Electronics World

APRIL, 1971
60 CENTS

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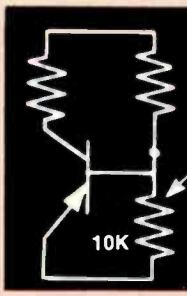

Low voltage of .08 volts prevents transistors from conducting and misreading circuit. Resistor will now read 10K as it should. Also prevents any damage to transistor.

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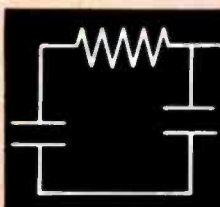

Higher voltage of 1.5 volts causes semiconductors to conduct to read proper front-to-back ratio or conductivity of transistors. Meter would not be complete without hi-ohms reading.

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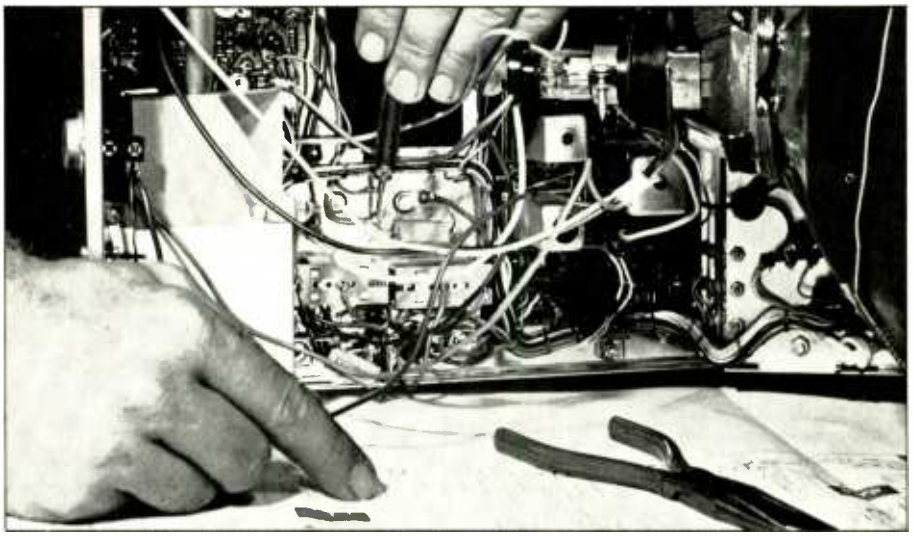

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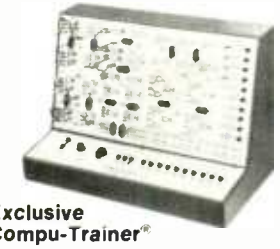

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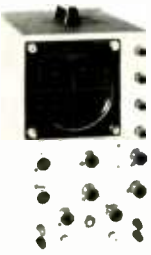

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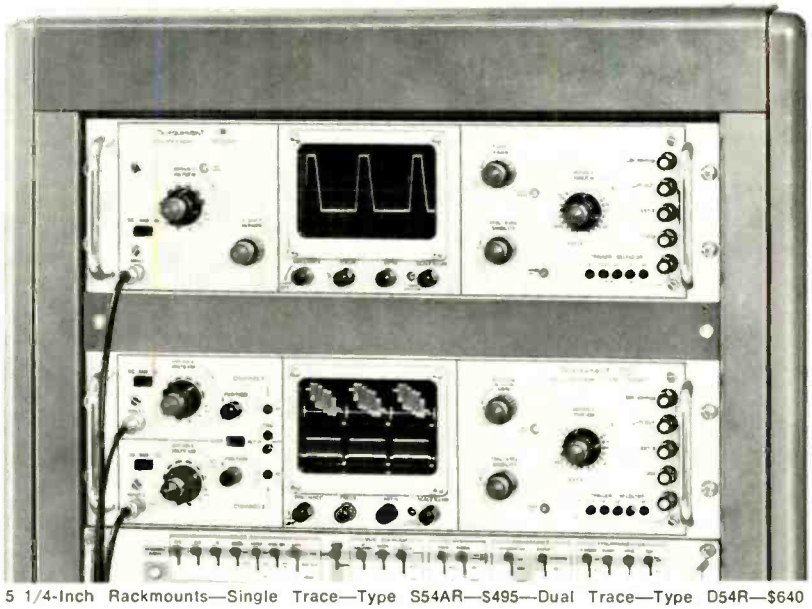

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Electronics World

APRIL 1971 VOL. 85, NO. 4

Contents

Electronics World

THIS MONTH'S COVER shows a half dozen of the 19 solid-state v.o.m.'s that we have tested for our feature story on this subject. Products shown are (from top left): Simpson 2795, Sencore FE149, and B&K 176. Below the latter unit are the RCA WV-510A and Heath IM-25. Being held at lower left is the Triplett 310-FET. For details on features, performance, and prices of these and other t.v.o.m.'s, refer to the story on page 39. Cover photo: Dirone-Denner.

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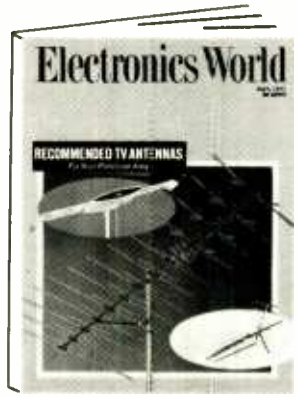
April, 1971

Coming Next Month

Special Feature Article



HOW TO PICK THE RIGHT TV ANTENNA FOR YOUR LOCATION

A number of criteria are involved in making such a selection—including what signals you expect to be able to receive, distance from the TV transmitter, terrain surrounding your home, and the sensitivity of your receivers. Forest Belt explains these important points, describes new features incorporated in current antenna models, and provides a chart of recommended types to make antenna selection easy.

ERTS—Satellites to Serve Man

This new breed of satellite to be launched early next year will provide scientists with a tool to measure and manage the natural resources upon which mankind depends for his existence. These sophisticated "birds" will be able to locate schools of fish, pinpoint blight, catalogue water resources, detect air and water pollution, and locate promising sources of minerals.

Know Your Electronic Chemicals

As electronic circuits become more complex, chemicals have been developed to handle a wide range of servicing problems—from quick cooling for checking intermittents to making tuners and switches perform more reliably. John Frye brings you up to date on all that is newest and best for the service technician.

Classical Recording Techniques

If multichannel techniques, such as those used in recording jazz/rock, were employed with classical recordings—the qualities of a live performance could be captured, according to Fred Catero. Don't miss his suggestions on how this could be done.

All these and many more interesting and informative articles will be yours in the ***May*** *issue of ELECTRONICS WORLD . . . . . on sale* ***April 20th***

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ELECTRONICS WORLD (April, 1971, Vol. 85, No. 4.) Published monthly at One Park Avenue, New York, New York 10016, by Ziff-Davis Publishing Company—also the publishers of Airline Management and Marketing Including American Aviation, Boating, Business & Commercial Aviation, Car and Driver, Cycle, Flying, Modern Bride, Popular Electronics, Popular Photography, Skiing, Skiing Area News, Skiing Trade News, Stereo Review, and Travel Weekly. One year subscription rate for U.S., U.S. Possessions, and Canada, $7.00; all other countries, $8.00. Second Class postage paid at New York, N.Y. and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash.

NEWS HIGHLIGHTS

We're Losing a Precious Resource

With unemployment at a 9-year high at the end of the year and with more and more electronics scientists, engineers, and technicians out of work, we are in danger of losing one of our most precious resources—technical manpower. Whether you're talking about California, Washington State, or Connecticut, where unemployment figures are well above the national average, many talented workers are being turned away from electronics. Not only will many of these people be lost to the industry, but interest in engineering as a career is also falling. This loss of technical talent is not only a personal tragedy to the man without a job, but the country will also be the loser. There is no shortage of technical jobs to be done. Urban problems, pollution control, mass transportation, mail and written communications are areas that need help from electronics people. So there are plenty of jobs to be done and we should not be ready to declare all our electronics brains surplus.

To help their unemployed members, the IEEE recently announced a 50-percent reduction of dues and fees for those now out of work and seeking re-employment. The half-price membership applies through December 1971. Members must submit a signed statement to IEEE headquarters indicating that they are involuntarily unemployed and seeking re-employment. Rebates of dues are also being given.

A bright spot in the picture comes from the New Jersey Council for Research and Development. A survey of their over-100 members indicates that, although there is a temporary oversupply of Ph.D's, research technicians will still be in demand in '71 despite the sluggish economy. The R&D Council recently had a major Technician Career Conference at *Bell Labs* in Holmdel which attracted about 500 science teachers, guidance counsellors, and administrators. State chairman H. J. Wallis said: "We're trying to break down the idea that everyone has to have a four-year education in order to obtain the 'good life.' Technicians are in good salary brackets now and their prestige and status are definitely on the up-trend."

National Union (Emerson) Suing Japanese

A suit has been instituted by *National Union* (owner of *Emerson* and *DuMont TV*) against seven major Japanese TV manufacturers and their U.S. sales subsidiaries for violations of the U.S. anti-dumping act and anti-trust statutes. The suit seeks triple damages of over $360 million and an injunction against *Matsushita, Tokyo Shibaura, Hitachi, Hayakawa* (*Sharp*), *Mitsubishi, Sony*, and *Sanyo*, among others. The suit charges that the companies combined and conspired to fix and inflate television prices in Japan to finance their now dominant penetration of the U.S. TV market which was achieved by dumping in this country at unfairly low prices. *National Union* claims that as a result, the U.S. TV manufacturing industry has been damaged and the company was forced to shut down its *Emerson* television manufacturing facility in Jersey City, N.J. and related cabinet manufacturing plants in Canastota, N.Y., causing great losses.

FTC Goes for Continuous Power Rating

The Federal Trade Commission has been pushing hard to try to clear up some of the confusion and down-right misleading advertising that has been going on regarding output-power ratings of hi-fi amplifiers. Whether these amplifiers are used in radios, phonos, tape players, or component receivers and power amplifiers, the poor consumer is given output power in terms of music power, peak power, peak music power, instantaneous power, a ±1-dB power, *ad nauseum*. The FTC, charging "wide abuse" by the industry, has scheduled a public hearing on April 13 concerning a Trade Regulation Rule relating to advertising of power output of audio equipment for home-entertainment products.

The proposed Rule says that when power is advertised, the most prominent and conspicuous figure given must be the manufacturer's rated minimum *sine-wave continuous (r.m.s.) power in watts per channel*. Also, the indicated load impedance must be specified and all channels should be simultaneously driven. The rated power band or power frequency response in hertz must also be disclosed as must the rated total harmonic distortion at any power level from zero to the rated power output, for each rated power output. Any other power ratings that are given, such as music, peak, or instantaneous power, must be less prominently displayed and these must be made in accordance with standard rating and test methods that are well known and generally recognized.

If the new Rule is adopted, it should go a long way toward helping the harried consumer trying to select a piece of audio equipment. The continuous power rating is the one we have been using for many years in our own lab-tests of hi-fi equipment. The Electronic Industries Association (EIA) has been opposing the proposal; their position is that the industry should police its own advertising. However, EIA has been working on a new audio amplifier standard that goes along with FTC requirements.

Big Year for Batteries

Industry sales of dry batteries for commercial use were at an all-time high in 1970—about $45 million at retail—according to information we have from *Mallory Battery Co.* This was an increase of 5 percent over the previous year due to increasing use of battery-operated tape recorders, radios, cameras, and flashlights, as well as portable TV's and new battery-operated appliances and toys. High-performance alkaline batteries represent an increasing chunk of the market, which is expected to increase by another 5 or 6 percent by the end of this year.

There's even been a commercial nuclear battery announced. This is a miniature, nonthermal radioisotope-fueled battery that will deliver very low power but for long periods of time—up to 10 years. Called Betacel by its developer, *Donald W. Douglas Laboratories* (*McDonnell Douglas*), the new battery should be useful in implanted prosthetic devices, such as pacemakers and nerve stimulators, biomedical telemetry devices, and specialized space and oceanographic instruments.

We've also heard about a new type of battery charger that dramatically shortens the time needed to recharge nickel-cadmium storage batteries. The charger will do the job in as little as one-eighth the time now needed. The unit sends a series of high-current pulses into the battery and then applies a reverse-current pulse to remove accumulated gas and other products of polarization. Charger is being made by *Christie Electric Corp.* (under license from *McCulloch Electronics Corp.*) for use by NASA, aircraft companies, and the military. Before you rush out and buy one though, you should know that the price ranges from $1500 to $2500 per charger.

Japanese Agree on Color Video Cartridge Standard

Three Japanese manufacturers, *Sony*, *Matsushita*, and *Japan Victor*, will start marketing by the end of this year standardized color video tape cassettes as well as recorder-players which will comply with the U.S. NTSC standards. These 60-minute, ¾-inch video tapes are housed in cassettes measuring about 8¾" × 5½" × 1¼"; blank cassettes are expected to sell for between $22 and $28, while recorded ones will probably retail between $80 and $140. The recorder-players are scheduled to sell for around $550 to $700, with mass production expected to lower these prices considerably. The three companies are also negotiating with European manufacturers *Grundig*, *Phillips*, *Telefunken*, and *Zanussi*.

Billion Dollar Video Cassette Market by 1980

There's lots of activity in the video cassette and cartridge market these days. A recent study by "Edubusiness," a biweekly newsletter devoted to the education and training market, indicates that world sales of video cassette recording and playback systems are expected to reach $1 billion annually by 1980. The report predicts that consumer use will ultimately constitute the largest single segment of the market. Also, it states that one of the major hurdles is the development of suitable standardization for the new video-recording products.

On this same subject, we note that *Motorola* has set up a network of almost 400 independent service organizations to service its Teleplayer unit. This unit plays cartridge film programs through a standard TV set using the *CBS* Electronic Video Recording (EVR) technique. Service will be available anywhere in the country using *Motorola's* extensive service facilities and capabilities. The field-service network will be supported with service backup and parts availability from 84 distributors in major metropolitan areas as well as by 26 regional service reps.

Upcoming Electronics and Hi-Fi Shows

The electronic industry's largest engineering show is at the same place and at the same time this year. The IEEE Show is scheduled for March 22-25 at the New York Coliseum (four floors of exhibits) and at the N.Y. Hilton, both in New York City.

The Institute of High Fidelity (IHF) will hold its third suburban Hi-Fi Show in the San Francisco area from April 1 to 4. Previous such shows in Westbury, N.Y. and Newton, Mass. proved to be so successful that the IHF is continuing with the suburban show concept. The San Francisco show will be at the Cabana Hyatt Motel in Palo Alto. ▲

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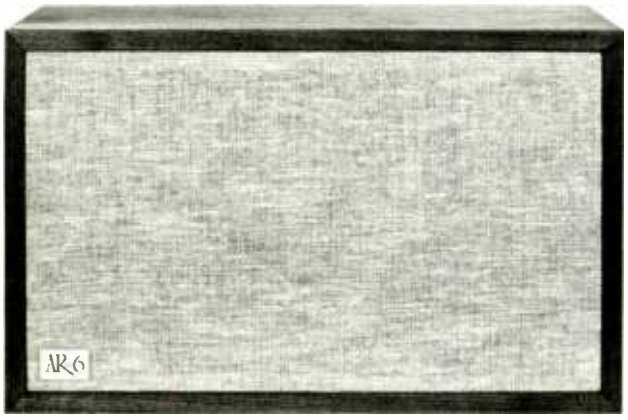


WHEN we reviewed the four basic models of *Acoustic Research* speaker systems in the September issue, it appeared that the *AR* line covered all popular price ranges with uniformly excellent performance. Thus, we were curious about the new model, the AR-6. Where did it fit into the company's product line, in price and performance?

The dimensions of the speaker gave the first clue, since it is a true bookshelf design, of approximately the size of the AR-4x, but with different proportions. The AR-6 is 19½" wide by 12" high by 7" deep, weighs 20 lbs, and can fit comfortably on almost any ordinary bookshelf. Its price, which is $81 in oiled walnut, or $72 in unfinished pine, places it squarely between the AR-4x and AR-2ax. Before considering its performance qualities, it would be instructive to take a look inside the speaker.

The AR-6 is a two-way system, with an acoustic-suspension woofer 8" in diameter. The free-air resonance of the woofer is 25 Hz, and the system resonance in the sealed cabinet is 57 Hz, which also happens to be the system resonance of the AR-2ax and AR-5 systems. The AR-6 woofer cone, supported by a urethane edge suspension, is capable of a 1" linear excursion. It features a unique magnet structure, with several small magnets around the pole piece instead of the customary single magnet. According to the manufacturer, this allows a very long linear cone excursion with reasonable efficiency and at a reasonable cost.

The crossover to the tweeter occurs at 1500 Hz. The tweeter is a new design, with a 1" diameter, having excellent high-frequency dispersion. Its level is adjustable by a continuous control in the rear of the cabinet. Our measurements confirmed the excellent dispersion of this speaker, which appeared to be better than that of the AR-2ax, and quite comparable to the AR-5 and AR-3a systems.

The AR-6 is a nominal 8-ohm system. We measured its electrical impedance at about 7 ohms over most of the audio-frequency range, increasing to 15 ohms at the bass resonance of 57 Hz and to about 12 ohms at what appeared to be a secondary system resonance at about 600 Hz. The minimum impedance, which occurred in the 10- to 20-kHz region, was slightly more than 5 ohms.

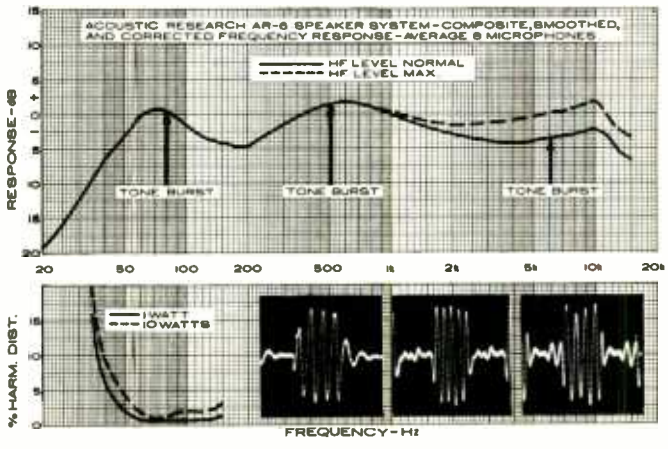
The bass response, below about 300 Hz, was measured relative to that of a calibrated reference speaker, to eliminate the effects of room resonances. The AR-6 proved to have a bass response almost identical to that of the AR-2ax or AR-5, which use a 10" woofer in a much larger cabinet. Like all *AR* speakers, the low-frequency distortion of the AR-6 was quite low, under 2% down to 50 Hz at a 1-watt drive level, and increasing to 5% at 42 Hz. The long-throw woofer proved itself well able to handle large excursions, since the distortion at 10 watts was only slightly greater than at 1 watt.

Above 300 Hz, we averaged the response measured at eight points in the room. After smoothing and correcting for microphone response, the final composite response curve of the speaker was within ±3 dB from 47 Hz to 12 kHz. This was with the tweeter level set to the indicated "normal" position; setting it to the maximum improved the over-all flatness measured, and extended the upper response limit at –3 dB to 15 kHz. Tone-burst response was uniformly good at all frequencies.

When we tested the speaker in a live-*vs*-recorded listening comparison, we found only two areas where its sound did not quite faithfully reproduce the original. The extreme high frequencies (such as those required to reproduce wire brush and cymbal sounds) were slightly dulled. Advancing the tweeter level to a point between the "normal" and maximum settings optimized this portion of the spectrum. We also detected a slight emphasis of the mid-range, which we would suppose to be related to the slight elevation in the response curve in the 300- to 1000-Hz region (by about 3 dB).

The AR-6 came remarkably close to matching the performance of the most costly *AR* speakers and its sound resembled them to such a degree that it would be difficult to tell them apart without a critical side-by-side comparison. It shares their well-known property of seeming to lack bass—until the program calls for some real bass. This diminutive system can deliver very clean, powerful, output at 35 Hz.

The speaker is fairly inefficient. The manufacturer suggests driving it with an amplifier rated for at least 20 watts per channel (continuous power). Despite its size, it is not a "lightweight" speaker, and can handle up to 100 watts per channel of conventional (not rock) music program material.



The AR-6 fills an important gap in the company's product line, offering sonic performance very close to its larger and more expensive models, in an enclosure as small as the AR-4x. The $80 price class in speakers is highly competitive, and there are several excellent choices available to the buyer. The AR-6 is a strong and worthy runner in the field and if you are partial to deep, clean bass, it is among the leaders in that area of performance. ▲

Sound Technology 1000A FM Alignment Generator

of the swept display indicates a nonlinearity in the tuner. The i.f. and discriminator circuits are aligned to produce the smoothest, widest, and most uniform display possible. As a final check, the sweep width can be reduced to 150 kHz, corresponding to 100% modulation, and the vertical scale of the oscilloscope expanded to reveal the smallest departure from flatness. The amplitude of any irregularity, expressed as a percentage of the total vertical amplitude, is a direct measure of IM distortion. The rated peak nonlinearity of the generator in the Dual-Sweep mode is less than ±0.3% over a 150-kHz bandwidth.

Clearly, the Model 1000A is an uncommonly versatile instrument. It was designed for a manufacturer's final-test or quality-assurance departments, or for the service specialist dealing in the highest caliber of home receiving equipment. This unit makes more use of up-to-date components and techniques than any comparable laboratory instrument we have seen. For example, its design employs 8 linear IC operational amplifiers, an IC power-supply voltage regulator, and two digital IC's serving flip-flop and gating functions. In addition, there are 22 transistors (5 of them FET's) and 13 diodes.

The end result is a compact instrument, 8⅜" high by 11⅛" wide by 11¾" deep and weighing only 12 pounds. It is very nearly a single unit FM/stereo-FM test laboratory, whose functions could only be partially duplicated by a clumsy and expensive array of separate instruments.

Tests and Evaluation

Our tests of an instrument such as this had to be done indirectly, by comparison with other instruments whose performance was in some respects inferior to the unit we were "testing." Nevertheless, we were able to satisfy ourselves that this instrument does what is claimed for it, and then some.

Our own FM signal generator, a *Boonton* Model 202B, has a residual distortion of about 0.5% at 75-kHz deviation. We used it to measure the IHF usable sensitivity, distortion, signal-to-noise ratio, and stereo crosstalk of a new FM receiver, and similar measurements (except for crosstalk) on an older mono-FM tuner of high quality. A *Scott* Model 830 multiplex generator was used to develop the composite modulating signal for the stereo measurements. The same measurements were then repeated using only the *Sound Technology* Model 1000A.

With our own equipment, the IHF sensitivity of the receiver measured 3.0 microvolts; with the Model 1000A it was 2.9 microvolts—remarkably close in view of its relatively loose output-level specifications. The distortion measured 0.54% with our equipment, and a remarkable 0.07% with the Model 1000A. The two sets of stereo-crosstalk measurements agreed within 3 dB at all frequencies. The signal-to-noise ratio was 72 dB with our equipment; 73 dB with the Model 1000A.

With the mono tuner, our equipment showed an IHF sensitivity of 2.1 microvolts, while the Model 1000A gave a reading of 2.6 microvolts—still within specification limits. Distortion with our generator was 0.53%; with the Model 1000A it was 0.19%. The signal-to-noise ratios were, respectively, 70 dB and 73 dB.

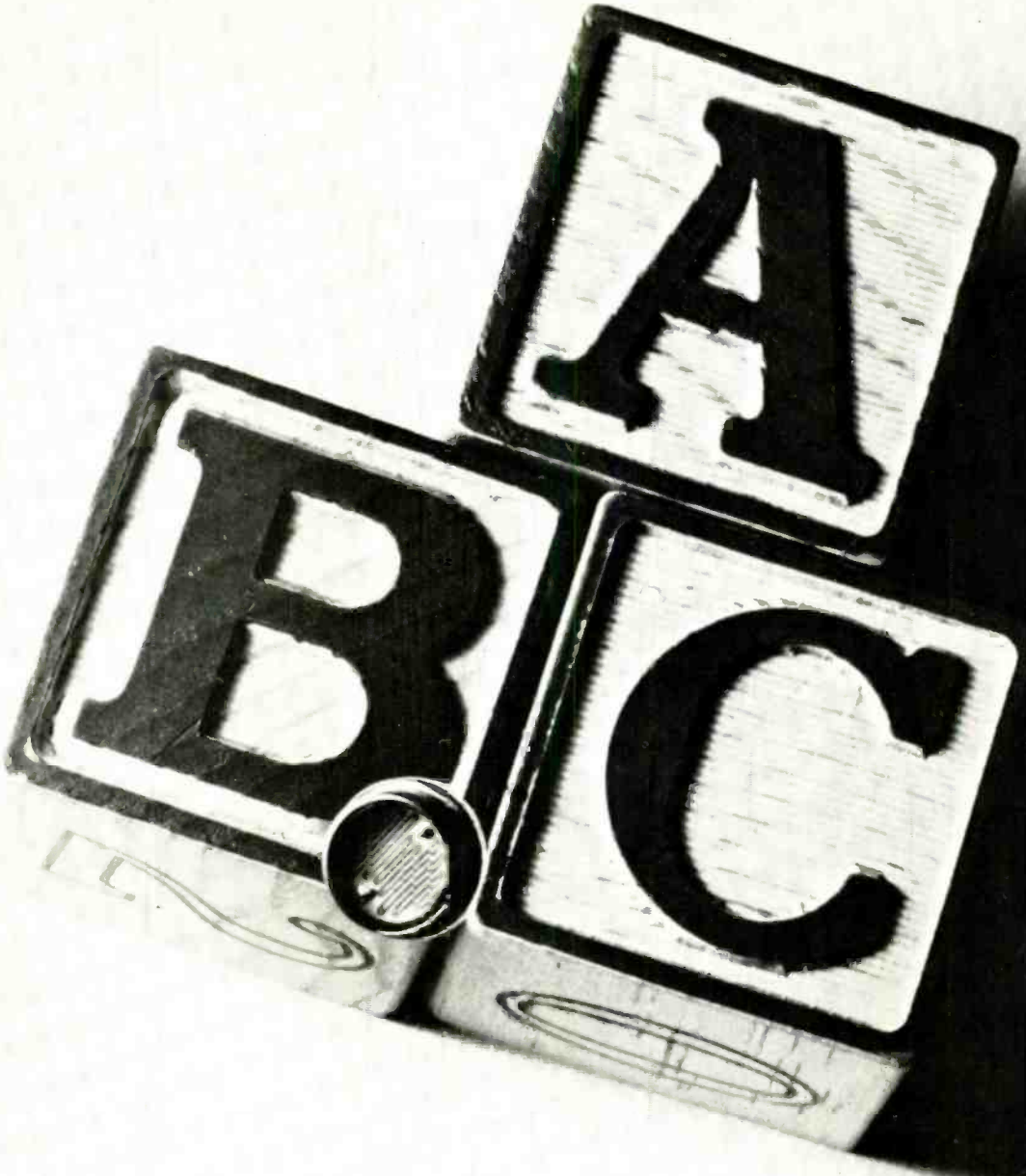
We then used the Dual-Sweep mode to align the mono receiver. It was interesting to note how easily rather large irregularities from 100 kHz to 300 kHz away from the center frequency could be produced by conventional alignment methods. With a little practice, the Dual-Sweep technique allowed a modest reduction in distortion, but with an improved symmetry over a wide bandwidth which makes the receiver easier to tune for low distortion.

In effect, Dual Sweep replaces the rapid, but purely *qualitative* sweep alignment of a discriminator by visual display of its S-curve with an equally fast, but precise and *quantitative* indication of the tuner's IM distortion.

Our only criticism of the generator is the choice of 1 kHz as its internal modulating frequency. The IHF standard on FM tuner measurements specifies a 400-Hz modulating frequency and this frequency has long been a part of other standard measurement practices for home FM receivers. The principal reason for this, we believe, is that harmonics of 400 Hz appear in the correct amplitude relationship to the fundamental, even the third harmonic is reduced by only about 1 dB by the tuner's de-emphasis circuits. On the other hand, the second harmonic of a 1-kHz modulating signal is reduced by 1.9 dB, and the third harmonic is down 3.8 dB, relative to the 1000-Hz level, since de-emphasis begins just below 1000 Hz. This can give misleadingly optimistic readings of tuner distortion. Of course, 400 Hz can be used with the Model 1000A, from an external source (which we did), but it should be internally available, either instead of or in addition to the 1-kHz signal.

(Editor's Note: The manufacturer will supply the instrument with a 400-Hz modulating frequency if desired at no extra cost. However, this means that separation will have to be measured at 400 Hz rather than 1 kHz. Both frequencies are available at the flick of a switch as an extra-charge option.)

All in all, the *Sound Technology* Model 1000A is a fine instrument, which we wouldn't mind having in our own laboratory. Its price is $1250. ▲



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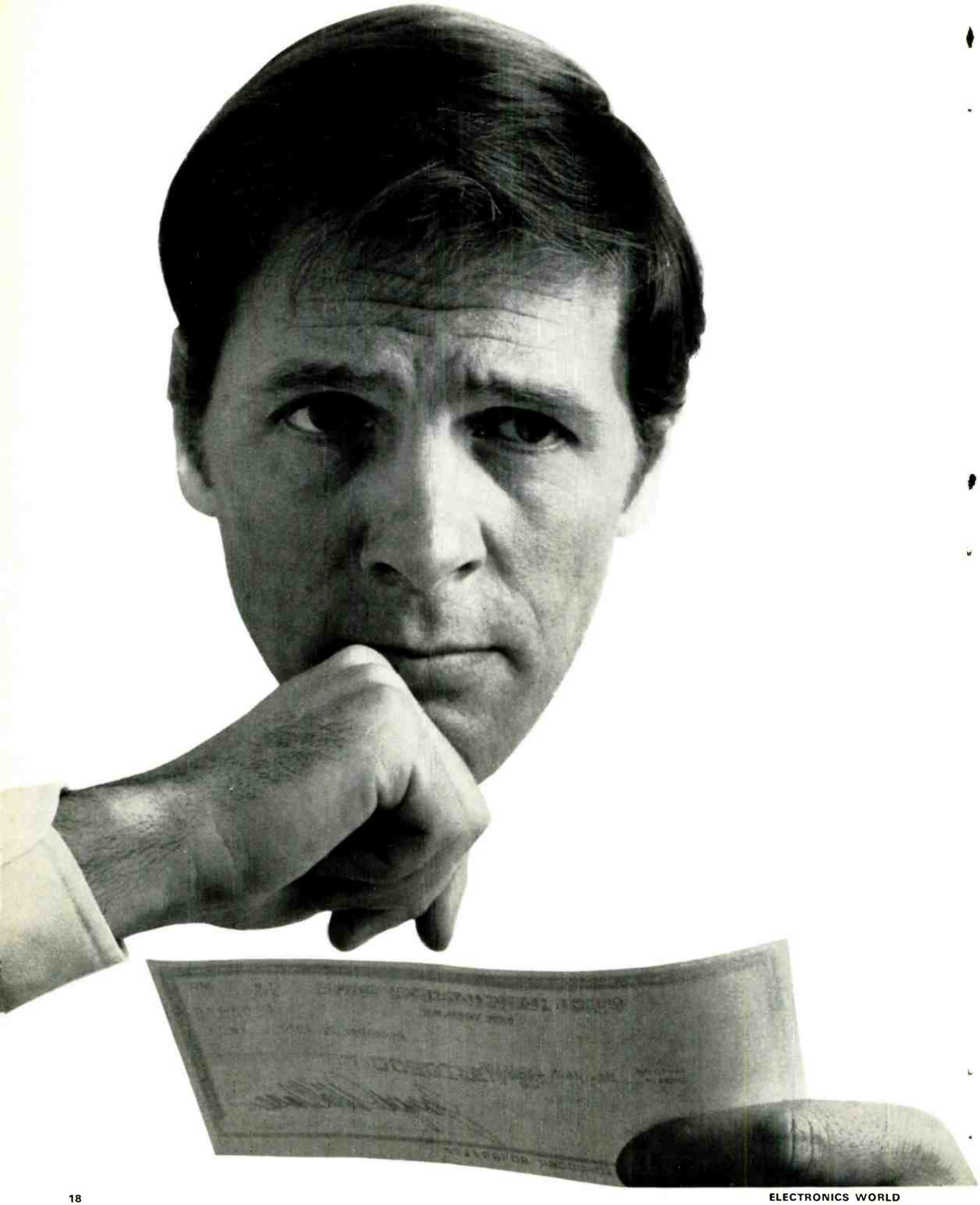

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LETTERS

TURNTABLE TESTS

To the Editors:

In reference to the article in the June, 1970 issue of ELECTRONICS WORLD "EW Lab Tests New Automatic Turntables," I would like to commend Mr. Julian Hirsch and his associates for a superb qualitative analysis of the topic.

The test covered an objective cross-section of the most popular manufactured models and used a good selection of cartridges as similar as possible. The descriptions of the models and results were concise and to the point and the article as a whole was very informative. The tests evidently were conducted with great care.

I, myself, have a *Garrard* SL55B and such a test has answered questions that I have had in relation to its comparison to other models. Therefore, I feel sure that many readers were glad to see such an article.

WILLIAM G. SHUMAKER, JR.
Durham, N. C.

We are planning on updating the report on automatic turntables shortly, including tests on the newest available models.—Editors

* * *

NEW LOOK IN TV SCHEMATICS

To the Editors:

The article "A 'New Look' for Television Schematics" by R.E. Herzog in the November, 1970 issue is a step in the right direction. But it shows *GE* still lagging in providing up-to-date schematics by continuing to show a line across unconnected wiring in place of a "loop," the latter being used in all other schematics in the magazine.

In my over 30 years of using schematics, I have often found where the draftsman had omitted the heavy dot in such schematics (including *GE's*), he caused the service technician much grief. For example, it appears in the sample schematic that *C*164 might have been intended to be connected to the bottom of the primary of *T*153, though I could not be certain without actually examining the circuit. Rarely have I found errors in schematics where loops were used, and they are much easier to follow. Can schematics ever be standardized?

B. J. BROWN
Trion, Ga.

We certainly agree with Reader Brown, especially when there is an inconsistency within the same schematic. For example, in L156 the capacitors are connected to the coil but no connection dots are used. Yet, right next to these components the coils L157 are shown connected to C160 with dots. Perhaps GE's *justification for this is that L156 is a pre-assembled filter unit.—Editors*

* * *

A 4-CHANNEL AMPLIFIER

To the Editors:

In regard to my article entitled "A 4-Channel Amplifier for Multi-Speaker Systems" in the November, 1970 issue, some who construct this may run into a slight problem due to improper ground techniques.

In order to alleviate this problem, but not as a substitute for faulty construction techniques, a circuit may be added to the input as an oscillation suppressor. Insert a 2700-ohm resistor between the input capacitor and the base of Q1. Shunt the 10,000-ohm input resistor with a 100-pF capacitor.

Also, some readers wondered about that 5-μH choke used at the output as a parasitic suppressor. It consists merely of #20 Formvar wire closely wound over the body of the 10-ohm resistor shown in parallel.

L. H. GARNER
Torrance, Calif.

* * *

ADDING EXTRA CHANNEL

To the Editors:

David Hafler's article "Adding Extra Channel for Improved Hi-Fi Ambience" (October, 1970) was interesting indeed. After trying the setup, I saw that herein lies, also, a very sensitive method for balancing the two channels of a stereo system.

Mr. Hafler writes, "The rear loudspeaker produces *difference* information only." (If the signals at each end of this speaker were the same, there would be no potential across it and no signal output.)

If, then, the amplifier is fed a monophonic source and both channels are balanced, we should get no signal from the rear speaker. This indeed happens. If one balance control on the amplifier is varied while the other one is held constant, the volume at the rear speaker goes through a very noticeable and rather sharp null as the control setting

passes through the point of equal output of the two channels. If both bass and treble controls are set to compensate precisely the same way for each channel (this may vary from the actual positions of the knobs), the null is almost perfect. If the tone controls are not compensating exactly alike, there is a residual bass or treble signal in the rear speaker.

PETER M. PERRY
North Wales, Penna.

The technique described has been used in some stereo amplifiers and balance meters just for the purpose mentioned by Reader Perry.—Editors

* * *

ANOTHER COLOR ORGAN

To the Editors:

I enjoyed reading the excellent article by Mr. Fred W. Holder "Color Organs & Strobe Lights Enhance Music" (January, 1971). We are one of those companies which is "coming into the field almost daily" and which missed the opportunity being included.

Our unit, Model 711, has four 500-watt channels, and is built into an oiled-walnut housing with anodized aluminum front panel. We will be glad to furnish additional details.

EDWARD WOLK, Sales Mgr.
Mechani-Lab
4048 Charlton Rd.
S. Euclid, Ohio 44121

* * *

SONY COLOR TV

To the Editors:

In reference to Mr. Belt's "Directory of 1971 Color-TV Chassis" in the January issue, I would like to correct the notation for the demodulation axes used in *Sony* receivers.

Sony does not use *X* and *Z* demodulation axes as listed. We have three demodulators operating on demodulation axes that are very close to B-Y, G-Y, and R-Y. However, the R-Y axis is shifted 26° from the quadrature position.

G. P. MCGINTY, Manager
Technical Publications & Training
Sony Corporation of America
Long Island City, N. Y.

* * *

SPECIAL SECTIONS AVAILABLE

For those of our readers who might be interested in the "Special Sections" we have published in the past, eight of the more recent ones (since 1967) are still available in limited quantities:

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"Linear IC's"	*July, 1970*
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"Linear IC's"	*July, 1968*
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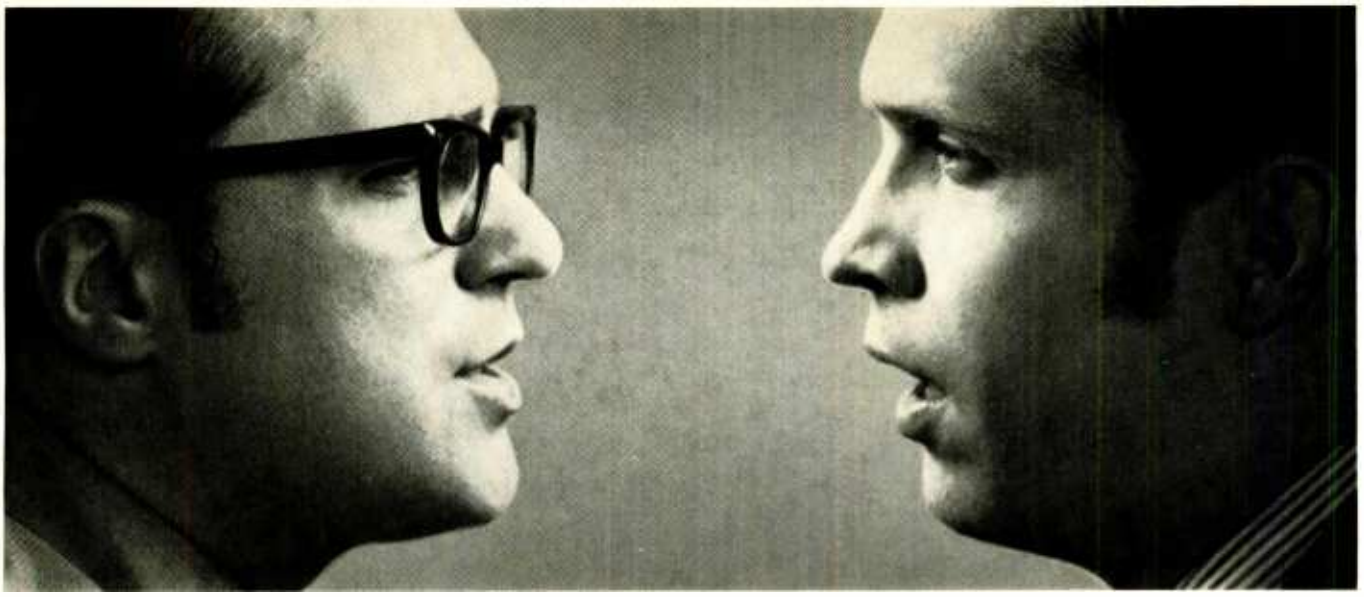

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Conducting high-energy impact implosion test on a laminated TV picture tube. This test uses a weight of 10 lbs or more suspended by wire and allowed to free-fall from a height of about 4½ ft onto a steel pin inserted through a hole in the specially constructed closed cabinet. The pin bears against the picture tube, which implodes and scatters glass from the front opening. Normally, the test engineer, who is wearing heavy gloves and a safety face mask, does not stand quite this close to the cabinet during the test. ▶

By GUY J. BURNETT
Underwriters' Laboratories, Inc.

Intensely involved with "consumerism" for years, Underwriters' Laboratories continues to protect buyers of radios, phonographs, microwave ovens, and TV sets. Here are its standards and various test procedures for such products.

IN RECENT YEARS the American consumer has become intimately involved in a new movement: "consumerism." Although not yet a cult, it can be placed more in the realm of doctrine—"a principle accepted by a body of believers or adherents to a philosophy." Consumerism also implies the principle that the consumer shall be protected from hazards inherent in any product he buys.

As consumerism spreads, organizations dedicated to its propagation spring up or gain new public recognition. One organization—the oldest and the largest of its kind in the world—has been testing products for safety since 1894. Its name: *Underwriters' Laboratories*, or simply, *UL*.

The *Laboratories* was born out of a need created in 1893 when Thomas Edison introduced the first large-scale use of his incandescent light at Chicago's Columbian Exposition. From meager beginnings the *Laboratories* has grown into a major, worldwide corporation employing over 2000 persons. An independent self-supporting safety testing organization, *UL* was sponsored by the American Insurance Association until 1968 when sponsorship and membership were broadened to take in representatives of consumer interests, governmental bodies and agencies, standardization groups, educational and public-safety bodies, representatives of public utilities, in addition to the insurance industry. This increased scope of operation took place because *UL* became aware of the need to communicate more freely with a broader spectrum of society—especially those concerned with consumer interests.

The *Laboratories* has expanded its testing services to include over 13,000 manufacturers throughout the world. These testing services are concentrated within six engineering departments: (1) Burglary Protection & Signaling; (2) Casualty & Chemical Hazards; (3) Fire Protection; (4) Marine; (5) Heating, Air Conditioning & Refrigeration; and (6) Electrical.

Of the six engineering departments, Electrical is the largest. There, safety evaluations are made on hundreds of different types of appliances for use in the home, in commercial buildings, in schools, and in factories. Principally, the work of this department continues to be the testing of electrical appliances, electrical hardware, electrical conductors, and equipment intended for use in hazardous locations, as defined in the National Electrical Code.

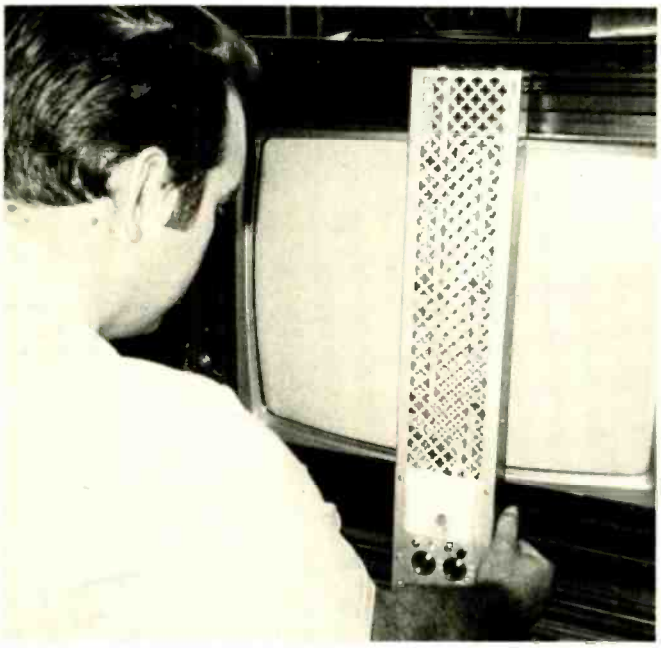
As might be expected, a significant portion of *UL's* electrical-appliance work is in the home-entertainment area, involving such items as radios, television receivers, tape machines, amplifiers, and tuners. Another important area is in the electric heating appliance field which covers a wide spectrum of products—one of which is the microwave oven.

As with every product brought in for scrutiny, each electrical appliance must undergo a multitude of often severe tests to insure its safety. For example, tests for radio and television receivers are specifically outlined in UL492 Safety Standard which contains some 402 paragraphs detailing essential safety tests and construction requirements. Of all these requirements, perhaps four test areas could be considered of primary concern: (1) fire hazard, (2) shock hazard, (3) picture-tube implosion, and (4) radiation.

Fire Hazard

In order to insure that temperatures capable of creating a fire hazard at any part of a receiver will not be produced, a temperature test is run. Table 1 shows the maximum ac-

Investigating possible shock hazards in a record player, the technician is measuring the size of the ventilating openings to see if additional probing tests are needed to check any live parts that may be accessible inside the enclosure used.



Making preliminary x-radiation check over a large area at the front of the picture tube in a TV receiver under test.

Table 1. The maximum acceptable temperatures in a receiver to be considered to be potentially free from fire hazard. The various exceptions and footnote references have been omitted.

MATERIALS AND COMPONENTS	DEGREES CELSIUS
1. Conductors with rubber or thermoplastic insulation	60
2. Rubber strain-relief bushings	60
3. An electrolytic capacitor	65
4. A cabinet of thermoplastic material	65
5. A selenium rectifier	75
6. Varnished cloth	85
7. Fiber	90
8. Wood or other combustible material	90
9. Fuses	90
10. A silicon rectifier	100
11. Exterior surface of an over-all enclosure	90
12. Coil-winding surface employing impregnated organic insulation or enameled wire	90
13. Laminated phenolic composition	125
14. Phenolic composition	150
15. Softening point of any sealing compound	

ceptable temperatures which are permitted to exist at specific points in a receiver if it is to be considered potentially free from fire hazard. These temperature measurements are made with thermocouples and, after three successive readings taken at 15-minute intervals indicate no change, the temperature is considered constant.

During this test the appliance is always set up to simulate actual conditions of home use. A receiver is tested with the maximum projection on its rear surface in contact with a flat, vertical wall of wood or comparable heat-insulating material, except that the spacing between the wall and the back of the appliance is never less than one inch. Any covers likely to be closed during operation are closed for the duration of the test. Rubber or felt-like materials are removed from the supporting feet in order to simulate wear during normal use. Horizontal ventilating screens and those having holes less than $^3/_{64}$ inch in diameter are covered with loose cotton to duplicate the normal accumulation of dust in household use. In the case of tests on phonographs, even the record-album compartments are loaded to represent a normal operating condition.

The temperature on a coil winding is measured by applying a thermocouple to the hottest part on the surface of the coil winding. If the winding is enclosed, a hole is drilled in the case; and if the unit is potted, a heated wire may be used to ream a hole in the compound to accommodate the thermocouple which is placed in contact with the coil surface. The temperature of a copper winding is determined by comparing the resistance of the winding at the measured temperature with its resistance at known temperature.

Shock Hazard

UL considers shock hazard to exist in a radio receiver at any accessible part of a circuit involving a potential of 125 V or less, measured between the part and ground, or other accessible parts if the potential is more than 42.4 V peak and current through a 1500-ohm load is more than 5 mA.

Shock hazard is considered to exist in a television receiver at any part involving a potential of between 42.4 V peak and 40 kV peak in the following cases:

1. The current through a load of not less than 500 ohms exceeds 300 mA after 0.0003 second.

2. The current through a load of not less than 500 ohms exceeds 5 mA after 0.2 s.

3. The time required for the current through a load of not less than 500 ohms to decrease to 5 mA is between 0.1 and 0.2 s and the total quantity of electricity passed through the load up to that time exceeds 4 millicoulombs (mC).

4. The time required for the current through a load of not less than 500 ohms to decrease to 5 mA is between 0.03 and 0.1 s and the total quantity of electricity passed through the load up to that time exceeds $75T–350T^2$ mC, where T is the time in seconds.

5. The potential is more than 5 kV peak and the total capacitance of the circuit is more than 3000 pF.

Shock-hazard voltage and current are measured with a special diode vacuum-tube meter, as shown in Fig. 1. Current measurements are made with the plug of the power cord inserted in the wall outlet in one position and then with the cord reversed. If the appliance has a d.c. rating, measurements are made with the appliance connected, in turn, to each side of a three-wire, d.c. supply circuit.

Current measurements are also made with all parts connected together just as they might be hooked up during normal operation. Unreliable insulation, such as that often used on the wire between the voice coil and speaker frame or between live parts and the metal frame of a stereo phonograph pickup, is short-circuited during the test. Current measurements are also made (1) with any operating controls or adjustable control that the user might operate, in all

possible positions of contact; and (2) either with or without tubes, separable connectors, and similar devices in place.

Implosion Hazard

To be considered free from implosion hazard a TV receiver must safely contain or limit the spread of flying glass caused by implosion of a picture tube. This is evaluated by actual full-scale implosion tests on complete receivers. Table-model sets are mounted on a rigid, 30-in high test stand and two barriers, 9½-in high and 72-in long, are placed on the floor 3 and 5 feet from the front of the receiver. Floor-model receivers are tested on the floor, properly spaced from the two barriers. One of two test methods, either thermal shock or high-energy impact, is then followed.

In the thermal-shock method, the rim of the picture tube adjacent to the seal is scratched six times. Then the heated end of an ordinary glass rod is passed through a prepared access hole in the cabinet and pressed firmly on the scratched surface of the tube. If an implosion doesn't occur within 10 s, the rod is withdrawn and the scratched area is slowly covered with cold water. If this does not induce implosion, the entire process is repeated.

The high-energy impact method utilizes a weight of 10 lbs or more, free-falling from a height of approximately 4½ ft onto a 1-in diameter steel pin inserted through a hole in the cabinet and resting on the picture-tube rim.

For a television receiver to meet *UL* requirements, four conditions must exist at the conclusion of either test: (1) the safety glass (if it has one) has not fallen or been blown from the cabinet, except for small slivers; (2) there is no single piece of glass between the two barriers weighing more than ½ oz; (3) all the glass between the two barriers weigh no more than ½ oz; and (4) there is no glass, except small slivers, beyond the 5-ft barrier.

Radiation

Determination of x-radiation emission from television receivers has always been a part of *UL's* testing procedures since the first receiver was listed by the *Laboratories* in the 1940's. More recently—on January 15, 1970—Federal regulations were established concerning x-radiation emission. *UL* requirements conform to these regulations and are as follows:

1. X-radiation exposure rates shall not exceed 0.5 mR/hr (milliroentgens per hour) at a distance of 5 cm (about 2 in) from any point on the external surface of the receiver.

2. Measurements shall be made with an instrument whose radiation-sensitive volume shall have a cross section parallel to the external surface of the receiver of an area of 10 cm² and no dimension larger than 5 cm.

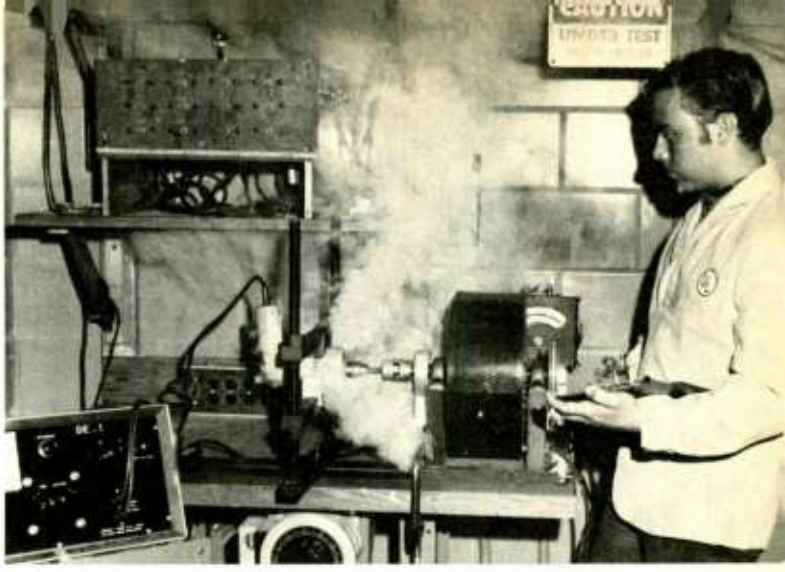
To the above, *UL* has added two more requirements:

1. To eliminate variations in x-radiation measurements produced by actual television program material, a picture is obtained by injecting picture information into the receiver antenna terminals by means of a suitable signal generator capable of producing a stationary Indian-head or equivalent test pattern. This arrangement provides a stable, standard picture of program quality, available to all persons making x-radiation measurements and thus offering a standard basis for such measurements.

2. Presence of x-radiation is detected by scanning-type survey meters and, wherever appreciable amounts of x-radiation are detected, final readings are made with a *Victoreen* Model 440RF-C meter which meets the above-mentioned 10 cm² area requirement.

In the case of microwave ovens, most concern is directed to the possible leakage of microwave energy rather than x-radiation. The U.S. Department of Health, Education and Welfare has recently established a regulation that the power density of emitted microwave radiation from ovens shall not exceed 1 mW/cm² at any point 5 cm or more from the

(Continued on page 59)



Burnout test on double-insulated electric drill under severe overload conditions. After burnout occurs, the insulation system is measured to see if it still provides safe isolation.

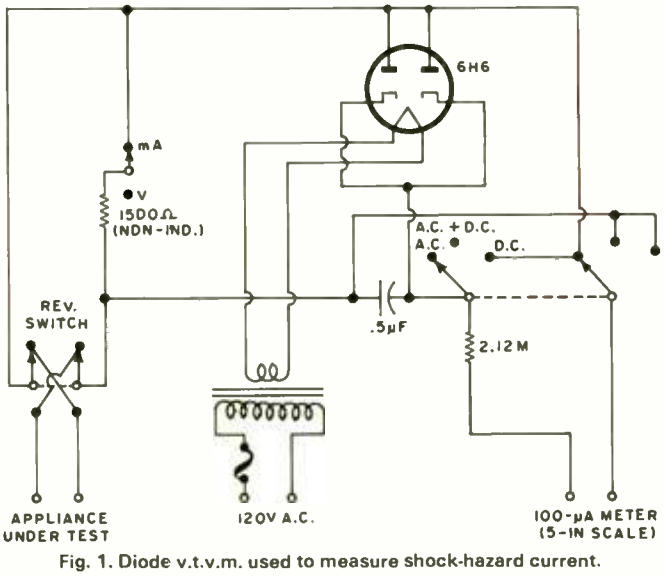
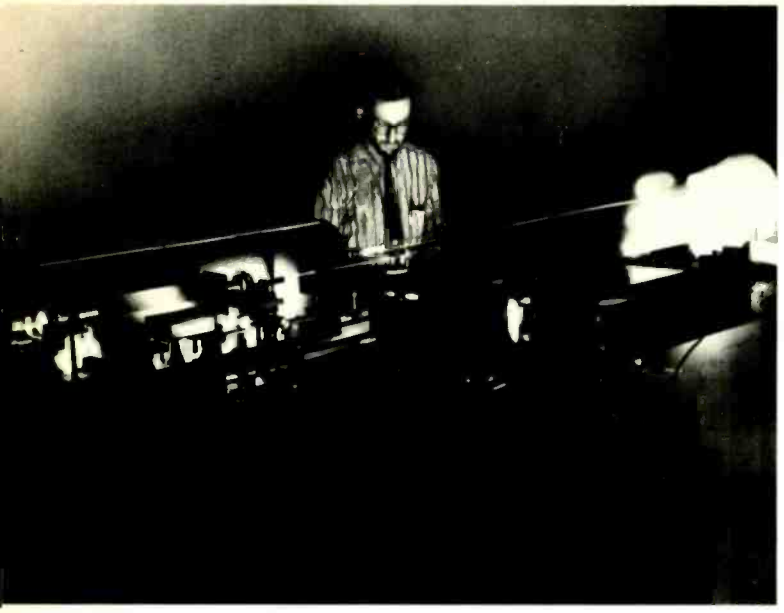
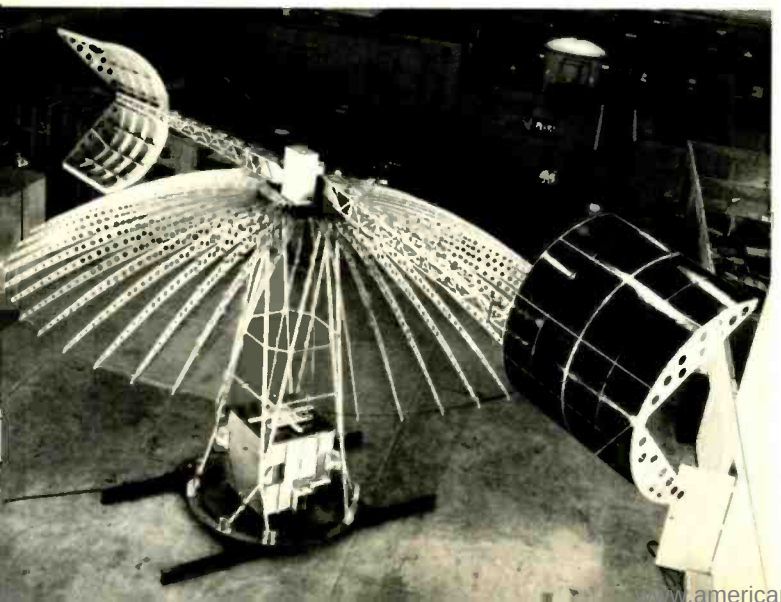


Fig. 1. Diode v.t.v.m. used to measure shock-hazard current.

The seated subject is undergoing tests conducted by the Laboratories for reaction to electric shock. She has submerged her left arm in a large container of water to which one side of the electric test circuit is connected. With her right hand she is using a metal jigger to transfer rice from the containers at her right into an opening at the rear of the table, resting her arm on the inverted metal bowls in the process. The other side of the electrical circuit is connected to these bowls. Every so often, voltage is applied to circuit so that a small, measured amount of leakage current flows. The current, which may range from 0.05 mA to several mA, is indicated on the lighted indicator in front of the observer at the left, who notes the current reading and indicates the reaction of the test subject during test.



Recent Developments in Electronics

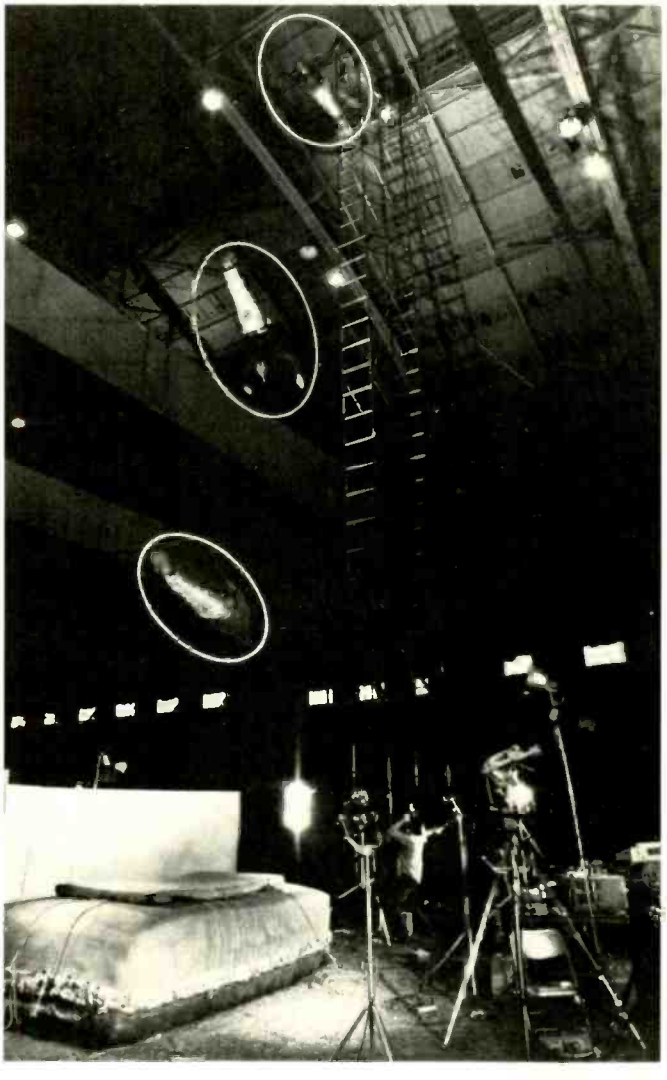


Laser Fog-Detection System. (Top left) A system of detecting offshore fog banks and providing better warning to ships is being developed for the Coast Guard by the U. S. Dept. of Transportation's Systems Center. The system uses a laser to detect the presence of fog banks at distances ranging from one-half mile to three miles. At present the Coast Guard has equipment which can detect general fog conditions but not individual fog banks. The laser light would be transmitted outward from a shore installation. As the light beam reaches a fog bank it would trigger alarms, such as fog horns and buoy signals, in unmanned lighthouses. The system is still in the laboratory stage where the measurements are being made using a simulated fog bank of water vapor generated by expanding liquid nitrogen in the atmosphere.

Electronic Stop Watch. (Center) A new, completely electronic, handheld timing device which registers hours, minutes, seconds, and hundredths of a second on a digital display panel was used by judges to time sporting events at the Sixth Asian games in Bangkok in December. The display is produced by electroluminescent diodes. The timer, which weighs just under one pound, is "T"-shaped to fit judges' hands. The unit is weatherproof so that it can be used outdoors even in inclement weather. The timer is accurate to within 0.0083 second per hour over a temperature range of –4°F to 122°F. Heart of the timer is an accurate crystal oscillator which, along with the digital-display circuitry, is powered by rechargeable nickel-cadmium batteries. The device was developed by the Japanese watchmaking concern Seiko, which is the official timer for the games as well as for the upcoming 1972 Winter Olympics at Sapparo, Japan.

Satellite for Educational TV. (Below left) This full-scale model shows how the new Applications Technology Satellites (ATS) "F" and "G" will look when orbiting the earth. One of the experiments planned for the satellites is to provide educational television for the first time to millions of persons in India. At present there is only one TV station in India and this serves the area around the capital at New Delhi. When the new satellites are launched in 1973 and 1974, programs will be beamed to community receivers located in remote villages. There, many persons will be seeing national leaders, such as Premier Indira Ghandi, for the first time. The satellites will also relay weather data from Nimbus satellites to ground stations and control air traffic on congested air routes on a limited experimental basis. The satellites will be built for NASA by Fairchild-Hiller; other companies participating in the project include Honeywell (for controls), Lockheed (for antenna), IBM, and Philco-Ford.

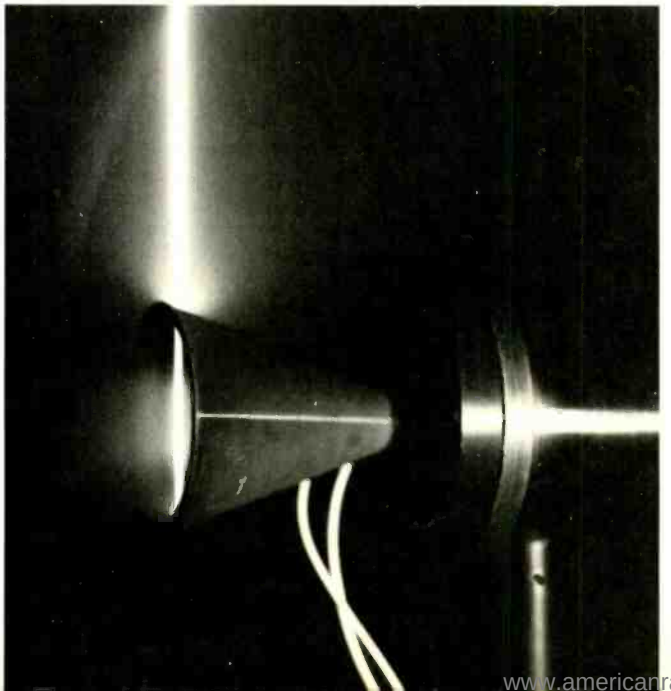
Alarm for Breath Stoppage. (Top right) An alarm that protects premature babies from apnoea, a condition in which the baby suddenly stops breathing for no apparent reason, is shown here. The infant merely lies on a special mattress which is connected to the alarm unit; nothing is actually connected to the child. The mattress has a number of tubular sections filled with air. When the baby breathes, the slight movements of its body cause air from these sections to circulate around a pinhead-sized thermistor, which is then cooled by the moving air. Should the baby stop breathing, the air stops circulating, the thermistor temperature rises slightly, and the alarm sounds. The device, developed by engineers of ITT's British subsidiary Standard Telephones and Cables Ltd., should help busy nurses keep tabs on premature infants in their care.

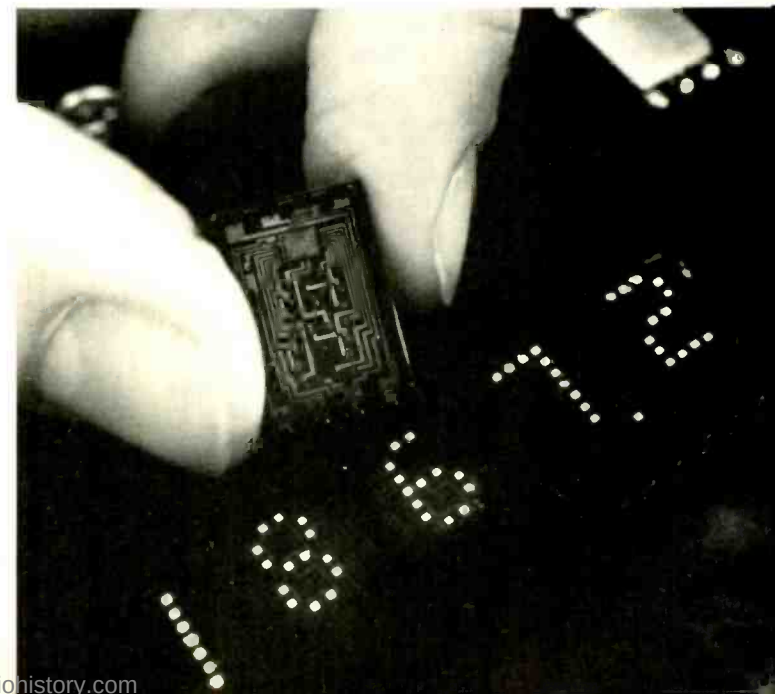


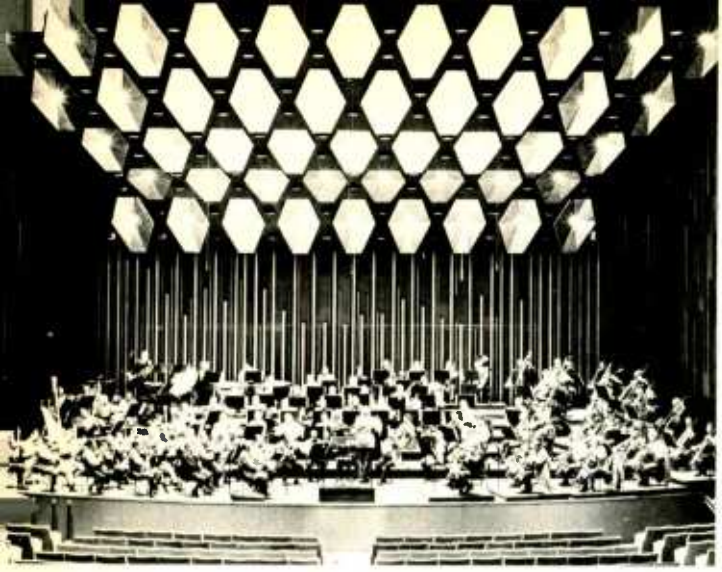
Telemetered Fall Shows Impact Forces. (Center) A circus performer is making 57-foot drops for safety researchers to allow them to study the effects of high-speed impacts. The triple-exposure photo shows Ross Collins heading for a cushion of foam-rubber strips three-feet thick. The performer was outfitted with accelerometers on his head and chest that indicated an impact of up to 55 G's when he slammed into the foam rubber at speeds up to 40 miles per hour. Collins was under contract for a week to General Motors researchers who are studying impact forces that are similar to those experienced in automobile crashes. When they get this problem solved, perhaps they will solve the problem of low-speed collisions which often result in many hundreds of dollars worth of auto damage.

Electron Beam Measures Rocket Exhaust. (Below left) Electron beams are being used to measure the density and temperature of rocket-exhaust flows at Cornell Aeronautical Lab. Information derived from the study will be used to predict the performance of the small rockets (microthrusters) which control the attitude of satellites in outer space. A 10- to 15-kV electron beam is passed through the exhaust gas flow; collisions between electrons and molecules of gas produce a fluorescence which is analyzed by spectroscopic methods. A graphite test nozzle was used, with small holes drilled into the top half of the nozzle wall to permit the beam to pass inside. In this way it was possible to obtain measurements on the flow within the nozzle as well as in the exhaust plume.

Low-Cost Solid-State Display. (Below right) Operating at low voltages compatible with IC circuitry, this new light-emitting diode (LED) display requires no high-voltage power supplies and is now directly competitive with gas-discharge displays. This solid-state numeric readout, complete with its IC decoder-driver and memory, sells for $10 in 1000 quantities. Later, in large quantities, the price may be as low as $5 each, according to Hewlett-Packard, its manufacturer. Twenty-one LED's, mounted on a ceramic IC substrate produce the digits by means of a 4 by 7 dot array; character size is just over $^{9}/_{32}$ inch.







One goal of hi-fi reproduction is to try to recreate the reverberation of concert halls, such as Philharmonic Hall (New York).

Hi-Fi Speakers

By DON DAVIS/Director, Commercial Sound Products
Altec Lansing Div. of LTV Ling Altec

MUCH has appeared in various technical publications during the past year regarding the role of reverberant sound energy. It is apparent from many of these articles that there is some confusion about *reproducing* reverberant sound *vs producing* reverberant sound.

Currently there are strong advocates of the *production* of reverberant sound energy as a means to higher fidelity sound, as well as those who recognize that such production is a spurious addition to the original sound but feel it is, emotionally, a useful distortion. It is, of course, impossible to disagree with those advocates who say "my ears and mind prefer some new sound quite different from the original if done in an artistic manner." This certainly constitutes a very legitimate personal opinion and a successful product built for such a market can manifest itself in any form.

Speaking, then, for what may indeed be a minority, the author would like to define the case for those listeners who do not want to produce a new sound but are serious seekers of true *reproduction* of original sounds. For example, let's imagine that we would like to be able to reproduce in our home listening environment a faithful recreation of the sound heard at the most preferred seat in one of the world's great concert halls. What are the listening conditions at such preferred seats in terms of the ratio of direct to reverberant sound?

Beranek[1] states in "Music, Acoustics and Architecture" that "In the best-liked concert halls, listeners prefer the seats in the center of the main floor. This preference is due partly to the visual impression. But in a first-rate hall the main floor seats also have acoustical advantages. There the music reaches the listener at a pleasing loudness; the reverberation seems to surround him, the balance between direct and reverberant sound is satisfactory and both the middle and the ends of the orchestra are at approximately the same distance from him."

Table 1. Characteristics of nine world-famous concert halls.

AUDITORIUM	V IN FT^3	S IN FT^2	$\bar{a}$	PREF. LIST. DIST. IN FT	$2D_c$ IN FT	TIME INTERV. IN ms *
SYMPHONY HALL BOSTON	662,000	16,600	.662	64	65.65	15
TANGLEWOOD, LENOX	1,500,000	33,000	.663	68	92.58	19
CARNEGIE HALL NYC	857,000	21,360	.685	60	75.76	23
TEATRO COLON B.A.	760,000	21,200	.623	72	71.96	19
MUSIKVEREINSSAAL VIENNA	530,000	12,000	.652	56	55.83	12
STAATSOPER VIENNA	376,000	15,720	.595	62	60.53	15
SENDER FREIES BERLIN	455,700	10,600	.660	48	52.39	21
LA SCALA MILAN	397,300	17,600	.602	64	64.46	15
CONCERTGEBOUW AMSTERDAM	663,000	13,800	.692	48	61.18	21
					ASSUME A Q OF 5 FOR THE ORCHESTRA	

*THE TIME IN MILLISECONDS BETWEEN THE ARRIVAL OF THE DIRECT SOUND AND THE FIRST REFLECTED SOUND.

Beranek then goes on to name nine famous halls and gives the distance from the orchestra to the most preferred seat. Table I shows each hall by name, giving its total boundary surface area in square feet, and its average absorption coefficient $\bar{a}$. From these parameters it is possible to calculate the critical distance (D_c, the distance from the orchestra to that point where the direct sound energy is equal to the reflected or reverberant sound energy).

$$D_c = 0.14\sqrt{QSa}$$

where:

D_c = critical distance
Q = the directivity factor of the sound source
S = the total boundary surface area
$\bar{a}$ = the average absorption coefficient

Since $Q = \text{antilog}_{10} D_I / 10$

where D_I = the directivity index of the sound source, it is possible to derive Q from the integration of the polar envelope generated by the source[2]. The polar responses for the directional characteristics of musical instruments and the human voice[3] reveal that a $Q = 5$ for the classical orchestra would be supportable as an average figure.

If we assume a $Q = 5$ for the orchestra and apply the D_c formula to each of the nine famous halls, we find that the most preferred seat falls almost exactly at $2D_c$ (see Table I). This means that the ratio of direct-to-reflected sound at such a seat is –6 dB; that is, the direct sound energy falls 6 dB below that of the reverberant sound energy[4]. Of equal importance is the fact that the time interval between the arrival of the direct sound energy and the first reflected energy averages 17.9 ms. This means that the reflected sound travels an average of 20 feet more than the direct sound before reaching the listener's ears.

What are the properties of the sound that arrives at the listener's ears at the most preferred seat and how do they combine into a complex signal at the diaphragm of a recording microphone placed there?

Direct Sound

1. Attenuates with increasing distance according to inverse square law.

2. Has high frequencies attenuated with increasing dis-

for Reverberant Sound

The debate continues over the best way to bring the concert hall into the hi-fi listening room. Author presents additional material to support his case for more directional speakers with equalization to overcome room defects.

tance as a result of air absorption and humidity effects.

Reflected Sound

1. Attenuates with increasing distance according to inverse square law.

2. Has high frequencies attenuated with increasing distance by air absorption and humidity effects.

3. Varies its angle of incidence in striking boundary surfaces as polar response changes with frequency.

4. Is selectively absorbed, reflected, and refracted by the absorption coefficient of the boundary surface which varies with angle of incidence and frequency.

Combined Direct and Reflected Effects.

1. Direct and reflected sound arrives in-phase, out-of-phase, and at all degrees in between.

2. Ratio of direct-to-reflected sound varies according to Q of source, absorption of boundary surfaces, and distance from differing instruments.

Therefore, the waveform that is impressed upon the diaphragm of the recording microphone contains an extremely *complex resultant* of the arrival of all of these various components.

Loudspeakers and Four Channels

If we had a perfect loudspeaker in a perfect anechoic chamber that could *reproduce* this same complex resultant waveform at the listener's ears, and if the listener's ears and mind would receive exactly the same signal they would have received in the famous concert hall, and if the listener were familiar with the hall, then instant recognition would take place.

Again, quoting Beranek[1], "Persons trained in listening—for example, blind people, who receive all their cues about the environment around them through senses other than the eyes—can 'measure' the size of a room or judge the distance to a wall behind them by the length of the time interval between the direct sound and the first reflected sound."

The ability to observe the size of a hall by listening is not limited to the blind. Experienced music listeners may be able to sense the approximate size of a hall by the sound of music played in it; that is to say, by the length of the initial time delay gap. (See Fig. 1.)

The listener to a home music system is in the position of the blind man. Without visual reference he can cultivate sensitivity to the unique sounds of each recording hall by ear alone, if the recording engineer has not deliberately or unintentionally obliterated it. Looking at Fig. 2, which shows a few of the initial delay paths, we can see that:

1. The reflections have significant delays.

2. Their time of arrival is a major factor in judging the "color" of the hall.

If, in a normal-size living room, we choose to direct some of the sound right at the listener, remembering that this becomes impossible after a very short distance due to D_c[4], and we want to reflect the remainder off of a hard-wall surface, we could approximate the desired ratio of direct-to-reverberant sound, *but we would fail completely to reproduce the time delay required.*

A legitimate use of two additional channels could be to reproduce an initial time delay and a reverberant decay. But, again the room in which the sound is being reproduced would generate its own reverberant field to serve as noise (an unwanted sound) and the only way to maximize the signal-to-noise ratio would be to minimize the reflected

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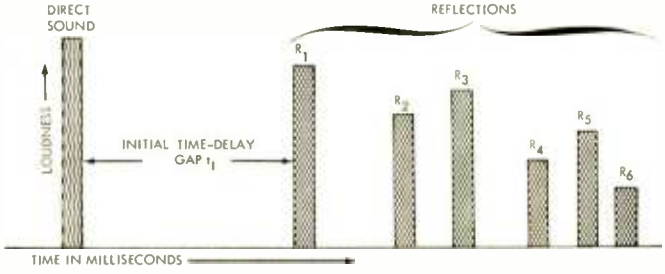
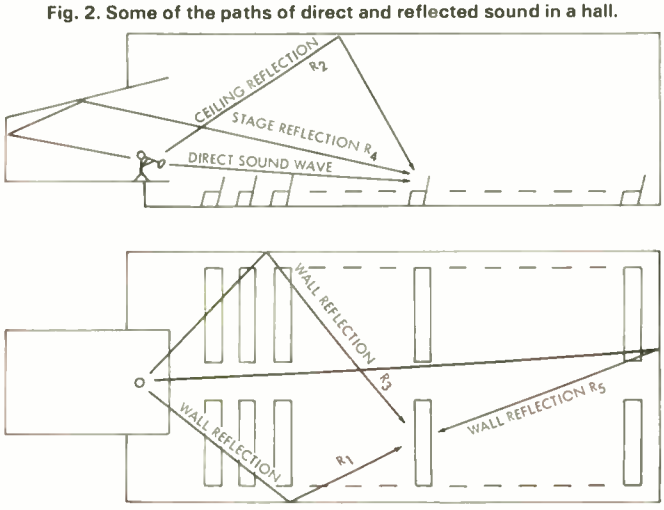
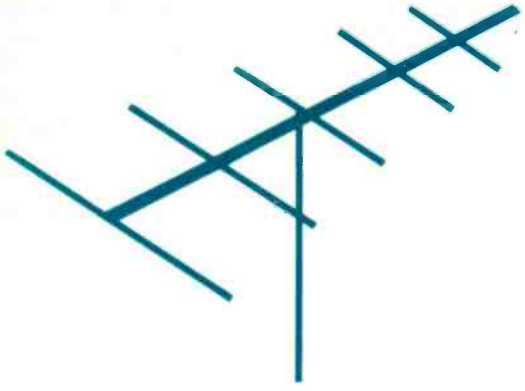


Fig. 1. Reflection-pattern diagram showing initial time-delay gap between the direct sound heard by listener and the first of the multiple reflections from walls, ceiling, floor, etc.

Fig. 2. Some of the paths of direct and reflected sound in a hall.





MULTI-SET TV-FM SYSTEMS for the Home

By THOMAS R. HASKETT

How to drive several TV and FM receivers from common antenna. What's available in passive and active couplers, splitters, combiners, baluns, as well as in complete home distribution systems.

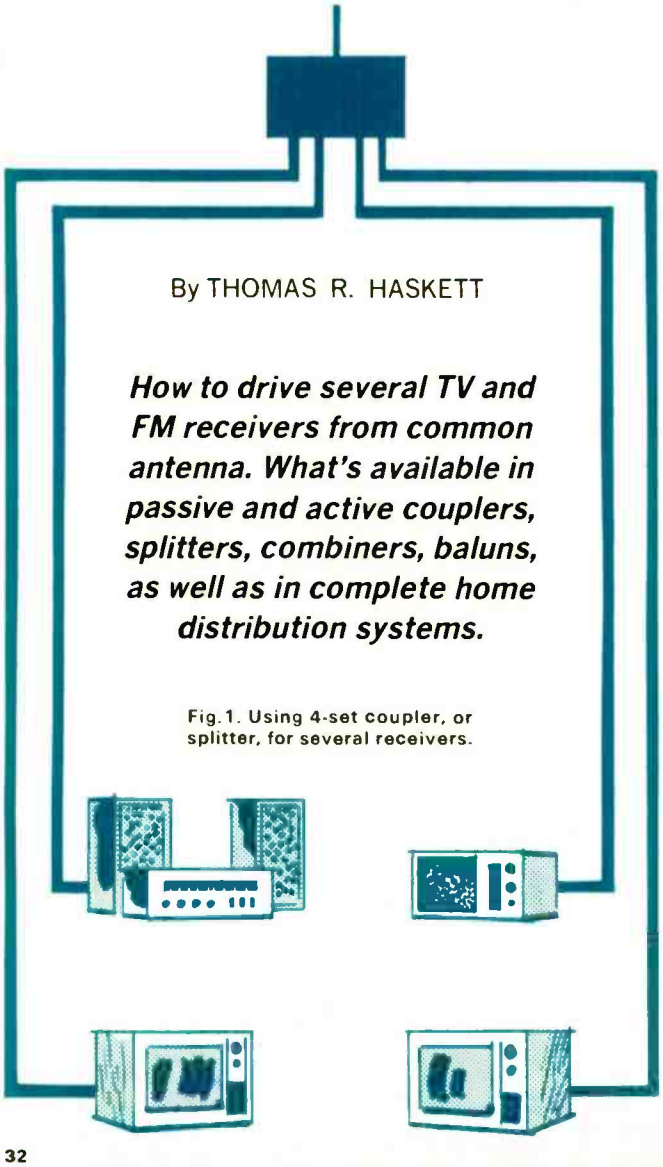


Fig. 1. Using 4-set coupler, or splitter, for several receivers.

WHAT with color TV and stereo FM, many a home has a color set and one or two older black-and-white receivers, and perhaps one or two FM or stereo radios. While rabbit ears and line-cord antennas work fairly well for black and white TV and mono FM, color and stereo require the cleaner signals, which—in many cases—only a good outdoor antenna can deliver.

For years multiple receivers have been driven from a single antenna (or antenna cluster) in hotels, motels, and hospitals. But a full-scale MATV (master-antenna TV) system can be expensive and complicated. Recently several manufacturers have broadened their lines of relatively inexpensive and simple components designed for small, home multi-set systems.

How Many Antennas?

If you're fortunate enough to live where all desired TV and FM stations are in the same general direction, you can probably get by with a single broad-lobe all-channel TV/FM antenna. Since you're driving several receivers with one antenna, it's worthwhile to spend more and get a good antenna.

(Editor's Note: If your present antenna is delivering a good signal to one set, it may be able to provide adequate signals for more than one receiver as well. If the antenna is marginal, however, a new one should be installed. For help in selecting the right one for your particular location, watch for our roundup on antennas, scheduled for next month's issue.)

In many cases, though, some of the TV/FM stations will be in different directions. It's usually impractical to use a single antenna with a rotator; what if two people want to watch two stations in different directions? The solution is usually two or more antennas, with their outputs combined into a single downlead for distribution.

Whatever antenna(s) you use, if you live in an isolated area, be sure to ground the mast with #12 wire and a ground spike several feet long, or by a cold-water pipe connection. And use a lightning arrester in the lead-in at the

Listing of manufacturers producing equipment referred to in article along with company abbreviations used in the tables.

ALL
Allied Radio Corp.
100 No. Western Ave.
Chicago, Ill. 60680

ACA
Antenna Corp. of America
Highway 61-N
Box 865
Burlington, Iowa

B-T
Blonder-Tongue Laboratories Inc.
9 Alling St.
Newark, N.J. 07102

CM
Channel Master Corp.
Ellenville, N.Y. 12428

F
The Finney Co. (Finco)
34 W. Interstate St.
Bedford, Ohio 44014

GAV
Gavin Instruments Inc.
1450 U.S. Route 22
Somerville, N.J. 08876

GCT
GC-Telco
GC Electronics
400 So. Wyman St.
Rockford, Ill. 61101

JRLD
Jerrold Electronics Corp.
Distributor Sales Div.
401 Walnut St.
Philadelphia, Pa. 19105

JFD
JFD Electronics Corp.
15th Ave. at 62 St.
Brooklyn, N.Y. 11219

LAF
Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, N.Y. 11791

M
Mosley Electronics Inc.
4610 No. Lindbergh Blvd.
Bridgeton, Mo. 63044

RMS
RMS Electronics Inc.
50 Antin Pl. Bronx, N.Y. 10462

W
Winegard Co.
3000 Kirkwood St.
Burlington, Iowa 52601

first point it enters the house. You can usually buy these accessories where you get the antenna.

Passive Couplers

Also called "splitters," these devices are simply resistive or inductive impedance-matching devices which allow you to feed the antenna signal to two or more receivers, as shown in Fig. 1. A splitter also provides interset isolation (typically 15 dB). Without such isolation, the local oscillator

300 ohms	
ACA PX-82 (2-set)	W CC-282 (2-set)
ACA PX-84 (4-set)	W CC-482 (4-set)
B-T A-102 (2-set)	
B-T A-104 (4-set)	75 ohms
CM 0044 (2-set)	CM 0047 (2-set)
CM 0046 (4-set)	CM 0045 (4-set)
F M-200 (2-set)	F M-260 (2-set)
F 3001 (2-set)	F M-261 (4-set)
F 3003 (4-set)	F M-265 (3-set)
GAV C-207 (2-set)	F M-266 (2-set)
GCT A-1090 (2-set)	F M-267 (3-set)
GCT A-1095 (4-set)	F M-268 (4-set)
JFD SC42 (2-set)	JFD SC42-75 (2-set)
JFD SC72 (4-set)	JFD SC72-75 (4-set)
JRLD MF-82 (2-set)	JRLD 1563 (2-set)
LAF 99F40313 (2-set)	M M-22 (2-set)
LAF 99F40321 (4-set)	M M-24 (4-set)
M PC-2 (2-set)	W CC-782 (2-set, 75-ohm in, 300-ohm out)
M PC-4 (4-set)	W CC-787 (2-set)
RMS C-2UV (2-set)	
RMS C-4UV (4-set)	

Table 1. Passive couplers or splitters for common impedances.

of one receiver can interfere with the desired signal received by another set.

In most areas, both v.h.f. and u.h.f. TV stations are on the air, so the most useful couplers to get are those which will handle all 82 TV channels and the FM band. A sampling of these is shown in Table 1. The most common types are two- and four-set versions, although a few three-set couplers are made. Start with a four-set model and add other couplers as needed, as shown in Fig. 2.

You can buy couplers to work with either 300-ohm twinlead or 75-ohm coaxial cable. The choice depends on a

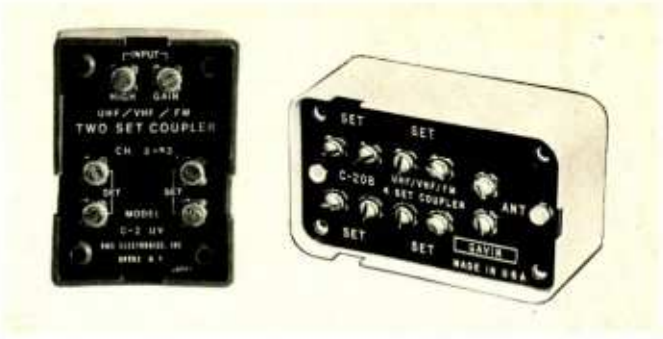
300 ohms	
ACA BA-83 (2-set)*	W BC-382 (4-set)
B-T DA-4U/V-300 (4-set, medium-signal area)	W BC-830 (2-set)
B-T V/U-All (2-set, weak-signal area)*	75 ohms
B-T Homer-300 U/V (4-set, medium-signal area)*	ACA BA-87 (2-set)*
CM 0069 (4-set)	F M-26 (2-set)
GAV 6032 (4-set)	F M-121 (4-set)
JFD PC4382-CD (4-set)	F M-123 (4-set)
JFD PC4782-CD (4-set, 300- or 75-ohm in, 300-ohm out)	GAV 6031 (4-set)
JRLD TA-84 (4-set)	W BC-782 (4-set)
	W BC-870 (2-set)
	*All-channel TV but no FM.

Table 2. Listing of active couplers or amplified splitters.

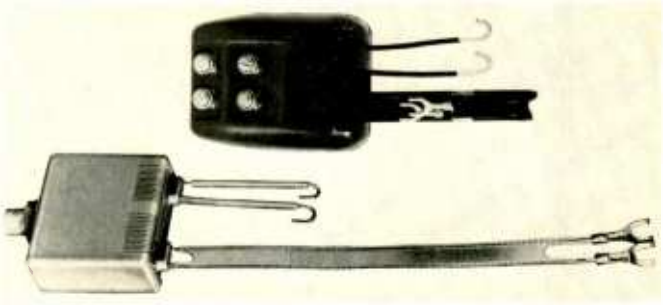
number of factors, such as how far from the stations you are, how much local interference you experience, and the ease of routing you want. Here are a few pointers:

Ordinary flat 300-ohm twinlead, while cheapest, is poorly suited for many installations because it has high losses with weather effects, poor noise immunity, and must be carefully routed away from metal and a.c. lines.

Seventy-five-ohm coax is less susceptible to weather and noise degradation and can be routed almost anywhere. But the installation costs more, especially when the cost of baluns (300-to-75-ohm matching transformers) is included.



Typical 2-set and 4-set passive couplers designed for twinlead.



Some u.h.f./v.h.f. splitters have tapoff for FM set, others combine impedance transformation from 75 to 300 ohms.

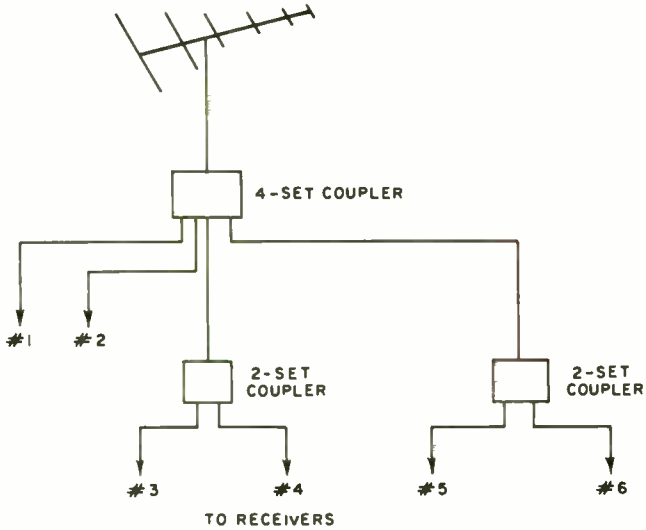
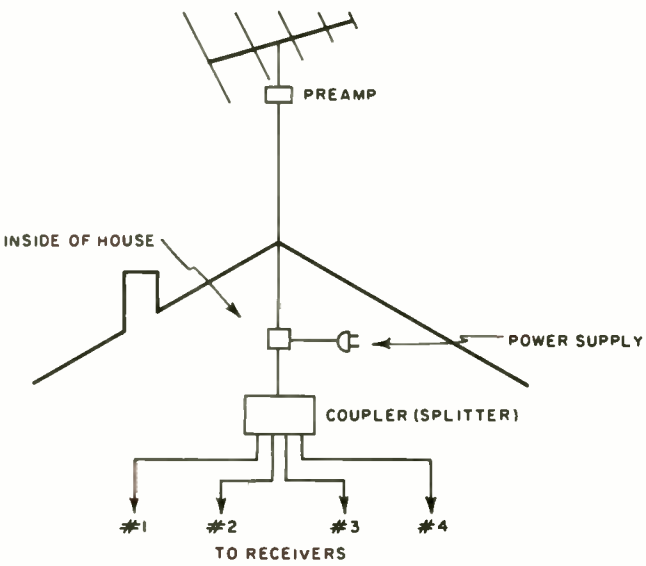
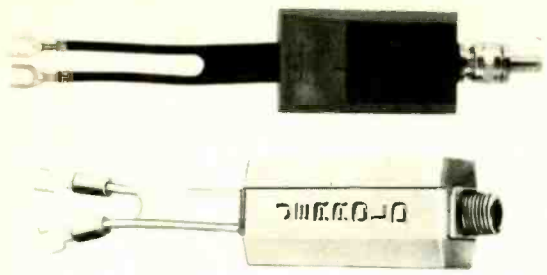


Fig.2. How to feed six sets from single high-gain antenna.

Fig.3. Antenna-mounted preamp overcomes feedline losses.





Matching transformers or baluns for 75- to 300-ohm impedances.

Foam coax is good, with the lowest losses and cost of any coax.

Heavy-duty 300-ohm twinlead is a good buy and offers maximum protection against everything but noise. Therefore, it's good for high-signal-level areas with little noise.

Shielded 300-ohm twinlead is preferred as offering the most protection from noise and weather, and ease in routing, consistent with reasonable cost.

For a more complete discussion, see "TV-FM Lead-In: What Kind to Use?" in the January, 1970 issue of this magazine.

Active Couplers

Since passive couplers cause a signal loss (typically 3.5 dB for two-set types and 7.0 dB for four-set types), you can use them only in medium- to high-signal-level areas. Beyond 10-20 miles from stations, you should probably use an active coupler (also called an "amplified splitter"). Some such couplers are zero-gain devices, providing just enough amplification to overcome splitter and isolation loss. Other amplified couplers offer a net gain of 5-8 dB. Table 2 is a sampling of all-channel versions which will handle v.h.f., u.h.f., and FM. You can buy other types for only v.h.f., FM, or u.h.f.

In general, there are two- and four-set amplified couplers

Active couplers for 2 or 4 sets and for twinlead or coax.

to work with either 300- or 75-ohm systems. Most are intended for use in medium-signal areas and you will need a medium-gain antenna which delivers at least 1000 μV for

300 ohms	
ACA AA-83	JRLD 4283-S (2 outputs, higher gain)
B-T Coloramp U/V	LAF 18F02149
B-T U/Vamp-2 (separate inputs for u.h.f. and v.h.f./FM)	W AC823B
CM 0067	**75 ohms**
F M-22	ACA AA-87
JFD SP2382-CD	CM 0068
JRLD 4283 (2 outputs)	F M-23
JRLD 4283-2 (2 outputs, separate inputs for u.h.f. and v.h.f./FM)	JFD SP2782-CD
	JRLD 4287-S
	W AC-895B

Table 3. Antenna preamps should be used in weak-signal areas.

the weakest station. That means you can use an amplified coupler generally out to around 50 miles from the stations.

Antenna Preamplifiers

An active coupler is usually mounted inside the house, driven by a run of lead-in from the rooftop antenna. That run may have enough signal loss—particularly at u.h.f.—to put the picture into snow or lose the color subcarrier. In a weak-signal area, the better idea is a mast-mounted preamplifier, which amplifies the signal by 10-15 dB *before* the downlead. Table 3 lists preamplifiers which handle all TV channels and FM. Again, both 300- and 75-ohm types are

300 ohms	75 ohms
ACA SX-38	ACA SX-78*
B-T 4539	B-T 4540
CM 0032A	CM 0048*
F 3020	F 7520*
GAV C-206	GAV CT-210*
GCT A-1075	JFD MT-56*
JFD SS21	JRLD FSX-1314*
JRLD FS-1314	M UV-2*
LAF 99F40339	RMS TRS-732*
M UV-1	W CS-175*
RMS SP-332	
W CS-285	

*75 ohms in, 300 ohms out

Table 4. List of v.h.f./u.h.f. splitters for antenna terminals.

available. You can also buy preamps for only v.h.f., u.h.f., or FM.

As Fig. 3 shows, the preamplifier itself mounts on the mast or antenna. The power supply is installed in the house. The same lead-in carries both r.f. down and low-voltage a.c. or d.c. up. Following the power supply, you will probably want a multi-set coupler. In some cases, you can use a passive type. But in deep fringe areas, you'll probably want an amplified coupler as you'll need all the gain you can get.

Band Splitters

We've been talking about an all-channel TV-FM system. Obviously the output needs only v.h.f. to v.h.f. tuner, only u.h.f. to u.h.f. tuner, and only FM to FM set.

Table 5. Three-way splitters for v.h.f., u.h.f. TV plus FM.

300 ohms	75 ohms in, 300 ohms out
ALL 11A1340	F 7530
F 3030	RMS TSF-777
GCT A-1086	W CS-387
JFD SS-83	
JRLD FS-1314-FM	
RMS SPF-555	
W CS-380	

B-T A-107 (300 ohms)	GAV C-201 (300 ohms)
CM 0034 (300 ohms)	JFD SC20 (300 ohms)
CM 0048 (300 ohms in, 75 ohms out)	JRLD 1460C (300 ohms)
F 3014 (300 ohms)	W SD-33 (300 ohms)
F M-251 (75 ohms)	W SD-37 (75 ohms)

Table 6. V.h.f./u.h.f. antenna combiners tie 2 antennas together.

Table 4 lists v.h.f./u.h.f. splitters for use at the TV receiver antenna terminals. If you have an AM-FM-TV console, the three-way splitters in Table 5 are useful, as they include an FM tap. You can also buy FM-only taps, which block TV signals. Splitter insertion loss is typically on the order of 0.5-1.0 dB.

Antenna Combiners

What if you decide to install two or more antennas to pick up TV/FM stations in different directions or with different signal strengths? The solution is an antenna combiner which is something like a splitter working backward. One significant difference: A combiner is built for outdoor service, mast mounting, and is weather-resistant, while an indoor coupler usually isn't.

Table 6 lists v.h.f./u.h.f. combiners. You can also buy

ACA TX-5 (indoor)*	GAV T-101 (outdoor)
ACA TX-5M (outdoor)*	GCT A-1088 (outdoor)*
B-T U/V-3413 (indoor)*	GCT A-1089 (indoor)*
B-T MT-283 (indoor/outdoor)	JFD MT-51
CM 7280 (indoor)	JRLD T-2000 (indoor)
CM 7200 (outdoor)	LAF 99F40347
F M-248 (outdoor)	M MTR-37A
F 7512-A (outdoor)	RMS TR-730 (indoor)
GAV T-201 (indoor)	W T-28 (indoor)
	W T-28M (outdoor)

*V.h.f. and u.h.f. only

Table 7. Impedance-changing (75/300-ohm) baluns or transformers.

types to combine FM with v.h.f. TV. Again, both 300- and 75-ohm types are available.

Baluns

If you use a 300-ohm installation throughout, you'll have no need for these impedance-matching transformers. But most antennas and receivers have 300-ohm impedance, so

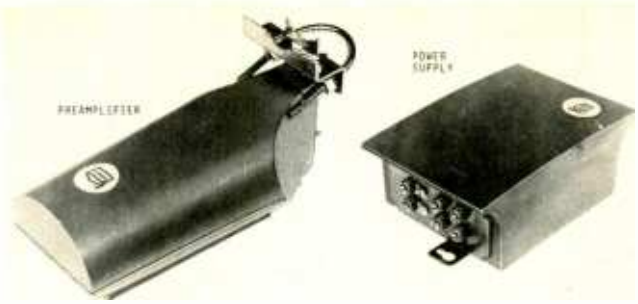
F HWK-75 (4-set, 75 ohms)
F HWK-300 (4-set, 300 ohms)
JFD HS41-300 (8-set, 300 ohms, medium-signal area)
JFD HS42-300 (8-set, 300 ohms, weak-signal area)
JFD HS41-75 (8-set, 75 ohms, medium-signal area)
JFD HS42-75 (8-set, 75 ohms, weak-signal area)
JRLD HAS-4 (4-set, 75 ohms)
W HS0-782 (4-set, 75 ohms)

Table 8. Packaged multi-set systems include amplified coupler.

with a coax installation you'll need baluns at both ends of each line. Table 7 lists some, most of which will handle v.h.f., u.h.f., and FM. You can also buy v.h.f.-only models. Indoor baluns aren't weatherproofed, while outdoor types are, and are designed for mast mounting.

Note that some band splitters listed in Tables 4 and 5 are also baluns, accepting 75-ohm input and providing 300-ohm outputs. Thus, you can kill two birds with one stone by using them in a 75-ohm system.

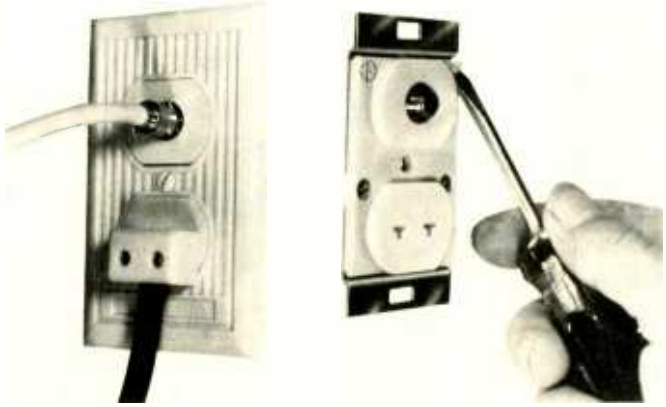
(Continued on page 63)



Antenna-mounted preamplifier and power supply/2-set coupler.

A number of companies have complete distribution systems which include amplified coupler and wallplate connectors.

Professional wall tapoffs work from 75-ohm coax, provide either 75- or 300-ohm outputs plus screwdriver-adjusted isolation. Wall tapoffs for home use usually do not include all of these features.



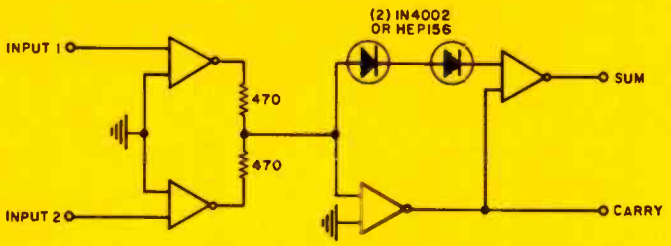


Fig. 1. Emergency "exclusive-or" circuit that behaves like a positive-logic half-adder. When both inputs are high "Sum" output will be low and "Carry" output high. When both inputs are low, "Sum" and "Carry" outputs will be low. The "Sum" output will be high and "Carry" output low only when "Input-1" and "Input-2" are different—one input low and other high.

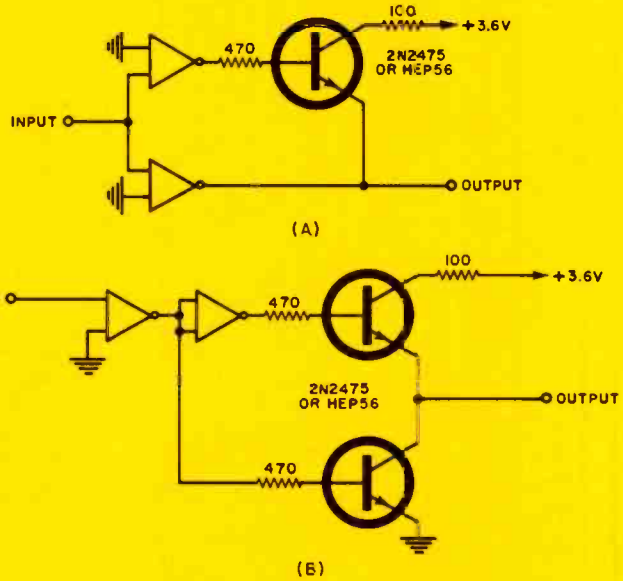
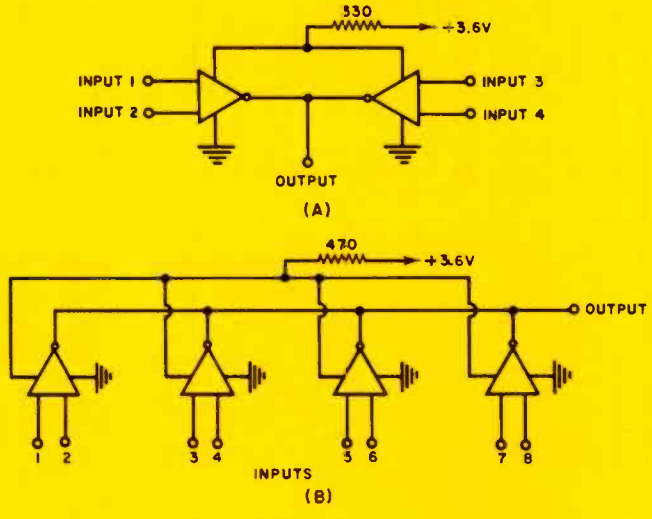


Fig. 2. Emergency (A) inverting and (B) non-inverting buffer circuits having fan-outs of at least 60. The inverting buffer has a fan-in of 6 while non-inverting buffer has fan-in of 3.

Fig. 3. Circuit diagrams showing how (A) a 4-input gate is assembled from a dual 2-input gate and (B) an 8-input gate from a quad 2-input gate to produce multiple input gates.



Unusual, *but Useful,* Digital Circuits

By FRANK H. TOOKER

Collection of digital circuits that have been improvised for RTL setups operating at speeds up to 100 kHz at input.

RARE indeed is the electronics engineer, technician, or experimenter who does not occasionally find himself without an RTL (resistor-transistor logic) element he needs immediately. Under such circumstances, one must either do without (usually impossible or inadvisable) or make do.

Each of the circuits described in this article was born of emergency and has been used time and again. Each has been employed at speeds up to 100 kHz at the input although, in some instances, fan-out is reduced by the application.

Emergency "Exclusive-Or" Circuit

The circuit of Fig. 1 may seem odd as far as digital circuitry in general is concerned, but it supplies "Sum" and "Carry" functions of a positive-logic half-adder. It may be assembled using a quad 2-input gate (such as the MC724P or HEP570) or a pair of dual 2-input gates (such as the μL914 or HEP584). It is actually simpler than the assembled circuit of a conventional half-adder performing the same functions.

In the circuit of Fig. 1, if both inputs are high, the "Sum" output is low and the "Carry" is high. This occurs because the junction of the two 470-ohm resistors is low. The input to the carry gate is therefore low, making its output high. Its output feeds one of the inputs of the sum gate, making this gate's output low.

If both inputs are low, the junction of the two 470-ohm resistors is high, making the carry gate's input high directly and the sum gate's input high *via* the two silicon diodes connected in series. Under this condition, both the "Sum" and "Carry" outputs are low.

If one input is high and the other is low, the potential at the junction of the two 470-ohm resistors drops to a mid-

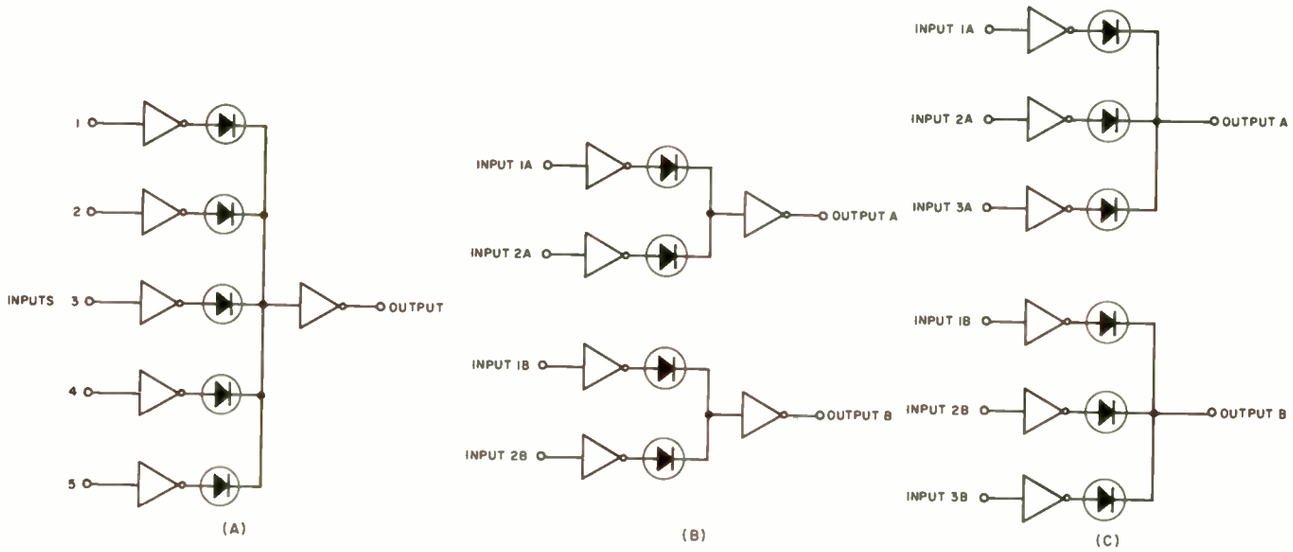


Fig. 4. Circuit diagrams showing how (A) a 5-input "and" gate, (B) a dual 2-input "and" gate, and (C) a dual 3-input "nand" gate can be assembled using a hex inverter and some diodes.

value. This is sufficient to make the carry gate's input high but it is inadequate to overcome the potential hills of the two diodes plus the potential hill of the sum gate's input circuit. The sum gate input is therefore low and, consequently, with the "Carry" output low, the "Sum" output is high.

The two diodes are actually power rectifiers—not intended for digital applications. Nevertheless, we usually do have a few of these on hand, and if the "Sum" output is not heavily loaded, these diodes perform quite satisfactorily at speeds up to 100 kHz. The 1N4001 and HEP154 will work but they do not perform quite as well in this setup, due to their higher junction capacitance. If you have a couple of 1N914's on hand, by all means use them.

Emergency Buffers

When considerable experimenting or development work is being done, the need for a buffer probably crops up more often than that of any other element. The output of a preceding stage just doesn't have what it takes to feed one or more input of a synchronous setup.

Of course, where this type of work is being done, an adequate supply of MC799P's or HEP571's should be on hand. It is practically guaranteed, however, that when a buffer is needed most, the buffer compartment of the part's bin is empty—at least it is if the author's experience is any criterion.

Fortunately, if a complement of the output of the preceding stage is available, we can come up with the simple but very effective inverting buffer shown in Fig. 2A. This setup has a fan-in of 6 and will easily give a fan-out of 60. This is at least six times the fan-out of a JK flip-flop, such as the MC790P or HEP572, and four times that of a medium-power gate.

If the complement of the preceding stage's output is not available, we must go to a non-inverting buffer. We can have one by adding just one more transistor, as shown in Fig. 2B. This one has a fan-in of 3 and a fan-out of at least 60. Actually, the term "at least 60" means that we have never had occasion to use either of these circuits to drive the T inputs of more than twelve medium-power JK flip-flops. Both of these circuits will very likely work harder without complaining, if they have to.

Multiple-Input Gates

Next to the need for buffers, the call for multiple-input gates must certainly be next in line. In fact, there are probably some who would say that the order should be reversed.

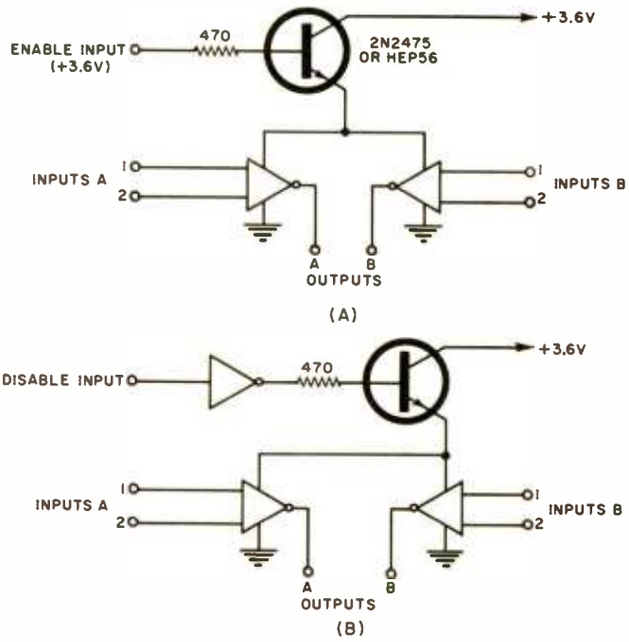
While we can always use a four-input gate as a three-input gate simply by grounding the unused input—or press a transistor such as the 2N2475 or HEP56 into service as an expander—there are times when "beginning from scratch" is necessary or desirable.

A 4-input gate can be easily assembled using a dual 2-input gate, as shown in Fig. 3A. The leads extending from the tops of the logic symbols in this diagram represent, collectively, the +3.6-volt (pin 8) lead of an IC such as the μL914 or HEP584.

The collector resistors inside these IC's have a value of about 640 ohms. When we parallel the outputs, as we do in Fig. 3A, the effective value of the resistance drops to one-half its original value, or 320 ohms. We make up the difference by connecting a 330-ohm resistor between pin 8 of the IC and the +3.6-volt bus. The fact that the total collector resistance is now 650 ohms—rather than 640 ohms—is of no particular consequence. In fact, a common 680-ohm value

(Continued on page 73)

Fig. 5. Circuit diagrams of (A) an enable gate that controls all gate functions and (B) disable gate that performs a function similar to an input on both logic gates simultaneously.



tube characteristics changed.

The solid-state "v.t.v.m." was made possible by the development of the field-effect transistor (FET). The FET has an extremely high input impedance (higher than that of many vacuum tubes) and is compatible with the power-supply voltages and operating levels of bipolar transistors. Although

impedance converter. This is the system employed in the *Heath* IM-16 and IM-17, *Eico* 240 and 242, *EMC* 116, and *Mercury* 4000 meters.

More sophisticated circuits are occasionally employed. The *Sencore* FE20 is fully symmetrical, with each of the bipolar differential transistors driven by an FET. The sym-

Waveshaping

Eico 242

EMC 116

Mercury 4000

ship is true; with distorted or pulse waveforms, the r.m.s. scales may be far off and the peak-to-peak indication is more meaningful.

The *Simpson* 2795 offers the unique capability of capacitance measurement. The internally generated a.c. switching signal is passed through the unknown capacitor and the a.c. current through the capacitor is measured by the meter. Measurements can be made from approximately 100 pF to 2000 μF.

Other Features

Most t.v.o.m.'s are fully battery-operated, which is an obvious convenience. Some can also be operated from a.c. line power, saving the battery cost if they are to be used only as bench instruments while retaining the option of battery power in the field. These include the *Eico* 240 and 242, *Heath* IM-16 and IM-25, *RCA* WV-510A, and *Sencore* FE149.

There is considerable variety in such features as combination probes for a.c./d.c./ohms measurement (*versus* separate test leads for these functions), choice of ranges, provision for d.c.- or a.c.-current measurements, and optional high-voltage r.f. probes. For a.c. measurements (and some d.c. measurements, where circuit performance might be affected by capacitive loading), the input capacitance is important. Depending on the meter and choice of ranges, this may vary from 10 pF to 175 pF.

Some meters are clearly bench instruments; others are small and light enough to be taken to the job, and two (the *Sencore* FE20 and *Heath* IM-17) are fully protected by their carrying cases. Individual preference and specific application requirements obviously will play a major role in one's choice of a t.v.o.m.

Summary of Features and Applications

A comparison of the features, performance, and prices of a representative group of t.v.o.m.'s and a similar assortment of v.o.m's (such as were described last month), will reveal several facts:

1. There is no intrinsic advantage to either type of instrument from the standpoint of accuracy. Both types were well within the accuracies required for service use. (*However, the average accuracies of the t.v.o.m.'s tested last month as a group were somewhat better than the average accuracies of the present group of t.v.o.m.'s, due mainly to the inherent simplicity of the passive meters.—Editor*)

2. There is no clear price differential between the two types. Both are available over a wide, intermixed price range, although, in general, v.o.m.'s are available at lower prices.

3. Many t.v.o.m.'s are bulkier and heavier than v.o.m.'s, making them undesirable for field use. On the other hand, many other compare favorably with v.o.m.'s in size.

4. Both types of meter have similar a.c. frequency-response characteristics.

What, then, should determine which type of instrument you choose, assuming that a choice must be made? Principally, it is a matter of how much circuit loading you can tolerate in your work. If your work involves high-impedance circuits, the t.v.o.m. will be a much more accurate instrument, simply because it has less effect on circuit operating conditions.

Then there is the matter of sensitivity. Many t.v.o.m.'s can measure a.c. or d.c. voltages into the millivolt range, allowing their use for audio stage-gain measurements or transistor-biasing measurements. Resistance measurements can be made at values from 10 to 100 times higher than would be possible with a v.o.m.

On the debit side, almost all t.v.o.m.'s require a zero adjustment before use, and sometimes when switching ranges. In the case of ohms measurement, this may involve several successive adjustments of the zero and ohms range controls, each time a range is switched. (*Also, t.v.o.m.'s are more complex and may not have the very long-term stability of the simpler v.o.m.'s, especially for occasional use.—Editor*)

Test Program

Nineteen t.v.o.m.'s, from nine manufacturers, were evaluated for this survey. The procedures were identical to those employed in last month's v.o.m. survey. Standardized voltage, current, and resistance levels were measured with each meter. Errors were expressed as a percentage of full-scale readings, for each type of measurement. Frequency response, in a.c. voltage measurement, was expressed as the change in meter reading (as a percentage of full-scale) with a constant applied voltage over a frequency range from 30 Hz to 20 kHz.

In the accompanying Test Results section of this article, the salient features of each meter are presented, together with the maximum measured errors in each mode of operation. The listing is alphabetical, by manufacturer and model number.

The mere listing of maximum ±percentage errors at the arbitrarily selected test levels may not give a fair picture of the relative accuracies of the meter, as it presents a "worst-case" condition. If the average error is taken in each major mode of the four to six readings at different levels, an isolated inaccuracy will not have a disproportionate effect on the evaluation. Such an average error is always less than the maximum figures given.

Some of the instruments, such as those from *Eico*, *EMC*, and *Heath*, are available in kit form. In this case, their accuracies depend on the accuracy of the standards used to calibrate them as well as the meter design. Our tests were made on factory-assembled versions. ▲

Optical Character Recognition

An overview of some sophisticated techniques used by computer input devices to accurately read written and/or printed characters.

By DAVID L. HEISERMAN

The IBM 1288 OCR system, besides reading handwritten numbers, five handwritten alphabetic characters, and all the standard computer alphanumerics printed by machine like its predecessor, the IBM 1287, can also read Gothic type. The Model 1288, introduced in early 1970, rents for $4755 per month, costs $223,390, must be used in conjunction with a 360 computer.

COMPUTERS are fast. They can make millions of computations in less time than it takes a man to add two and two. However, getting instructions and information into a computer and out again is a different story. So, today's demand for higher computing speeds is paralleled by a similar demand for in/out hardware.

Punch cards are an ever popular medium for getting information from man into a computer. Unlike other kinds of computer input media, it's possible to duplicate the information on punch cards with a typewriter so people can read the cards, too. Utility bills are examples of fast turnaround documents that must be read by men and machines, so the cards have information both typed and punched on them.

Punching cards and typing information on them are time-consuming tasks which are reaching monumental proportions in this day of credit cards and feverish information exchange between men and computers. It would be nice if half the work could be cut out—either the typing or the punching.

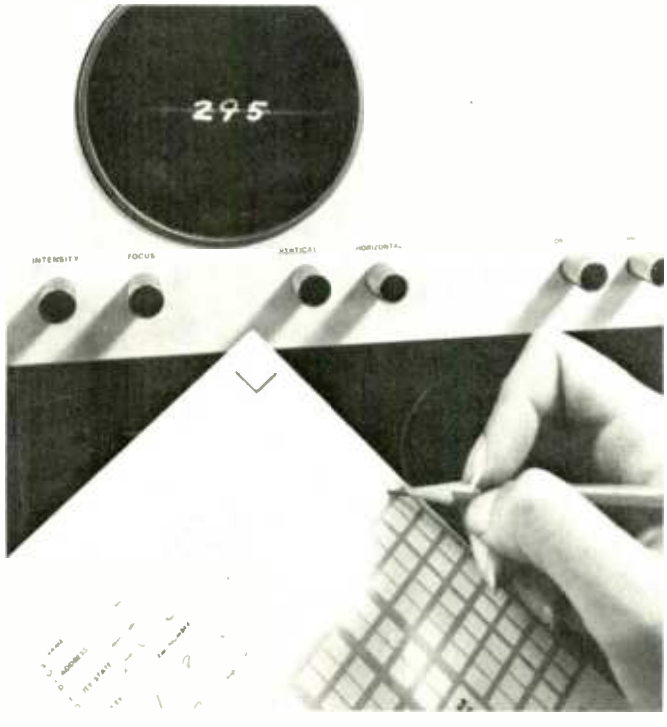
Banks were the first to feel the need for input devices that could read written characters. Long before the advent of credit cards, banks began using magnetic-ink readers to handle personal check transactions. Many large retail firms followed their lead and bought magnetic-ink cash registers and journal tape readers. Magnetic-ink readers served many businesses long enough for the electronics industry to develop the first optical readers.

The first units could read marks printed on paper with ordinary ink. These devices were actually a variation of the punch-card idea, using marks instead of holes. Mark readers caught on quickly and the credit-card industry boomed. Photosensors could read marks on credit-card receipts in a tenth the time it took to punch out the information on a card. Software companies also entered the mark-reader area, and firms like *Addressograph* built up whole new operations based upon manufacturing and selling credit-card equipment and supplies.

Although marks on paper are no easier for humans to read than holes punched into cards, developments in the optical mark-reader industry gave engineers the confidence they needed to develop more sophisticated optical readers. The result was the first optical character readers (OCR).

By 1966, companies such as *IBM* were marketing optical character readers that could read 64 different typewritten characters. The *IBM* 1287 reader, coupled with the 360 digital computer, could also read five different handwrit-

Operators can easily monitor and check OCR systems with flying-spot scanners, such as IBM's 1287, by using built-in CRT.



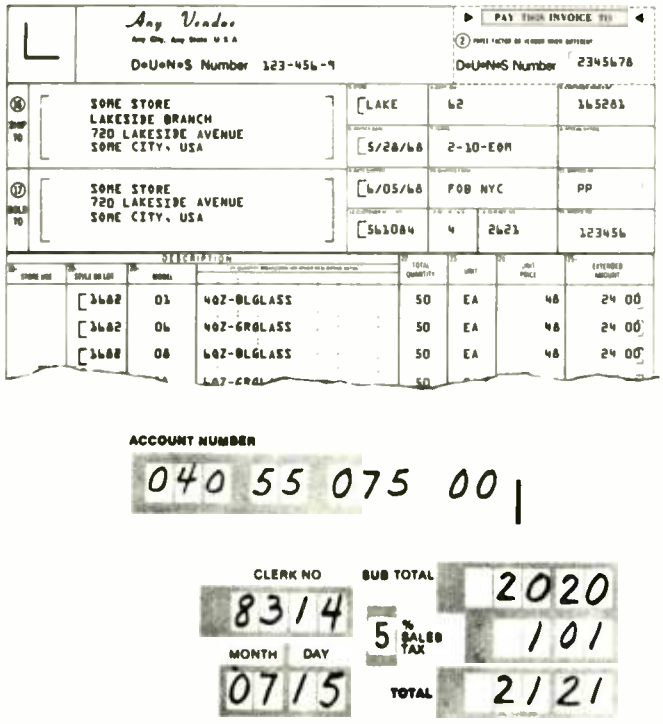


Fig. 1. Sample forms illustrating versatility of OCR systems. Machine can read into a computer all typewritten letters and numbers on invoice at top and hand-printed numbers from sales slip shown at bottom. Note the "L" mark in the upper left-hand corner. OCR optical systems use such marks as reference points.

ten alphabetic characters and cash-register journal tapes.

With the coming of this first generation of OCR equipment, magnetic-ink cash registers quickly became a thing of the past, and major credit-card firms began replacing marks with numbers capable of being read by people. Banks, however, have been slow in replacing their established magnetic-ink check readers.

As part of its modernization program, the U.S. Post Office Department is currently installing OCR equipment in major cities throughout the nation. This equipment is able to read Zip Codes and addresses printed on special mailing labels. The equipment won't be able to read handwritten addresses—postmen have trouble reading some peoples' handwriting as it is. Since more than 80 percent of the mail handled by the Post Office is business mail, the Department hopes businesses will use the OCR mailing format to speed delivery.

Classification of OCR Systems

Present-day OCR systems can be classified according to the kind of paper documents they handle—cards, full printed pages, or journal tapes.

Optical card readers can accept cards ranging in size from about 3½ by 3 inches up to 8 by 4 inches, and between 3 and 9 mils thick. Cards that meet these specifications include the familiar fast turn-around documents, such as utility bills, insurance premium notices, magazine subscriptions, etc.

An operator stacks these cards into an OCR machine much the same way punch cards go into a conventional card reader. A vacuum device lifts the cards, one at a time, and transports them to the optics. A revolving vacuum drum runs the cards through the optics, and sends them on to the sorting mechanisms. Typical operating speeds for OCR card readers run from 600 cards per minute for the 8-inch size up to 1100 per minute for smaller cards.

Page-reading OCR systems accept conventional 8½ by 11-inch typewritten documents. Reading line by line, page-reading OCR inputs can computerize data-laden documents at the rate of twelve single-spaced pages per minute. Sales reports, purchase orders, insurance application forms, and even tax returns can be run through such an OCR system. (See Fig. 1)

A page-reading OCR scanner can be programmed to accept all of the information printed on the page, or just the "filled-in" portions. The main point of the OCR page reader is to extract numerical data or short bits of information for storage and manipulation in a computer system. Although impractical in most cases, it is entirely possible to read and store the entire text of letters, magazines, and books with existing OCR and computer systems.

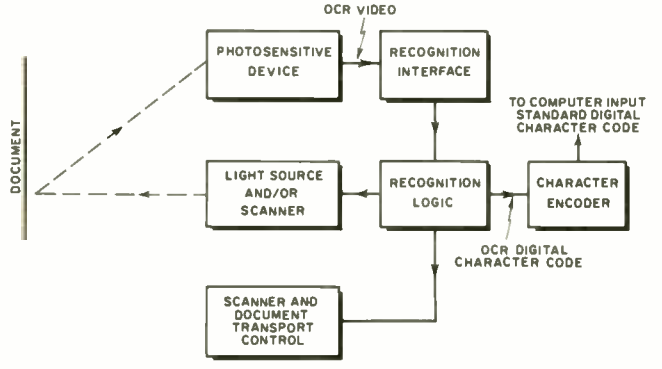
Entering graphic data directly into a computer is an application of page readers that is still in the experimental stage. Technically speaking, this feature is outside the functional definition of character readers, but it will soon be a useful "add-on" operation for many OCR users.

An elevator-type carriage lifts a stack of pages to a vacuum transport system that carries the pages one at a time into the optics. Under the control of the computer, a scanning system reads each character and line of print, and stores the data. If a portion of the text doesn't "make sense" to the computer, it may re-scan the text up to ten times before rejecting it. Recent developments in the document-copying industry provide the mechanical ingenuity needed to handle important papers without the risk of tearing or creasing them during a journey through the OCR system.

OCR journal tape readers speed cash-register or adding-machine data into the computer at the rate of about 52 lines per second, or up to 1600 characters per second. Large department stores and supermarkets recognized the need for ultra-rapid data entry about the same time the banks did. Tens of thousands of daily sales transactions made punch-card data entry to a computer impractical. Like banks, large retail stores tried magnetic-ink readers for a while, but converted to OCR as soon as hardware was available.

Document-handling systems are not unique to OCR computer inputs. Although often designated by the kinds of documents they can handle, OCR systems can be specified more meaningfully by the kinds of optical systems they employ.

Fig. 2 Simplified block diagram of a typical OCR system.



OCR Optics

One of the primary tasks of an OCR system (Fig. 2) is to change black-on-white printed characters into digital pulses for a computer processor or memory unit. The optics section of an OCR system is responsible for this job—it acts as the "eyes" of a computer.

Like a conventional television system, OCR optics handles its video challenge by means of image dissection. In one way or another, all OCR optical systems dissect the image of a printed character into quantized pieces (Fig. 3). Each of these pieces represents a portion of the character being read, or the white field surrounding it. Such "black" and "white" bits of video information can be easily translated into "yes" or " no" digital pulses for the computer.

At the present time, there are only two different techniques for dissecting character images and changing them into digital pulses. One technique uses lenses to focus a character's image directly onto an array of photovoltaic cells or photodiodes. With this arrangement, the document generally moves past stationary optics (Fig. 4). The other technique uses scanning optics and a single photosensor for image dissection. With this technique, the document generally stands still while the optics move.

Photosensor Arrays

The photosensor-array technique shows up in two different forms—as one- or two-dimensional arrays. The one-dimensional photosensor array (Fig. 5) uses a single vertical line of about 10 to 50 miniature sensors. A bright light focused onto the document reflects onto the sensor array. As a character moves through the optical system, a timing circuit "strobes" the character's image as it appears on the vertical-sensor array. This produces a series of video pulses that represent vertical segments of the character and the white field around it.

Logic circuits behind the one-dimensional sensor array unload the data from one vertical segment into a serial shift register. The sensor array takes a fast look at the next vertical segment and unloads that data into the shift register, too. As a character moves through the optics, then, the serial shift register becomes loaded with data representing all the vertical segments of black-and-white information.

When the character has moved past the optics, the logic circuit unloads the shift-register data into a character recognition system, and clears the electronics for the next character.

One-dimensional sensor arrays generally break a character down into five to ten vertical segments. The larger the number of vertical segments, the smaller the chances of a misread character. However, using a larger number of vertical segments to step up reader accuracy slows down the data entry time for each character. So, OCR one-dimensional sensor-array systems have to play off recognition accuracy against reading time.

OCR systems that use one-dimensional sensor arrays are among the least expensive on the market today and, because they have to balance reading accuracy against reading time, they're generally limited to applications involving reading only several lines of large, standardized print. Documents in this category include fast turn-around billing cards and credit-card receipts.

A two-dimensional photosensor array eliminates the speed and accuracy limitations of the one-dimensional OCR system. Instead of looking at a number of vertical segments of each character, two-dimensional sensor arrays look at the entire character at once (Fig. 6). State-of-the-art two-dimensional photosensor arrays look at as many as 800 points, simultaneously, in about the same length of time it takes to read only one or two vertical segments in a one-dimensional array.

The logic, shift-register sequences, and recognition systems for a two-dimensional OCR sensor array are about the same as those in a one-dimensional array. The essential differences are that the two-dimensional arrays do not require a series input-shift register but do require a lot more data-handling hardware between the sensors and the recognition system.

The sensor logic in a two-dimensional array is blanked off until the character is in position. At that instant, a trigger enables the "read" circuitry and the black-and-white video information from the sensors enters a shift register in parallel form. The video "black" and "white" pattern then goes into the recognition system, clearing the register for the next character.

The upper limit for reading speed for a two-dimensional OCR sensor array is determined mainly by the speed of the logic circuitry. In practice, however, the reading speed is set by the spacing of the printed characters or by the rate the documents run through the logic.

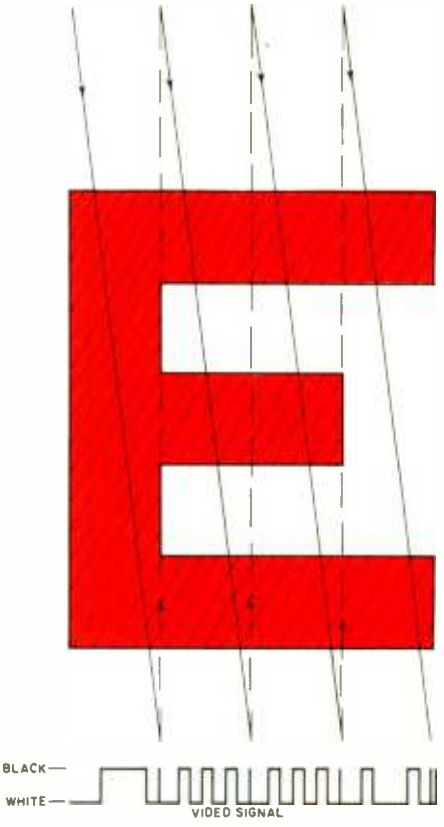


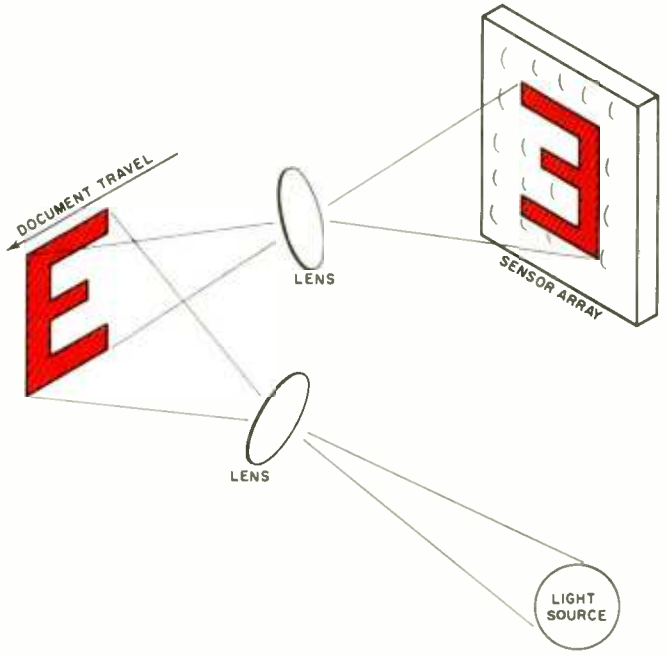
Fig. 3. Scanning-type OCR readers dissect images like an ordinary TV raster. However, OCR scans are generally in a vertical direction. "Black" and "white" bits that make up video signal can be easily converted into "yes" or "no" digital pulses for computer.

Like a one-dimensional sensor array, accuracy of the reading is roughly proportional to the number of elements the sensors look at. Although an OCR user can buy some speed with a two-dimensional array, hardware cost still limits the arrays to jobs that require reading only a few lines of large print on each document.

Scanning Optics

Unlike the OCR sensor arrays, OCR scanning optics do not require documents to be moved in order to read them. In all scanning systems, the optics dissect a character by

Fig. 4. Stationary optics used to focus a character's image directly onto a two-dimensional sensor array OCR reader.



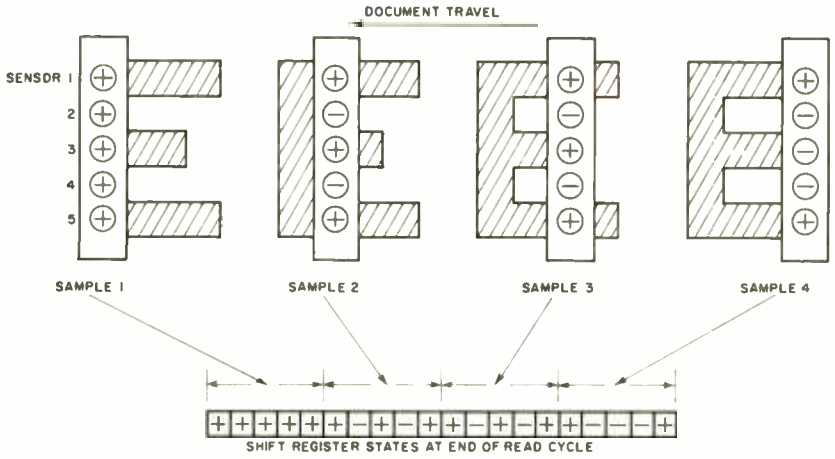


Fig. 5. One-dimensional sensor array OCR readers "read" successive vertical segments of a character as it passes through the optics. Note that the black and white fields are shown as "+" and "–" signs, respectively, in the register.

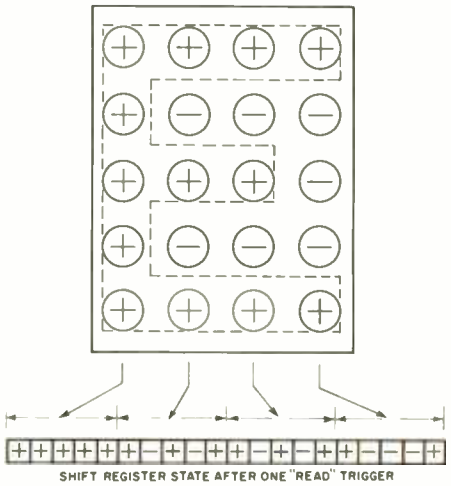


Fig. 6. Two-dimensional OCR sensor array "reads" an entire character at one time, and stores its video data, black (+) and white (–), in a parallel shift register.

scanning over it with a light beam. A photosensitive device picks up changes in the amount of light reflected from the document and passes the resulting video signal on to the recognition logic. Logic circuits tell the scanner when to proceed to the next character. Many OCR scanning systems have sophisticated feedback circuits that place the scanning operation under the control of the photosensor, the recognition system, or the computer.

There are three basic kinds of OCR scanners in use today: vibrating mirrors, Nipkow discs, and flying-spot scanners. These three systems have different price tags and different degrees of versatility and reliability.

In vibrating-mirror systems, a lens focuses a fine beam of bright light onto a mirror that vibrates through a predetermined set of motions. Light from the mirror falls onto the document, scanning the characters one at a time. A photovoltaic device or photomultiplier tube senses changes in light intensity from the document, and translates them into video signals for the character-recognition circuits.

Vibrating-mirror OCR scanners are seriously limited in their speed and versatility by the mechanical inertia of the mirrors themselves. Although several development labs, such as the one at *General Scannings, Inc.*, are working on advanced laser deflection systems for OCR, inherent mechanical problems still limit the popularity of vibrating-mirror scanners.

The Nipkow disc scanner (Fig. 7) uses a metal disc perforated with a row of holes arranged in a spiral pattern. By spinning the disc and focusing the image of a character onto a small portion of it, the holes run past the image, letting vertically scanned segments of it pass through. A photosensor behind the disc translates the scanned image into a long series of video signals.

The mechanical Nipkow image-scanning system was originally developed in 1884 for the first crude "television" system. Only poor-quality photosensors prevented 19th-Century "pictures by wire" from becoming a reality. Although it's old fashioned, the Nipkow system works especially well with today's sensitive and reliable photomultipliers. *Farrington Electronics* is one company that, for nearly fifteen years, has been working with the Nipkow system for optical scanners.

The ultimate in speed and reliability in OCR readers today is the flying-spot scanner (Fig. 8). Using a CRT beam as a point source of light, deflection circuits make the light scan a character with a predetermined pattern. A photomultiplier tube picks up the light reflected from the character and changes it into a long series of video pulses.

CRT deflection signals start the beam in the upper left-hand corner of the document and make it run through a zig-zag pattern until it encounters the first printed character. When this happens, the scanning system goes into a different scanning mode designed to dissect the character into lines of video information that can be recognized by the recognition circuitry.

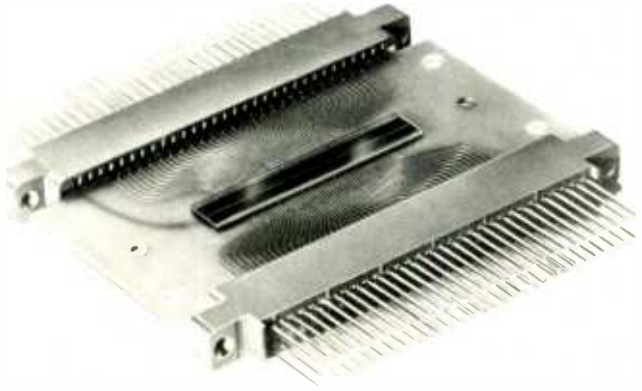
If the recognition system recognizes the character being scanned, it signals the deflection logic to return to the zig-zag mode until the beam encounters the next character. If, on the other hand, the recognition system doesn't recognize a character, it can signal the deflection logic to scan the character again and again.

In the event a character is still not recognizable by the recognition circuits after about ten scans, the logic can be programmed to reject the document, placing a spot of ink or an asterisk over the questionable character. Other systems might handle an unrecognizable character by flashing a fault light and displaying the character on a CRT screen for an operator to study. The operator can enter the proper character code directly into the recognition system by means of a keyboard providing, of course, he can interpret the faulty character himself.

Flying-spot deflection circuits can be programmed to deal with many different type sizes, document formats, and line spacings. Coupled with the proper recognition systems, flying-spot scanners can read characters written by hand as well as those printed by a computer or typewriter. Thus, flying-spot scanners can be adapted to any kind of OCR job done today—fast turn-around billing cards, cash-register or adding-machine journal tapes, full-size printed documents, and even Post Office mailing addresses.

Flying-spot OCR scanners are the most expensive on the

Photograph of a 256-element, one-dimensional OCR photosensor array manufactured by United Detector Technology.



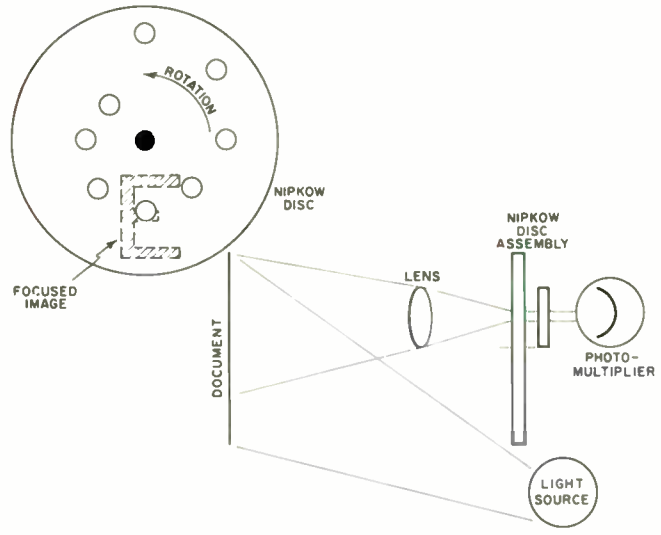


Fig. 7 OCR scanning system using the Nipkow disc arrangement.

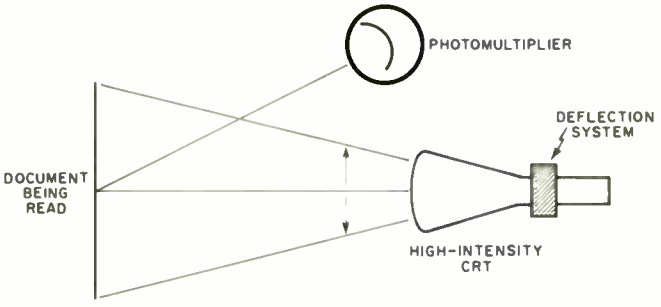


Fig. 8. Simplified diagram of the flying-spot scanner; ultimate in speed and reliability in OCR readers today.

market today. Vibrating-mirror systems are often the least expensive but, unfortunately, the slowest and least versatile. *Farrington's* Nipkow disc scanners fall between the flying-spot and vibrating-mirror OCR scanners in cost, versatility, and reliability.

Reader/Recognition Interface

Present-day character recognition circuits must have all available data on one character before it can recognize it reliably. Character data outputs from optical scanners are generally in a serial, time-dependent form. Outputs from a one-dimensional OCR sensor array reader are partly in parallel and partly in serial form. Only a two-dimensional sensor array generates character data in the parallel form directly usable by the recognition circuits.

A reader/recognition interface circuit is responsible for changing all character data from a reader into a parallel form compatible with the recognition circuitry. In the case of a scanning-type reader, the interface circuitry consists of a serial-to-parallel data converter. Such a device can be a shift register designed to accept serial information from the photosensor and unload it all at once in parallel form.

Since a one-dimensional photosensor array produces data representing successive vertical strips, part of the character data is already in parallel form. The data from one vertical strip "reading" can go into a parallel input shift register to clear the photosensors for the next vertical strip. During the transition from one vertical strip to the next, the data can be fed serially into a larger serial-to-parallel data converter. When this larger shift register has accumulated data from all the vertical strips for a character, the system can unload the data in parallel fashion into the recognition logic. The larger shift register should have a bit capacity equal to the product of the number of sensors in the one-dimensional array times the number of vertical segments allowed for each character.

Data from a two-dimensional sensor array reader is already in parallel form. A shift register designed to accept parallel data from the sensors and unload paralleled data into the recognition logic is all that is necessary.

Timing circuits must be included in all interface circuits to keep the optical activity in step with the recognition operations. In the scanning systems, the timing pulses are quite similar to video sync pulses for a TV system. The sensor arrays use a master clock oscillator to keep all the OCR operations, including the document transport, in step.

The main job of OCR recognition logic is to convert digital character codes in reader format into conventional computer character codes. Some recognition systems available today analyze as much of each character as possible, cost and reading time being the only limiting factors. Other systems look only for certain features that distinguish one printed character from another.

Area or "whole character" recognition systems use an averaging technique to determine which character the sensor output resembles most. The more data the recognition logic has on each character being read, the better its chances of being correct.

If an area recognition system has a repertoire of 64 different characters, for instance, there are 64 different resistor matrices connected to the last reader shift register. Some recognition circuits on the market today look at hundreds of different points and, by the way, have nearly as many resistors in the decoding matrix for each character.

Just about every printed character has at least one or two points in common with many other characters. So, virtually every resistor matrix in an area-recognition system puts out a little bit of a signal, no matter what character the system happens to be reading at the moment. However, the highest matrix output voltage should come from the matrix designed to decode the character being read. Ideally, the resistor decoding matrix for the letter "E" has a higher output than any other matrix when the letter "E" is being read.

A level-sensing and comparison circuit decides which of the 64 character matrices has the highest signal output and then delivers the appropriate code to the conventional character code generator.

Area-recognition systems are especially suitable for reading different kinds of typewritten characters as well as those written by hand. To keep the logic simple and inexpensive, OCR manufacturers often train users to print characters in a form easily handled by the recognition system.

A simpler kind of recognition system, called either a feature or stroke recognition system, places most of the recognition burden upon the character type style.

The standard OCR-A type font breaks down the features of its characters into basic horizontal and vertical strokes. Five vertical strokes define the upper half of the character in a vertical direction, and five more vertical strokes define the lower half of the character in that direction. Three horizontal strokes—upper, middle, and lower—define the horizontal strokes in the respective parts of the characters. All characters in this type font produce at least two points of difference in the recognition logic.

The recognition hardware for feature analysis is virtually the same as for area analysis. Using the OCR-A font, reading accuracy approaches a maximum when there are only 13 positions in the main recognition shift register. Area recognition systems have a readability accuracy that is roughly proportional to the number of positions in the shift register—a hundred or more is not unusual.

Although computer technology is making great strides in optical character recognition, OCR is only part of a broader area of active research known as "pattern recognition." Pattern-recognition systems are capable of interpreting drawings and complicated visual displays as well as printed characters. This work is bringing technology a step closer to eliminating awkward man-machine interface. ▲

Crumbling Resistance to Color TV

Some reasons people give for not buying color TV are valid and some are not—but none should be ignored.

By **John Frye**

IT was the first spring day which the Midwest had been impatiently awaiting since the first day of spring. The front door of Mac's Service Shop stood ajar as Matilda, the office girl, arranged a bouquet of early spring flowers on her desk. Mac and Barney, sitting side by side on the service bench, idly watched her through the open door of the service department.

"Those jonquils are a pretty yellow," Barney observed. "They are just the color I like to see the dots all over the screen when I kill the blue gun."

Matilda stopped her fussing long enough to give him a withering look. "Barney, I'm not sure if you are the most unromantic clod I know or the most dedicated service technician," she said. "Anyone reminded of a convergence job by these beautiful flowers has to be one or the other."

Mac leaned his head back against the sweep generator, closed his eyes, and recited: "And then my heart with rapture thrills/And dances with the daffodils."

"Now that's more like it," Matilda remarked. "I was thinking of Wordsworth's lovely poem when I bought these. Mac, you'd better take Barney aside and give him a good fatherly talk about the flowers. He has apparently been concentrating too much on the bees and the birds—especially the birds."

"Okay, you two, get off my back," Barney said with a grin. "Can I help it if almost everything reminds me of color TV or seems to lead into color TV? Take last night, for instance. Mom's card club met at our house last night; so I stayed in my room and planned to catch up on some of my technical magazine reading. My bedroom is just above the room in which they were playing, and a warm-air register carried the sound from below quite well.

"The first thing I knew I was listening to these women discussing color TV. Only three of the eight women actually had color sets in their homes and the other five were explaining why they still stuck with their black-and-white receivers. Oddly enough, the color-set owners, including Mom, seemed to be on the defensive."

"How could that be after they watched that beautiful Rose Bowl Parade New Year's Day?" Matilda asked. "Think what you would miss if you saw it only in different shades of gray."

"I know, I know," Barney agreed; "but these women did have reasons. In the first place, most of them are in their fifties or early sixties and are very cost conscious. Two are widows living on pensions, and the others are anticipating their husbands' retirement. With inflation as rampant as it is, what looked like comfortable security a dozen years ago now seems pitifully inadequate. So it is not surprising that a major reason they gave for not buying color TV was the original cost and the anticipated cost of maintenance. They pointed out a color set of comparable screen size costs about twice what a B&W receiver costs. They argued it cost a lot more to maintain a color set and quoted from experiences of friends and scared each other with stories of whopping service bills."

"It would not be too hard to make a case on that point," Mac admitted. "A recent survey made in three Midwest states revealed the average service shop charge for minor TV service was $6.80 for B&W and $13.00 for a color receiver. I recently saw an advertisement for a West Coast service shop in which it was stated the basic fee for B&W service was $20 as opposed to $35 for color. Again, I notice that a company offers original 90-day warranty to distributors at a charge of $8 for a B&W console in the home and $28.00 for a color console in the home. No knowledgeable person would argue that it is, on the average, as cheap to maintain a color set as it is a black-and-white."

"True," Barney agreed, "but then their arguments moved into areas not so easily defended. They attacked the quality of color reception and the difficulty of operating a color receiver so as to maintain a consistently good picture."

"Since they don't have color sets, on what are they basing these observations?" Matilda asked.

"On what they see on screens of color sets running in stores and in the homes of friends," Barney explained. "One woman, for example, told about recently being in a department store that had five sets lined up side by side, all carrying the same program on the same channel. 'And you know what?' she said triumphantly, 'the colors were not the same on any two pictures! I want to see the colors the way they really are. If I have to guess, I may as well keep my black-and-white receiver and continue using my imagination. It will be a lot cheaper.' "

"The guy who set up that TV set display should be fired," Mac growled. "We know how a slight difference in setting of brightness, tint, color, or contrast controls can make insignificant changes in the picture that do not detract from its enjoyment at all. But when you invite odious comparisons—as the man did with that display—you are bound to exaggerate these differences to the point where they are disturbing. Even if the sets were all perfectly adjusted to present nearly identical pictures in the beginning, some drifting of circuits would be bound to occur. On one set the drift might be in one direction and on another in the opposite direction so that the changes reflected in the two pictures would be opposite-going so as to exaggerate the change in either one."

"I'll bet they mentioned the change in tint that is usually seen in changing channels or in changing from program to the commercial on the same channel," Matilda offered.

"You would win the bet," Barney answered. "As one woman put it, 'If a color-set owner wants to keep a decent picture on the screen at all times, he has to be constantly jumping up and down and fiddling with the knobs.' "

"Your mother's friends must be taking some of their observations from color receivers that are a half-dozen years old or older," Mac said. "Sounds to me as though those sets they were watching might not have had automatic frequency control or fine tuning, automatic color control, and automatic tint. I hasten to say I know that these features do not automatically solve the problem of keeping a consistently good picture on the screen, but they help."

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"Yes, and more help is on the way and almost here," Barney said. "I'm talking especially about the Vertical Interval Color Reference Signal, or VIR, developed by EIA's Engineering Department Broadcast TV Systems Committee and tested with the cooperation of the major TV networks for three months at the end of last year. Selected programs included the VIR signal which transmitter engineers at individual stations used to adjust their equipment so the picture each station telecast corresponded closely to the picture originally sent from the studio. The VIR signal provides reference or calibration marks for picture contrast, tint, and color. When engineers learn how to make the best use of this signal, I'm sure there will be much less need for knob-twiddling, even on the older-model TV sets."

"Candidly, I think it is high time," Mac said. "It has always been a source of deep personal annoyance to me to see color adjustments set properly for a program be way off when the commercial came on. We both know this has been the case. It is almost axiomatic for the TV installer to warn the customer: 'Set the controls properly for the program and do not change them for the commercial.' I should have thought the people who pay for the commercials would have been yelling about this a long time ago. Now with the use of the VIR signal, improved consistency in TV film colorization, and possible tightening of transmission standards, we should achieve a uniformity of transmitted signals that will make practical the use of pre-set tint controls in combination with brightness and contrast adjustments."

"Sounds to me," Matilda said, "as though the clutch, shift lever, and hand choke on color receivers are finally going to be replaced with automatic transmission, power steering and brakes, and automatic choke."

"Listen to the girl!" Mac chortled.

"But there's truth in what you say, Matilda. I hate to think how many people are watching color TV on poorly adjusted receivers right this minute. Only when proper adjustment is easy, or better still, automatic, will this condition cease."

"Other objections the women offered were not really fair," Barney continued. "They complained the faces of people changed color according to whether they were close to the camera or far away and that shadows on color TV looked blue. Any artist or color photographer could tell them these things are normal. Shadows *are* blue, and a face does look more ruddy close at hand than in the distance. It has to do with the way the eye perceives large colored areas and small ones."

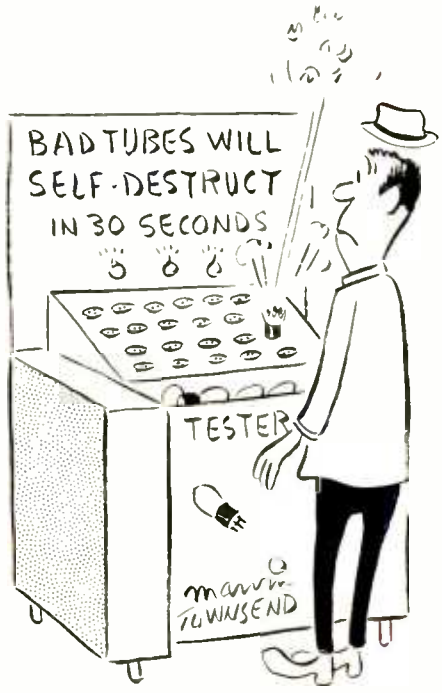
"Nonetheless, if I were a color-TV manufacturer in this country, I'd listen carefully to all these reasons for not buying color," Matilda said. "I was reading the other day that there are 83 million B&W sets in this country and only 31 million color sets. And we all know that 1970 was a disappointing year as far as color-TV sales were concerned. Those 83 million black-and-white set owners need some wooing by the color-set manufacturers to break down their resistance."

"I'm sure the manufacturers realize this," Mac answered, "and I honestly believe most of the objections to color TV we've discussed are rapidly melting away. Take the matter of price: improved production techniques involving automation, the widespread use of solid-state devices—especially IC's—greatly increased volume, and tough competition from the Japanese are going to bring down the comparative cost of color sets."

"Yeah, and solid-state module-type of construction, together with the standardization of IC's will make color-TV service calls fewer, faster, and less costly, with probably an extension of new-set warranties," Barney offered.

"I agree," Mac said, "and finally standardization of transmissions and automatic features on color receivers will combine to make the sets easy to adjust for stable, near-perfect, fuss-free reception. From where I sit, I think black-and-white TV will soon be as much of a rarity as a black-and-white movie. Color TV is about to get its second wind.

"And speaking of second wind, are you ready to do a little useful work now? We'll be generating our own set of complaints if we don't get those sets back to the owners in time for the first exhibition games." ▲



(Continued from page 31)

sound by increasing the directivity of the loudspeaker.

Casting aside, for the moment, all practical considerations, for accurate reproduction of the original ratio of direct-to-reverberant sound:

1. We would desire the concert hall used for the recording to be used as a listening room.

2. We would have a loudspeaker for each type of instrument in the orchestra and each of these speakers would have a varying directivity with frequency that matched the type of musical instrument that they were to reproduce.

We could then go back to the preferred listening seat and enjoy the concert.

A Practical Compromise

In order for a wider audience to participate, we could draw all the necessary parameters from the above to design a system for really faithful reproduction:

1. A loudspeaker that is sufficiently directional to allow all listeners to sit in a predominantly direct sound field from the reproducer, thereby hearing the effects generated in another room by a musical producer.

2. A loudspeaker that is equalized to nullify the effects of loudspeaker-room resonances and absorptions.

If all this is true, how is it that many "experts" have honest doubts regarding its validity? Primarily because other sound-system problems have for years masked these effects in reproducing systems. The rough amplitude response of loudspeakers interacting with the small rooms they are normally used in masked all of the more subtle effects with the gross resonances they exhibited. With the advent of presently available equalization methods, both engineers and music lovers are able to cancel out these serious resonance effects and really hear the subtleties of a good recording, properly reproduced.

Home-type omnidirectional loudspeakers must be considered as producers of a new sound. The listener either likes it or dislikes it. They cannot, however, be called faithful sound reproducers any more than the addition of an echo channel to a sound system enhances accuracy. ▲

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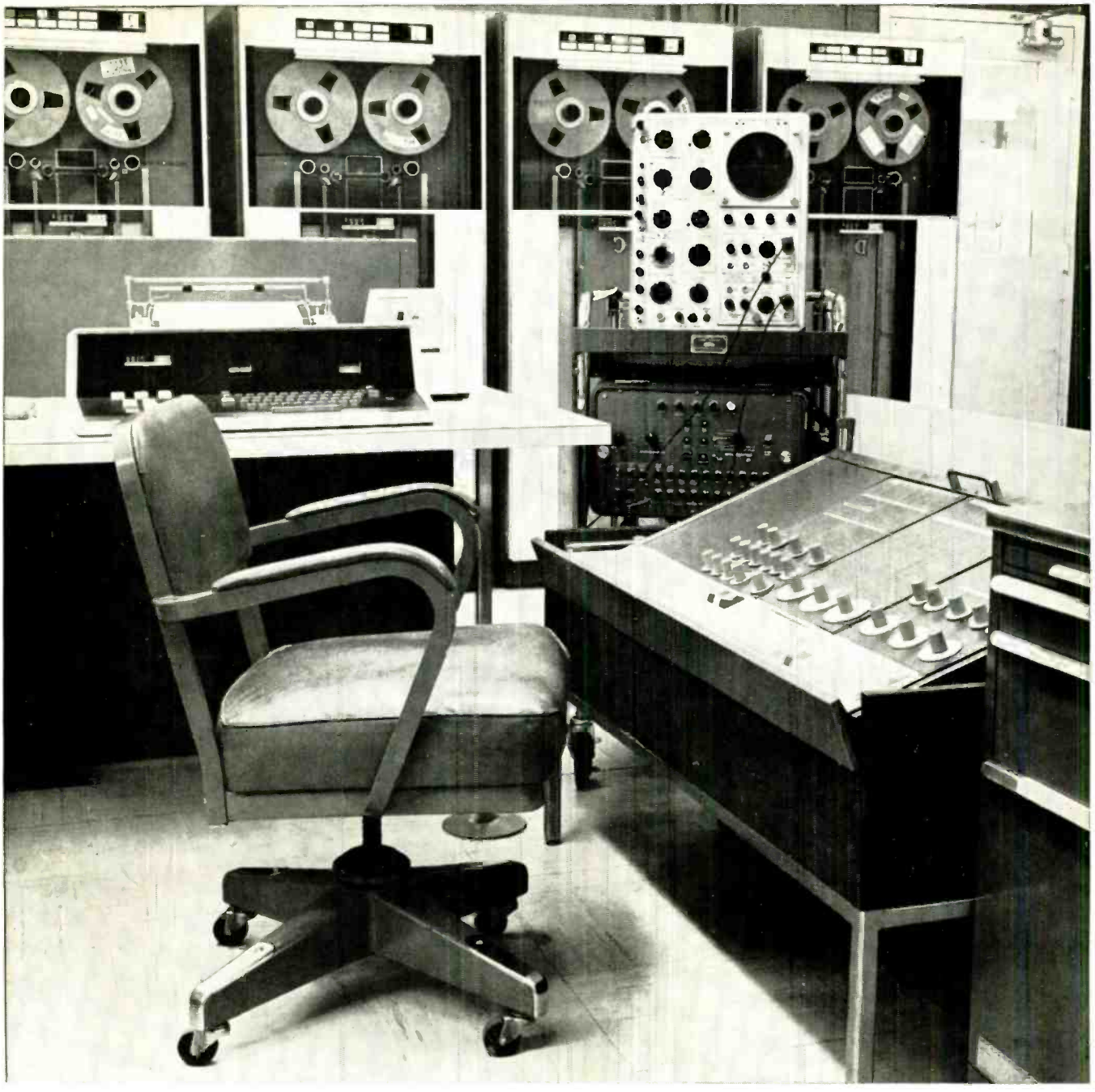

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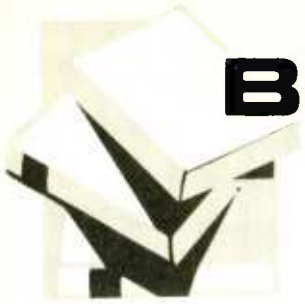


BOOKS

"INTERNATIONAL CODE TRAINING SYSTEM" by International Teaching Systems, Inc. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 46268. 96 pages. Price with LP records $7.50, with tape cassette $10.95.

This is a programmed course designed to teach Morse Code quickly and painlessly. When originally offered in 1963 the text was accompanied by three LP discs carrying the requisite code exercises but now it is also available with a single cassette containing the same material in more convenient form for those with cassette players.

The text is divided into five sections and four appendices. By following the programmed method faithfully and consistently, anyone should be able to master Morse in a relatively short period of time. In addition to the actual instruction, the book includes information on using the key, code-speed requirements for various FCC license exams, the RST signal reporting system, "Q" signals, and common CW abbreviations.

* * *

"ELECTRON MICROSCOPES" by J.A. Swift. Published by *Barnes & Noble, Inc.*, New York. 88 pages plus tables. Price $6.50.

This slim volume manages to pack a lot of information into a few pages and provide both theoretical and practical data on commercially available electron microscopes and their attachments.

The author, manager of *Unilever's* electron microscope section in England, has assumed that his readers have the requisite technical background and makes few concessions to those without a working knowledge of math and the metric system (which is used throughout). The text is divided into five sections covering the theory of the transmission electron microscope, its component parts and their function, specialized techniques and attachments, the scanning electron microscope, and the future of electron microscopy. A bibliography and three tables containing data on currently available units complete the book. The text is illustrated by a number of line drawings.

* * *

"HI-FI STEREO SERVICING GUIDE" and **"RADIO RECEIVER SERVICING GUIDE"** by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 46268. 111 & 96 pages, respectively. Price $3.95. Soft cover.

Both of these volumes are addressed to the professional service technician and the author assumes that the user will be familiar with all of the standard service-shop test equipment and have such instruments available.

The hi-fi volume breaks the audio system down into its logical components and treats each section separately. The AM and FM tuners are dealt with first after which the author covers troubleshooting procedures for stereo multiplex sections. The audio amplifier and how to service it is next and finally the installation of hi-fi speakers is covered in some detail. Two final chapters discuss system evaluation and trouble localization and test-equipment performance verification. All of the material is lavishly illustrated and the text material is straightforward and concise.

The second volume is rather specialized, covering as it does only AM receivers (both tube and transistor types). Here, again, the author has divided the receiver into sections and deals with each stage separately. A final chapter which will delight many collectors and technicians deals with the subject of restoring antique radio receivers. Yes, there are still *Atwater-Kents* around which their owners refuse to give up!

Like the hi-fi guide, this volume in no-nonsense, well illustrated, and easy to use.

* * *

"ADVANCED ELECTRONIC INSTRUMENTS AND THEIR USE" by Sol D. Prensky. Published by *Hayden Book Company, Inc.*, New York. 191 pages. Price $6.95. Soft cover.

This specialized text is addressed to laboratory technicians, engineering aides, and other scientific personnel working in electronics, chemical fields, biological disciplines, or in aerospace. The equipment discussed by the author is a far cry from service-shop v.o.m.'s, v.t.v.m.'s, and scopes. Rather, emphasis is on instruments capable of making measurements in the nano, pico, and femto ranges.

In addition to providing practical information on specific instruments, the text emphasizes standardization and calibration procedures and describes laboratory test methods used by technicians working with these instruments.

The text is elaborately illustrated and an extensive bibliography is included for those wishing additional information on any specific type of instrument.

* * *

"MONOCHROME TELEVISION SERVICING COURSE" compiled by M.N. Beitman. Published by *Supreme Publications*, 1760 Balsam Road, Highland Park, Ill. 160 pages. Price $3.00. Soft cover.

This is a completely revised and updated edition of a basic handbook designed to permit the radio technician to upgrade his skills to handle black-and-white TV servicing as well. A second volume covering color-TV servicing is planned as a companion book.

The presentation is elementary, starting with the theory of the transmitted signal, making simple adjustments to correct poor pictures, circuit faults causing poor pictures, pinpointing bad tubes by viewing the screen, TV antennas, picture tubes, locating circuit faults, aligning a TV receiver, using test equipment, tube and transistor TV sets, and visual troubleshooting.

The writing is informal, concise, and easy to understand. With the many photographs, picture-tube patterns, diagrams, line drawings, and charts included with the text. those using this volume as a home-study manual should have no difficulty in grasping the subject matter.

* * *

"MEASUREMENTS FOR TECHNICIANS" by Abraham Marcus & John D. Lenk. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 07632. 362 pages. Price $16.00.

The "technicians" of the title are those operating in industry or in scientific laboratories, not radio or TV technicians. The measurements are, therefore, more sophisticated and precise than those involved in making routine voltage checks around a TV chassis and call for more elaborate equipment.

The author has pointed out that a good working knowledge of electricity and electronics is prerequisite for an understanding of the material covered here.

The text is divided into five main sections covering number systems and counters, the measurement of electrical quantities, the measurement of physical and chemical quantities, time measurements, and special measurements (including solid-state; waveform, distortion, and modulation; antenna and transmission line; and microwave).

Numerous photographs, charts, line drawings, and graphs are used to illustrate the subject matter, making this text suitable for home study by those with the requisite background. ▲

Behind the UL Label

(Continued from page 27)

external surface of the oven, measured prior to the oven's acquisition by a purchaser and thereafter 5 mW/cm², also measured at any point 5 cm or more from the oven's external surface. This emission limit is now being observed by *UL* in its safety evaluation of microwave ovens.

Follow-Up & Submittals

Unique in many respects, *UL* requirements attempt to encompass every conceivable hazard which could develop in a product. However, once those requirements have been met, what guarantees that those same requirements will be maintained in future production? The *Laboratories* has solved this problem through the establishment of a department called Follow-Up Services. Briefly, this department is designed to provide a formal check on the manufacturer's compliance with applicable *UL* requirements. Follow-Up Service inspection centers and representatives are located in over 233 U.S. cities and foreign countries.

Many products listed by *UL* may cease to meet its standards because of misuse, exposure to adverse conditions, failure to follow instructions, failure to inspect and maintain the product and its components, or other factors arising after manufacture which affect product safety.

UL does not and cannot attempt to anticipate all abnormal conditions. Its standards and requirements are predicated on proper use and maintenance over the normal, useful life of the product, as well as the assumption of certain stipulated abnormal conditions under which the product must perform in a safe manner. *UL's* opinions, findings, and listings are based upon and limited by these assumptions.

Manufacturers' submittals of new equipment to *UL* have increased substantially in the past few years. Each year the *Laboratories* increases its new-work engineering services by about 10%. This figure represents an average of the combined submittals to the six engineering departments.

What is the reason for this annual rise in product testing? Perhaps this question could best be answered by saying that as the buying public becomes increasingly safety-conscious and aware of *UL's* role in testing for public safety so, too, does the manufacturer recognize and respond to this public awareness by seeking a *UL* label for his product. ▲

If preliminary survey shows presence of x-radiation, final exact readings are taken with Victoreen Model 440RF-C survey meter as shown. Meter on TV monitors high voltage.

Digital Music Maker

By BILL CARLQUIST

Produce your own musical tones with simple, inexpensive box containing three readily available RTL digital IC's.

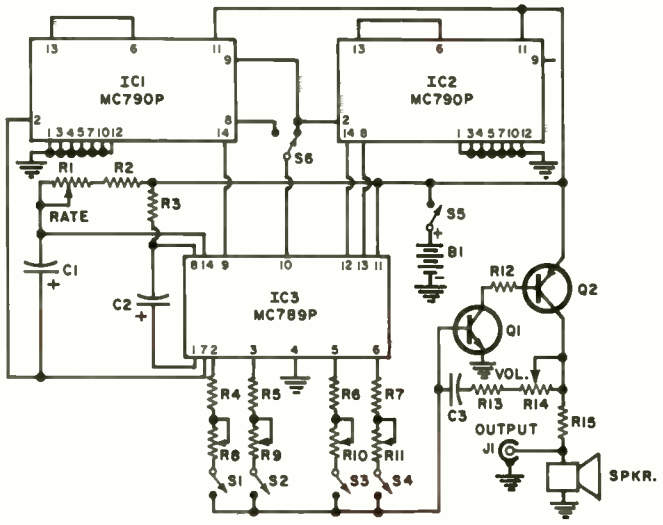
Front view of the "Digitone" built by author. Note controls are left unmarked to make selection of tones more exciting.

IT'S called "Digitone" because this "do-nothing box" uses digital circuits to produce musical tones. It can make repetitive 16-note melodies with which you'll spend many hours amusing yourself and friends. Digitone is designed around three commonly available RTL (resistor-transistor logic) digital integrated circuits and can be built in a few hours for under $15. *IC*1 and *IC*2 are dual JK flip-flops, while *IC*3 is a hex inverter. There are six knobs on the device: four control the tones emitted; one the volume; and the last the speed of the sequence. The output can be fed into your hi-fi system for added dimension.

Construction

Construction is entirely non-critical. The unit can be housed in a small plastic or metal box. Select a box of appropriate size and drill holes for the six pots, the switch, and the output jack. You may label the controls if you wish, but it is more exciting if a person is left free to twirl the knobs without knowing their functions. This is a good time to use up some old knobs you may have accumulated. Mount speaker and battery holder with cement, then allow to dry.

Schematic diagram and parts list for the "Digitone" discussed in the article. Use of the s.p.s.t. switches, S1-S4, is optional.



R1—10,000 ohm linear-taper pot
R2—6800 ohm, ½ W res.
R3—3900 ohm, ½ W res.
R4, R5, R6, R7—100,000 ohm, ½ W res.
R8, R9, R10, R11—250,000 ohm linear-taper pot
R12—390 ohm, ½ W res.
R13—22 ohm, ½ W res.
R14—500 ohm linear-taper pot
R15—4.7 ohm, ½ W res.
C1, C2—10 μF, 6 V elec. capacitor
C3—0.02 μF capacitor
J1—RCA-type phono jack
S1, S2, S3, S4—S.p.s.t. sw. (optional for R8, R9, R10, R11)
S5, S6—S.p.d.t. slide switch
B1—Two 1½-V "C" cells in series
IC1, IC2—MC790P integrated circuit (HEP 572)
IC3—MC789P integrated circuit
Q1—"n-p-n" transistor (2N706, 2N4124, see text)
Q2—"p-n-p" transistor (2N404, 2N4126, see text)

Leave five inches of wire from the speaker and battery. Only three leads are needed if the negative battery terminal is also connected to one of the speaker terminals. The s.p.s.t. switches *S*1, *S*2, *S*3, and *S*4 are optional. A second s.p.d.t. slide switch can be connected in a similar manner as *S*6 between pins 13 and 14 on *IC*2 and pin 12 of *IC*3. This will reverse part of the sequence and provide even more combinations of notes.

Before applying power, carefully recheck the wiring. Wrong connections are not only hard to find but can cause IC's to burn out. Insert the IC's in the appropriate places—pin 1 is designated by a small depression molded into the plastic. Use heat sparingly when soldering—sockets are recommended.

When all is ready, turn the unit on. A melody should be heard. The speed of the sequence may be varied with the rate control, *R*1. The unit draws about 70 mA, so keep it turned off when not in use. To connect it to your hi-fi system, insert a phono plug into *J*1.

How it Works

Two of the transistors in *IC*3 are connected as a multivibrator. The rate of oscillation is controlled by *R*1. The square-wave output is fed to the first of four flip-flops (*IC*1 and *IC*2) where the frequency is divided by two each time. The four frequencies thus obtained are routed through the four remaining inverters in *IC*3. Pots *R*8, *R*9, *R*10, and *R*11 pick off the desired amount of each frequency and the sum is fed to a voltage-controlled oscillator made up of *Q*1 and *Q*2. Thus, depending upon the exact pot settings, sixteen different tones will result in a repeated sequence. Volume is set by *R*14. ▲

Introducing Memorex Recording Tape. The tape that can shatter glass.

New Memorex Tape can shatter glass because it records and plays back with exacting precision. Memorex Tape records every note, every pitch, every harmonic, every nuance of music, then plays them back the same way they sounded live.

Quite a claim.

Quite a tape.

We found a singer who could maintain the pitch necessary to shatter glass and projected his voice with enough volume to vibrate a glass to its shatter point. At the same time, we recorded that pitch on Memorex Tape.

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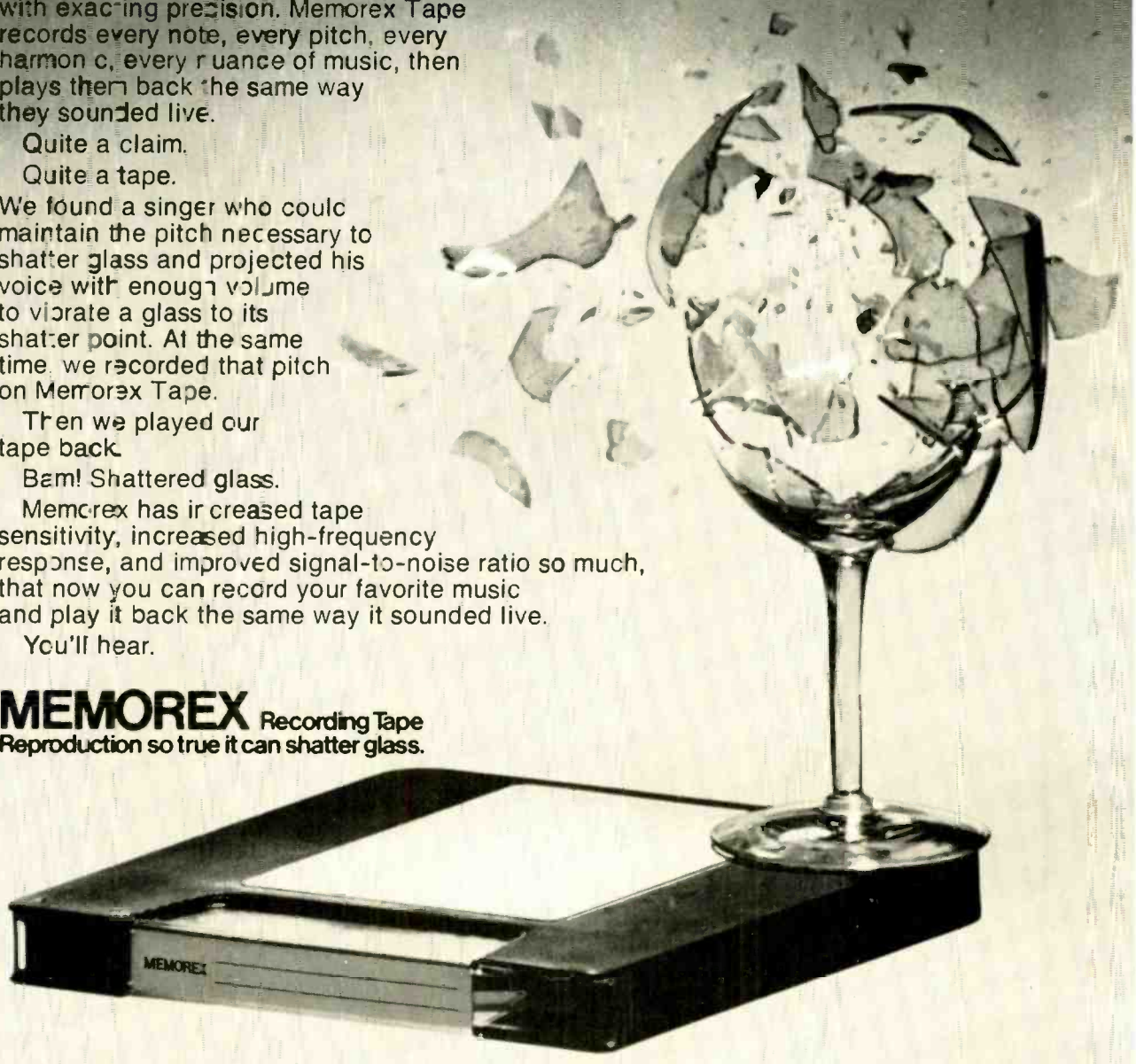
Bam! Shattered glass.

Memorex has increased tape sensitivity, increased high-frequency response, and improved signal-to-noise ratio so much, that now you can record your favorite music and play it back the same way it sounded live.

You'll hear.

MEMOREX Recording Tape
Reproduction so true it can shatter glass.



Incidentally, our cassette tape also shatters glass.

T.V.O.M. Test Results

(Continued from page 41)

accuracy ±2.5%. **A.c. volts** 7 ranges from 1 to 1000 V, input resistance 10 MΩ shunted by 29 pF, accuracy ±4.5%. **D.c. current** (±) 5 ranges from 100 μA to 1 A, accuracy ±3%. **Resistance** 5 ranges, center readings 10Ω to 10 MΩ. Jewel pivot movement. Mirror scale, length 4¼". **Dimensions** 7⅜"×5¼×3½". **Weight** 3 lb, 4 oz. **Price** $69.95.
PERFORMANCE: D.c. volts +1.7%, −0%. **A.c. volts** +0%, −4.5%. **D.c. current** +3.2%, −0%. **Ohms** +0%, −8%. **Frequency response** 2.7%.
COMMENTS: Movement over-damped, slow response. Moderate meter-pivot friction. Balance shift 0.2%.

Sencore Model FE16

FEATURES: Identical to Model FE14 except for accuracy specifications: **D.c. volts** ±1.5%. **A.c. volts** ±3%. **Price** $84.50.
PERFORMANCE: D.c. volts +1.3%, −0%. **A.c. volts** +0%, −4.7%. **D.c. current** +0%, −1.7%. **Ohms** +0%, −7%. **Frequency response** 2.0%.
COMMENTS: Movement slightly over-damped. Negligible pivot friction. Balance OK.

Sencore Model FE20

FEATURES: D.c. volts (±) 9 ranges from 0.1 to 1000 V; 3 ranges from 3 to 30 kV with h.v. probe, input resistance 15 MΩ shunted by 90 pF or 10 pF (Isolation position of probe), accuracy ±1.5%. **A.c. volts** 9 ranges from 0.1 to 1000 V, input resistance 12 MΩ shunted by 90 pF, accuracy ±3%. **D.c. current** (+) 9 ranges from 100 μA to 1 A, accuracy ±3%. **Resistance** 7 ranges, center readings 12Ω to 12 MΩ, "Hi-Pwr" (1.5 V) and "Lo Pwr" (0.08 V) effective on all ranges. Jewel pivot movement. Mirror scale, 5" long. Fuse protection for circuits. **Dimensions** 9¾"×8"×4". **Weight** 7 lb, 4 oz. **Price** $129.50.
PERFORMANCE: D.c. volts +0.9%, −1.3%. **A.c. volts** +0, −6%. **D.c. current** ±1.2%. **Ohms** +4%, −9%. **Frequency response** 10%.
COMMENTS: Steel portable case, Hi-Voltage probe stores in cover (supplied). Meter response is over-damped. Moderate meter-pivot friction. 120 kΩ isolation resistor in probe allows d.c. measurements without capacitance loading of circuit. Changes reading by approx. 0.3%. Balance shift 0.8%.

Sencore Model FE149

FEATURES: D.c. volts (±) 8 ranges from 0.5 to 1500 V; 3 ranges from 5 kV to 50 kV with optional probe, input resistance 15 MΩ shunted by 45 pF, accuracy ±1.5%. **A.c. volts** 8 ranges from 0.5 to 1500 V, input resistance 15 MΩ shunted by 125 pF, accuracy ±3%. **D.c. current** (±) 9 ranges from 150 μA to 5 A, accuracy ±3%. **A.c. current** Same ranges and accuracy as d.c. current. **Resistance** 8 ranges, center readings 6Ω to 60 MΩ. Jewel pivot movement. Mirror scale, length 6". Fuse-protected circuits. Battery powered or a.c. **Dimensions** 9½"×7½"×6". **Weight** 6 lb, 12 oz. **Price** $169.50.
PERFORMANCE: D.c. volts +1.1%, −0.6%. **A.c. volts** +1%, −2% (error increases on 0.5-V range). **D.c. current** +1.3%, −0.3%. **A.c. current** +0%, −4%. **Ohms** +2%, −5%. **Frequency response** 3.9%.
COMMENTS: Meter over-damped. Moderate meter-pivot friction. Push-button range and function selection. Balance shift 0.3% (designed for upright operation only).

Simpson Model 313

FEATURES: D.c. volts (±) 8 ranges from 0.3 to 1000 V, input resistance 11 MΩ, accuracy ±3%. **A.c. volts** 8 ranges from 0.3 to 1000 V, input resistance 10 MΩ, accuracy ±3%. **D.c. current** (±) 5 ranges from 100 μA to 1 A, accuracy ±3%. **Resistance** 7 ranges, center readings from 10Ω to 10 MΩ. Taut-band suspension. Scale length 7½". **Dimensions** 6⅝"×7¾"×3⅞". **Weight** 4 lb, 7 oz. **Price** $125.00.
PERFORMANCE: D.c. volts ±0.5%. **A.c. volts** +0%, −2.7%. **D.c. current** +1.1%, −0.8%. **Ohms** +0%, −5%. **Frequency response** 1.8%.
COMMENTS: Slow meter movement, over-damped. Balance shift 0.8%.

Simpson Model 2795

FEATURES: D.c. volts (±) 13 ranges 1 mV to 1000 V, input resistance 10 MΩ on 10 V and higher ranges; 1 MΩ/V on lower ranges, accuracy ±1%. **A.c. volts** 13 ranges from 1 mV to 1000 V, input resistance and accuracy same as for d.c. **D.c. current** (±) 14 ranges from 1 μA to 3 A, accuracy ±1%. **A.c. current** Same ranges and accuracy as for d.c. **Resistance** 6 ranges, center readings from 50Ω to 5 MΩ. **Capacitance** 6 ranges, center readings from 0.001 to 100 μF. Taut-band suspension. Mirror scale, length 4". Protected by fast-acting relay (push-button reset) and fuse. **Dimensions** 8"×5"×3¼". **Weight** 3 lb, 9 oz. **Price** $230.00.
PERFORMANCE: D.c. volts +0.3%, −0.4%. **A.c. volts** +0.7%, −0%. **D.c. current** +1.5%, −0%. **A.c. current** +1%, −2.9%. **Ohms** +5%, −0%. **Microfarads** +0%, −1%. **Frequency response** 2% to 5 kHz, increased error at 20 kHz.
COMMENTS: Unique FET chopper circuits eliminate all zero adjustments and drift. Stabilizing time required after range changes. Moderate response time for meter, single small overshoot. Balance shift 1.2%. Made in Austria.

Triplett Model 310-FET

FEATURES: D.c. volts (±) 6 ranges from 0.3 to 600 V, input resistance 10 MΩ, accuracy ±3%. **A.c. volts** 5 ranges from 3 to 600 V, 5kΩ/V, accuracy ±4%. **D.c. current** (±) 2 ranges, 120 μA and 1.2 mA, accuracy ±3%. **Resistance** 4 ranges, center readings from 50Ω to 50M Ω. Taut-band suspension movement. Scale length 2". **Dimensions** 4¼"×2⅝"×1⅛". **Weight** 10 oz. **Price** $74.00.
PERFORMANCE: D.c. volts +0.6%, −0.8%. **A.c. volts** ±1.7%. **D.c. current** +0.8%, −0%. **Ohms** +0%, −10%. **Frequency response** 1.2%.
COMMENTS: Extremely compact, lightweight meter. Moderately fast response, slightly under-damped with single small overshoot. Balance OK.

Triplett Model 602 Type 1

FEATURES: D.c. volts (±) 8 ranges from 0.3 to 1000 V, input resistance 11.12 MΩ, accuracy ±3%. **A.c. volts** 8 ranges from 0.3 to 1000 V, input resistance 10 MΩ, accuracy ±3%. **D.c. current** (+) 4 ranges from 1 mA to 1 A, accuracy ±4%. **A.c. current** 4 ranges from 1 mA to 1 A, accuracy ±4%. **Resistance** 6 ranges, center readings from 10Ω to 10 MΩ. Taut-band suspension. Scale length 3¾". Fuse-protected circuits. Auto-polarity feature. **Dimensions** 6⅝"×5"×3¼". **Weight** 2 lb, 9 oz. **Price** $100.
PERFORMANCE: D.c. volts +0%, −1%. **A.c. volts** +0%, −1.5%. **D.c. current** +1.7%, −0%. **A.c. current** +0%, −2%. **Ohms** +3%, −5%. **Frequency response** 1%.
COMMENTS: Auto-polarity very convenient to use, eliminates zero adjustments. Conventional ± polarity selection by push-buttons. Multi-turn zero and ohms adjustments simplify use. Meter response fast, single small overshoot. Balance shift 0.8%.

Triplett Model 801

FEATURES: D.c. volts (±) 10 ranges from 50 mV to 1500 V, input resistance 11 MΩ, accuracy ±2%. **A.c. volts** 12 ranges from 5 mV to 1500 V, input resistance 10 MΩ shunted by 75 pF, accuracy ±3%. **D.c. current** (±) 12 ranges from 5 μA to 1.5 A, accuracy ±3%. **A.c. current** 12 ranges from 5 μA to 1.5 A, accuracy ±4%. **Resistance** 7 ranges, center readings from 10Ω to 10 MΩ (conventional); 8 low-power ranges (35 mV applied to circuit) with center readings from 1Ω to 10 MΩ. Taut-band suspension. Mirror scale, length 5¾". Fuse-protected circuits. **Dimensions** 6½"×8"×5". **Weight** 7 lb, 4 oz. **Price** $200.00.
PERFORMANCE: D.c. volts +0.1%, −0.5%. **A.c. volts** +3.3%, −2%. **D.c. current** +0.7%, −1.7%. **A.c. current** ±0.7%. **Ohms** +1%, −6%. **Frequency response** 0.3%.
COMMENTS: Exceptional flexibility and choice of ranges. Low-power ohms-zero adjustment quite critical. Meter movement slow, over-damped. Balance shift 0.3%.

EDITOR'S NOTE: Although the above nineteen solid-state v.o.m.'s certainly are not all the t.v.o.m.'s that are currently available on the market today, they at least are representative of what a large number of test-equipment manufacturers are offering to the service technician. Note also that the performance figures measured are "worst-case" measurements we obtained at the specific values of test voltages, current, and resistance used. Naturally, the average performance of all the meters we tested was substantially better than the percentages given.

For those of our readers who are interested in similar coverage of a number of conventional, passive-type volt-ohm-milliammeters, please refer to our roundup story on this topic which appeared in last month's issue.

Multi-Set TV-FM Systems

(Continued from page 35)

Packaged Systems

Several manufacturers offer kits to drive four or eight receivers from a single antenna. Listed in Table 8, the kits contain an amplified coupler, twinlead or coax, fittings, and baluns. Some models have more gain for weak-signal areas.

Traps

In some cases, a strong local TV or FM station will overdrive a preamplifier or amplified coupler. The trouble shows up as loss of sync, herringbone r.f. beat, or windshield-wiper effect on every channel but the offender. The solution is a trap ahead of the amplifier, tuned to the offending frequency. You will probably want to watch or hear the strong station, so adjust the trap for less signal, not for a complete null. FM and TV traps are available from splitter and accessory manufacturers.

Installing the System

Plan ahead of time the location of the antenna, splitters, and outlets. Concealed wiring is desirable, but may be impractical in your house. Concealed wiring usually requires either 75-ohm coax or shielded 300-ohm lead for ease in routing.

If you have an attic, it's probably the best place to mount the splitter; then branch the circuits from there. You can drop each line down the middle of a wall. For neatness, you may want to mount a wall plate and jack in each room. This makes it convenient to unplug and move receivers. Wall plates and jacks for both 300- and 75-ohm systems are available from such companies as *Jerrold, JFD, Mosley,* and *Winegard.*

If concealed wiring isn't practical, you can split the feed on the roof and run each line down the outside wall, dropping into each room through a window or adjacent to one. Another useful technique is to feed second-floor locations from the attic, and to feed the ground-level rooms from the basement.

If you must run 300-ohm unshielded twinlead, avoid proximity to 117-volt a.c. lines and metal objects. Use few metal staples, as they will cause signal loss and impedance mismatch, which can lose the color subcarrier and the stereo-FM pilot.

Other tips: Use a drip loop at the antenna preamplifier and where the downlead enters the building, to let moisture drain off. Route amplifier output lines away from the input to an amplified coupler, to avoid feedback and oscillation. ▲

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GR-371MX

GR-269

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Big-set features. Automatic Fine Tuning brings in perfect picture and sound at the touch of a finger; solid-state VHF utilizes MOS Field Effect Transistor for less noise, visibly better reception; 3-stage IF unusual in a "compact", provides increased signal gain for better all-around picture quality; switch-controlled degaussing circuit lets you demagnetize set after moving it from one area to another, thus assuring pure, clean color; "Instant-On" is standard.

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Kit AS-103, speakers, cabinet and all circuitry, 68 lbs. **189.95***

GD-160 — New Heathkit Cab-to-Camper Intercom.

Economical, two-way communication for the camping family on the move. Allows driver to converse with passengers in the camper or travel trailer, or monitor sleeping children. Master unit in cab has "Standby", "Talk" and "Monitor" positions. Remote unit in camper has "Standby", "Talk" and "Radio" settings, with the latter bringing music and news into the camper directly from the front-seat radio. Kit includes master and remote intercoms, 15' connecting cable. Quick disconnect coupling optional. Operates on 12 volt automatic system.
Kit GD-160, master, remote and cable, 5 lbs. **25.95***

GD-110, 120, 130 — New Heathkit Home Intercom System.

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Kit GD-110, master unit, 4 lbs. **39.95***
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Kit GD-29, 97 lbs. **399.95***

GT-101 — New Heathkit Hilltopper Trail Bike.

Here's a trail bike that combines portability with ride and handling characteristics found only in much larger machines. Features telescoping fork up front, adjustable shock absorbers at the rear wheel. Powered by a durable 5-h.p., 4-cycle Tecumseh engine, coupled to an infinitely variable torque converter that gives low-speed pulling power or 35 m.p.h. cruising at the twist of the spring-loaded throttle. Hefty two-wheel brakes give sure stopping power. Big 18x8.50-8" rear tire provides great traction on the steepest grades, over sand or snow. Fold-down handlebars and collapsible foot pegs make it a cinch to stow. Options include running lights, powered by alternator, and front-wheel snow ski.
Kit GT-101, 160 lbs. **299.95***

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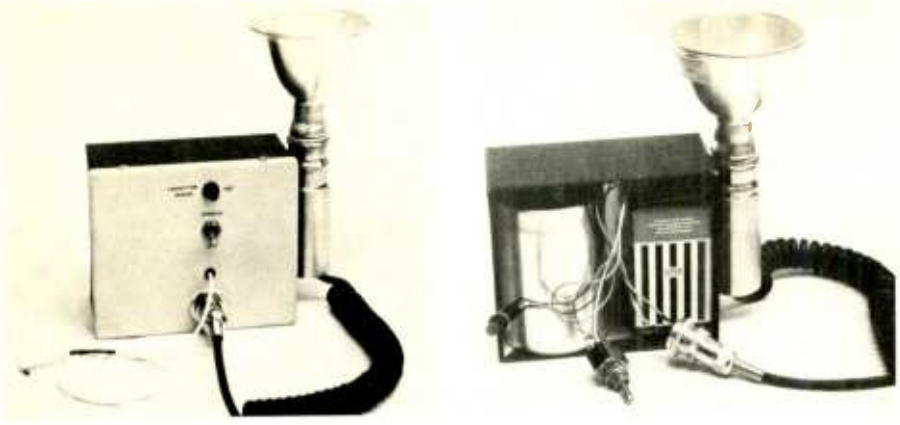


Rapid-Flash unit built by author showing (left) panel with "Operate" switch and "Capacitor Peaked-Test" push-button and (right) internal view with capacitor C1 and battery B1. An etched circuit board, containing remaining electronic components, plugs directly into B1 (although not obvious in photograph).

Rapid-Flash

By WALTER W. SCHOPP

Here is a lightweight electronic flash unit that features fast recycling time and SCR triggering for camera contact protection.

ELECTRONIC flash units are available in a variety of sizes from miniature camera-mounted types to shoulder-busting packages capable of lighting a football field from the end zone. The small flash units work well but the light output is limited. Using a smaller flash unit means you will have to either use a larger lens opening (*f* stop), faster film, or get closer to the subject for a given situation. More often than not, all the variables are at their upper limit, in which case the only answer is a larger flash. There are certain disadvantages here too.

A larger flash unit may provide enough light output for any film speed or distance but becomes heavy and bulky due to the large batteries and capacitors. Aside from being heavy and awkward to carry, the larger units have other disadvantages. Large capacitors take longer to charge than do the smaller ones used in the mini-flash units. Waiting for the ready light to show that the capacitor is charged may seem like a long time if the photographer is in a hurry. Another disadvantage of these heavyweights is that the camera's small shutter contacts are often required to make and break potentials as high as 400 volts (see Fig. 1). This voltage is enough to erode the camera's contacts to the point where they become unreliable. Owning an expensive camera with a pitted set of flash contacts is a sad and costly experience.

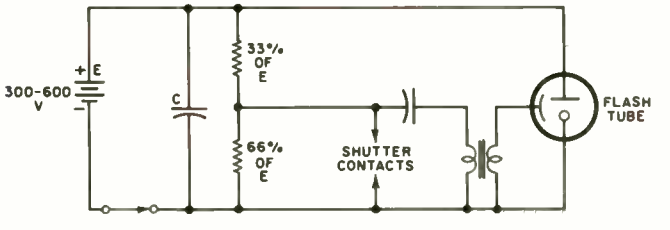


Fig. 1. Schematic of typical large flash unit. Note how contacts must take full force of high make-and-break potentials.

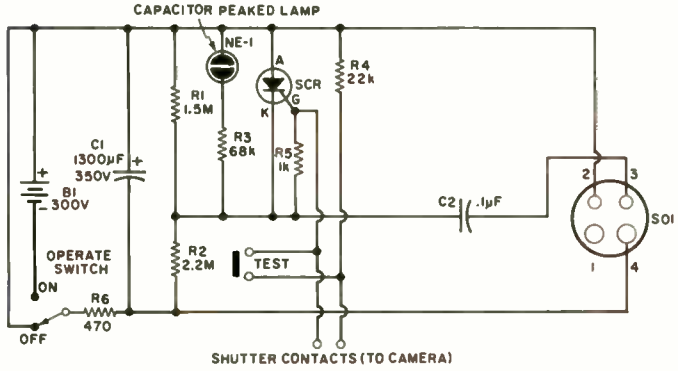


Fig. 2. Schematic of Rapid-Flash unit discussed in article.

Somewhere between the miniature camera-mounted and the ultra-large flash units, there is a happy medium. This optimum flash unit should be large enough to produce sufficient light for most films and situations, but small enough to carry comfortably. This "ideal" unit should also have a fast recycle time and a method of protecting those valuable little contacts inside the camera.

The Rapid-Flash, although not a powerhouse as far as wattage is concerned, is sufficient for most applications. It produces 58 watt-seconds input to the flash tube. It has a recycle time of less than three seconds which means it will be ready for the next flash by the time the film is advanced for the next picture. Contact arcing is virtually eliminated by triggering the

R1—1.5 megohm, ½ W res.
R2—2.2 megohm, ½ W res.
R3—68,000 ohm, ½ W res.
R4—22,000 ohm, ½ W res.
R5—1000 ohm, ½ W res.
R6—470 ohm, 2 W res.
C1—1300 μF, 350 V elec. capacitor (Mallory #CG 132 T 350 F 1)
C2—0.1 μF, 200 V capacitor (C-D 2P1)
Switch—S.p.d.t. switch (Cutler-Hammer 8810K15 or equiv.)
SO1—4-pin tube socket (Amphenol #77MIP4 or equiv.)
NE1—Combination neon lamp/n.o. push-button (Grayhill #40-1)
B1—300-V battery (Burgess U-200)
SCR—2N2326 or C6B (General Electric)

Circuit board available from Nielsen Diversified, 934 Miranda Way, Livermore, Calif. 94550 for $1.95 postpaid. Flash lamp available postpaid for $22.00 from Kemlite Laboratories, Inc., 1819 W. Grand Ave., Chicago, Ill. 60622

flash tube with an SCR. A flash tube/reflector combination with a built-in triggering transformer was chosen to reduce the number of loose parts and to facilitate ease of construction. All electronic components other than the "Operate" switch and "Capacitor Peaked-Test" neon lamp and push-button are mounted on the etched circuit board which plugs directly into the battery. This type of construction is compatible with a variety of housing methods and reduces the chances for wiring errors.

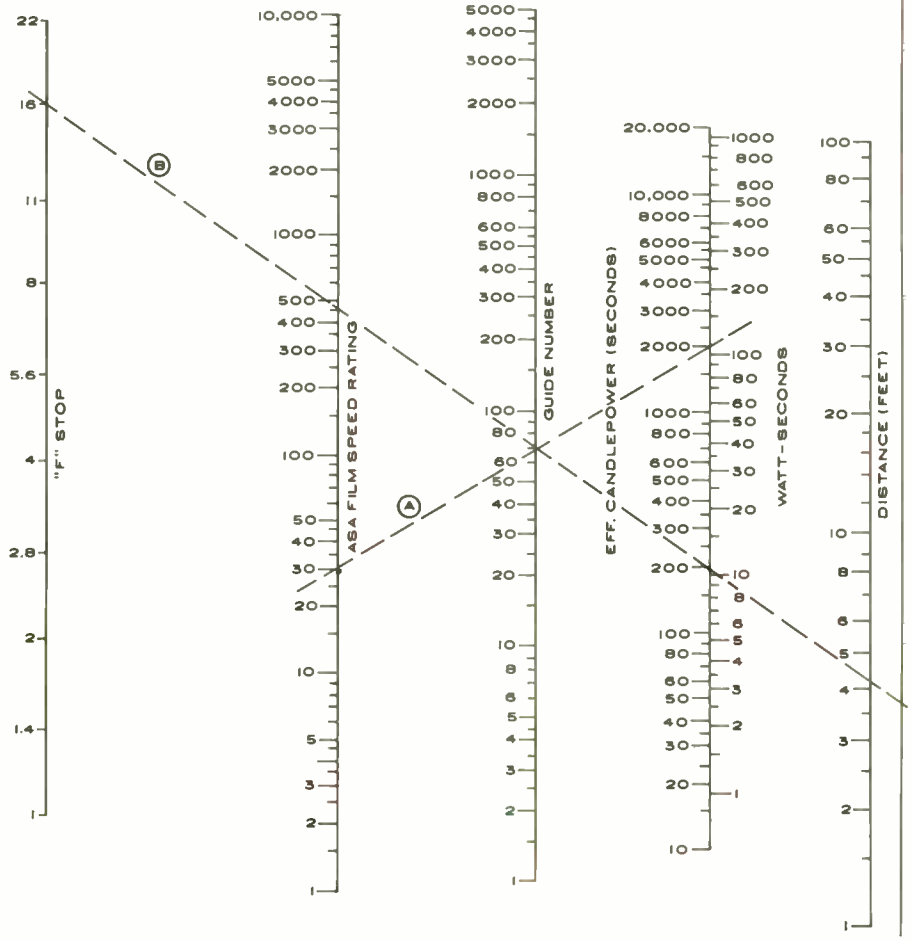
Referring to the schematic, Fig. 2, when the "Operate" switch is turned on, capacitor *C*1 is charged through limiting resistor *R*6. When the capacitor is charged, the voltage developed across resistor *R*1 is sufficient to light the "Capacitor Peaked" neon lamp, *NE*1. This indicates that the flash unit is ready to fire. Consequently, when the shutter contacts momentarily make as the picture is taken, the SCR is triggered. This creates a short-circuit across resistor *R*1 and causes a large voltage pulse across *R*2. This pulse is coupled to the flash tube *via C*2.

When the SCR is triggered, the voltage across the SCR drops to zero, thus turning off the SCR and preparing it for the next charge cycle. When the switch is turned off, *C*1 is discharged through *R*6 as a safety precaution.

The circuit board construction facilitates housing the electronic components in the "shutter-bug's" own case, box, or bag. The minimum space required is 3" × 4" × 5".

A combination neon-lamp/push-button was used for the ready indicator lamp. The push-button section (Test) was connected across the shutter contacts and is used to trigger the flash unit manually. This is a desirable feature when setting up a picture-lighting situation using a peak flash-reading meter such as the one described in the June issue of the magazine. If a peak-flash reading meter is not available, the nomogram of Fig. 3 may be used to correlate the variables needed to use the electronic flash. *Care should be exercised when handling the exposed components as a shock hazard exists because of the high voltage.* ▲

Fig. 3. Nomogram for determining variables needed to use electronic flash when peak flash-reading meter is not available. In the example shown, electronic flash-to-subject distance is obtained by first laying a straightedge (A) from the ASA Film Speed Rating (30) to Eff. Candlepower/s flash-tube output (2000) to determine the Guide Number (70). Then lay straightedge (B) from this point to "F" Stop (16). The line will intersect distance scale at the proper value (41/4 feet). In a similar manner, the required "f" stop setting can be determined for a known distance from the subject.



(Continued from page 38)

holding it high. If the input terminal is considered to be normally high, the output of A is normally 0. Since both sides of the capacitor between A and B are near ground potential, very little charge builds up. When the input goes to 0 (this must be a fairly quick transition), the output of A goes to 1. Since the voltage across a capacitor cannot change instantaneously, the inputs of B are forced to a logic 1 level, and this drives the output to 0.

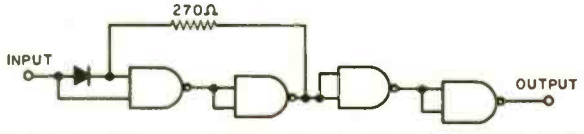
This 0 is fed back to A, holding its output high. The capacitor begins to charge through the resistor and, as a result, the inputs of B begin to drop toward ground potential. When the inputs of B have returned to their normal 0 state, the output goes to 1. The output has now gone from high to low and back to high with the application of only one input pulse. The amount of time that the output stays low depends upon the values of R and C and may be altered by varying C (the value of R shown should not be changed appreciably).

Fig. 4B shows the one-shot combined with a Schmitt trigger-like circuit for improved triggering characteristics. An equation is also given to allow calculation of C to provide pulses of a given duration. Note that the one-shot produces an output for both long and short input pulses.

These circuit configurations and equations were derived from *Texas Instrument* SN7400 *nand* gates, but other types of gates should work as well. The pulse width equation, however, will not necessarily be correct. As shown in Fig. 4C, *nor* gates can also be used to perform shaping functions. Input signals to either of these circuits must not exceed the maximum input ratings of the gates. ▲

NUMBER OF DIODES IN SERIES	APPROXIMATE ON-THRESHOLD (VOLTS)	APPROXIMATE OFF-THRESHOLD (VOLTS)
1	2.20	1.55
2	3.00	1.55
3	3.50	1.55

(A)

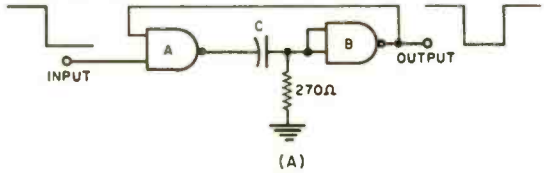


NOTE: THE ON-THRESHOLD MAY BE MODIFIED BY USING 2 OR 3 DIODES IN SERIES

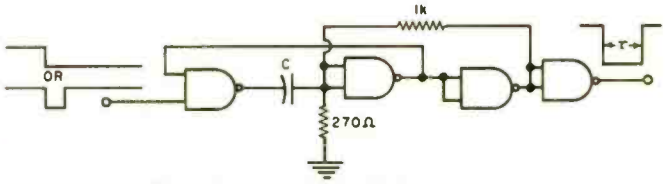
(B)

Fig. 3. (A) Threshold voltages. (B) Improved Schmitt trigger.

Fig. 4. (A) One-shot circuit. (B) An improved one-shot with triggering equation shown. (C) "Nor" gate one-shot circuit.

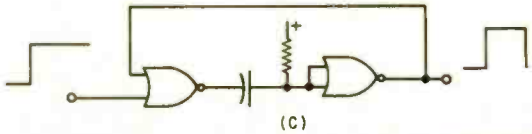


(A)



τ = ONE-SHOT TIME ≅ 350 x C. IF C = 1μF, FOR EXAMPLE, τ = 350μs

(B)



(C)

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V.T.V.M. BATTERY ELIMINATOR

By WARREN G. HELLER

A simple regulated power supply that takes the place of the "C"-cell ohmmeter supply.

MANY vacuum-tube voltmeters, while they plug into the 117-volt line, have no power supply to drive the ohmmeter circuit. Instead, a 1.5-volt "C" cell is used, giving rise to several associated nuisances. As the cell runs down, accuracy on the lower scales is drastically affected, despite re-zeroing. Balancing can become tedious during the course of many resistance measurements, especially if the cell's voltage rises upon recovery from moderate loading (X1 or X10 scale). For the occasional user, the battery is often dead (and possibly corroded) when the instrument is needed.

This regulated power supply can be built at low cost, will fit into the space presently occupied by the "C" cell, and runs directly off the filament supply in your meter. Or, if you have plenty of space inside, it can be put together on a small piece of phenolic and installed inside the instrument housing.

If the power supply is built on a phenolic board, construction can proceed directly from the schematic. For the "C"-cell package, a "cordwood module" is made which is then inserted into a cardboard tube. Cardboard caps insulate the ends and three lead-out wires provide the necessary external connections.

The base-emitter drop of transistor $Q2$ and diode $D2$ provides the reference voltage, 1.5 volts. This reference is held quite constant because the collector current of $Q2$ varies only slightly as the output is loaded. Transistor $Q2$ senses any slight change in the output voltage and has a small corresponding change in collector current. This in turn changes the voltage dropped across $R2$ and causes a change in the base current of driver transistor $Q1$. The collector current of $Q1$ changes in such a direction as to restore the voltage across $R1$ to its 1.5-volt value.

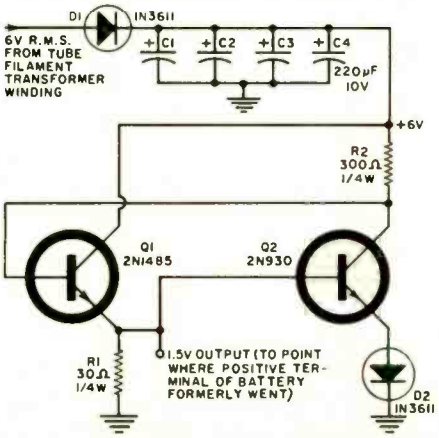
Diode $D1$ provides half-wave rectification of the 6-volt a.c. power. Capacitors $C1$ through $C4$ provide some filtering of the raw 6-volt d.c. The regulating mechanism provides the rest.

Several of these circuits have been built and all were found to remain within ±5% of the nominal 1.5 volts for loads varying from 10 ohms to open circuit (corresponding to X1 and X1 meg) scales. If low-*beta* transistors are used, this regulation could degrade further. Also, if the transistors used happen to have an unusually large or small base-emitter drop, the nominal 1.5 volts will be in error. This can be compensated for, at some degradation of the regulation, by adjusting bias resistor $R2$, but no more than 50% in either direction.

Poor regulation and erratic behavior could also be an indication of oscillation. This can be eliminated by the addition of a 0.01-μF capacitor between the collector of $Q2$ and ground.

Other filament-supply voltages, such as 12 volts r.m.s., can be used by increasing $R2$ accordingly (about 600 ohms should suffice). Higher output can be had (such as 3 volts) by using additional diodes (two more for 3 volts) in series with $D2$ and then reducing the value of $R2$. ▲

Schematic of the 1½ -V battery eliminator. The diodes can be any silicon type capable of carrying 300 mA. All four capacitors are 220-μF units or a single 900 -μF capacitor may be used. Q1 can be any silicon transistor with beta of over 20 capable of dissipating 2 watts of power while Q2 can be any silicon transistor with beta above 50 at a collector current of 10 milliamps.



Unusual Digital Circuits

(Continued from page 37)

is often used for the collector resistor when assembling a discrete-component gate. The fan-out decreases only slightly.

Similarly, we can assemble an eight-input gate using a quad 2-input gate, as shown in Fig. 3B. In this case, the collector resistors paralleled inside the IC provide an effective resistance of only 160 ohms—so we add a 470-ohm resistor in series with the +3.6-volt (pin 11) lead. This brings the total resistance to 630 ohms which is close enough.

But suppose we need a 5-input *and* gate, or a dual 2-input *and* gate? We have them. A hex inverter and five diodes give us the 5-input gate, as shown in Fig. 4A, and they do it in less space than an assembled conventional circuit would require. In this circuit, if all inputs are low, the output is low. If we make up to four inputs high, the output remains low. All five inputs must be high before output goes high.

The dual 2-input *and* gate also uses a hex inverter but, as shown in Fig. 4B, this one requires only four diodes. As in the preceding circuit, both inputs of either gate must be high before its output goes high. Fig. 4C shows how a dual 3-input *nand* gate may be assembled using a hex inverter and six diodes.

"Enable" and "Disable" Gates

A couple of circuits used occasionally by the author but never seen by him elsewhere are the enable and the disable gates, shown in Figs. 5A and 5B, respectively.

Each of these setups consists of a dual 2-input gate with the emitter-to-collector circuit of a transistor connected between the IC's pin 8 and the +3.6-volt bus. The enable signal is fed directly to the transistor's base (*via* a 470-ohm resistor), while a disable signal is applied to the base through an inverter.

In the enable circuit, the outputs remain low, regardless of the state of the conventional inputs, until and unless the enable input is made high.

The disable-gate circuit of Fig. 5B allows the conventional inputs to control the outputs in the usual manner, as long as the disable input is low. In a sense, the function of the disable input is similar to that of an additional input on each of the two gates simultaneously. When all conventional inputs are low, and the outputs are high, applying the disable input causes the outputs to go low.

When a transistor such as the 2N2475 or HEP56 is used in an enable or disable setup, fan-out of the gates is decreased only slightly. ▲

NEW PRODUCTS & LITERATURE

For additional information on items identified by a code number, simply fill in coupon on Reader Service Page. In those cases where code numbers are not given, may we suggest you write direct to the manufacturer on business letterhead.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • COMMUNICATIONS

PROGRAMMABLE REGULATORS

A new line of compact, general-purpose laboratory voltage regulators has just been introduced as the JQE series.

With 31 models available in bench or rack-mount versions, each power supply is equipped with a panel-adjusted overload current filter and

is capable of being converted to current regulation by using external sensing and feedback resistors. The units feature a linear full-dissipation series "n-p-n" transistor regulator, driven by a monolithic linear IC amplifier. Output is fully programmable with an offset zero control as an option, as is an overvoltage crowbar.

The various units offer a choice of voltages ranging from 0-6 V to 0-150 V, in 100, 250, 500, and 1000 (+) watts. Two dual-range, 2-inch, 2% recessed meters monitor the output voltage and current.

A comprehensive data sheet listing the models and complete specifications is available on request. Kepco

Circle No. 3 on Reader Service Page

MINIATURE TOOL KIT

A new 10-piece miniature tool assortment for use by radio, TV, and hi-fi technicians is now available as the No. 59 kit.

It contains interchangeable screwdriver blades in sizes 0.055", 0.070", 0.080", 0.100", Nos. 0 and 1 Phillips, Nos. 4, 6, and 8 Allen wrenches, and an awl. All blades are made of hardened, tempered, nickel-plated tool steel. The set comes complete with a swivel-top, knurled, chuck-type handle for positive gripping. Tools and handle fit neatly in a handy plastic carrying case. Moody Machine

Circle No. 4 on Reader Service Page

BACKGROUND MUSIC UNITS

Two new units designed to make background music both easy and economical for firms to provide have made their appearance as the BM300 receiver and TP160 tuner.

The receiver is a 30-watt, solid-state unit designed to provide high-fidelity FM and AM reception as well as facilities for other music sources and paging. The unit incorporates FET circuitry, ceramic filters, IC's, and interstation muting in the FM section for static-free and interference-free pickup of even the weakest stations. It has inputs for connecting several external sound sources including record player, tape deck, microphone, and intercom paging phones.

For those who already have a p.a. system and merely wish to add background music, the front-end of the RM300 is available separately

as the TP160 tuner. It can also be used in centralized sound consoles. It features push-button band selection as well as push-button FM muting which eliminates interstation noise. Bogen

Circle No. 5 on Reader Service Page

SOLID-STATE STEREO AMP

A solid-state integrated stereo preamp/amplifier featuring 18 transistors, six diodes, and two FET's has recently been introduced as the LA-125B.

Rated at 80 watts per channel, frequency response is 22-20,000 Hz ±1 dB at 1 watt and the power bandwidth is 13-35,000 Hz. Harmonic distortion is less than 1% at rated power output, according to the company.

Controls include front- and rear-panel tape outputs, front-panel headphone output jack, two microphone/musical instrument input jacks, low- and high-frequency filters, and individual bass and treble push-button loudness switches. In addition, the instrument provides a speaker-mode/amplifier-mode control, program-source selector, concentric balance/volume, treble, bass, and tape monitor controls.

Housed in a simulated walnut-grained metal cabinet, the amplifier measures 13" w. × 3⅞" h. × 9 $^{7}/_{32}$" d. Lafayette

Circle No. 6 on Reader Service Page

SECURITY CONTROL

A new electronic master control for security purposes is said to provide wider area coverage and more concentrated protection than ever before. The low-cost solid-state master panel controls various types of detection devices including

radar sensors, ultrasonic sensors, stress sensors, and perimeter sensors. It will also activate any of the standard signaling devices, such as bells, sirens, and automatic phone dialers.

The new Series 110 control features delay circuits to allow the user to leave the guarded premises, an internal rechargeable standby power supply, special anti-tamper circuitry, and a compact housing measuring only 9½" × 9½" × 2⅝" over-all. Detectron Security

Circle No. 7 on Reader Service Page

50-MHz PLUG-IN SCOPE

The new 7403N mainframe, with the 7B53N time base and 7A18 amplifier plug-ins, offers a 6½" CRT, 5-mV dual-trace, delaying-sweep, 2%-accuracy unit plus a third plug-in compartment for future requirements.

Available in either rack-mount or free-standing versions, the scope features three plug-in compartments (2 vertical and one horizontal), a 6½" CRT, and a 8 × 10 div. (1.22 cm/div.) display area providing more viewing area than most other 50-MHz scopes, according to the company.

The instrument features vertical mode switching, trigger-source selection, color-keyed panels, and push-button switches. It weighs only 30 pounds.

The two plug-ins provide 50-MHz bandwidth, 5-mV dual trace, delaying sweep, mixed sweep, and a 5-ns sweep rate. Tektronix

Circle No. 8 on Reader Service Page

RADIO DIRECTION FINDER

The Model 601 solid-state, portable radio direction finder covers the marine beacon, broadcasting, and medium frequency marine band. A functional four-push-button selector permits instant change of operating mode.

The null meter can be used for taking a bearing by the conventional method or the direct reading "steer left/right" homing indicator can be instantly switched for easily steering a course directly to a known navigational aid. A jack is provided on the front panel for earphone operation.

The direction finder comes in a blue and white case with handle and operates from standard flashlight batteries. Illumination is provided for both the slide-rule dial and the homing indicator for nighttime operation. Comco

Circle No. 9 on Reader Service Page

STEREO AMPLIFIERS

Three stereo power amplifiers have recently been added to the company's line of audio components as the Mark IIB, Mark IIIA, and Mark IVB.

These solid-state units feature 12 output transistors and have no driver or output transformers of any kind. Each channel has its own power supply and gain control enabling maximum efficiency from both channels simultaneously. Power output of each channel (r.m.s. per channel at 8 ohms, both channels driven 20 to 20,000 Hz) is: Mark IIIA, 120 watts; Mark IIB 90 watts; and Mark IVB 60 watts.

All three units have a rated r.m.s. harmonic distortion of less than 0.1% for any audio frequency 20-20,000 Hz, IM distortion of less than 0.1%; S/N ratio 100 dB below rated output; damping factor 150+; and stability with any type of load, or no load, including electrostatic speakers.

The units measure 17" wide × 13½" deep × 5¾" high and have brushed gold anodized front panels. SAE

Circle No. 10 on Reader Service Page

PHONE ANSWERING/DIALING

A deluxe telephone answering system using a cassette and a telephone amplifier/dialing instrument have been introduced by Crown Radio Corp. The answering device, called a "valet," is the third of this type of product being marketed by the firm in the U.S.

The valet, Model CTA-4450, answers incoming telephone calls and plays a message in the user's voice, recorded on an endless loop cartridge. The unit then receives and records on a cassette the caller's message, after which it shuts off, ready to take the next call. The caller's recording time can be set for 30, 60, or 90 seconds. It can also function strictly as a telephone answering device whereby the caller is merely given a message, requesting that he call back later.

The Model CAD-8 "auto dial" combines a solid-state automatic dialing system for home and office telephones with extra voice amplification. The unit memorizes up to 24 telephone numbers containing up to 13 digits and automatically dials the number and connects the person called. Once a number is recorded on tape and listed, all the user has to do is select the number (1 to 24) he wants to call, press the Call button, and the unit will start dialing automatically.

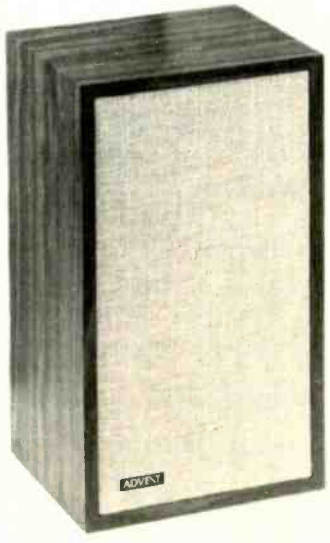
Data sheets giving complete specifications on either or both of these units are available on request. Send your letterhead request to Crown Radio Corp., 228 E. Harris Ave., South San Francisco, Calif. 94080.

SMALL SPEAKER SYSTEM

A small, two-way, acoustic-suspension speaker system which measures 11½" × 20" × 9¼" deep and is housed in a durable vinyl-clad walnut grain cabinet has been put on the market recently.

Nominal impedance is 4 ohms to take advantage of the higher power available at that impedance from most transistor amplifiers and receivers.

A newly designed low-frequency driver uses a low-vacuum drawn cone to drastically reduce cone break-up products, the primary cause of tonal coloration in dynamic speakers. The ¾" dome tweeter with a large "doughnut" roll suspension enables it to handle large amounts of power at midrange frequencies without overload, yet maintain wide dispersion at high frequencies, according to the company.



The system is designed for use with amplifiers and receivers capable of delivering a minimum of 15 watts r.m.s. per channel into 4 ohms. Advent

Circle No. 11 on Reader Service Page

RESISTOR TEST BRIDGE

A high-speed resistor test bridge designed for incoming inspection, quality control, and production sorting of resistors has been introduced as the No. 75-4320.

The bridge has a wide resistance range of 0.1

ohm to 11 megohms, tolerance limits up to ±10% in steps of 0.01%, good resolution, and fast response allowing over 100 tests per second. Power dissipation in the unknown resistance is less than 12 milliwatts.

Since ease of operation is a major feature, in-line digital dials are used for setting both nominal resistance and tolerance limits; no other settings are required and no computations are necessary. Accuracy is ±0.04% and depends on highly stable resistors only. Custom logic and control are available to meet individual tests and sorting applications. Descriptive literature with complete details is available on request. James G. Biddle

Circle No. 12 on Reader Service Page

COMPACT STEREO AMP

The compact Model D-40 stereo power amplifier is designed for custom hi-fi installations or may be used in the home with its accessory walnut enclosure. The amplifier is only 1¾" high without the enclosure.

Specifications include 40 watts per channel

r.m.s. into 4 ohms at 0.05% THD, or 170 watts total (IHF) into 4 ohms. IM distortion is less than 0.3% from $^1/_{100}$th watt to 30 watts at 8 ohms while hum and noise is 100 dB below 30 watts output. Power bandwidth is 5-50,000 Hz ±1 dB and the damping factor is over 200.

According to the company, the unit is completely stable with all speaker loads and has excellent square-wave response and a risetime of 1.5 μs.

Frequency response is 20-20,000 Hz ±1 dB at any level up to 30 watts into 8 ohms and 5-100,000 Hz ±0.5 dB at 1 watt. A brochure with complete specs and performance graphs is available on request. Crown International

Circle No. 13 on Reader Service Page

PORTABLE P.A. CONSOLE

A portable mixing console with a power amplifier delivering 250 watts r.m.s. continuous is now available as the PA-VI. The console has six input channels, internal reverb, and individual volume, high- and low-equalizers with reverb send controls for each channel.

Precise control of the system response is pro-

vided by a master gain control, vu meter, four two-position anti-feedback filters, reverb contour, and reverb send controls. Other features include echo in/out for tape echo, a recording output, and four speaker outputs. A full line of optional speakers designed to be used with the console is also available. Peavey

Circle No. 14 on Reader Service Page

COMPACT SYSTEMS

Three models in a new line of Sony products have just been introduced. Designated the CF-500, CF-610, and CF-620, each model contains a high-performance stereo cassette recorder, AM/stereo-FM radio, a complete stereo control center, and a pair of extended-range speaker systems.

The top of the line is the CF-620 which offers such features as a tape select switch which optimizes performance for both standard cassettes

and the new high-performance chromium dioxide cassettes; straight-line volume and tone controls; sensitive FET AM/stereo-FM tuner; and a walnut grained cabinet. In addition, the CF-620 has magnetic phono, auxiliary, and microphone inputs; a telescopic FM antenna, a Sonymatic recording control, a three-digit tape counter, and a stereo headphone monitor jack. Superscope

Circle No. 15 on Reader Service Page

UNIVERSAL 45 R/MIN ADAPTER

A new patented universal adapter for 45 r/min records is designed to eliminate the inventory and identification problems of retailers and distributors.

Called "Omnidaptor," the new unit will fit more than 90% of all automatic record changers currently in use in the U.S. and Canada. Replacing almost 50 round and flat adapters now on the market, the new round device is fully automatic and employs a gentle dropping motion, according to the company. On some phonographs, it permits a greater number of 45's to be stacked for automatic playing. It is molded of high-impact styrene for durability. Aldshir

Circle No. 16 on Reader Service Page

LOW-COST 3" SCOPE

The Model 536A low-cost, 3" oscilloscope is especially designed for training, inspection, and monitoring applications. The front-panel design is uncluttered, controls are grouped by function

for easy operation, and the 3" CRT face is flat, thus providing a sharp trace.

The vertical amplifier is a.c.-d.c. coupled and fully compensated for optimum response with a sensitivity of 20 mV/cm over a d.c. to 1.5-MHz bandwidth. The sweep-frequency, from 10 Hz to 100 kHz, is in four ranges continuously variable in the respective ranges.

The scope features a three-step attenuator with a variable trimmer, plus a built-in 5% calibrator that stabilizes time and voltage. Solid-state throughout, the unit weighs only 15½ pounds and measures 5½" wide × 7½" high × 14" deep. Made by Kikusui Electronics of Japan, it is available from stock in the U.S. Additional details will be forwarded on request. Marubeni-Iida (America) Inc.

Circle No. 17 on Reader Service Page

MANUFACTURERS' LITERATURE

REPLACEMENT PARTS

A 64-page catalogue listing an extensive line of replacement parts for radio and television receivers is now available for distribution to service technicians, experimenters, and parts distributors.

Catalogue No. 100 includes resistors, fusing devices, circuit breakers, convergence controls, service accessories, electronic chemicals, audio cables, adapters for hi-fi and cassette-type recorders, battery holders, and prototype kit components. Each product is pictured and described and all products are indexed for quick reference. Workman

Circle No. 18 on Reader Service Page

ELECTRONIC WIRING SYSTEMS

Vol. 1, No. 12 of "Innovators for Industry" contains an article entitled "The Electronic Wiring System" by Paul B. Miller which will be of interest to those involved in installing and maintaining MATV and CATV systems.

The article points out potential applications for such systems, discusses the basic components that go to make up such installations, how to calculate losses, and provides a glossary of MATV terms. Belden

Circle No. 19 on Reader Service Page

CARTRIDGE SELECTION

Recently revised literature, designed to assist the audiophile in selecting the proper cartridge for his playback equipment, is now available without charge.

A 16-page booklet details intended applications and provides full technical specifications on the 681 Professional Series and 500 Broadcast Series of magnetic cartridges and replacement styli. A four-page brochure, entitled "A Critique by the Experts," is a reprint of various laboratory tests which have been run on these two models. Stanton

Circle No. 20 on Reader Service Page

SPEAKER SYSTEMS

A four-page brochure which describes in detail a new line of seven speakers for custom hi-fi/stereo systems is now available for the asking.

Systems choices include the five "Futura" packages which range from a single full-range speaker to three-way systems with crossovers. All systems packages include information on dimensions of the cabinets to be used to house the speakers. The individual speakers used in the various systems are also available separately with specifications provided on each model. CTS

Circle No. 21 on Reader Service Page

RELAYS, TIMERS & COUNTERS

An up-to-date reference book featuring a wide selection of timing, counting, and switching devices and controls, available from stock, is now ready for distribution.

The new publication covers magnetic relays; solid-state, electronic, thermal, motor-driven, pneumatic, and spring-driven timers; solid-state temperature controls; photoelectric controls; counting devices; buzzers; and foot switches. The book contains detailed specifications, wiring diagrams, illustrations, and prices. Relay Specialties

Circle No. 22 on Reader Service Page

PHONO-CARTRIDGE DATA

Three brochures which have been designed to help hi-fi enthusiasts find the right cartridge for their particular equipment are currently available.

One, a general product brochure, is a four-page listing of product specifications and data on a complete line of XV-15 and V-15/3 series magnetic cartridges and replacement styli, plus information on the new V-15/Phase IV series of cartridges and styli. The second publication is a fold-out color brochure which illustrates and describes the company's DCF concept and is entitled "Bach, Berlin and Beatles." The third publication is a DCF chart, a guide for stereo enthusiasts in picking the right model XV-15/DCF-rated magnetic cartridge for their playback gear. Pickering

Circle No. 23 on Reader Service Page

PRECISION INSTRUMENTS

A precision instruments catalogue, a 36-page extract from the company's "Buyer's Guide," covers both general-purpose test equipment and special two-way radio test equipment and service aids.

Each of the units listed in Catalogue TIC-3515 is pictured and a complete rundown on specs, controls, and applications provided. The material in the catalogue is indexed for easy reference. Motorola Communications

Circle No. 24 on Reader Service Page

INDUCTORS AND CHOKES

Dale Electronics, Inc., Columbus, Nebraska 68601 has just published a new catalogue showing its expanded line of standard inductors and chokes.

Included in the new publication are complete specifications on the company's new TE Series of encapsulated toroidal inductors. Designed to meet MIL-T-27C, the TE Series features a broad inductance range (50 μH to 4 H) with a high Q and a wide selection of Q vs frequency. Molded inductors include Types IM-2 and IM-4, with inductances ranging from 0.10 μH to 1000 μH.

In addition to standard inductors, the new

catalogue describes a hybrid series-resonant trap combining inductive and capacitive functions. apabilities in custom chokes, bobbins, toroids, .f. transformers and inductors, and variable-itch inductors are also outlined.

A letterhead request addressed to Department 860 of the company will bring a copy of the catalogue.

MOSFET PRODUCT GUIDE

RCA Solid-State Division has published a product guide (MOS-160C) which describes its line of MOS insulated-gate field-effect transistors.

Included in this 20-page publication are data on single-, dual-, and dual-gate-protected MOSFET's, typical circuits utilizing these devices, and background information on MOS construction and applications. Types for military, industrial, and commercial applications are included.

Letterhead requests should be addressed to RCA Commercial Engineering, Harrison, New Jersey 07029. Be sure to specify MOS-160C.

MINIATURE CERAMICS

A 16-page catalogue covering miniature ceramic capacitors is now available from USCC/Centralab.

The catalogue covers a wide variety of sizes and capacitance values in both NPO and W dielectrics: radial and axial lead capacitors in molded, epoxy, and resin-coated cases; chip capacitors; a new line of coaxial feedthrough capacitors and filter-caps; listings for MIL-C-11015 and MIL-C-39014 capacitors as well as characteristic curves for both NPO and W dielectrics and details on tests performed during manufacture and subsequent high-reliability testing.

Letterhead requests addressed to the company at 2151 N. Lincoln St., Burbank, California 91504 will be honored promptly.

POWER SUPPLIES

A six-page supplement to the firm's power-supply catalogue has been printed and is now available for distribution.

The supplement describes newly offered low-voltage logic supplies, constant-current modules, dual-tracking supplies, and a programming interface to relieve grounding problems in systems work. It also describes the company's high-speed line, the JQE-HS group of voltage-agile programmable power supplies. Kepco

Circle No. 25 on Reader Service Page

HIGH-POWER LED's

A 15-page report, CA-131, discussing the technology and uses of high-power gallium-arsenide light-emitting diodes has been announced.

The report details the theory of operation of gallium-arsenide emitters, providing comparison between them and silicon and germanium LED's. It also provides information about device performance characteristics, including specifications on series resistance, forward voltage, optical power, spectral distribution, radiant intensity, and frequency response. Package configuration, specifications, and typical circuits employing gallium-arsenide LED's are shown as well.

To obtain a copy, write on your business letterhead to Texas Instruments Incorporated, Inquiry Answering Service, P.O. Box 5012, M/S 308, Dallas, Texas 75222 and ask for Application Report CA-131.

NICKEL-CADMIUM BATTERIES

A line of high-rate nickel-cadmium storage batteries, ranging in capacities from 8.5 to 570 ampere-hours, is covered in a revised specifications catalogue which is now available from the manufacturer.

A feature of the new 6-page catalogue is its complete data on battery racks, including full information on the four rack configurations available as standards. These racks cover 12-, 24-, 32-, 48-, 125-, and 240-volt systems. Performance data on engine cranking and switchgear rates is also included as well as charging data, performance at various end voltages, dimensional data, and typical applications. NIFE

Circle No. 26 on Reader Service Page

COMMERCIAL SOUND SYSTEMS

A six-page catalogue has been published giving detailed specifications and descriptions of the firm's broad line of commercial sound components and special-purpose sound-system products.

The listing includes amplifiers, tuners, turntables, boosters, mixers, carrying cases, and cabinetry—all designed for p.a. and commercial sound installations. Each unit is pictured with specifications tabulated in easy-to-use form for immediate comparison. Bell P/A

Circle No. 27 on Reader Service Page

CAPACITOR LINE

Miconics Industries, Inc. has just issued two complete catalogues covering the full line of capacitors manufactured by General Instrument and Southern Electronics.

The General Instrument line, covered in a 24-page, 2-color catalogue, includes dipped silver mica capacitors as well as aluminum electrolytic and polyester film capacitors in all sizes. The Southern Electronics line (16-page, 2-color catalogue) features a complete range of MIL-approved ceramics.

For copies of either or both of these catalogues, write Miconics, Dept. C, 135 Eileen Way, Syosset, New York 11791.

V.O.M. DATA

A catalogue sheet on the new 260, Series 6 v.o.m. is now ready and contains complete specifications and ordering information on the unit.

The data sheet outlines the various features of the instrument including external access to the battery and fuse compartment, varistor overload protection, rugged taut-band meter movement, and an optional 5-kV safety probe. The Series 6 is being offered in a number of options, all of which are detailed on the data sheet. Simpson Electric

Circle No. 28 on Reader Service Page

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ELECTRONICS MARKET PLACE

COMMERCIAL RATE: For firms or individuals offering commercial products or services. $1.00 per word (including name and address). Minimum order $10.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance.

READER RATE: For individuals with a personal item to buy or sell. 65¢ per word (including name and address). No minimum! Payment must accompany copy.

GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. All copy subject to publisher's approval. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to: Hal Cymes, ELECTRONICS WORLD, One Park Avenue, New York, New York 10016.

FOR SALE

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Radios, Parts, Picture Catalog 25¢. Meshna, Nahant, Mass. 01908.

CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco-A22, Box 10563, Houston, Texas 77018.

INVESTIGATORS, LATEST ELECTRONIC AIDS. FREE LITERATURE. CLIFTON, 11500-J NW 7th AVE., MIAMI, FLORIDA 33168.

SENCORE, B & K TEST EQUIPMENT UNBELIEVABLE PRICES. FREE CATALOG AND PRICE SHEET. FORDHAM RADIO, 265 EAST 149TH STREET, BRONX, N.Y. 10451.

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

ELECTRONIC PARTS, semiconductors, kits. Free Flyer. Large catalog, $1.00 deposit. Bigelow Electronics, Bluffton, Ohio 45817.

BURGLAR ALARM SYSTEMS and accessories. Controls, bells, sirens, hardware, etc. OMNI GUARD radar intruder detection system, kit form or assembled. Write for free catalog. Microtech Associates, Inc., Box 10147, St. Petersburg, Florida 33733.

HIGH-SENSITIVITY WIDE-BAND AM-FM RCVR

38-1000 MHZ AN/ALR-5: Consists of brand new tuner/converter CV-253/ALR in original factory pack and an exc. used, checked OK & grid main receiver R-444 modified for 120 v, 50/60 hz. Packed with each tuner is the factory inspector's checkout sheet. The one we opened showed **SENSITIVITY:** 1.1 uv at 38.4 mhz, 0.9 at 133 mhz, 5 at 538 mhz, 4½ at 778 mhz, 7 at 1 ghz. With book & pwr-input plug 275.00

30 mHz Panadapter for the above 97.50

R-390/URR Rcvr: Collins xtl-zero-beating, driftless rcvr, grid 100% perfect, w/book 795.00
R-390A/URR has mech. filters, grid. perfect .. 995.00

Hammarlund **SP-600JX** Receiver tunes 540 kHz to 54 MHz continuous, double conversion. 2 uv or better sensit. Xtl & non-xtl Selectivity 500 Hz to 13 kHz. 6 favorite stations can be xtl-selected. Overhauled, aligned, grtd. with book, only 375.00

Regular Power Supply for Command, LM, Etc.

PP-106/U: Metered. Knob-adjustable 90-270 v up to 80 ma dc; also select an AC of 6.3 v 5A, or 12.6 v 2½ A or 28 v 2½ A. With matink output plug & all tech. data. Shpg. wt. 50 lbs. 19.50

BARGAINS WHICH THE ABOVE WILL POWER:

LM-(*) Freq. Meter: .125-20 MHz, .01%, CW or AM, with serial-matched calib. book, data, matink plug. Shipping wt. 16 lbs. 57.50
Same, less calib. book 12.95
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CIRCLE NO. 145 ON READER SERVICE PAGE

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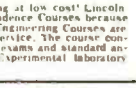

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CIRCLE NO. 129 ON READER SERVICE PAGE

CIRCLE NO. 140 ON READER SERVICE PAGE

CIRCLE NO. 132 ON READER SERVICE PAGE

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