156.75 MHz) an "environmental" channel to be used for the broadcasting of weather information, notices to mariners, local conditions, hazards to navigation and other items of interest to mariners. This was done with the intention that it would eventually replace the 162.55-MHz Weather Bureau forecasting service as far as the marine community was concerned. Channel 17 (156.85 MHz) was designated the "state control" channel for "communications, other than Port Operations, in the Maritime Mobile Service on very high frequencies (vhf) between coast stations, operated by a government, other than Federal, boating administration and ship stations in which messages are restricted to those of immediate concern and are related directly
Save money and improve car performance at the same time.

Maintenance costs go down and performance increases when you put a Delta Mark Ten Capacitive Discharge Ignition System on your car.

For eight years we've been telling you about the tremendous advantages of CDI systems. We've promised and delivered better performance for cars, boats and trucks. Hundreds of thousands of satisfied customers testify to that fact. However during these eight years, we've been asked over and over again, "If CDI systems are so great, why doesn't Detroit adopt them?" It's taken a long time, but finally Detroit has recognized the value of the CDI system. Chrysler, long noted for excellence in engineering, is now installing electronic ignitions in new cars. Have you seen their ads? Heard their commercials? They're repeating what we've said for eight years.

Electronic ignition systems not only improve performance, but eliminate the need for most tune-ups. If you're not buying a new car, but want new car performance, put a Mark Ten or Mark Ten B on your present automobile. If you're purchasing a new car with no CDI system, install a Mark Ten or Mark Ten B and enjoy the benefits of low maintenance and increased performance.

HERE'S WHAT A MARK TEN WILL DO FOR YOU:

Mark Ten and Mark Ten B—up to 20% increase in gasoline mileage □ Eliminates 3 out of 4 tune-ups □ Installs in only 10 minutes □ Spark plugs last 3 to 10 times longer □ Dramatic increase in performance □ Promotes more complete combustion □ Instant starts in all weather.

Mark Ten B—Improves combustion, reducing contaminants □ Handy switch with redundant contacts for instant return to standard ignition □ Applicable to ANY 12 volt negative ground engine □ Eliminates starting and idle problems □ Longer spark duration during cranking and idling.

Superior Products at Sensible Prices

Mark Ten (Assembled) $44.95 ppd
Mark Ten (Deltakit) $29.95 ppd
Mark Ten B $59.95 ppd

Kit available in 12 volt only, positive or negative ground

(12 volt negative ground only)

Order today!

DELTA PRODUCTS, INC.
P.O. Box 1147 / Grand Junction, Colo. 81501
(303) 242-9000

Please send me literature immediately: □
Enclosed is $__________ □ Ship ppd. □ Ship C.O.D.

Please send:
—Mark Ten B @ $59.95
—Standard Mark Ten (Assembled) @ $44.95
—6 Volt: Neg. Ground Only □ Positive Ground
—12 Volt: Specify □ Negative Ground
—Standard Mark Ten (Deltakit®) @ $29.95
(12 Volt Positive or Negative Ground Only)

Car Year ___________ Make ____________________________
Name ____________________________________________
Address __________________________________________
City/State Zip ________________________________

CIRCLE NO. 15 ON READER SERVICE CARD
to the regulation and control, or rendering of assistance.”

It was this state control channel which 
NYPD's Harbor Patrol Unit chose as the 
backbone of its communications system. Being responsible for the enforcement of the New York State Navigation Law, the 
Federal Boating Act of 1958, marine 
legislation in the Administrative Code and 
Park Department regulations and—presumably—the recently enacted 
Federal Boat Safety Act of 1971, the 
Harbor Patrol Unit is brought squarely 
under the FCC requirements. To it they 
added channel 16 (which they monitor 
continuously), channel 12 (156.6 MHz) and channel 6 (156.3 MHz).

Before June 1971, when the new system went into operation (the same time, 
incidentally, that the group was elevated from “precinct” status—the Harbor 
Precinct—to its present quasi-autonomous 
position as the Harbor Patrol Unit) the 
HPU had to make do with a disjointed and 
frequently unsatisfactory communications set-up. If its Randall’s Island headquarters 
wanted to contact one of its eleven launches 
patrolling the ten “posts” in the waters 
under its jurisdiction, it had to call the 
NYPD Communications Central at 240 Centre Street in Manhattan by telephone, 
then wait until one of the two police 
frequencies was free before the message 
could be relayed.

Besides the drawback of having to use a “third party” which usually wasn’t familiar 
with the Harbor Patrol Unit’s operation 
(leaving to fouled-up messages), there was the added disadvantage that the summer boating months, when the HPU’s case-load 
was heavy and effective and fast 
communications were vital, constituted exactly the same time of year when police activity ashore was at its height. Hence, both “police” frequencies were unavailable to Harbor Patrol Unit traffic for long 
stretches.

“With our present responsibilities,” says 
Captain John Lowe, the Harbor Patrol 
Unit’s Commanding Officer, “it’s extremely important that we be able to talk directly to our patrol craft. There are times when minutes are vital.” Lowe went on to cite instances where it was necessary to have a quick interchange of ideas so that a decision could be made as to whether to use some of the Unit’s special equipment such as its remote-control underwater television camera used to pinpoint hard-to-find objects on the harbor’s murky bottom.

**A Solid Coverage Area.** To insure 
coverage area under its jurisdiction— including the waters in Long Island Sound (from the Westchester County Line), 
New York Harbor, the North River up to 
Spuyten Duyvil Creek and all navigable 
waters to the New Jersey shore as well as 
two miles into the Atlantic Ocean and 
assorted lakes—the Harbor Patrol Unit 
have its transmitter/receiver atop one of 
Manhattan’s skyscrapers. The unit is 
remotely controlled from the Randall’s 
Island station house.

All eleven of the Harbor Patrol Unit’s 
50’ twin diesel-powered launches are 
equipped with 4-channel vhf/FM marine 
radiotelephones as well as two-channel 
police-frequency transceivers. None of the 
launches carries 2-3-MHz marine band 
equipment nor does the Randall’s Island 
base. This might be regarded as a weak 
point in the HPU’s communications system 
as can the minimal 4-channel coverage 
of the 39-channel vhf/FM marine band. 
However, in view of the Harbor Patrol 
Unit’s specialized operation and the fact 
that pleasure craft will be gradually 
disappearing from the 2-3-MHz band 
during the five-year transition period 
between January 1, 1972 and January 1, 
1977, it should serve at least for the time 
being.

The need for a separate two-way network is obvious when you consider the Harbor 
Patrol Unit’s work. Law enforcement 
occupies a small percentage of its case 
load. In 1970, for instance, the total of 
out-and-out “police” cases—grand larceny, 
petit larceny, criminal mischief and the 
like—came to only 199 while there were 
580 search and rescue cases. In addition, 
there were 107 cases involving the recovery 
of bodies of which 23 were by grappling 
and/or scuba divers. During the year the 
Harbor Patrol Unit rescued 106 persons in 
distress. The total assignments for 1970 
came to 2768.

The HPU’s involvement with search and 
rescue promises to be even closer from 
now on. The first six months of 1971 showed that there were already 495 search 
and rescue missions among which were 37 
rescues and 315 cases of assistance to boats 
which were disabled, adrift or sinking. In 
addition, the Unit investigated 36 boating
accidents and was assigned to patrol 32 regattas and other special boating events.

Communications is the Backbone. Along with another expert in the field, the United States Coast Guard, the Harbor Patrol Unit has found that communications is the backbone of search and rescue. Higher echelon thinking in the NYPD evidently echoes this philosophy. When the IIPU’s vhf/FM system went into operation in the summer of 1971, it was decided to relieve the group of some time-consuming land duties so that it could focus full-time on the 576 miles of New York City’s waterfront, the 146 square miles of water under its jurisdiction and the still-growing pleasure boat population. Its responsibility for the Triboro Bridge was divided between the 114th Precinct (Queens), the 25th Precinct (Manhattan) and the 40th Precinct (Bronx). Randall’s and Ward’s Islands went to the 25th Precinct, Welfare Island to the 114th and Rikers Island to the 40th.

Basically, the Harbor Patrol Unit’s use of its vhf/FM communications system goes like this: channel 17 (156.85 MHz) is the one on which the majority of HPU traffic is carried. This is a ship-to-coast only channel, incidentally. Channel 16 (156.8 MHz), the national distress, safety and calling frequency, is monitored continuously by both the base station on Randall’s Island and all police launches. Channel 12 (156.6 MHz) serves as the Harbor Patrol Unit’s link with the Coast Guard for routine (non-distress) traffic as well as with other ship stations for the operational handling, movement and safety of vessels. “Ship”, by-the-way, means anything capable of being used as a means of conveyance on the water, including pleasure craft according to the FCC. Channel 6 (156.3 MHz) is used for ship-to-ship only safety communications.

By now, the novelty of having its own two-way radio system has worn off although Operations Officer Sgt. John Murphy still occasionally calls the unit farthest from Randall’s Island just to impress visitors. It remains for the 1972 pleasure boating season to put the Harbor Patrol Unit’s vhf/FM network to the acid test. In any event, it’s all a far cry from 1858 when a squad of patrolmen manned a fleet of five rowboats and did a lot of yelling at each other.

JUNE 1972
This important job (and its big income) is reserved for a qualified electronics technician. It can be you!

It's a fact. There are thousands of jobs like this one available right now for skilled electronics technicians. What's more, these men are going to be in even greater demand in the years ahead. But how about you? Where do you fit into the picture? Your opportunity will never be greater ... so act now to take advantage of it. The first step? Learn electronics fundamentals ... develop a practical understanding of transistors, trouble-shooting techniques, pulse circuitry, micro-electronics, computers and many other exciting new developments in this growth field. Prepare yourself now for a job with a bright future ... unlimited opportunity with lasting security ... prestige and a steadily growing paycheck.

Cleveland Institute of Electronics courses have been stepping stones to good jobs in electronics for thousands of ambitious men. Why not join them? You can learn at home, in your spare time, and tuition is remarkably low. Read the important information on the facing page. Then fill out the postage-free reply card and drop it in the mail today. Without obligation we'll send you all the details. But act now ... and get your high-paying job just that much sooner.
How You Can Succeed In Electronics ...Select Your Future From Seven Career Programs

The "right" course for your career
Cleveland Institute offers not one, but seven different and up-to-date Electronics Home-Study Programs. Look them over. Pick the one that is "right" for you. Then mark your selection on the bound-in reply card and send it to us. In a few days you will have complete details... without obligation.

1A. Electronics Technology
A comprehensive program covering Automation, Communications, Computers, Industrial Controls, Solid-State Devices, and preparation for a 1st Class FCC License.

1B. Electronics Technology with Laboratory
Includes all areas of Course 1A including 1st Class FCC License preparation. In addition, student receives 161-piece Electronics Laboratory and 17 "lab" lessons for "hands-on" experience.

2. Broadcast Engineering
Here's an excellent studio engineering program which will get you a 1st Class FCC License. Now includes Video Systems, Monitors, FM Stereo Multiplex, Color Transmitter Operation and Remote Control.

3. First Class FCC License
If a 1st Class FCC ticket is your goal, this streamlined program will do the trick and enable you to maintain and service all types of transmitting equipment.

4. Electronic Communications
Mobile Radio, Microwave and 2nd Class FCC preparation are just a few of the topics covered in this "compact" program. Highly recommended for jobs with telephone companies.

5. Industrial Electronics & Automation
This exciting program includes many important subjects such as Computers, Electronic Heating and Welding, Industrial Controls, Servomechanisms and Solid-State Devices.

6. Electronics Engineering
A college-level course for men already working in Electronics... covers Steady-State and Transient Network Theory, Solid-State Physics and Circuitry, Pulse Techniques, Computer Logic and Mathematics through Calculus.

An FCC License... or your money back!
The CIE courses described here will prepare you for the FCC License specified. In fact, we are so certain of their effectiveness we offer this warranty: Should you fail to pass the FCC examination after completing a CIE license preparation course, we will refund all tuition payments. You get an FCC license... or your money back. This warranty is valid during the entire completion time established for your course.

CIE's AUTO-PROGRAMMED* Lessons help you learn faster and easier
Cleveland Institute uses the new programmed learning approach. Our Auto-Programmed Lessons present facts and concepts in small, easy-to-understand bits... reinforce them with clear explanations and examples. Students learn more thoroughly and faster through this modern, simplified method. You, too, will absorb... retain... advance at your own pace.

Employment Assistance available for all CIE students... at no extra cost
Once enrolled with CIE, you will get a bimonthly listing of high-paying, interesting jobs available with top companies throughout the country. Many CIE graduates hold such jobs with leading companies like American Airlines, AT&T, General Electric, General Telephone and Electronics, IBM, Motorola, Penn Central Railroad, Raytheon, RCA, Westinghouse and Xerox... to name a few.

CIE Lessons are continually up-dated.
All lesson books and materials from CIE are continually revised or replaced according to the current needs of industry and the rapidly advancing and changing state of the art.

New Revised G.I. Bill Benefits:
All CIE courses are approved for full tuition refund under the new G.I. Bill. If you served on active duty since January 31, 1955, OR are in service now with more than 180 days active duty, check box on reply card or coupon to get latest G.I. Bill information.

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

If card has been removed, mail this coupon for 2 FREE BOOKS

Name_________________________________________Age________________________
Address__________________________________________State__________________
City______________________________________________Zip______________________

☐ Veterans & Servicemen: check here for G.I. Bill information.

Accredited Member National Home Study Council

CIRCLE NO. 12 ON READER SERVICE CARD
THE Telex 1320 series of communication headphones employs highly sensitive drivers which are designed to be impervious to temperature and humidity and to have closely controlled operating characteristics. The earpieces are molded of a high-impact ABS plastic similar to that used in telephones. The Mylar cone drivers are protected by a stainless steel grille. The removable vinyl covered ear cushions are filled with polyurethane foam. The 6' straight cord is fitted with a molded plastic phone plug and attaches to the earpiece with a molded connector. The connector is locked into place with a pin which can easily be removed to facilitate on-the-spot field replacement of the cord. The adjustable headband is made of vinyl-padded stainless steel.

The series 1320 phones are available with either single or dual earpieces and with or without carbon or dynamic microphones on adjustable booms mounted on the left earpiece. We tested the Model CS-7, a dual earpiece headphone without the microphone attachment.

The nominal impedance of the CS-7 phones is specified as 600 ohms; our measurements revealed a constant impedance of approximately this figure from 20 Hz to 10,000 Hz. It increased to 800 ohms at about 20,000 Hz. The frequency response, measured with our nonstandard “artificial ear” coupler setup, was very similar to that of a number of moderately priced stereo headphones in the $20 to $40 range which we tested in the past. It extended from 20 Hz to 15,000 Hz (the upper limit of our microphone calibration) with the normal irregularities one experiences with coupler measurements of earphone response. We would judge that the manufacturer's specification of usable response of 20 to 20,000 Hz is a justifiable claim.

At a drive level of 3 volts rms (corresponding to 15 milliwatts), the acoustic output had a harmonic distortion content of 3 percent at 400 Hz. Although we did not attempt to measure the actual acoustic output with this drive level, the resulting listening volume was very high—somewhat louder, in fact, than we would normally care to use.

In a rough sense, we can relate the characteristics of the Telex CS-7 phones to those of several popular stereo headphones. In general, its frequency response and smoothness are quite comparable to those of typical medium-priced phones, and its efficiency is higher than average, by as much as 10 dB at middle and low frequencies. It is comfortable to wear, with snug fitting ear cush-
ions and a weight of only one pound. Acoustic isolation from outside noises appears to be about average when compared with stereo headphones which also use padded or liquid-filled ear cushions.

We used the CS-7 phones with two communication receivers. In both cases, the listening volume was more than adequate, and the phones were comfortable over long listening periods. Comparing their sound reproduction quality to that of the military surplus phones we had been using, the improved bass response of the CS-7 was immediately apparent in the form of improved quality on SSB signals. It also made the hitherto unnoticed audio hum in the receiver only too audible. In this case, the hum was not really objectionable, but many receivers have considerable audio hum, relying on the speaker or headphone low-frequency cutoff to attenuate and damp it out. Using the CS-7 phones with such a receiver is akin to using wide-range loudspeakers with a very inexpensive amplifier—the deficiencies of the source are faithfully reproduced!

The list price of the Telex Model CS-7 communication headphones is $29.95.

Circle No. 65 on Reader Service Card

AUDIOTEX MODEL 30-5104 SPEAKER SYSTEM
(A Hirsch-Houck Lab Report)

A SPEAKER system designer faces several possible trade-offs between size, weight, efficiency, power-handling ability, frequency response (particularly at the lower bass frequencies), and price when putting together a practical system. No speaker system can excel in all of the above mentioned areas; few are outstanding in more than a couple of them. The Audiotex Model 30-5104 speaker system, manufactured in Japan and marketed in the U.S. by GC Electronics Division of Hydrometals, Inc., is an excellent illustration of one approach to the design problem.

This speaker system, measuring 15½" x 9½" x 9" and weighing only 9 lb 10 oz, is a two-way design employing an 8" woofer and a 3" cone-type tweeter. The crossover frequency is unspecified. The 8-ohm system is designed for a maximum power rating of 25 watts.

Lab Tests. In our multiple microphone frequency response measurement, the Audiotex speaker system had a surprisingly smooth output over most of the audible frequency range. Between 250 Hz and 15,000 Hz, the output varied by only ±3.5 dB, which would be a creditable achievement for far more expensive speaker systems. However, one of the obvious compromises in the system’s design is the sacrifice made in the bass performance. The response of the system fell off below 150 Hz, and was down 10 dB at 70 Hz relative to the midrange level.

The low-frequency power handling ability is also limited. The distortion, normally low beyond 150 Hz, climbed rapidly to 5 percent at 135 Hz and to 14 percent at 120 Hz. These measurements were made at a 1-watt drive level. The impedance of the system was between 7 and 15 ohms over most of the frequency range, rising to a maximum of 22 ohms at the system’s resonant frequency of 100 Hz. The tone-burst response was uniformly good over the entire useful range of the speaker system.

Our tests showed which operating parameters had not been sacrificed in the final system design. The efficiency of the Audiotex speaker system, for example, is high compared to many other compact systems. In fact, over most of the useful frequency range, it is about 10 dB more efficient than
are other similarly priced small speaker systems we have tested in the past.

Although the foregoing could be interpreted to mean that the Audiotex speaker system produces 10 dB more volume for a given driving power (which it does), it is more realistic to view it as requiring only one-tenth as much driving power as most other compacts for the same volume level. The Audiotex system is not intended for loud playing, but it will do a fine job at normal listening levels in average sized rooms. Because of its efficiency and limited low-frequency output, it can be driven effectively by some of the least expensive receivers and amplifiers which would be unsuitable for use with the usual inefficient "bookshelf" speaker system.

**User Comments.** We compared the Audiotex speaker system in an A-B fashion to other small speaker systems selling at or slightly higher in price than the 30-5104. The signal source was a low-cost receiver, selling for less than $175, which delivered about 10 watts per channel and consider-
ably less at very low frequencies. Our immediate impression, once we had compensated for the considerably louder sound from the Audiotex system, was of a clean, somewhat projected sound character with a rather thin bass. The receiver's loudness compensation, however, was able to restore a satisfactory balance, especially at the low-volume control settings made possible by the system's high efficiency. The comparison speaker could play as loud as the Audiotex, but only with the volume control nearly all the way up.

As part of a budget-priced music system or as an extension speaker system, the Audiotex 30-5104 could be a logical and satisfying choice. An excellent application would be for the rear speaker systems in a four-channel stereo setup where their high efficiency can be an advantage and the low frequency and power limitations would be partially offset by the 3-dB lower level drive supplied to the rear speaker systems.

The Audiotex 30-5104 speaker system comes housed in a walnut-finished enclosure. Selling price is $49.95.

---

**TRIPLETT MODEL 990 MAINTENANCE IN A CASE**

If you lug around a suitcase full of test instruments when going on service calls, only to discover that you are missing an important part or that a delicate piece of equipment has been damaged during transport, take heart. At a cost of $221, Triplet is now distributing their "maintenance in a case" Model 990 industrial test instrument...
lab which can be used to make fast and accurate measurements of voltage, current, resistance, output level in decibels, rotational speed in rpm, and temperature.

The versatile lab consists of a Model 900 multimeter which has special temperature, dB, and rpm scales in addition to the usual complement of voltage, current, and resistance scales. Complete with its own leather carrying handle, the multimeter also features a fast-acting overload protection circuit.

A Model 901 tachometer/generator is supplied to provide the VOM with the capability of measuring rotational speed between 0 and 500 rpm in one range and between 0 and 5000 rpm in a second range. A rubber tip on the tachometer/generator is held in firm contact with the center of the rotating part; the speed of rotation is then an indication of pointer swing on the special rpm scale of the multimeter. Virtually any type of rotating machinery—including motors and blowers—can provide an rpm indication with this tach/generator-VOM combination.

The temperature probe can be used for air, liquid, or surface temperature measurements in two ranges: -50° F to +100° F and +40° F to +300° F. This probe is used to measure the operating temperature of any type of equipment, inlet and outlet temperatures of furnaces and air conditioners.

A Model 10 clamp-on ammeter adapter
is provided in the Model 990. It is used to measure ac current flowing through a wire without having to break the conductor to insert the meter into the circuit. A Model 101 line separator is also provided to separate one conductor of two-conductor cables so that the Model 10 clamp-on can be used in two-conductor cable systems. Model 611 leads are used to connect the clamp-on ammeter to the multimeter. And a dc current shunt is provided to extend the current measuring capabilities to 100 amperes with only a 250-mV drop.

Having just about all of the test equipment in one padded case (see photo) certainly eases things from a physical viewpoint. As far as use is concerned, we found that the package does a good job. No problems were encountered in using any of the devices supplied nor in interpreting any of the multimeter scales with the specific sensing devices used.

In our bench tests, we used the temperature probe to check warm semiconductors and heat sinks. The ac ammeter section was used to check the rated current (converted to watts) of various electrical appliances, while the dc portion was used for checking the current consumption of several electronic items—among them an audio amplifier and a shortwave receiver. In A-B checks between the Model 990 and several other special-purpose test instruments, we judged that the former provides reasonably good to excellent accuracy in all modes of operation.

Circle No. 67 on Reader Service Card

LEADER INSTRUMENTS MODEL LFC-943
TV FIELD STRENGTH METER

The things one hooks up to the antenna terminals of a television receiver determine the quality of the picture which will appear on the screen. The list of hookup items includes the orientation and directional characteristics of the antenna, the performance of any boosters used, the level of the incoming signals from MATV and CATV outlets, and the performance of multi-receiver antenna signal splitters. On the other hand, how does one compare the effective “pickup” of the various types and sizes of antennas on the market, assuming that there is a choice to be made? There is, of course, the guess—which-is-better routine in which you change antennas while comparing results. But this means that you have to remember what the previous antennas, boosters, and amplifiers produced in the way of usable signal.

Now there is an easy way out of the selection dilemma for the specialist who handles all types of antennas and signal transmission systems. All he needs is the battery-powered Model LFC-943 field strength meter available from Leader Instruments. This extremely easy-to-use instrument covers the entire vhf/uhf TV range from channel 2 through channel 83. It indicates signal strength in both decibels and microvolts from -40 to +60 dB (10 µV to 1 V) on the vhf channels and from -30 to +40 dB (31.6 µV to 100 mV) on the uhf channels.

The user hooks up the antenna, coupler, or amplifier to be checked to the antenna input terminals on the test set; tunes the channel selector in the test set to the appropriate station (an internal audio system allows the sync buzz to be heard to aid in peaking the tuning); and observes the movement of the meter pointer. A set of attenuators can be switched into the circuit as needed to produce a usable meter indication. The final signal strength is then the meter pointer indication plus the value of the switched-in attenuators.

An earphone is provided for using the LFC-943 in areas where the ambient noise is high. A neck strap, also provided, allows hands-free operation, permitting the user to make mechanical adjustments on the antenna or electrical adjustments on an amplifier or coupler/splitter system. A switch position is provided for testing the internal batteries.

The LFC-943 is essentially a narrow band TV receiver. For the vhf band, the signal is applied through switchable attenuators to the vhf tuner. A four-stage solid-state i-f amplifier then drives a diode...
detector whose rectified output current drives the meter movement, calibrated in terms of dB and μV. For audible monitoring, an internal audio system is used to drive either an internal speaker or an earphone, either of which can be switched in as desired.

In the uhf configuration, the input to the uhf terminal drives a conventional solid-state uhf tuner whose output is coupled through the attenuator network to the vhf tuner where it is applied in the conventional uhf position. The remaining circuitry is the same as in the vhf configuration.

Operating power is derived from eight C cells; and a transistorized voltage regulator converts the incoming 12 volts to a constant 9-volt output.

We used the LFC-943 field strength meter to check a number of multi-set splitters and a few antennas. We were surprised to note the differences in output levels between the splitters, with some having surprisingly high losses scattered across the TV band. Other splitters were found to be reasonably flat across the band.

Circle No. 68 on Reader Service Card

Mura "Thermym" Temperature Probe

One of the more common problems one encounters when working with transistors—especially the medium- and high-power types—is knowing how hot a transistor should get when operated properly and how hot it can get when operated improperly. Most of us merely place a fingertip on the case of the transistor and take a wild guess at how hot it is, basing our guesses on how long we can keep our fingertips there. Most transistor specification sheets supply—in addition to electrical operating parameters—the correct operating and maximum temperatures. Even so, a fingertip is hardly a reliable temperature probe. And who ever heard of a calibrated guess?

Having worked with bulb thermometers and a couple of home-buil thermistor temperature sensors, we are fully aware of their shortcomings. Consequently, we welcome the appearance of the Mura "Thermym" temperature sensor adapter. This device is designed to be used in conjunction with virtually any ohmmeter you have. Its temperature measuring range goes from a low end temperature of −60° F to a top end of
400° F; translated into engineering and scientific terms, the temperature range is from -50° C to 200° C.

After plugging the Thermy into the ohmmeter, the user merely touches the 1½"-long probe-like tip to the surface whose temperature is to be measured. He then notes the resistance indicated on the ohmmeter scale and uses the indication to look up the exact temperature on the chart attached to the probe handle. In essence, the temperatures measured by the Thermy are a function of the ohms scale you are using. Also, the reaction time of the adapter is fairly good, stabilizing quite rapidly after probe-to-surface contact is made. Accuracy of measurement is also pretty good.

The Thermy is supplied with a 3' cable and a snap-cover case and the price, including case, is $14.95.

KURZ-KASCH AUTO-PROBE

WHEN we have to check out the various electrical circuits in our motor vehicles—cars, boats, motorcycles, airplanes, or farm tractors—what usually happens is out comes our trusty VOM and we set to work. Unfortunately, in some cases while undergoing the inevitable acrobatics under the dashboard or under the hood and balancing the meter in precarious places, most of which are not level, tragedy strikes as the VOM takes a dive for the hard concrete pavement. Scratch one once-useful meter.

If you have to make a number of electrical checks in and around your vehicle or trailer, Kurz-Kasch, Inc., would like you to know about their handy "Auto-Probe" tester which they sell for $4.99. Looking like a shirtpocket pencil flashlight, the Auto-Probe has a sharp test tip (for getting through wire insulation without having to break the circuit) at one end. Out of the other end comes a 40" flexible wire terminated in an alligator clip.

Two Indicator Lamps. Behind the translucent cap at the test tip end of the Auto-Probe is a pair of small incandescent lamps, one white and the other red. When the lead is clipped onto chassis ground via the metal vehicle frame, touching the probe tip to a "hot" lead causes the red lamp to light. If the probe tip is touched to any point at chassis ground, however, the white lamp comes on. On the other hand, if contact is made to a disconnected wire, neither lamp comes on.

The Auto-Probe’s circuitry is contained in a sturdy chrome steel case measuring ½” in diameter and 6” long. Also contained inside the housing is a pair of AA cells which provide power to the tester.

The Auto-Probe is available in a 12-volt negative or positive ground model.
TV SIGNAL SPLITTER

BY C. R. LEWART

THE circuit shown here provides a simple means of connecting two or more TV sets to a common antenna. Besides providing excellent separation, and a good terminating impedance to the antenna lead-in, the circuit may also be used for mixing or distributing r-f signals at other than TV frequencies.

The two-set splitter consists of three equal-valued resistors, each selected to match the impedance of the lead-in. The three resistors, together with the impedance of the lead-in, form a Wheatstone bridge. Each TV set will "see" a 300-ohm impedance, and will be isolated from the other sets. Assuming that the input impedance of the TV sets is close to 300 ohms, the lead-in cable will see an impedance of 300 ohms, and thus be perfectly terminated. The electrical loss in the circuit is 6 dB.

To supply three, four, or more TV sets, the diagram also shows how a number of splitters may be interconnected. For four TV sets, losses will be 12 dB, for eight sets 18 dB, etc. For three TV sets, one will have only 6 dB with 12 dB for the other two. These losses compare with the approximate 4% dB for a coil-type TV signal splitter.
The backbone of all instruments used for measuring voltage, current, and resistance always used to be the familiar analog or moving-pointer meter, usually having a number of different scales. With the development of the gas-discharge readout tube, a new breed of test instrument came into being. Gone was the need for scale interpolations, and gone were the nonlinear and crowded meter scales that made accurate reading difficult. The readout tube also led to the creation of an easy-to-use frequency measuring device or counter.

In the early days, the gas-discharge readouts were driven by vacuum-tube circuits. Thus, the first digital instruments were rather bulky and expensive and were found only in research labs. With the introduction of the transistor, these instruments came down both in size and price, and were more commonly available. Then along came the digital IC. It was this event that rapidly led to the many various new types of digital instruments we see in present catalogs. The single-plane 7-segment display was soon developed. With more advanced semiconductor techniques, especially in light-emitting diodes, the complete solid-state 7-segment readout came into being. With their lower power requirements and small size, they have led to the development of really portable, high-quality, and reasonably priced instruments.

In the not-too-distant future, we shall most likely see the use of liquid crystal readouts with an even greater reduction in power requirements.

There are, at present, two types of digital-readout instruments: the multi-meter that, in various configurations, measures ac and dc voltage, current, and resistance; and the frequency meter (which may also include event counting).

Two methods of creating time bases for digital instruments are used. The first has the commercial power line as the frequency reference, and the other has a crystal-controlled oscillator used as a clock. Because the power line frequency can wander somewhat from the nominal 60 Hz, accuracy beyond 2½ or 3 digits is always in doubt. With a crystal oscillator approach, the clock frequency is always very close so that the timing interval is excellent and accuracy can be maintained to many decimal places.

The accuracy of most digital instruments is expressed as a percentage of the indication and usually ranges from 0.1% to 0.001%. In most cases, the last digit in frequency counters is always in doubt by ±1 count.

The DVM. Digital voltmeters are essentially special-purpose frequency counters because the input voltage is converted into a proportional number of pulses which are counted. This can be done in a number of ways; direct voltage-to-frequency conversion is the simplest. In this approach, the input voltage...
controls the frequency of a voltage-controlled oscillator. The oscillator is gated on and off with a known gate time, and the number of pulses passed during this period is displayed on the readouts.

Another approach is to start up a known-frequency oscillator and when the unknown input voltage is at the same level as an internally generated ramp, the oscillator is stopped. The number of oscillator pulses fed to the readouts is arranged to represent the actual value of the input voltage.

Digital multimeters are usually specified in terms of strange numbers like “2½” or “3½” digits. A 2½-digit instrument has two complete decades (0-9) and a single “1” on the left side. This type of instrument can indicate 1.99, 19.9, or 199 units; while the 3½-digit type can indicate 1.999, 19.99, 199.9, or 1999 units. All digital instruments are equipped with an “overrange” indicator to signal when the capacity of the display has been exceeded. When this indicator comes on, it is a signal to reset the instrument to the next higher range. Many instruments also include automatic polarity indication, and automatically adjust the decimal point to the correct place depending on the range.

As with analog multimeters, always make sure that the DVM you select has a high input impedance to avoid loading the circuit under test. To have a negligible effect on circuit loading, the input impedance must exceed the measured load impedance by at least a factor of 10^n where n is the number of digits in the display. Of course, the sensitivity of the instrument must be such that it will work with the expected signal level.

Frequency Counter. An electronic frequency counter compares (gates) an unknown frequency against a known time interval and presents the results on the digital readouts. In some instruments, provisions are also made for period measurements. In this approach, an unknown time period gates on a known frequency oscillator, with the results displayed.

Most frequency counters come with whole-digit display and include an overrange indicator. Frequency ranges are from about 1 Hz to about 35 MHz. However, front-end scalers are available to enable the counter to reach about 175 MHz.
There are three main sources of errors in a frequency counter. These are a ±1 count ambiguity, time-base instability, and trigger error noise. The ±1 count ambiguity occurs because the input pulses and the time base are normally not synchronized. The larger the number of events counted, the less the error, and this explains why long gate times result in higher accuracy in frequency measurements. Time base instability is usually due to power line frequency fluctuations (when this method of gating is used), or crystal drift when using this type of oscillator as the gate time source. Trigger error is due to the fact that the counter cannot tell the difference between a real signal and noise mixed with the signal.

Who Makes What. Following are some examples of the less expensive digital instruments: Heath Company IM-102 digital multimeter ($229.95 in kit form) is a 3½-digit instrument using a dual-slope integrator that does not depend on a stable clock for accuracy. With an input impedance in excess of 1 megohm on ac and 100 megohms on dc, this unit has 5 ac and 5 dc voltage ranges from 200 mV to 1000 V; 5 ac and 5 dc current ranges from 200 µA to 2 amperes; and 6 resistance ranges to 20 megohms. Accuracy is ±0.2% (0.1% with “tweaking”), and all circuits are overload protected. The instrument also has automatic polarity indication.

Heath also produces the IB-101 frequency counter ($199.95 in kit form) that indicates from 1 Hz to 15 MHz. Having a 5-digit display that can be switched to 8 digits via a front-panel control, the input impedance is 1 megohm and a 1-MHz crystal-controlled oscillator provides an accurate time base. If you have to go higher in frequency, the Heath IB-102 frequency scaler ($99.50 in kit form) can be used. Performing accurate scaling from 2 to 175 MHz, this “front end” can extend the capability of the IB-101 (or any other comparable counter) to 175 MHz. Division ratio is 10:1 or 100:1 at the touch of a switch.

The Triplet Model 6028 ($275) is a 2½-digit (a conventional 2½-digit display with an added readout that indicates whether the result is above or below ½) portable multimeter having an input impedance of 10 megohms on ac and dc voltage ranges and 5 ac and 5 dc ranges from 100 mV to 1000 V; 5 ac and dc current ranges from 100 µA to 1 ampere; and six resistance ranges to 10 megohms. All ranges are overload protected. Besides an overrange indicator, this instrument also has automatic polarity indication, and is one of the few digital instruments that can operate from built-in batteries.

The Weston Model 1250 frequency counter ($395) uses a full five-digit, solid-state display and has a frequency response from 5 Hz to over 32 MHz in four ranges. Sensitivity is 250 mV rms, and input impedance is 1 megohm. It uses a 1-MHz crystal-controlled oscillator as the clock. This bench instrument also provides a 1-MHz pulse output at TTL levels for use in testing external logic circuits. It also has leading zero suppression.

Weston's Model 4440 digital multimeter ($285) has 3½ digits of readout, is line or battery operated, and weighs less than 2½ pounds. Some features are: automatic polarity indication, leading zero suppression, and complete overload protection. It covers ac and dc voltages from 200 mV to 1000 V with a 10-megohm input impedance, ac and dc current to 199.9 µA, and resistance from 200 ohms to 2 megohms. A battery position is also included. The unit can be operated from rechargeable or conventional “C” cells.

Simpson makes several digital instruments. Their latest, the Model 460 portable, digital VOM ($395) is a 3½-digit instrument with 26 ranges. Among these are ac and dc voltages from 200 mV to 1000 V; ac and dc current from 200 µA to 1 ampere; and resistance to 200 megohms. Input impedance for voltage is 1 megohm for ac and a minimum of 10 megohms for dc. Among other features are automatic polarity indication, built-in line supply and battery power, and the unique use of an analog meter to indicate nulls or peaks when doing alignment. Full overload protection is provided for each range, and the display is non-blinking.

The Hickok Model 3301 ($385) uses a 3½-digit non-blinking display and has 27 ranges. These include 5 ac and dc voltage ranges from 100 mV to 1000 V, 5 ac and dc current ranges from 100 µA to 1 ampere, and 7 resistance ranges to 100 megohms. Full overload protection is provided on all ranges and an optional battery power supply is available. You can also specify BCD output for interfacing with data acquisition system.
introducing the 1440: a powerful addition to our quality family of kit calculators priced from $99.50

The first of its kind available anywhere, the 1440 was developed by MITS -- the original kit calculator company -- to answer the need for a high caliber calculator at an easily affordable price.

Using only the highest quality components from such American manufacturers as AMP, IRC, National Semiconductor, Sprague, and TI, the 1440 follows the tradition of the 816 (featured on the cover of Popular Electronics in November, 1971).

Design standards assure customer satisfaction when 5% resistors; fully interconnected, double sided, plated through PC boards; extra large LED's; individual mounting sockets for all IC's; pre cut, stripped, and tinned wire; and double injected, feather touch keyboards are the rule.

Comprehensive, detailed instructions covering Theory of Operation (with complete schematics and logic diagrams), Step by Step Assembly, Troubleshooting, and Applications make assembling a MITS calculator as easy as it is enjoyable. And a full 90 day warranty (1 year on assembled units) insures that you'll get a product you can count on long after you buy it.

You can even increase the 1440's capacity to that of a small desktop computer by the addition of completely compatible printing and programming units (available summer '72) to the interfacing that's already there -- so your needs will never outgrow its capability, and with six functions (+, −, x, ÷, x^2, √) and two memories (a constant and an independent data memory) that's a lot of power.

A reasonable price was the only remaining factor in the 1440's design. We think that $199.95 (assembled $249.95) is fair, and we hope you'll agree. To make ordering yours simple, we accept Mastercharge and Bank Americard. Why not give us a call today?

Our four function 816's (with 'computerizing' interfaces) and the single chip 808 have undergone design improvement too. They're available at: $99.50 (808), $149.95 (816A), and $159.95 (816B).
Planning to move?
Let us know 6 to 8 weeks in advance so that you won’t miss a single issue of Popular Electronics including Electronics World

Attach old label where indicated and print new address in space provided. Also include your mailing label whenever you write concerning your subscription. It helps us serve you promptly.

Write to: P.O. Box 1096, Flushing, N.Y. 11352, giving the following information.

If you have no label handy, print OLD address here.

[Address form]

☐ Change address only.
☐ Extend subscription. ☐ Enter new subscription.
☐ Payment enclosed (1 extra issue per yr. as a BONUS)
☐ Bill me later.

Add’l postage: $1 per year outside U.S., its possessions & Canada.

FROM KIT TO CAR IN 80 MINUTES!
Electronic ignition is “in”. Update your car with the TOPS in power, efficiency and reliability — the TIGER SST capacitive discharge ignition (CDI).

The TIGER delivers everything other CD’s promise — and more: quicker starting, more power, more gas mileage, tune-ups eliminated, lifetime plugs and points, reduced repairs and pollution.

The TIGER can be built and installed in your car in 80 minutes. The TIGER is unique! Errors in construction or incorrect installation will not harm the TIGER on the engine. The TIGER will not operate under either condition.

The TIGER comes with a switch for TIGER or standard ignition for 12V negative ground only.

SATISFACTION GUARANTEED or Money Back.

Simpli-Kit $29.95 — Assembled $39.95

POST PAID

WE ACCEPT:
Mastercharge or BankAmericard.
Send check or money order with order to:

Star Corporation
DEPT. W, P.O. Box 1946
Grand Junction, Colorado 81501

CIRCLE NO. 41 ON READER SERVICE CARD

RAYTHEON MARINE EQUIPMENT CATALOG
Raytheon’s full line of marine electronic equipment for navigation, communication, and safety is featured in a new 16-page catalog. Two dozen radars, radiotelephones, radio direction finders, loud hailer s, loran receivers, and Pathometer depth sounders are illustrated and described in detail. Prices are not quoted.

Address: Raytheon Marine Products, 676 Island Pond Rd., Manchester, NH 03103.

STANCOR TRANSFORMER CATALOG
The new Stancor Transformer Catalog (No. 207) lists more than 1900 standard transformers for design engineers. Included in the listings are full technical data, mounting dimensions, photos, and other specifications for audio and power transformers, chokes, and inductors.

Address: Essex Int’l., Inc., Controls Div., Stancor Prods., 3501 W. Addison St., Chicago, IL 60618.

BROOKSTONE HARD-TO-FIND TOOLS CATALOG
The Second 1972 Edition A catalog of hard-to-find tools and accessories available from Brookstone is a goldmine for anyone who has ever needed a non-standard tool and couldn’t find it anywhere. In addition to tools, the catalog lists such items as a hand-held searchlight which puts out a blazing 200,000-candlepower beam, a professional resistance soldering machine, an automatic wire stripper, and a sophisticated fire alarm system. Tools listed are all finest quality.

Address: Brookstone Co., Dept. C, 10 Brookstone Bldg., Peterborough, NH 03458.

SCIENTIFIC MEASUREMENTS LITERATURE
Currently available from Scientific Measurements is a five-sheet handout. The Data Sheet contains information on the 16 possible 2-input, 1-output binary combinational circuits on one side and the rules of Boolean algebra on the other side. Three other sheets provide information on the company’s Comp-U-Kit Logic Lab 1, Analog Computer 1, and Pulse Generator. The final sheet lists the prices for the various Comp-U-Kit modules.

Address: Scientific Measurements, Inc., 2945 Central, Wilmette, IL 60091.
MODERN OPERATIONAL CIRCUIT DESIGN
by John T. Smith

This book presents the body of circuit design techniques and information which have applications in a wide range of scientific disciplines. Until now, the use of such knowledge has been the province of the highly trained designer of military systems. This book, however, provides the non-specialist with ample information for assembling his own circuits and solving his own problems. Especially important, all circuits illustrated have been successfully built and tested by the author.


FREE McIntosh CATALOG and FM DIRECTORY

Get all the newest and latest information on the new McIntosh Solid State equipment in the McIntosh catalog. In addition you will receive an FM station directory that covers all of North America.

SEND TODAY!

McIntosh Laboratory Inc.
2 Chambers St., Dept. PT-672
Binghamton, N.Y. 13903

NAME ____________________________

ADDRESS _________________________

CITY ___________________ STATE _______ ZIP _______

CIRCLE NO. 27 ON READER SERVICE CARD

JUNE 1972
New Products

PACE SSB AND CB TRANSCEIVER

The Pace Division of Pathcom Inc. has introduced a new SSB and AM Citizens Band Radio, called the Sidetalk 23. The combination 46 channel SSB and 23 channel AM transceiver is all solid state with 15 watts PEP. It has adjustable squelch with fine tuning control of each channel (clarifier). A noise blanker circuit has front control switch, and a crystal-lattice filter provides proper band-pass with over 60 dB suppression on unwanted side bands.

Circle No. 71 on Reader Service Card

LAFAYETTE RADIO STEREO SYSTEM COMBO

The Model LRX-900 combination stereo receiver and cassette recorder available from Lafayette Radio Electronics Corp. incorporates special circuits which reproduce regular stereo records, tapes, and FM broadcasts with 4-dimensional effects. The sensitive FM tuner utilizes "Acritude" for instant center-station tuning. The cassette deck features switchable standard/Cr02 tape bias equalization, large recording meters, sound-with-sound mixing, and automatic mechanical/electrical shutoff.

Circle No. 72 on Reader Service Card

MOSLEY 5-ELEMENT CB BEAM ANTENNA

The Deluxe Mosley CB Mini-Beam Model GA-5D antenna is designed to deliver full-size beam performance in a compact package. Ten deluxe high-Q coils molded onto the element extensions reduce size without limiting electrical capability. A new swaging technique seals both ends of all coil sections to prevent moisture accumulation and assure reliable all-weather performance. The compact GA-5D was designed to reduce the area exposed to wind so that the antenna can be mounted, without a tower, on a TV antenna mount and turned with an inexpensive TV rotor.

Circle No. 73 on Reader Service Card

TRIPLETT MICRO-POWER FET VOM

The Model 603 battery-powered FET VOM developed by Triplet can be left on continuously without appreciably warming down the batteries. It draws only 10 μA as a result of an exclusive "TMP" (Triplet Micro Power) circuit; Current drain is so low, in fact, that carbon-zinc batteries should last as long as they do on a shelf. Besides TMP, the meter features Low Power Ohms which permits safe testing of transistors and IC's, an Auto Polarity circuit, and an amplifier circuit which incorporates a high degree of feedback for making both ac and dc scales linear. On both dc and ac measurements can be made out to 1000 volts and 1000 mA (1 ampere) with 3% accuracy. Ohmmeter ranges cover from RX1 through RX1 meg. The output ranges go from -30 dB to +62 dB with 3% accuracy.

Circle No. 74 on Reader Service Card

DUOTONE DELUXE STEREO HEADPHONES

The Duotone Co., Inc., has announced the availability of their new top-of-the-line Model VCI-100 stereo headphone set. The VCI-100 reproduces sound over the range of from 15 Hz to 25,000 Hz and has a power-handling capacity of 1 watt. Impedance is 4-16 ohms.

CALECTRO

YOUR ELECTRONICS SUPERMARKET

CIRCLE NO. 20 ON READER SERVICE CARD
Individual volume controls are provided for each earcup. The earcups are cushion padded for user comfort, and the phones come with a 15-ft coil cord to which is attached a standard three-conductor phone plug.

Circle No. 75 on Reader Service Card

**SCIENTIFIC AUDIO PREAMP EQUALIZER**

The Mark IX Preamp/Equalizer recently announced by Scientific Audio Electronics, Inc., has operational characteristics similar to those used in recording studios. The equalizers can be used to compensate for poorly equalized records, to modify the tonal quality of loudspeakers, and, in some instances, to compensate for room characteristics. The equalizer section uses five frequencies instead of tone controls. Toroidal LC bandpass filters with 12 dB/octave slopes are used. The equalizers are variable to ±16 or ±8 dB. A defeat switch is provided for electrically removing the equalizers from the audio system, and a tape copy facility is provided to eliminate patching to the rear of the chassis.

Circle No. 76 on Reader Service Card

**HEATHKIT 25" VHF/UHF COLOR TV KIT**

The Model GR-900 solid-state color TV with a 25" diagonal measurement, uhf detent tuning, and ultra-rectangular picture tube has now taken its place at the top of the Heath Company's color TV receiver line. The user can preset up to 12 uhf channels in his area to take advantage of the detent tuning. Pushbutton power tuning scans both vhf and uhf stations in either direction. An angular tint switch selects either normal or wide-angle color demodulation to reduce tint and flesh tone changes when switching channels. Instant-on operation with override, pushbutton aft and automatic tint control, and adjustable tone control are also included. The ultra-rectangular picture tube design gives the viewer 315 sq in. of viewing area. As usual in Heathkit TV's, the GR-900 has built-in service features and comes with a volt-ohmmeter for easy servicing setup, and troubleshooting.

Circle No. 77 on Reader Service Card

**SHURE IMPEDANCE-MATCHING TRANSFORMER**

Owners of transistorized tape recorders equipped with medium-impedance inputs can now get superior performance from their recordings...
through the use of a new Shure Model A97A line-matching transformer and a high-quality, low-impedance microphone. Usually, the mike comes with home and portable recorders as a utility unit which cannot take advantage of the full performance potential of the recorder. Use of a Model A97A and a high-quality microphone (such as Shure's 575SB or 585SB) not only improves the audio input signal, it also permits the use of long cables without loss of high frequencies and without hum and noise pickup.

Circle No. 78 on Reader Service Card

ONKYO LINEAR SUSPENSION SPEAKER SYSTEM
A three-way "linear suspension" speaker system (Model 20) featuring a 12" woofer, a 2" hemispheric dome midrange speaker, and a 1" hemispheric dome tweeter is being marketed by Onkyo. The drivers are specially designed and manufactured to minimize undesirable resonances. A unique integrated crossover network with exclusive filter circuitry helps provide smooth, clean transitions. The crossover control panel located on the rear of the enclosure contains 5-position midrange and high-frequency switches which allow the listener to adjust driver levels in 2-DB steps to suit his listening tastes. Frequency range is 35-20,000 Hz; maximum power handling capacity is 50 watts, with 10 watts rms minimum required.

Circle No. 79 on Reader Service Card

TOYO 4-CHANNEL DECODER
The new Model QC-002 4-channel decoder made by Toyo Radio Co. of America, Inc., recovers both the "hidden ambiance" contained in ordinary 3-channel programs and the four original channels from encoded (matrixed) programs. The decoder is designed to feed into any 4-channel amplifier or any pair of 2-channel amplifiers. The all pushbutton controls include Effect Selectors which allow the user to choose between solo effect, simulating the ambiance of a small concert hall with a single performer; concert hall ambiance, or surround sound, which gives the listener the sensation of being located in the middle of the orchestra.

Circle No. 80 on Reader Service Card

SBE DIGITAL READOUT HAM TRANSEIVER
Linear Systems, Inc., has announced the introduction of the SBE Model SB-36 amateur radio transceiver which incorporates a digital counter to provide a six-digit direct frequency readout on all ham bands. The SB-36 has a power output of 500 watts PEP on SSB, full frequency coverage of all ham bands from 80 to 10 meters, built-in VOX capability, semibreak-in operation on CW, and a deluxe sideband generating system featuring separate crystal lattice filters for USB and LSB.

Circle No. 81 on Reader Service Card

From its Sequential Cam System that antiquates the conventional noisy cam gear and swinging plate to its Synchronous Power Unit, the BSR McDonald 810 is designed to match or exceed the performance of any automatic turntable currently available. Some other highlights include a Variable Pitch Control, A 12" dynamically balanced turntable platter, A viscous-damped cue and pause control with exclusive friction Cue Clutch to keep the arm cued over the exact groove, A Concentric Gimbal Arm Mount, Push-button operation, The price? $149.50. From BSR, The world's largest maker of automatic turntables.

BSR (USA) Ltd., Blauvelt, N. Y. 10913
THE SMALL-PARTS MARKET

The Surplus Scene dealers can hardly qualify as small-parts suppliers in the same sense as the big industrial mail-order houses. Nevertheless, they do offer some fantastic buys in some standard and many hard-to-find components. Typical of Surplus Scene offerings are such items as computer-grade and standard types of electrolytic capacitors, pulse and power transformers, toroids, relays and switches, power resistors and potentiometers, etc.

Starting with G & G Radio Supply Co. (45 Warren St., New York, NY 10007), look for great buys in receiving and special-purpose vacuum tubes, crystals in the $1.60 price range, and panel meters.

Baynton Electronics Corp. (2709 North Broad St., Philadelphia, PA 19132) has a lot to offer the bargain hunter in the way of test equipment for all areas of electronics, plus a very good selection of coaxial cable connectors and cable assemblies. They also have some good buys in low-pass interstage and line filters, hard-to-find multi-turn miniature trimming potentiometers made by Bourns, crystal can relays, and solid-state components.

Looking for special types of power transformers, filter reactors, and filter capacitors? Then look to Surplus Center (P.O. Box 82209, Lincoln, NE 68501). While you’re at it, look into rectifiers such as a 50-ampere, 50-PIV stud-type which they have for only $2.49 and an IBM rectifier that normally lists for $10.50 but is on sale for $2.69. (It contains two 12-ampere, 50-PIV silicon rectifiers already mounted on a heavy-duty aluminum heat sink).

Poly Paks (P.O. Box 942, S. Lynnfield, MA 01940) is a bonanza for small parts such as resistor and capacitor assortments, miniature reed switches, coils and chokes, tape heads, motors, and microminiature relays. Good buys can also be had on fiber optics and loudspeakers.

Small parts occupy the lion’s share of the Delta Electronics Co. (Box 1, Lynn, MA 01903) catalog. Listed is everything from potentiometers to capacitors to switches. A special buy is a 7-gang pushbutton switch assembly containing six dpdt and one 4pdt switches made by CentraLab; it goes for $1.35. Computer-grade capacitors are listed for $2-$7 for lots of five.

For coaxial connectors, variable capacitors and noise filters, John Meshua Jr. (P.O. Box 62, Lynn, MA 01904) has “knockouts for thin wallets” as they state. There are other goodies as well—like insulated sleeving, rubber feet, thermistors, terminal strips, and Teflon press-fit standoffs.

Herbach & Rademan, Inc. (401 East Erie Ave., Philadelphia, PA 19134) offers many specialized components. Their listings include stepping and rotary relays, heat detectors, toggle switches, and Ledex rotary solenoids. The company’s catalog flyer is a monthly—titled, appropriately, “This Month”—and offerings change accordingly. Past catalog listings featured fantastic buys on numeric readouts (always in demand), transformers, solenoids, and relays.

For our last entry, we have Edmund Scientific Co. (380 Edscorp Bldg., Barrington, NJ 08007). They have such diverse items as an electronic desk-top calculator with an 8-position, seven-segment display readout for $199.50; psychedelic lighting displays; numeric indicator tubes; a batch of $50 worth of transistors for only $2.50; and an infrared sensor alarm kit for $6.95. Send for their latest catalog and see how diverse their offerings are.
FOR SALE

FREE! bargain catalog. Fiber optics. LED's, transistors, diodes, rectifiers, SCR's, triacs, parts. Poly Paks, Box 942, Lynnfield, Mass. 01940.


LDWEST Prices Electronic Parts. Confidential Catalog Free. KNAPP, 3174 8th Ave. S.W., Largo, Fla. 33540.


ELECTRONIC PARTS, semiconductors, kits. FREE FLYER. Large catalog $1.00 deposit. BIGELOW ELECTRONICS, Bluffton, Ohio 45817.

RADIO—T.V. Tubes—36¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans. $2.00. Relco-A33, Box 10563, Houston, Texas 77018.


TV TUNER REPAIRS—Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for $1. Refundable. Frank Bocek, Box 835, Redding, Calif. 96001.

CONSTRUCTION PLANS: Laser . . . $2.00. Investigation Aids—2-FM Microphone Transmitters . . . $1.00. FM Telephone Transmitter . . . $2.00. Sound Telescope . . . $2.00. Space Monitor—Missile Tracker . . . $2.00. Free equipment and kit catalog. Howard, 20174 Ward, Detroit, Michigan 48235.

GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. All copy subject to publisher’s approval. All advertisers using Post Office Boxes in their addresses MUST supply publisher with permanent address and telephone number before ad can be run. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Hal Cymes, POPULAR ELECTRONICS including ELECTRONICS WORLD, One Park Avenue, New York, New York 10016.

SEND ONLY $2.00 (cash, Ch., M.O.) and pay post and handling. Offer expires 01/1/40. DO NOT SEND MONEY—REDUCED SALES ARE OFFERED TO FANS OF POPULAR ELECTRONICS. Send for new catalog.うまüm Tests, Inc., 3174 Long St., West Los Angeles, Calif. 90024.

NOW! Enjoy the great outdoors in comfort with your pocket size electronic Skeeter Skat mosquito repeller. $9.95 postpaid USA. Satisfaction guaranteed. Detectron, Dept. G-6, P.O. Box 243, San Gabriel, Calif. 91778.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.


PYROTECHNICAL chemicals, casings, tools, supplies, fuse, literature. Giant, illustrated catalogue/handbook includes formulas, instructions—50¢, with samples—$1.00. Westech, Logan, Utah 84321.

ELECTRONIC COMPONENTS—Distributor prices, Free catalog. Box 2581, El Cajon, California 92021.

ANTIGRAVITY, experiment and theory. Rushed—$2.00. U.S. Inquiries. Intertech 749, Box 5373, Station-F, Ottawa, Canada.

LEARN the facts of electronics and your privacy. Send for the Tron-X Manual, P.O. Box 38155, Hollywood, CA 90038. $5.95.

JAPAN HONG KONG DIRECTORY. World products information. $1.00 today. Sekai Shogyo Annex, Hillyard, Washington 99207.

EUROPEAN and Japanese bargains catalogs. $1 each. Dee, P.O. Box 9308, North Hollywood, Calif. 91609.


GET "Music Only" FM Programs. SCA Adaptor fits any FM tuner or receiver. Free literature with order. Kit $14.50 (with Squelch $19.50) Wired and Tested $25.00 (with Squelch $29.50). All plus postage and insurance. Thousands Sold. SWTPC, Box E32040, San Antonio, Tex. 78284.
IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

FEATURE ITEM:

50 MEGAHERTZ LOW COST COUNTER

Here is a new item, featured because of numerous customer suggestions. We have taken the basic power supply chassis and cover from our clock kit, and by substituting a new front panel and printed circuit board, have made a lowest cost frequency counter. The unbelievable low cost is due to our use of our large stock of unused surplus parts, the new 74196 50 MHz decade counter, and the commonality of parts with our other kits. Readout is to six digits, time base is 1 second, 0.1 seconds, or external. Design is modular, for ease of construction, compactness, and expandability.

$58.00

BUILD YOUR OWN ELECTRONIC CALCULATOR FOR ONLY $108.00!

A complete calculator kit, complete with self contained power supply and case. Indispensable in the home, office or school. Simple enough for a child to build. Some of the features of the calculator are as follows:

- MOS integrated circuits (extra large scale integration) reduce the number of components to a minimum, for easy assembly
- Displays eight digits on large size seven segment display
- Full function complement keyboard features addition, subtraction, multiplication, division, alternate display, multiplication by a constant, clear all, clear entry, and decimal point set.
- Sixteen digit entry and sixteen digit results are possible with alternate display key.
- Leading zeros suppressed
- Chain operation
- All integrated circuits and displays are socket mounted and replaceable.

So reliable and simple to build, we can make this guarantee: If for any reason you cannot succeed in getting your calculator to function properly after completing construction, for a flat handling fee of $10.00, B and F will repair and ship back your calculator anywhere in the USA. This applies regardless of the age of the assembler, barring gross negligence or the use of acid solders in construction.

SANKEN HYBRID AUDIO AMPLIFIERS AND SUPPLY KIT

We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F. Sanken and the Sanken U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- 10 Watt RMS Amplifier
- 25 Watt RMS Amplifier
- 50 Watt RMS Amplifier

$4.75
$14.75
$22.50

Complete kit for 100 watt rms stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis.

$88.00

Same for 50 watt rms stereo amplifier includes two 25 watt Sankens, etc.

$58.00

B & F ENTERPRISES

Phone (617) 532-2323

P.O. Box 44, Hathorne, Massachusetts 01937

JUNE 1972

99

PANORAMA of industrial and government electronic surplus in our monthly picture catalogs. Startronics, Box 17127, Portland, Oregon 97217.

ELECTRONIC HOBBYISTS and professional builders love our 3¢ film resistors; 1¢ electrolytics and 1¢ micas. Great catalog 35¢. Electrovalue-America, Box 276, Swarthmore, Pa. 19081.

ELECTROENCEPHALPHONE, Brainwave feedback equipment. I&J Enterprises, 24120 E 3rd West, Bothell, Wash. 98011.

PRINTED Circuit Drill Bits. Trumbull, 833 Balra Drive, El Cerrito, Calif. 94530.


Laser parts catalog 60¢, Mynihan, 107 North Brightlon, Atlantic City, New Jersey 08401.

SURPLUS MINIATURE REGULATED POWER SUPPLIES for logic, linear IC's, function meter. Voltages: 5 to ±24V. Currents: 25 to 1000 mA, $9.00 to $18.00. Stock list, Instant Instruments, 306 River Street, Haverhill, MA. 01830.

FREE Catalog. Parts, circuit boards for Popular Electronics projects. PAIA Electronics, Box C14359, Oklahoma City, OK 73114.


FIRE & BURGLAR ALARMS
1972 Handbook & Catalog
Save Hundreds of Dollars
Learn the cost of Professional Alarm Equipment. Know how it is installed. Discover how you can save Hundreds-Of-Dollars by installing your own system. See the latest in technology such as LASER BEAMS, INFRARED BODY HEAT DETECTORS and ELECTRONIC SIRENS. 1972 "Handbook & Catalog" 84 pages, just $1.00 postage and handling. $1.00 is credited to first order.

ALARM COMPONENT DISTRIBUTORS
33 New Haven Ave., Dept. P.E., Milford, Conn. 06460

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction Plans—Complete, including drawings, schematics, parts list with prices and sources. . . . Long-Range "Sound Telescope"—This amazing device enables you to hear conversations, birds and animals, other sounds thousands of feet away. Very directional. Transistorized, uses 9V battery —$3.00 . . . Robot Man—Psychedelic shows—Lasers—Emotion/Lie Detector—Touch-Tone Dial—Quadraphonic Adapter —Transistorized Ignition—Burglar Alarms—Sound Meter . . . over 60 items. Send 25¢ coin (no stamps) for complete catalog. Technical Writers Group, Box 5994, State College Station, Raleigh, N.C. 27607.

WE SELL CONSTRUCTION PLANS, Kits and Wired Units—silver recovery unit—x-ray fluorescence machine—chemical formulary (home products)—200 watt inverter (12vdc-120vac)—coin cleaner/electroplater—plans $5.00 each—alterator adapter (produce 120 volts from ANY alternated vehicle) plans $.95—PLUS MANY MORE—ask for free catalog—Creative Products, Department EF, 1551 East Loop 820, Fort Worth, Texas 76112.

ELECTRONIC ORGAN KITS, keyboards, oscillator coils, I.C. tone generators, every component for electronic organ assembly, 25¢ for catalog. Devtronix Organ Products, 5872 Amapol Dr., San Jose, Calif. 95129.


AMPEX FR100B 14 channel recorder $29.00. Weber, 4205 Sherrod, Pittsburgh, Pa. 15201.


SEVEN-SEGMENT DIGITAL CLOCK! Complete plans, schematics, parts lists, and operating theory for discrete component Digital Clock—$3.00 . . . Increase your understanding of Digital Circuits, Logic Theory . . . COMPLETE COURSE in Digital Electronics—all you need to know for Logic Designs—$10.00. DYNASIGN—The House of Dynamic Designs, P.O. Box 60-A, Wayland, Mass. 01778.

12VDC to 400VDC converter kit. Excellent for CDI. Mail $5.95 today, Converter, Box 1164, Norman, Okla 73069.

NEW Electronic Touch Control Dimmer—Unbelievable. Attractive clear case. Built-in night light. Non-volatible memory. $22.50, Kit $15.95. CMD, Box 573-PE, Union City, Tenn. 38261.


MAGNETIC PICKUP CD ignition plans. Write SES Enterprises, Box 607, Ferndale, Wash. 98248.

SURPLUS Amplifiers, new $11.95, other items. Write: Glenn, P.O. Box 555, N. Miami, Oklahoma 74358.

HOBBYISTS! Logic IC project kits. Combination Lock $5.95. Catalog free. John Huntley, 1351 Mahoney, Rodeo, Calif. 94572.

I'M selling out my electronics business. All or part. Includes parts and equipment too numerous to list. 50% to 70% below wholesale. For itemized inventory and price list send $1.00; deductible from any order. Aktronics, 2333 E. Bugle Drive, Chesapeake, Virginia 23321.

ALPHA THETA Brainwave Feedback Instrument. Relaxed awareness, meditation, body control. Inner Space Electronics, Box 308PE, Berkeley, Calif. 94701.


TEST EQUIPMENT, Aerospace-Laboratory Grade. Request your needs; will mail appropriate catalogs (we have 24 catalog categories). Only for Engineers, Businesses, Schools and advanced Technicians. Goodheart, Box 1220, Beverly Hills, Calif. 90213.


PLANS AND KITS

FREE Kit Catalog: Why does every major College, University, Technical School, Research & Development Center buy from us? Because we have the highest quality and lowest prices. Free catalog. SWTPC, Box H32040, San Antonio, Tex. 78284.

FREE Kit Catalog: Digital Microcirc $29.95. Also Segemented and Nixie Readouts, Timebases, Scaler, Electronic Digital Clocks (all featured in Popular Electronics) SWTPC, Box C32040, San Antonio, Tex. 78284.

POPULAR ELECTRONICS Including Electronics World
LOWEST PRICES: ON BRAND NEW FULLY TESTED & GUARANTEED IC'S

BEST SERVICE: 10% DISCOUNT ON ALL ITEMS NOT SHIPPED IN 24 HOURS
MOST CONVENIENT: ORDER DESK 1-800-323-2595 (TOLL FREE)

PLEASE NOTE: To qualify for prices in the last three columns, you must order in EXACT multiples of 10 for all IC items on your order.

<table>
<thead>
<tr>
<th>Catalog No</th>
<th>1-100</th>
<th>101-1000</th>
<th>1001-10000</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7440</td>
<td>26</td>
<td>99</td>
<td>999</td>
<td>1000</td>
</tr>
<tr>
<td>7441</td>
<td>26</td>
<td>99</td>
<td>999</td>
<td>1000</td>
</tr>
<tr>
<td>7442</td>
<td>26</td>
<td>99</td>
<td>999</td>
<td>1000</td>
</tr>
<tr>
<td>7443</td>
<td>26</td>
<td>99</td>
<td>999</td>
<td>1000</td>
</tr>
<tr>
<td>7444</td>
<td>26</td>
<td>99</td>
<td>999</td>
<td>1000</td>
</tr>
</tbody>
</table>

Large V-7 segment LED readout similar to the popular MA-1 but with improved brightness. Has left-hand decimal point. Fits in a DIP socket. Expected life: Over 100 yrs.

SELECTABLE RIPPLE BLANKING

PANASONIC, NIKON, IBM, ABB, and SONY computer equipment. Inquire about our special offer.

MOLEX IC SOCKET PINS: Use these economical pins instead of ordering your IC's to PC boards. Sold in continuous type in multiples of 10 pins only.

LOWEST PRICES: Any multiples of 10 of any IC's. Add $0.75 for 7490 pin, $0.50 for 7490 pin. For LED filament-type add $2.00. Each 1 IC's to PC boards. Sold in multiples of

UNIVERSAL DECADE COUNTING UNITS
1. Easy to read single plane LED or Filament-type Readout with wide angle viewing.
2. LCD Outputs available
3. Ready, Set, 0-98.
4. Selectable Ripple Blanking
5. Selectable Decimal Point
6. Counter Available
7. Plug-in Module
8. Molex Sockets for all IC's & Readout
9. Tin-plated G-10, 2-oz Copper, Glass Epoxy Board
10. Three methods to introduce new segments, on different cards, or on separate from your order. Please allow several weeks. 

Price (Per Decade):
Basic Unit consisting of 7490, 7447, Filament-type 7-segment, and EEPROM.

Options:
For LED Readouts instead of Filament-type add $2.00. For 7475 Latch add...1.25. For 7475 Latch instead of 7475. For LED filaments add...$1.75. For LED filaments instead of 7475.

Orders over $100.00 will receive both books. Orders over $100.00 will receive a complete LIBRARY of DIGITAL & ANALOG data & application books totaling 1000 pages FREE. PLEASE NOTE: Data books are shipped separate from your order. Please allow two weeks for delivery.

CIRCLE NO. 39 ON READER SERVICE CARD
PORTABLE Digital V-O-M Kit push-button Ranging Switch, Compact (8x5x3) size. Battery or A.C. operation. P.O. Box 1281, Minnetonka, Minnesota 55343.


FREE BROCHURE. All new way to faster, better circuit development and digital logic design. In kit or assembled form. Exceltech, Inc., Box 17056, San Diego, Calif. 92117.


FREE Electronics plans and kit catalog. McCord Electronics, Box 41, Sylvania, Ohio 43560.

BRAINWAVES—Build your own machine. We have plans, kits. Write: Extended Digital Concepts, Box 9161, Berkeley, Calif. 94709.

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. All merchandise brand new and factory sealed. LYLE CARTRIDGES, Dept. P, P.O. Box 69, Kensington Station, Brooklyn, New York 11218.

STEREO Components at lowest prices. Send for free catalog. Carston, Box 1094-A, Danbury, Conn. 06810.


WANTED


QUICK CASH . . . for Electronic Tubes, Semi-Conductors, Equipment (Receivers, Transmitters, Scopes, Vacuum Variables etc.) Send Lists now! Write: Barry Electronics, 512 Broadway, New York, NY 10012. (212) 925-7000.

WANTED TO BUY OR RENT: Starlight, Infrared, or other Night Observation Equipment—Military or Commercial Manufacture. Ed Killiam, Dept. of Zoology, Colorado State University, Fort Collins, Colorado 80521.

ELECTRICAL SUPPLIES AND EQUIPMENT


CIRCUIT BOARDS made to your schematic. SKEPE, 2502 Castle Rock, Diamond Bar, California 91765.

TUBES

RADIO & T.V. Tubes—36¢ each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

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.


TUBES receiving, factory boxed, low prices, free price list, Transterionic, Inc., 1306 40th Street, Brooklyn, N.Y. 11218A, Telephone: 212-633-2800.


JUNE 1972

---

**TAPE AND RECORDERS**

**STereo TaPe RENTaL** for particular people. Free catalog. Gold Coast Tape Library, Box 2262, Palm Village Station, Hialeah, Fla. 33012.

BUY Irish Tape Open Reel & Cassettes & 8-Track Blanks at Discount Prices. Write: Direct Mail Cassette Corp., Box 71, Plainview, N.Y. 11803.

**RECORDING TAPE** made by top American manufacturer, guaranteed not "seconds" or "white box"; 2400' mylar, $2.29; 1800' mylar $1.69; 1200' acetate $7.99. Send for information and quantity pricing. Alheimer Audio Electronics, 219 Columbia Street, Utica, New York 13502.

**old Radio** Programs on cassettes or reels. High quality, low prices, thousands to choose from, professional equipment, catalog 50¢. Remember Radio Inc., Box 2513, Norman, Okla. 73069.

**RENT** 4-Track open reel tapes—all major labels—3,000 different—free brochure. Stereo-Parti, 55 St. James Drive, Santa Rosa, Calif. 95401.

**MEMOREX** recording tape, audio & video lowest prices, write for free information. Bergetz Systems Co., Box 1181, Melrose Park, Ill. 60161.

**VIDEO Tape** 1/2 in. wide from the number one manufacturer. Reconditioned and guaranteed. 30 minutes $5.50, 60 minutes $9.25 plus shipping. Ehl, P. O. Box 20643, San Diego, Calif. 92120.

**RECORDING? DUBBING? EDITING?** Use the "Dublet" control. Integrate two or more recorders into your music system. End tangled cables, ruined tapes. Brochure J-5, Duble Co., 1509 Oklahoma, Norman, Okla. 73069.

**RENT** Stereo Tapes, open reel cartridges, cassettes. Complete catalogue $0.75. Write: Caltape, P. O. Box 5716, Redwood City, Calif. 94063.

---

**REPAIRS AND SERVICES**

TV Tuners rebuilt and aligned per manufacturers specification. Only $9.50. Any make UHF or VHF Ninety day written guarantee. Ship complete with tubes or write for free mailing kit and dealer brochure. JW Electronics, Box 51C, Bloomington, Indiana 47401.

---

**DO-IT-YOURSELF**

**PROFESSIONAL ELECTRONICS PROJECTS**—$1.00 up. Catalog 25¢. PARKS, Box 25665A, Seattle, Wash. 98125.

**PARTNERSHIP CHESS**—Send $1.00 for booklet of rules and instructions: Szczur, 631 Manchester, Norristown, Penna. 19403.

---

**INSTRUCTION**


These regulated power supplies have been designed to provide complementary power for Operational Amplifiers, Functional Modules, A-D & D-A Converters and Digital Logic. The supplies are completely self contained (no external parts required). epoxy encapsulation provides properties close to a true hermetic seal.

FEATURES
- Short Circuit Protection
- Over Range
- No Derating Over Specified Operating Range

MODELS
- MODEL SE904
- MODEL SE902
- MODEL SE909
- MODEL SE905

Output Voltage (VOC) regulator...
- 15%
- 1.00
- 100
- 100

Output Current (MA)
- 50
- 100
- 500
- 1000%

Line (105-125 VAC) (MAX)...
- 0.05%
- 0.05%
- 0.05%
- 0.05%

$18.95 $26.95 $22.95 $34.95

NE 556 Phase lock loops...
- 4.75
- 500 oms
- 10K
- 20K
- 25K
- 50K

NE 556 Phase lock loops...
- $4.75
- $4.75
- $4.75
- $4.75
- $4.75
- $4.75

Miniature trim pots, 500 oms...
- 10K
- 20K
- 25K
- 50K

Miniature trim pots, 500 oms...
- 10K
- 20K
- 25K
- 50K

Cost...
- $1.30
- $1.30
- $1.30
- $1.30

Send $2.00 for our Latest catalog featuring Transistors and Rectifiers; 325 Elm St., Cambridge, Mass.

F. C. C. 1st phone license training in 5 weeks. R.E.I.'s intensive training produces outstanding results. For information and free brochure call toll free: 1-800-237-2251, or write home office, Radio Engineering Incorporated Schools, 1336 Main Street, Sarasota, Florida 33577. Florida residents call (813) 955-6922.

HIGLY effective home study courses in Electronics Engineering Technology and Electronics Engineering Mathematics. Earn your Degree. Write for Free Descriptive Literature. Cook's Institute of Electronics Engineering, (Dept. 15), P.O. Box 10834, Jackson, Miss. 39209. (Established 1945).


F.C.C. TYPE EXAM... Guaranteed to prepare you for F.C.C. 3rd, 2nd, and 1st phone exams. 3rd class, $7.00; 2nd class, $12.00; 1st class, $18.00; complete package, $25.00. Research Company, 3206 Bailey Street, Sarasota, Florida 33580.

FCC First and Second Tests. $8.95. Electronic Tutoring, Box 24190, Cleveland, Ohio 44124.


AMATEUR RADIO. Complete correspondence tape-recorded license courses. Amateur Radio License School, 12217 Santa Monica Boulevard, Los Angeles, Calif. 90025.

C108 COMMANDER ELECTRONIC CALCULATOR $189
- Adds, subtracts, multiplies, divides
- Does mixed and chain calculations
- True credit balance examples
- Has direct entry and readout
- 16-digit decimal roundoff
- Error correction (C1) key lets you "regame" an entry without destroying calculations
- Keyboard rollover memory is great for preventing inaccurate entries
- AC 115/230V, 50/60 Hz Super Large Scale Integration (LSI)
- Height 2" x Width 61/4" x Length 12"
- Weight: 3 lbs.

2N3584 25Q Vcc NPN 2A Silicon Trans., $1.95
2N3055 7Am PNP Silicon Transistor, $1.00

DECADCounter KIT... Consisting of: 1-Nixie tube & socket (8754) $1.79
1-749$ $6.75
1-7441
709C OPER AMPS... $5.50
741 OPER. AMPS. $5.50
743 VOLTAGE REGULATORS... $1.25

NIXIE TUBES... Similar to Raytheon 8754, with socket & data sheet...

Terms: FOB Cambridge, Mass. Noni check or Money Order. Include postage, Average V4-lb. packages $1.00. No C.O.D.'s. Minimum Order $3.00. Rated companies 30 days net

PERSONALS

INVENTORS WANTED

INVENTORS! Don't sell your invention, patented or unpatented, until you receive our offer. Eagle Development Company, Dept. 9, 79 Wall Street, N.Y., N.Y. 10005.


INVENTIONS WANTED


MAKE FRIENDS WORLDWIDE through international correspondence. Illustrated brochure free. Hermes, Berlin 11, Germany.
FREE "Directory of 500 Corporations Seeking New Products." For information regarding development, sale, licensing of your patented/untapped invention. Write: Raymond Lee Organization, 230 GR Park Avenue, New York City 10017.


GOVERNMENT SURPLUS


ELECTRONIC Equipment and Parts. Big 36 page Free Catalog. Send for your copy today! Fair Radio Sales, Box 1105-P, Lima, Ohio 45802.

JEEPS Typically from $53.90 . . . Trucks from $78.40 . . . Boats, Typewriters, Knives, Airplanes, Clothing, Multimeters, Oscilloscopes, Transceivers, Photographic, Electronics Equipment. Wide variety, condition. 100,000 Bid Bargains direct from government nationwide. Complete sales directory and surplus categories catalog $1.00 (Deductible on orders from separate included catalog). Surplus Service, Box 820-J, Holland, Michigan 49442.

GOVERNMENT SURPLUS. Complete sales directory $1.00. Surplus Publications, Box 26062Z, Los Angeles, Calif. 90026.


BOOKS

FREE catalog aviation/electronic/space books. Aero Publishers, 329PE Aviation Road, Fallbrook, California 92028.


PUBLISH your book! Join our successful authors: publicity, advertising, promotion, beautiful books. All subjects invited. Send for free appraisal and detailed booklet. Carlton Press, Dept. ZOF, 84 Fifth Avenue, New York 10011.

RECORDS

CHAPEL Records Club—Free catalog. 1000-B Richmond, China Lake, Calif. 93555.

RUBBER STAMPS

RUBBER Address Stamps $2.00. Signature $3.50. Free Catalog. Jackson's, Box 443-S, Franklin Park, Illinois 60131.

BUSINESS OPPORTUNITIES

I MADE $40,000.00 Year by Mailorder! Helped others make money! Start with $10.00—Free Proof, Torrey, Box 318-N, Ypsilanti, Michigan 48197.

$200.00 DAILY In Your Mailbox! Your opportunity to do what mail-order experts do. Free details, Associates, Box 136-J, Holland, Michigan 49442.

START small, highly profitable electronic production in your basement. Investment, knowledge unnecessary. Postcard brings facts. Barta-PEB, Box 248, Walnut Creek, California 94597.

JUNE 1972

READOUT TUBE SPECIALS

POWER TRANSFORMER SPECIALS

NATIONAL ELECTRONICS NL-874

Long life, numerical display neon glow tube with inverted characters. Complete with data sheet. TUBE & STOCK NO. F5024 2.85 per set 3/8.00

Three secondaries. 30 volts 1 amp. 16 volts 3 amps. & 150 volts 100 ma. (ideal in capacitor input supply for neon indicator tubes above, or any NIXIE tubes. STOCK NO. F9254 3.00 ea. 3/8.00

Dual primaries, dual secondaries. Makes 12 volt 4 amp. or 24 volt 2 amp. or 48 volt 1 amp. supply. STOCK NO. F9201 3.50 ea. 3/10.00

Two 12 volt 2 Amp. secondaries. Makes 2 12 volt 2 amp. or 1 12 volt 4 amp. or 1 24 volt 2 amp. supplies. STOCK NO. F9202 2.95 ea. 2/5.00

42 volt ct. 4 amp. and 18 volt ct. 2 amp. secondaries. Many voltage combinations possible. STOCK NO. F9250 3.25 ea. 2/6.00

All transformers come with wiring diagram, and several suggested power supplies.

COMPUTER GRADE CAPACITORS (BRAND NEW)

40,000 mfd. 10 volts 1.25 ea. 6/7/00 Stk. No. F2026
70,000 mfd. 10 volts 1.75 ea. 6/9/00 Stk. No. F2118
6000 mfd. 65 volts 1.56 ea. 7/9/00 Stk. No. F2117
7,350 mfd. 75 volts 1.74 ea. 6/9/00 Stk. No. F2116

MINIMUM ORDER $3.00

Many other items—send for new 32 page catalog. All merchandise guaranteed. Please include postage. Excess will be refunded.

DELTA ELECTRONICS CO.

CIRCLE NO. 14 ON READER SERVICE CARD

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

MAILORDER MILLIONAIRE helps beginners make $500 weekly. Free report reveals secret plan! Executive (1K), 333 North Michigan, Chicago 60601.


HOME WORKERS wanted! For details, send 15¢ stamps. Mike Boorman, 7294A "L" Street, West Palm Beach, Florida 33401.

311 FAST, easy ways to make money! Free! Rush name, address, zip. Perry, 12626W Ventura Blvd., Studio City, California 91604.


BE your own boss, manufacture your product, free report. Write: Simpson, (466) 10014 South Paxton, Chicago 60617.

DISTRIBUTE "Mini-tools" for "Maxi" profits! Complete details and samples $1.00 (refundable). Cash Industries, P.O. Box 4804, Pittsburgh, Penna. 15206.

DISTRIBUTORS needed for 110 volt, 3,000 watt unit. Operates from any alternator. Big profit margin! ($20.00 value) $11.50 for first unit and information—refundable. $1.00 information only. P.O. Box 771, Rosemond, Calif. 91733.

PIANO TUNING learned quickly at home. Tremendous field! Musical knowledge unnecessary. GI Approved. Information Free. Empire School, Box 327, Miami Florida 33145.

REAL ESTATE

FREE . . . NEW . . . 248-page SUMMER CATALOG! Describes and pictures hundreds of farms, ranches, town and country homes, businesses coast to coast! Specify type property and location preferred. UNITED FARM AGENCY, 612-EP West 47th St., Kansas City, Mo. 64112.
MOVIE FILMS

SEND 50¢ for Pro Sports Film Catalog—Save $1.00 on first purchase. BASEBALL . . . FOOTBALL . . . HOCKEY . . . BASKETBALL—your choice Super 8/8mm, Color or B&W. SPORTLITE, Dept. ELECT., 20 N. Wacker Drive, Chicago, IL 60606.

RESORTS AND TRAVEL


TREASURE FINDERS

TREASURE FINDER locates buried gold, silver, coins, treasures. 5 powerful models. $19.95 up. Free catalog. Relco-A33, Box 10839, Houston, Texas 77018.


FISHER DETECTORS. You deserve the best. Free literature, FRL, Dept. P-E, P.O. Box 490, Belmont, CA 94002.


TRANSISTORIZED detectors—$19.95 to $79.95. Family fun and fortune. Catalog write: Treasureprobe PE 22, Tennyton, N.J. 07763.

HYPNOTISM


SLEEP learning. Hypnotic method, 92% effective. Details free. ASR Foundation, Box 7545PL, Fort Lauderdale, Florida 33304.

FREE Hypnotism. Self-Hypnosis. Sleep Learning Catalog! Drawer H400, Ruisoso, New Mexico 88345.

EMPLOYMENT INFORMATION


PLASTICS

REMODEL, reproduce, repair with Castoglas, metal, etc. Make flexible molds over any pattern. Manual 25¢. CASTOLITE, 72F/PEI, Woodstock, Ill. 60098.


MUSICAL INSTRUMENTS

**MUSIC**

**SONGS - POEMS**

Wanted for publishing and recording consideration

Accepted songs will be published & recorded at our expense - for information write to:

**Talent, 17-P E Longwood Rd., Quincy, Mass. 02169**

**POEMS & LYRICS**

OF RELIGIOUS, REVERANT & INSPIRED NATURE WANTED FOR IMMEDIATE RECORDING. WE ARE ONLY INTERESTED IN SONGS OF HOPE, GOD'S LOVE, THE COMFORT OF HIS WORDS AND WISDOM. SEND TO:

**CATHEDRAL RECORDING CO.**

**P.O. BOX 79, STUDIO PE**

**NO. WEYMOUTH, MASS. 02191**

**MAGAZINES**

**GUIDE TO EARNING EXTRA INCOME**

*A Ziff-Davis Publication*

All new—first time ever published! Everything you need to know about full and part time money-making. How to start your own mail order business • 22 proven and profitable home business ideas • How to earn extra $’s • Franchising • Vending machines • Advice on cutting living costs. Only 75c.

Order from Ziff-Davis Service Division, 595 Broadway, New York, New York 10012.

Enclose an additional 25c for postage and handling.

**MISCELLANEOUS**

**WINEMAKERS:** Free illustrated catalog yeasts, equipment. Sempex, Box 12276, Minneapolis, Minn. 55412.

**AMAZING INVENTION!**

- Non-Electric!
- Interchangeable Tips — 8 Irons in 1!
- Heats To 862° Within Seconds!
- No External Heat Of Any Kind!

"Quick-Shot" Cartridge Heated Soldering Iron. Used commercially for years — now available to you for the first time. 1001 uses — Indispensable where electric power is unavailable — where a torch can't be used — anywhere. 8 tips gives you the right tool for any soldering job at 1/3 the price of an additional iron. Cartridge activates in seconds — is non-flammable, non-explosive, emits no fumes, shelf life exceeds 4 years. It's the tool you can't afford to be without. Complete kit includes Soldering Iron, 1/4" Tip, Cartridges — Only $19.95 Post paid. Send order & payment to Kemode Manufacturing Co., Dept E, 409 Railroad Ave., Westbury, N.Y. 11590.

**MONEY BACK GUARANTEE.**

---

**POPULAR ELECTRONICS**

Including Electronics World

**JUNE 1972**

**ADVERTISERS INDEX**

**READER SERVICE NO.**

**ADVERTISER**

**PAGE NO.**

3 Antenna Specialists Co., The ........................................................................ 83
4 B. & F. Enterprises ........................................................................................ 99
7 B & K Division, Dynasam Corporation .......................................................... 22
8 BSR (USA) Ltd .............................................................................................. 96
Bell & Howell Schools .................................................................................... 90, 91, 92, 93
10 Bose Corporation .......................................................................................... 15
11 Burstein-Applebee Co. ................................................................................ 95
12 CRI, A Division of the McGraw-Hill Continuing Education Company ....... 54, 55, 56, 57
13 CTS Corporation ........................................................................................... 55
14 Delta Electronics Co. .................................................................................... 105
15 Delta Products, Inc. ...................................................................................... 69
16 EICO ........................................................................................................... 95
17 Edmund Scientific Co. ................................................................................... 108
18 El Instruments, Inc. ...................................................................................... 8
19 Electro-Voice, Inc. ......................................................................................... FOURTH COVER
20 Electro-Voice, Inc. ......................................................................................... FOURTH COVER
21 Environmental Products ............................................................................... 10, 11
22 GE Electronics ............................................................................................. 94
23 Grantham School of Engineering ................................................................ 7
24 Gregorian Electronics Corp. ......................................................................... 103
25 Heath Company ............................................................................................. 63
26 Johnson Company, E.F. ............................................................................... 14
27 Lafayette Radio Electronics .......................................................................... 81
28 Liberty Electronics, Inc. .............................................................................. 103
29 McIntosh Laboratory, Inc. ........................................................................... 89
30 MITS, Inc. ..................................................................................................... 87
31 Midland Electronics Company ................................................................... 67
32 Midland Electronics Company ................................................................... 67
33 National Radio Institute ............................................................................... 2, 3
34 National Technical Schools ......................................................................... 36, 37, 38, 39
35 Olson Electronics .......................................................................................... 79
36 P & S Electronics, Inc. ................................................................................ 71
37 Penwood Numechron Co. ........................................................................... 71
38 Poly Paks ....................................................................................................... 106
39 RCA Institutes, Inc. ..................................................................................... 18, 19, 20, 21
40 Revox Corporation ......................................................................................... 9
41 Sams & Co., Inc., Howard W. ...................................................................... 25
42 Schuster Organ Corp, The ........................................................................... 83
43 Share Brothers Inc. ......................................................................................... 65
44 Solid State Sales ............................................................................................ 104
45 Solid State Systems, Inc. .............................................................................. 101
46 Sonar Radio Corp. ......................................................................................... 89
47 Tektronix, Inc. ............................................................................................... 17
48 Tri-Star Corporation ...................................................................................... 88
49 U.S. Navy ....................................................................................................... 13
50 Valparaiso Technical Institute ..................................................................... 79

**CLASSIFIED ADVERTISING**

98, 100, 102, 103, 104, 105, 106, 107
DIGITAL COMPUTER LOGIC LAB

- Fascinating new way to learn computer type systems, truth tables, logic. Make ring counter, shift registers, memory. Make AND, OR, NOT, EXCLUSIVE OR, etc. Use standard circuitry, HD 7487. Connect different types, expand. No experience required.
- Stock No. 71,403A $3.75 Pd.

ASTRONOMICAL TELESCOPE KITS

- Grind your own mirror for powerful telescopes. Kits contain fine emulsion plates, mirror blanks, tools, abrasives, etc. Build your own 6" telescope with your own glass. Stock No. 70,003AV $10.75 Pd.
- Stock No. 70,004AV 6" dia. x 17" $15.95 Pd.
- Stock No. 70,005AV 8" dia. x 18" $24.50 Pd.
- Stock No. 70,006AV 10" dia. x 18" $44.50 Pd.
- Stock No. 70,007AV $72.50 Pd.

BLACK-LIGHT MIGHTY MITES

- Redes equivalents of 121's feature giving sur- prisitly bright black-light. Micro- bial growth can now instant starting enzyme, high-intensity bulb looks like a 6V lamp, 3500 hours of use. Stock No. 71,374AV 12V $14.95 Pd.
- Stock No. 71,299AV Stock No. 71,374AV Deluxe Incandescent Model $19.95 Pd.

UNIQUE LIGHTING HANDBOOK

- 100 information-packed pages. Fully equipped with charts, sketches, lighting equipment, techniques, developments. Covers all facets. Packed with solid black-light show production including strobes, backgrounds, color effects, etc. Stock No. 71,249A $10.00 Pd.
- Stock No. 71,299AV $3.00 Pd.

MAIL COUPON FOR GIANT FREE CATALOG!
Here's an easy and convenient way for you to get additional information about products advertised or mentioned editorially (if it has a reader service number) in this issue. Just follow the directions below... and the material will be sent to you promptly and free of charge.

1. On the attached postage-free card, print or type your name and address on the lines indicated.

2. Circle the number(s) that corresponds to the key number(s) at the bottom or next to the advertisement or editorial mention that is of interest to you. (Key numbers for advertised products also appear in the Advertisers' Index.)

3. Simply cut out the card and mail. No postage required.

**STEREO DEMONSTRATION RECORD**

This record is the result of two years of intensive research in the sound libraries of Deutsche Grammophon Gesellschaft, Connoisseur Society, Westminster Recording Company and Cambridge Records Incorporated. The Editors of Stereo Review have selected and edited those excerpts that best demonstrate each of the many aspects of the stereo reproduction of music. The record offers a greater variety of sound than has ever before been included on a single disc.

It is a series of independent demonstrations, each designed to show off one or more aspects of musical sound and its reproduction. Entirely music, the Record has been edited to provide self-sufficient critical presentations of an enormous variety of music arranged in a contrasting and pleasing order. It includes all the basic musical and acoustical sounds that you hear when you listen to records isolated and pointed up to give you a basis for future critical listening.

**WIDE RANGE OF DEMONSTRATIONS**

- Techniques of Separation & Multiple Sound Sources
- Acoustic Depth
- Ambiance of Concert Hall
- Sharp Contrast of Dynamics
- Crescendo & Diminuendo
- Very High & Very Low Pitched Musical Sounds
- Polyphony (2 or more melodies at once)
- With Both Similar & Contrasting Instruments
- Tonal Qualities of Wind, String & Percussion Instruments
- Sounds of Ancient Instruments
- Sounds of Oriental Instruments
- Sound of Singing Voice
- Both Classically Trained and Untrained
- Plus a Large Sampling of Finger Snapping, Hand Clapping, Foot Stamping & Other Musical & Percussive Sounds

**RECORDS ONLY $5.98 POSTPAID**

**CASSETTE ONLY $6.98 POSTPAID**

**SEND NO MONEY**

Use the postage-paid order card located at the top of the flap to the right to order your records and cassette. In the event the card has already been detached you can also place your order by circling the appropriate % on the Information Service Card to the right. Either way, your selection will be mailed to you along with an invoice for the regular price of only $5.98 for each record ordered, $6.98 for the cassette, postpaid.

Stereo Demonstration Record—Circle # 92
Stereo Demonstration Cassette—Circle # 93
Binaural Demonstration Record—Circle # 94

**BINAURAL DEMONSTRATION RECORD**

Binaural recording re-creates the directions, distances, and even the elevations of sounds better than any other recording method. The super-realism of binaural recording is accomplished by recording the acoustical input for each ear separately, and then playing it back through stereo headphones. Thus the sound intended for the left ear cannot mix with the sound for the right ear, and vice versa.

Binaural recording offers the listener the identical acoustical perspective and instrument spread of the original. The sound reaching each ear is exactly the same as would have been heard at the live scene.

**STARTLING REALITY.** The Binaural Demonstration Record offers 45 minutes of sound and music of startling reality. You'll marvel at the eerie accuracy with which direction and elevation are re-created as you embark on a street tour in Binaural sound—Sounds Of The City... Trains, Planes & Ships... Basketball Game, a Street Parade, a Street Fabrication Plant, The Bird House at the Zoo—all demonstrating the incredible realism of binaural sound reproduction.

**MUSIC IN BINAURAL.** The musical performances presented on the Binaural Demonstration Record transport you to the concert hall for a demonstration of a wide variety of music. Selections total 23 minutes, and include examples of jazz, organ, and chamber music.

**THE MOST SPECTACULAR SOUND EXHIBITION OF STEREO FIDELITY EVER AVAILABLE**
Dreaming about a pair of $300 condenser microphones?

Think seriously about these: $39.75*each!

Model 1710 Electret Condenser Omnidirectional Microphone

All of the great condenser advantages are here without compromise. Flat, extended range, excellent transient response, high output, low noise, and ultra-clean sound. But the new E-V electret condenser microphones need no high voltage power supply. Just an AA penlite battery to operate the built-in FET impedance converter. The result is studio performance without complications and at a dramatically lower price.

There are 4 new E-V electret microphones, including cardioid models, from $39.75 to just $75.00, audiophile net. Second-generation designs with unusually high resistance to heat and humidity. Hear them today at your nearby Electro-Voice soundroom. Or write for details.

More U.S. recording studios use Electro-Voice microphones than any other brand.

*Suggested retail price. Microphones shown on Model 421 Desk Stand: $19.00 each.

Can the EVX-4 4-Channel Decoder face up to records encoded for Columbia SQ, Sansui, Dyna, and all the rest?

Yes. Listen. Play “their” best demonstration records through the EVX-4 or the E-V 1244X add-on decoder/stereo amplifier.

In most cases you’ll hear little or no difference. Some records may even sound better to you through our decoder than through theirs! How can this be? Because you’re listening to music, not ping-pong or algebra. And our decoding is basic.

STEREO-4™ decoders can do the best job at the lowest cost for all 4-channel matrix records and FM broadcasts. Not to mention how well they enhance your present stereo records, tapes, and FM.

But don’t take our word for it. Listen carefully. Make your own discovery that “their” records can make the best case for “our” decoders!

EVX-4 Stereo Decoder $59.95 suggested resale

E-V 1244X Decoder/Stereo Amplifier $149.95 suggested resale

CIRCLE NO. 1 ON READER SERVICE CARD

CIRCLE NO. 2 ON READER SERVICE CARD