SPECIAL ISSUE: STEREO-HI-FI-AUDIO

75¢ ■ MAR. 1975

Radio-Electronics

34140

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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ALL ABOUT CURVE TRACERS
How They Work
How To Use Them

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56 Of The Latest Models

BATTLE OF THE TAPES
Open Reel vs. Cassette

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Circle 1 on reader service card

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Sylvania's new ECG™ 1000 series gives you over 140 new integrated circuits and modules for imported sets right on your distributor's shelves.

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

MARCH 1975 Vol. 46 No. 3

WHO'S ON TOP? Open reel? Cassette? It's a reel horse race. Get the details in the article starting on page 40.

Cover photo by Walter Herstatt
Cover design by Louis G. Rubsamen

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looking ahead

300,000-set TV recall

Largest television-set recall in history was ordered by the government's Bureau of Radiological Health when it ordered modification of some 300,000 Panasonic, Bradford (W.T. Grant) and Penncrest (J.C. Penney) color sets sold in the last two years to eliminate the possibility of emission of X-rays in excess of government standards. Importer Matsushita Electric Corp. of America at press time was fighting the recall order and said it would submit proof that most of the sets couldn't emit excess radiation in the field even though laboratory tests indicated the possibility existed.

None of the sets involved was found to be actually radiating above the permissible maximum. But in testing some 9-inch Panasonic color sets, the BRH found that when the filter choke was disabled and both user and service controls were maladjusted, the sets could be made to emit radiation nearly triple the limit through the tube's faceplate. This amount of radiation is still only one-tenth the level of natural background radiation. Panasonic agreed to modify the 15,000 sets of this model which were already in the field. BRH later ordered the company to modify all 300,000 sets—with screens up to 25 inches—using similar circuits, because it said Panasonic didn't submit proof that these sets were incapable of radiating in homes. The recall, if it is carried out, could cost as much as $15 million.

RCA VTR postponed

RCA's MagTape SelectaVision—a home VTR deck using ¾-inch tape — has slipped its schedule again. Once planned for 1975 introduction, it now seems to be aimed at 1977 or later, if RCA finally makes the decision to introduce it at all. Nevertheless, RCA is proceeding with development of a new model MagTape deck designed to be simpler and cost less than the first model and to offer two hours recording and playing time in the same book-sized cassette that formerly played for only one. The redesign was based on experience gained in tests in about 100 Indianapolis-area homes. Here's what RCA learned the public wants in a home VTR, based on these consumer-use tests: (1) A stand-alone deck that can be used with any TV set. (2) A built-in tuner, so one program may be recorded while another is viewed off the air. (3) A timer for recording programs unattended. (4) Sufficient recording time on a single cassette—up to two hours—to record a long program without changing cassettes. (5) A retail price of less than $1000.

RCA's tests also showed that the public is more interested in recording programs off the air than in viewing pre-recorded programming, that its developmental recorder worked with any set, but the mechanism was slightly noisy and the controls were a little too stiff and hard to use for most families. It is said that the redesigned unit will meet all criteria uncovered in the home tests.

Still a possibility for 1975 marketing is Sony's projected home VTR deck using ½-inch tape. As in RCA's new MagTape deck, Sony is believed to have doubled the information packing density of its cassette. The Sony unit is expected to be unveiled to dealers this spring, for sales in fall—possibly in conjunction with a home projection TV system.

RCA, meanwhile, is converting 300,000 square feet of one of its Indianapolis plants for engineering and manufacturing of its capacitance videodiscs and videodisc players. The target date for the commercial debut of the videodisc system is still believed to be 1976.

Pilot Radio sold

One of the oldest names in audio, Pilot Radio Co., is the latest to be sold to a Japanese company. Mitsubishi International, a major trading company, is acquiring the hi-fi firm. Controlling interest had been held by National Union Electric Co., which once owned the Emerson and DuMont television receiver operations. Motorola's television business was sold last year to Matsushita Electric Industrial Co., which now manufactures the sets in the U.S. and sells them under the Quasar brand name.

'All-channel radio' dies

Legislation to require including FM tuners in most or all radios manufactured or imported into the United States died with the outgoing Congress, after being passed by the Senate. As originally written, the bill would have required that all radios retailing for $15 or more receive both FM and AM stations. The House Commerce Committee later modified it to apply only to radios sold with new cars. But as the auto sales slumped deepened, automobile manufacturers lobbied behind the scenes, charging that the bill would further increase the price of cars, and it was quietly buried by the House Rules Committee. FM broadcasters say they will attempt to revive it in the new Congress, but it's no longer given much chance, despite endorsement by the FCC.

Shorter warranties

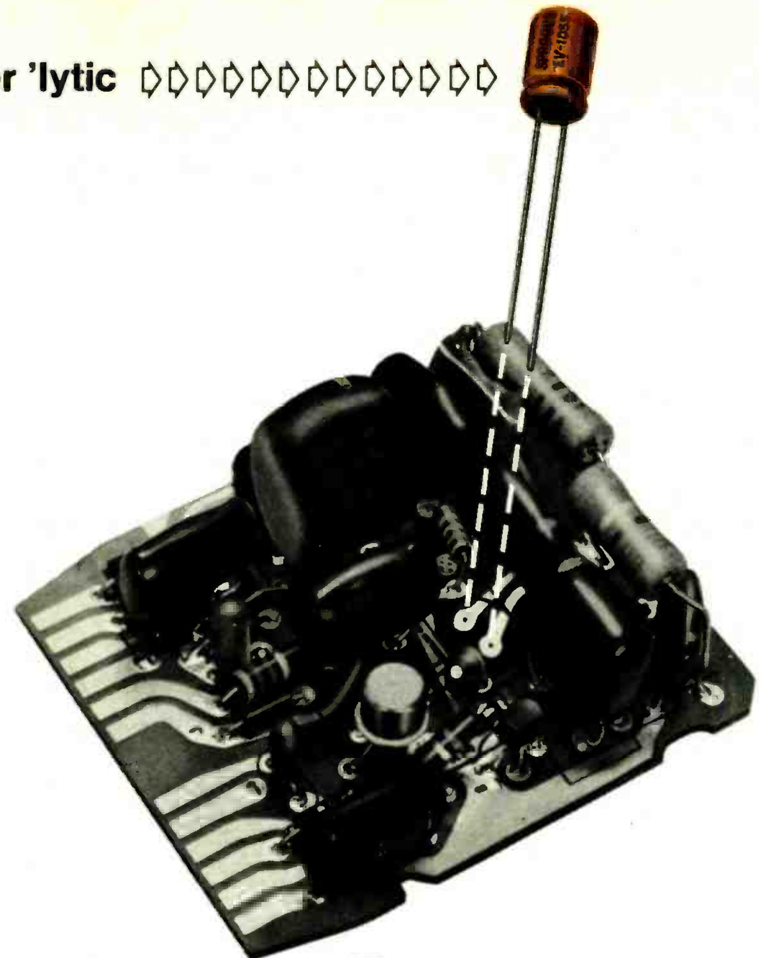
The one-year labor-inclusive television warranty is on the way out, and it now appears likely that the entire television industry will revert to 90 days labor, one year parts and two year picture-tube guarantees with the introduction of new models. RCA, the first to popularize the one-year labor warranty when it added it to solid-state color sets in 1970, has indicated that it will drop this policy when it premieres its 1976 model television sets, and the rest of the industry is almost certain to go along with RCA.

The full-year warranty was originally introduced to dramatize the reliability of solid-state television. Now that more than 85% of color sets being made are all-solid-state, RCA feels the point has been made. The full-year labor warranty has been increasingly unpopular among independent service technicians, whose associations have been applying pressure to have it removed. But the major factor in the demise of the extended warranty has been the rapid inflationary increase in costs. It's estimated that a one-year labor warranty costs a manufacturer as much as $20 more than a 90-day warranty. Thus, by eliminating the longer warranty, manufacturers hope to preclude the necessity of a large price increase which otherwise might be unavoidable this year.

A few manufacturers, led by Sylvania, experimentally returned to 90-day labor on some solid-state color leader models last year without adverse reaction. Zenith indicated it would probably go along with RCA's practice when it announced that its new solid-state black-and-white models to be introduced this spring would revert to 90 days' labor. Admiral, Magnovox and Quasar quickly stated they would go back to the 90-day warranty practice too.

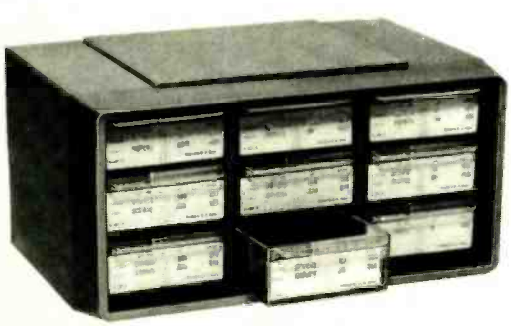
by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Type EV —
the space-saver 'lytic



board room

For space-saving 'lytic capacitor replacements on crowded printed wiring boards found in most of today's foreign and domestic consumer entertainment products, Sprague Type EV Verti-Lytic® Capacitors have the widest range of values . . . in the smallest case sizes . . . of any single-ended capacitors available anywhere!



Get on Board with the KE-17 Assortment

This handy assortment of 61 Type EV Capacitors in the 27 most-popular ratings gives you an on-the-spot inventory of the replacement capacitors you need for most of the sets you'll encounter. Sturdy blue plastic cabinet has nine pre-labeled drawers for fast, easy selection. And you pay for capacitors only . . . the cabinet is yours at no extra cost!

See these "new era" capacitors at your Sprague distributor's. Or, get the full story by writing for Brochure M-951 to: Sprague Products Co., 81 Marshall Street, North Adams, Mass. 01247.

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new & timely

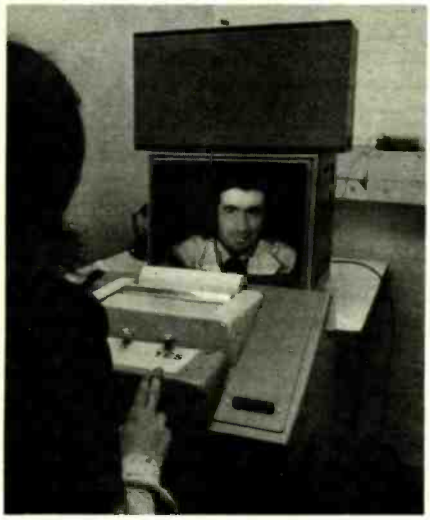
Patient takes own history with "audio-medical" device

A non-computerized audio system recently developed by Westinghouse permits a patient to make out his own medical history with very little instruction.

The new system, *DataQuest I*, uses audio tape cassettes that contain pre-programmed questions. The patient answers each question by pushing an appropriate button. His response determines what question will be asked next. This branching program insures standardized histories with no pertinent question skipped.

PATIENT PUNCHES OUT HIS ANSWER after hearing question from the DataQuest.

An advantage of the audio tape over any visual presentation or printed questionnaire is that nearly any patient—including one who may have reading difficulties or even a language problem—can use the audio history taker. The questions can even be asked in a foreign language, with the print-out in English.



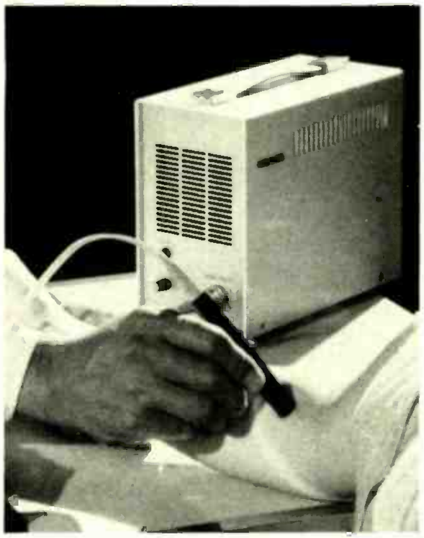
ALL OF THE QUESTIONS ARE ON TAPE, and so is the doctor who is doing the asking.

A system now undergoing tests in England goes even further. The Fulham Chest Clinic of London is experimenting with a taped interview, in which the questions are asked by a "taped" doctor who appears on a display screen ahead of the patient. Answers are given by pressing one of four buttons: yes, no, please repeat and ? (meaning, "I do not understand the question.")

Results so far indicate that a patient is more relaxed alone in a room with a doctor known to be "on tape," and is likely to give more complete, detailed and truthful answers than in a first interview with a "live" doctor, in which he is usually under greater psychological stress.

Blood-circulation indicator works on Doppler principle

Ultrasonic waves reflected from the blood flowing in veins, arteries or other blood vessels supply information on what is going on in a human circulatory system, in a new instrument developed by the Siemens Co. (Germany).



THE ULTRASONIC VESSEL INDICATOR checks the blood flow in a patient's arm vein.

The ultrasonic vessel indicator, as it is called by its developer, consists of an unltrasonic transmitter and receiver housed in a cigar-shaped probe, which is applied under slight pressure to the skin above the vessel to be examined. Ultrasonic waves emitted by the transmitter are reflected by the blood streaming through the vessels. Because of the Doppler effect, their frequency is varied by the speed and direction of the blood flowing through the vessels, and can be heterodyned to produce an audible signal in a loudspeaker. By noting the pitch of the note, the physician can judge the speed of the blood flow and note functional disorders or incompetence of the venous blood valves.

The signal can be displayed as an ultrasonic tone pattern on an oscilloscope, in addition to or instead of as an audible note. A magnetic tape recorder or a strip chart can also be connected to the ultrasonic vessel indicator.

Liquid crystals enable scientists to see pulses flow through IC's

A simple technique for observing electron pulses flowing through a tiny intergrated circuit with an ordinary optical microscope has been developed by two RCA scientists, Dr. Donald J. Channin and Gerald E. Nostrand. The technique consists of coating the IC with normally clear liquid crystal, which refracts light when stimulated by electricity.

Before applying the crystal, a surfactant, which causes the rod-like molecules of the crystal to align in the same direction, is placed on the surface of the IC. Then a drop of nematic liquid crystal is put on, and a thin glass cover plate placed over the crystal, like a contact lens on an eyeball.

When electron pulses travel through the IC, the electric fields they create rotate the molecules near them, changing the crystal's index of refraction in those areas.

The IC is placed in a conventional microscope and illuminated by light passed through a set of polarizers so arranged that normally none of the light reaches the microscope eyepiece. But when electricity passes through the IC, the refractive index change in the crystal caused by the electric fields allows light to pass through the polarizers, and the viewer gets a live picture of the pulses or signals flowing through the IC.

Mask defects and metallization failures are quickly spotted by this technique. "Hot spots," such as might be caused by shorts, show up in the microscope as bright areas. The technique can be used to investigate more subtle problems. For example, an IC can be examined with and without load, to determine what the loading does to the timing of the device. **R-E**

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Now you can get General Tires for auto or truck–FREE–with your purchase of RCA Entertainment Receiving Tubes from your participating RCA Tube Distributor.

Take your choice of any of these famous General Tire Co. Tires: Jet Air III, Dual Steel Radial, Belted Jumbo 780, and Sprint Jet. It's as easy as 1, 2, 3 . . .

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3. Redeem your certificates by mail according to instructions on certificate, for a purchase order you can take to your nearest General Tire Dealer and have your tires installed at no charge.

See your participating RCA Tube Distributor today for all the details and get "MORE MILEAGE WITH RCA." Certificates are redeemable thru September 30, 1975.

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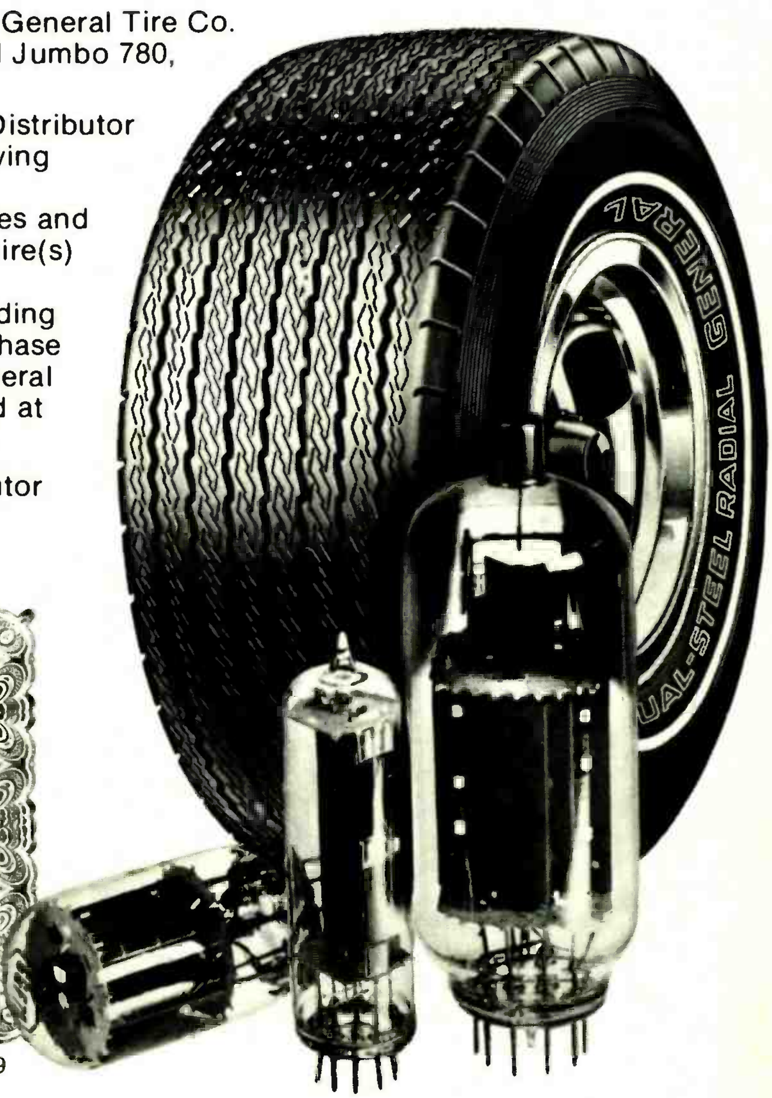

RCA Electronic Components

Compare what you get training and you'll

Compare costs

Only NRI offers complete TV/Audio Servicing Courses from $312 to $1,095 . . . with convenient, inexpensive time payment plans. In the Master Course in color TV servicing, with a 25" diagonal solid-state color TV, you save as much as $650 under the next leading home study school.

NRI saves you money because our costs are lower. We pay no salesmen, and we design our own kits and equipment. We don't buy "hobby kits" from others. Nor do we penalize you with big interest charges for time payments. We pass the savings on to you.

Compare training

NRI is one of the few home study schools that maintains its own full-time staff of technical writers, editors, illustrators, development engineers and publications experts. The people who design the kits also design the lessons . . . so that theory and practice go hand in hand. The lessons aren't "retro-fitted" to an outside-source "hobby kit". The NRI set is designed exclusively for training. The fact that it is also a superb receiver for your personal use is an added plus.

Compare choices

Most schools offer one course in color TV servicing, period. Only NRI offers you five different courses to match your needs and budget. The 65-lesson basic course, complete with 7 kits, costs as little as $312. Or you can step up to a $425 course that includes a 12" diagonal black & white portable TV for hands-on experience. Then there's the 19" diagonal solid-state color TV course for $695; the advanced color TV course for trained technicians with an 18" diagonal color TV for $535; and finally, the magnificent 25" diagonal solid-state color TV course, complete with console cabinet, oscilloscope, TV pattern generator, and a 3½ digit digital multimeter, for $1,095. Other schools charge you hundreds of dollars more for an equivalent course.

in TV/Audio home choose NRI.

Compare equipment

NRI has engineered the widest variety of professional electronic lab equipment ever designed entirely for training at home. When you enroll in the Master Course in TV/Audio Servicing, for instance, you receive kits to build a wide band, solid-state, triggered sweep, service type 5" Oscilloscope; color pattern generator; solid-state radio; and a digital multimeter.

Before you settle on any home training course, compare the over-all program. See if you are getting kits engineered for experimentation and training . . . or merely "hobby kits". Count the experiments . . . compare the components. Don't just count kits. (Some schools even call a slide rule a kit.)

Compare schools

Home study isn't a sideline with NRI. We've been its innovating leader for 60 years. Ask any of the hundreds of thousands of NRI graduates. They'll tell you . . . you can pay more but you can't buy better training.

Along with each course, NRI provides bite-size, fully-illustrated lessons; personally graded tests; and the kind of person-to-person teaching that makes learning easier and faster.

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appliance clinic

SMOKE AND FIRE DETECTION

by JACK DARR
SERVICE EDITOR

HOME "PROTECTION" SYSTEMS HAVE become very popular of late, especially with intrusion and burglar alarm systems. Home fire alarm systems have also become quite popular. There are three main types: smoke detectors, that go off when smoke interrupts a beam of light, etc.; flame sensing systems, which detect the light or infra-red from the flame; and thermal detectors, which are actuated when the temperature goes above a preset level.

We've just received data on a new and more sophisticated system for the detection of smoke, flame or fire. This is the Guardion Model R1-X made by the Pyr-A-Larm Co., 8 Ridgedale Ave., Cedar Knolls, NJ 07927.

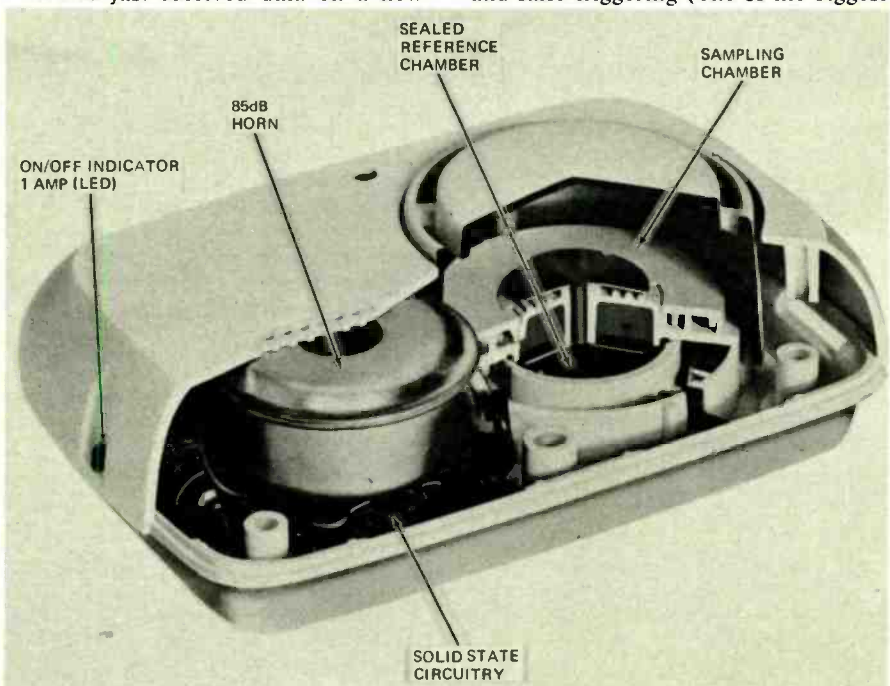

Figure 1 is a cutaway view of the unit. It's housed in a compact plastic case, and powered by a low-voltage (24-volt) supply. At the left is the small but loud horn, the warning device. It delivers more than 85 dB of sound, loud.

At the right of the picture is the sensing device; this is a new application of a well-known principle of ion detection. A source of alpha rays (Helium nuclei) is placed in a chamber with two charged plates. The ions liberated flow to these oppositely-charged plates, creating a minute but measurable flow of current. If a fire is *about* to start, the invisible combustion-products reach the outer sensing chamber. Here, they impede the normal flow of ions which maintains a balance against another, sealed reference chamber.

This reduces the ion-flow, and raises the voltage between the charged plates. This triggers a FET amplifier stage, and the alarm sounds. The sealed chamber serves as a reference, to compensate for changes in humidity, temperature and atmospheric pressure, which could otherwise cause instability and false-triggering (one of the biggest headaches in home alarm systems!) It also gives this unit a very high sensitivity, giving an alarm before a fire has had a chance to reach great proportions. This provides an invaluable "early warning," giving added time for escape and/or putting the fire out.

A pilot light on the case shows that power is on. This unit is very easy to check, and the maker recommends that this be done at least once a month. Test is very simple; just blow smoke through it from a cigarette. For non-smokers, light a strip of paper and blow this through the unit. It will go off. To stop it, blow clean air through it. Another good suggestion in the manual advises that the neighbors be told of these tests, so that they can recognize the characteristic sound of the alarm. **R-E**

Radio Shack FIRST!

New Realistic Microphone with Switchable REVERB

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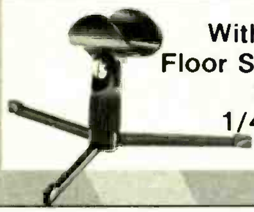

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2995

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Now you can create studio-type audio effects at the flick of a microphone switch—as you talk, sing or play. No special, expensive equipment is required. The Realistic® reverb mike has *dual* dynamic elements that produce a 1.5-second time delay for the echo effect. And you get a wide 50-10,000 Hz response in both reverb and normal modes. It's "the" mike for vocalists, musicians, standup comedians, all kinds of recording and public address work. In the normal mode you've got a high-quality omnidirectional, dynamic mike for everyday use, too. Lightweight non-reflective housing, Reverb In-Out switch, 200 ohms impedance, −80 dB output level. Fully self contained, no batteries required. 8" long x 1½" diameter. Fitted vinyl carrying case included. #33-1049. There's only one place you can find it . . . Radio Shack!

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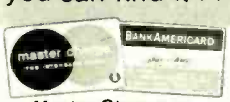

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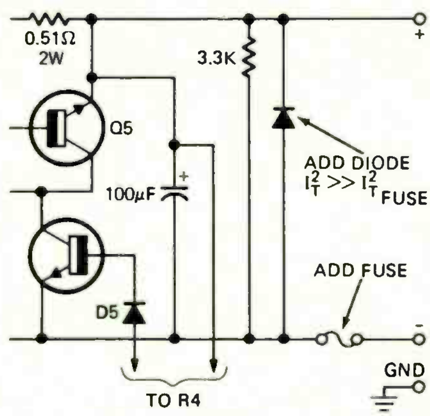
letters

HEATHKIT IP-18 POWER SUPPLY

May I take a few minutes of your time to suggest an alternative protective method to apply to the Heathkit IP-18



regulated power supply rather than the one proposed by Mr. Donald R. Hicke on page 49 of your September 1974 issue.

Mr. Hicke's method degrades the regulation of the power supply by adding the non-linear series impedance of a silicon diode. In addition, the regulated power supply impedance is drastically altered by adding a unidirectional element in the output path.

May I recommend the following circuit . . .

The fuse rating (amperes) should be sized in accordance with the continuous dc-rated output of the supply and the diode rating should allow the fuse to blow without damage to the protective diode itself.

RICHARD P. JOHNSON
Hingham, MA

DEAD CAR BATTERY

Your columns are usually very informative and interesting and I assure you I read them all.

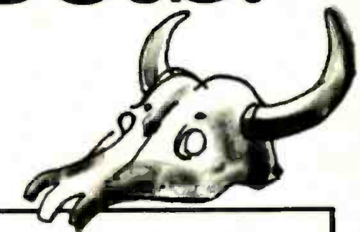
I must, however, take exception to a statement you make in your article on "Using the VOM Around the Car" that appeared in the September 1974 issue.

(continued on page 16)

WANTED:

Old Photofact® Sets!

We pay 50c each for old Photofact sets on our new Photofact Trade-in Program (TIP)!



Now, old Photofact® sets that you no longer need or use are worth 50¢ each on a trade-in for new sets! Here's your chance to update your servicing library with new Photofact sets that better answer your present-day servicing needs—and do it at a handsome saving. The TIP deal is this:

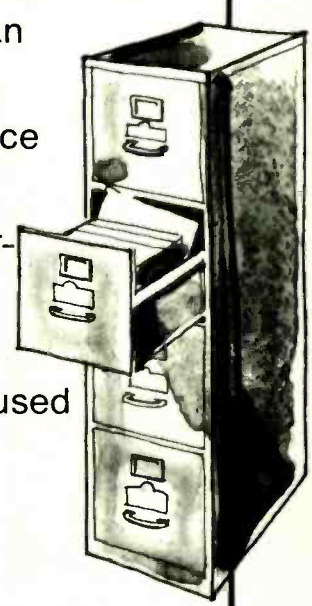
You must buy at least 60 new sets at one time.

We'll give you a trade-in credit of 50¢ per set for up to 200 new sets bought, but you cannot trade in more sets than you purchase.

Thus, every old set you trade in reduces the price of a new Photofact set by 50¢!

In addition, TIP offers still another money-saver—an order for 200 sets qualifies you to buy a 4-drawer Photofact metal file cabinet ($62 value) for only $35!

So dig out those dust covered sets you haven't used for years—call your Photofact distributor for details—and let's trade!



HOWARD W. SAMS & CO., INC.
4300 West 62nd Street, Indianapolis, Indiana 46206

Circle 9 on reader service card

LETTERS

(continued from page 14)

With regard to using jumper cables, you say "Start the engine of the helper car. Now try to start the engine of the dead one."

I suggest you check this out with someone who understands automotive electrical systems. My understanding was that under no circumstance should the helper car be started since the sudden demand of current by a nearly dead battery coupled with that of the starter could cause voltage regulator damage such as welded contacts or shorted components in solid-state regulators.

Keep up the columns. I find the majority of questions are interesting, although some people seem to get stuck on very simple problems. Still, they may be new at the game and the problems might not be simple to them.

ELMER STANDISH
Courtenay, B.C.
Canada

Thank you for the kind words and also for the criticism! These are appreciated! They keep us on our toes. However, in this case, I am going to differ with you mildly.

I have been working on and with cars for many years. I've rebuilt two MG's (one A and the previous B) from the ground up and I do most of my own mechanical work (and only three days ago, I had to start my wife's car with this same system!)

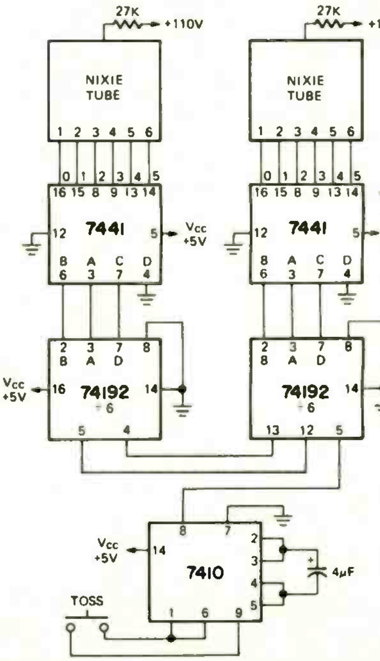
Seriously, this is the method used by all of the professional mechanics that I know. There is a reason. By starting the helper car's engine, you let its generating system carry the high load imposed upon it by the starter of the dead car. If you'll check this out, I think you will find that there is very little if any surge; note that even with an almost completely dead battery, there is very little arcing when the jumper cables are hooked up! I've never taken the trouble to actually read this with an ammeter, but I have started hundreds of cars with this system and so far never run into any problems.

Thanks very much for writing and I hope this will be a little help; good luck!

JACK DARR
Service Editor

ELECTRONIC DICE

This is my version of Electronic Dice. I wired the 0 thru 5 output of the 7441 IC to the 1 thru 6 of the Nixie tube so it will read 1 thru 6 randomly. I could have used some other IC such as the



7490, but the 74192 is what I had available. If a slower rate of toss is desired, the 4-μF capacitor can be made larger.

J. R. SMITH
Greenfield, WI

ELECTRIC BASS

Here is a project I believe should be of interest to some readers.

When you play a note on an acoustical bass, the note begins almost immediately to die out. (This is speaking of a plucked note, of course). But when you play a note on an electric bass, the note sustains itself quite a time. It does fade before you cut it off, but not nearly as fast as does a note plucked on an acoustical bass.

Electric bass notes are OK for rock bands, but not so good for jazz. It is very difficult to imitate an acoustical

(continued on page 18)

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Specifications

Functions:
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2 logarithmic
6 trigonometric

Keyboard:
18 key format with 4 "triple-action" function keys using standard, upper and lower case operation.

Display:
5-digit mantissa
2-digit exponent
(both signable)

Exponent:
200-decade range, from 10^{-99} to 10^{+99}

Logic:
Reverse Polish, with post-fixed operators for full flow chain calculations.

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Battery operated with 4 inexpensive AAA penlight batteries, providing over 25 hours of use.

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4⅜" high;
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LETTERS

(continued from page 16)

bass sound on an electric bass. I should think there are quite a few electric bass players who face this problem. So far as I know, however, no one has put on the market a device that would help.

The problem is to design a circuit that will cause an electric bass note to begin to decay almost immediately. The rate of the loss of volume should be adjustable. Since the "decay curve" of an acoustical bass note is probably not linear (there is probably a very rapid drop followed by a somewhat slower drop), it would be desirable to be able to adjust what I suppose is called the contour of the volume drop.

Maybe such circuits exist in connection with synthetic music devices. If so, I wonder how they could be adapted for use with an electrtic bass? The circuit should be battery-powered. It could go between the electric bass and the amplifier input or (in some cases) between the preamplifier and the amplifier. Both solid-state and tube amplifiers would be involved.

CARL HARTMAN
Newport Beach, CA

MATV, CATV AND GHOSTS

The article on the Winegard CTS-1 in your September issue was very interesting. From what I could get from the writer's article, he lives on Long Island and also has cable TV as I do. I noticed he has the same problem with "casper" that I had. The writer stated that the cables were radiating. This I find very hard to believe. In my years of experience, I have yet to see a "drop" cable radiate and cause casper unless, of course, the cable is cut or open. In my home I have CTS-1's hooked to three different TV feeder cables in a way that if the CATV goes out, a stronger signal seeking relay throws the three CTS-1's over to MATV. When I first installed this system a few months ago, I also had a "casper." I found two things wrong. First of all, one CTS-1 had a shorted MATV input. The second problem I found was that the CATV signal was too strong for the CTS-1 to handle and the switch was leaking over to the MATV side. A 6-dB pad fixed this problem very well. The writer did not say if he tried terminating the CATV and running a direct line from the MATV amp to the set. If this was done and "casper" was still there, I would suspect the CATV feeder on the road to have a leak somewhere. A fairly good way to find this out is from your neighbors. If they also have "casper" with their antenna, check their channel 6 and if a CATV program is trying to come in, call the CATV company and report the radiation.

In the same issue of **Radio-Electronics**, you wrote a very good article on *New Opportunities in Electronics*. I have a few points to add to the section on MATV. First of all, installing a few houses with a "home" MATV system does not make you qualified to bid on a very complex professional system in a motel or school.

On the section about sub-contracting for CATV, this is fine if that's all you want to do. There are "conflict of interest" laws that prevent "TV service men" from doing CATV work. The reason is that the installer could very well install the CATV in such a way the customer would still have a poor picture. The customer at this time would be very easy to convince his set is bad and tell the installer to take it out. Then all the installer would have to do is correct the CATV and bring the set back and "bingo" the installer had god knows how much written on the bill and get paid for doing nothing.

When I was an assistant engineer for a CATV company, I fired a technician for doing just that type of thing.

A few final points. You don't need a cherry picker to do CATV work, a good 30-foot fiber glass ladder will do.

I'd add an area I have found to be very profitable. It is car rewiring. You would be surprised how many body shops "farm" this type of work out. My best customer besides body shops is the local car rental companies. They have quite a few radios quit or "borrowed" by the customers or the customers will even take out some of the wires if they have the same type of car that was damaged by fire or something.

In closing, I wish to say that overall you have a very fine magazine. Keep up the good work.

JAY GOLDEN
Northport Communications
East Northport, NY

Thank you! **R-E**

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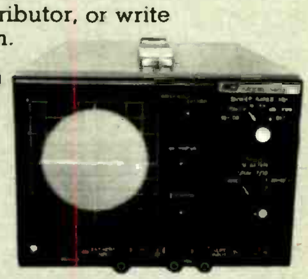

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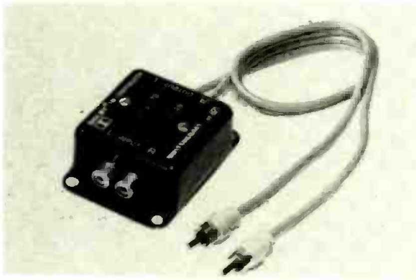
equipment reports

Switchcraft 621 Dolby FM Compensator



Circle 104 on reader service card

SINCE THE ANNOUNCEMENT BY THE FCC early last summer that FM stations may, at their option, change their pre-emphasis characteristics from 75-μs to 25-μs when using Dolby noise reduction systems, more than 30 FM broadcasters have either begun or expect to begin such broadcasts around the country. Those unfamiliar with the advantages to be gained by employing this lower value of pre-emphasis (and a corresponding de-emphasis at the receiving end) will find the subject discussed in detail in an earlier issue of **Radio-Electronics** (October, 1974). In that article, it was pointed out that even if you owned a separate Dolby noise reduction unit or had one already built into a high-fidelity tuner or receiver, you would *not* be able to avail yourself of the new Dolby sound (with its greater dynamic range capability and potentially lower background noise level) unless you modified the de-emphasis network presently incorporated in your tuner or receiver.

Many readers will no doubt be reluctant to tamper with even this relatively simple portion of the FM circuitry, while others may find that the existing de-emphsis network in their sets is part of a more complex filter, often encapsulated and inaccessible for modification. Realizing this, Switchcraft has introduced another "little black box", called the Dolby FM Compensator model 621. The little device retails for $12.95. Outputs from your tuner (left and right) are simply connected to the inputs of the device, while the outputs of the compensator go onto the usual amplifier.

In the absence of Dolby broadcasts, stations are still required to maintain conventional 75-μs pre-emphasis, and so a slide switch on the front of the compensator has positions for 75-μs and 25-μs de-emphasis. The response required for 75-μs de-emphasis is plotted in Fig. 1.

The Switchcraft device corrects this problem even though it is a totally passive circuit, with no stages of gain built-in. The simple circuit diagram is shown in Fig. 2. With the slide switch in the 75 position, the device introduces an insertion loss of exactly 10-dB because of the voltage divider action of R1-R2 (or R3-R4 in the alternate channel). Thus, in using the device, you will find that you will have

(turn page)

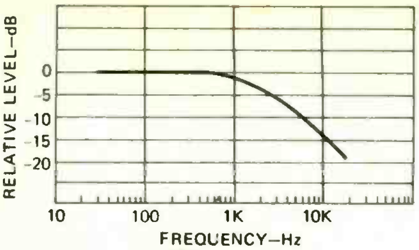


FIG. 1

to raise the volume control setting on your amplifier or receiver to compensate for this insertion loss. Most hi-fi components have plenty of extra gain available so that this will not pose a problem. Referring to Fig. 3, you

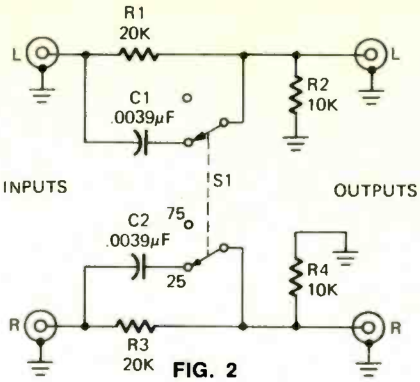


FIG. 2

will note that when the switch is thrown to the 25 position, a small capacitor (C1 or C2) shunts series resistor R1 and R3. The response of each output is as shown—rising with increasing frequency above about 1-kHz.

Now, consider the response curves shown in Fig. 4. Your tuner or receiver has a response (including the 75 microsecond de-emphasis) as

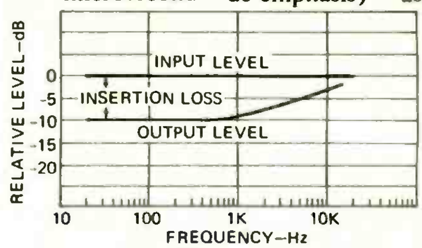


FIG. 3

shown in curve-b. If we arithmetically add the response of the compensator (when it is switched to the 25 position) curve-a to the existing tuner response curve, the net output response will be that of curve-c. Note that this net response has a turnover point which is almost exactly three octaves higher than that of the original 75-μs de-emphasis curve. In other words, it corresponds to a time constant of 25-μs, as required by the new Dolby format.

It should be pointed out, of course, that merely attaching the Switchcraft device to your existing tuner or receiver will not provide you with Dolby decoding. For that, you need a full outboard Dolby box or one built in to your existing equipment. In fact, Dolby has suggested that one of the reasons for the change to 25-μs is so that listeners **NOT** equipped with Dolby decoding will hear Dolbyized

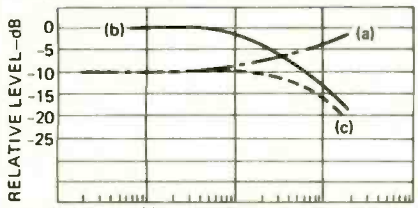


FIG. 4

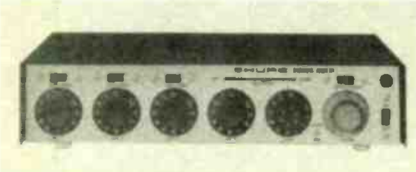
broadcasts with less treble shrillness than had been the case prior to this change. Although they won't be able to take advantage of the noise reduction capability built into the system, they will hear programs that are more nearly correctly balanced from a tonal compensation point of view *without* altering their existing 75-μs de-emphasis characteristic built into their tuners and receivers.

Shure M688 Stereo Mixer

NINE SINGLE-TRANSISTOR AMPLIFIER stages are combined in the M688

(turn page)

Stereo Microphone Mixer to merge up to four microphone inputs plus left and right channel high level auxiliary inputs to left and right stereo outputs. With its six front panel gain controls, two of which are dual concentrics, the mixer can flexibly handle



Circle 105 on reader service card

2 stereo or 4 monophonic inputs in tape recorder and amplifier-speaker applications.

Each of the four microphone inputs uses 3-pin professional audio connectors and feeds either the primary or secondary of an input transformer as selected by rear slide switches. One of the two terminations will be the right impedance to interface with most dynamic, ribbon and capacitor microphones. Shure does not recommend the use of ceramic and crystal microphones with the mixer. Input impedances were measured to be 500 ohms and 100,000 ohms on the low and high ranges respectively at 1-kHz. Input clipping levels were 3.5-mV and 48-mV at low and high impedances measured directly at the input connector.

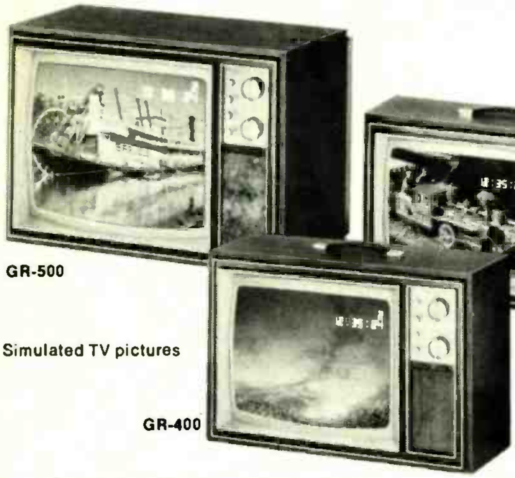
Preamp outputs are matrixed to the MIX BUS through series bridging resistors. Any of the first three channels can be opted to be either left or right channels by front panel slide switches. Channel 4 forgoes the switch and uses a PAN sliding potentiometer for placing the source anywhere between the left and right channels. An additional amplifier stage is inserted in the channel 4 signal path to compensate for the higher losses of the panaromic matrixing. Microphone 4 is particularly convenient for locating a vocal source wherever the operator desires. The left and right buses are connected directly to MIX BUS phono jacks which allow paralleling of additional microphone mixers to expand the number of input channels. These buses can also be mixed with left and right auxiliary inputs through dual concentric controls. High level, high impedance inputs from tape recorders, tuners, or phono preamps connect to the M688 through these two phono jacks.

Having been resolved into the left and right buses, the signals feed respective mix amplifiers with master gain controls at their outputs. As with the auxiliary control, the concentric pots can be displaced with respect to each other for relative adjustment of the directional sources. At this point the two stereo channels can be interconnected by a STEREO-MONO switch physically located above the master gain control.

Two output amplifiers are fed from the master gain controls. By adding equal signals from the emitters of both amplifiers, a monophonic L + R microphone output is formed with a switchable low output impedance of 25-600 ohms, or a high output impedance of 20,000 ohms. This output uses a professional 3-pin male connector. The higher voltage gain transistor collectors of the output stages are the main mixer outputs. The output voltages are in the 0.1 to 2 volt range and will drive preamps, power amplifiers, tape recorders or high level tuner inputs at impedance levels of 50,000 ohms or greater.

Overall voltage gain of the system from a high impedance microphone input to the auxiliary output was measured at 36-dB. Switching the input to a low impedance adds 23-dB because of the voltage stepup of the input matching transformer. Frequency response was down 3.5-dB at 20-Hz and 3.0-dB at 20-kHz. It was within Shure's spec of ± 3-dB from 40 to 20,000 Hz. From the Mix Bus to the auxiliary outputs the gain was 35-dB. The total harmonic distortion was below 0.5% from 20 to 20,000 Hz. **R-E**

15 exciting new projects for '75



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15, 17 & 19" (diagonal) Color TVs with On-Screen Digital Readout

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As much fun to build as it is to use. It's battery operated for complete portability. Built-in speaker, adjustable tone & volume, headphone jack. With key. Less battery.

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NEW Solid-State Dip Meter

Fully portable, fits in your hand. Covers 1.6 to 250 MHz in fundamentals. MOS-FET paraphrase amp, hot-carrier diodes, Q-multiplier. With case, 7 plug-in coils. Less battery.

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NEW Windshield Wiper Delay

Provides exactly the wiper speed you need for safe driving in any weather, from light mist to heavy rain. Works with most 12 VDC positive or negative ground cars.

Kit CH-1068 .... 14.95*

This FM Tuner Costs $2500!

by LEN FELDMAN

CONTRIBUTING
HIGH-FIDELITY EDITOR

THE LONG AWAITED SEQUERRA MODEL 1 FM Tuner is now in production. Anyone who attended one or more hi-fi shows over the last two or three years will recognize that name, because Richard Sequerra has been displaying prototypes of this tuner for at least that long. Like many other perfectionists, Mr. Sequerra delayed actual production of his masterpiece until he was satisfied that he had achieved the last ounce of performance from the tuner consistent with the present state of the art. Advances in that state of the art, coupled with rising production costs generally, have witnessed a succession of price increases. What was initially projected as a $1600.00 retail price tag has risen steadily. As of this writing, the Model 1 tuner can be purchased for $2500.00! A less expensive version — minus the panoramic analyzer display—can be had for $500.00 less, but to date, all units made and ordered have included this unusual display. When you learn what the display does, you'll appreciate why Sequerra's first production runs have all been of the higher priced version.

Circuit description

Before beginning our discussion, we thought it might be interesting to learn something about the number of major components which are used in the assembly of the tuner. In interviewing Dick Sequerra, we were handed a list which is headed with the following notation: "This is an approximate count of some components in the Sequerra tuner." We suspect that the word approximate is a bit of a put-on because the people at the Sequerra Company, in addition to being highly skilled as engineers, have a keen sense of humor and enjoy their work tremendously. Anyway, here's the list:

14—Field-effect transistors
61—Integrated circuits
75—Transistors
83—Diodes
10—Varactor diodes
2—Light Emitting Diodes (LED's)
1—Photo transistor
4—Read-out Chips
30—Incandescent lamps
2—Neon Lamps
40—Pot cores (variable inductors)
37—Potentiometers

The list also points out that there are some *93 adjustments* made during the assembly and final testing of the Model 1 tuner!

The product itself, shown at the top of this page, looks like no other tuner ever made before. A single tuning knob is located below the digital frequency display, which reads in tenths of a megahertz. Six buttons at the left determine what will be displayed on the 4½-inch flat-face instrument-quality oscilloscope, actuate the built-in Dolby noise-reduction circuitry and select maximum stereo FM separation or "high blend" for reduced noise in cases of weak-signal reception. The first button relating to the scope display selects the panoramic display (in which a panoramic view of all signals located 1 MHz above and below the tuned-to frequency appears as vertical "pips" on the scope face). The next button selects circuitry which displays carrier deviation and signal strength of the tuned signal. Signal strength is directly readable over a range of some 90-dB, from a few microvolts to a volt. The third button creates a center-origin X-Y display which can be used to check separation and phase characteristics of a stereo program, while the fourth button permits you to display external audio programming (via input jacks on the rear panel) from monophonic, to stereo, to quadraphonic. Typical patterns observed in the Panoramic display mode are illustrated in Fig. 1. Displays that might be observed when the tuning-display push button is depressed are shown in Fig. 2. Examples of mono and stereo displays observed while the third push-button is depressed are shown in Fig. 3.

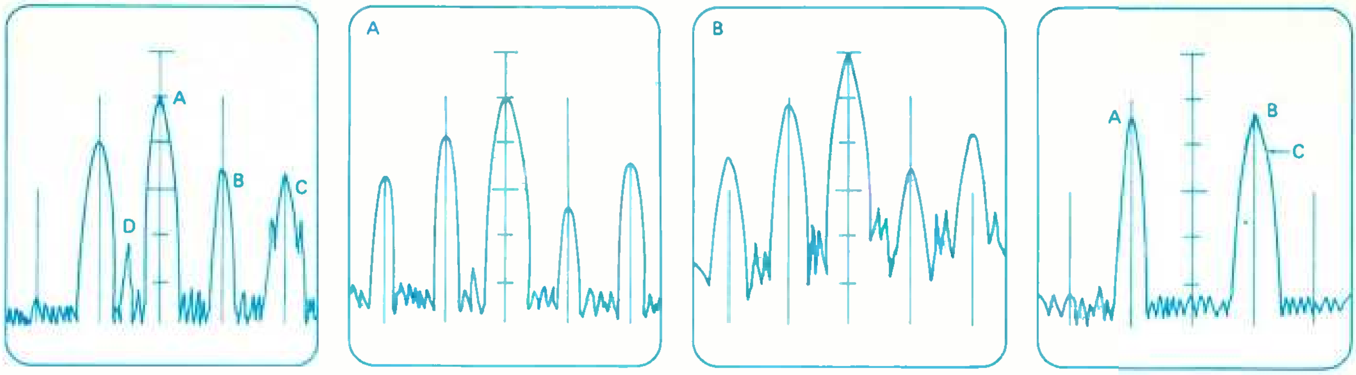
The three uppermost buttons at the right take care of mute defeat, interstation muting of noise, and muting of all but stereo transmissions. The fourth button selects mono or automatic stereo/mono switching. The fifth button provides two degrees of lighting intensity for the front panel illumination, while the last button is the power on/off switch.

The rear panel contains customer adjustments for the scope display, 75-ohm and 300-ohm antenna terminals, two pairs of output jacks (one pair equipped with output level controls), a detector output jack, the four external display input jacks, a remote-control adaptor socket, and a shorting jack which permits changing the de-emphasis from 75-microseconds to 25-microseconds when listening to newly approved Dolby FM transmissions. Sequerra foresaw the need for this refinement well in advance of the recent FCC action which permits Dolby broadcasting using the modified de-emphasis characteristics.

The front end

Because it is the first of its kind, we thought readers would be interested in seeing a complete schematic diagram of the critical front-end of the tuner. Referring to Fig. 4, the front-end consists of an input balun that feeds a two-pole filter in the form of the push-pull antenna transformer into a low noise FET cascode rf amplifier. A second push-pull grounded-gate rf amplifier feeds a push-pull FET balanced mixer. The front-end is varactor tuned, using twin pairs of MV-104 varactor diodes. Normally, varactor diodes used in such applications are voltage tuned over a range of from 4.0 volts to over 30 volts. As shown in the curve of Fig. 5, however, while substantial capacitance is obtained at the low-voltage end of this range, the curve is extremely non-linear at this region and the effective Q of the device is lowered as the capacitance increases. For this reason, Sequerra uses pairs of varactors in parallel, and is therefore able to operate over a voltage range of from 7.4 volts (where Q is higher and

DESCRIPTION OF



A. TUNED IN STATION ON CENTER FREQUENCY.
B. ALTERNATE STATION 400 kHz OFF CENTER FREQUENCY.
C. ALTERNATE STATION 800 kHz OFF CENTER FREQUENCY.
NOTE: 3-POINTED PIP INDICATES STATION SIMULTANEOUSLY BROADCASTING SCA.
D. ADJACENT STATION 200 kHz OFF CENTER FREQUENCY.

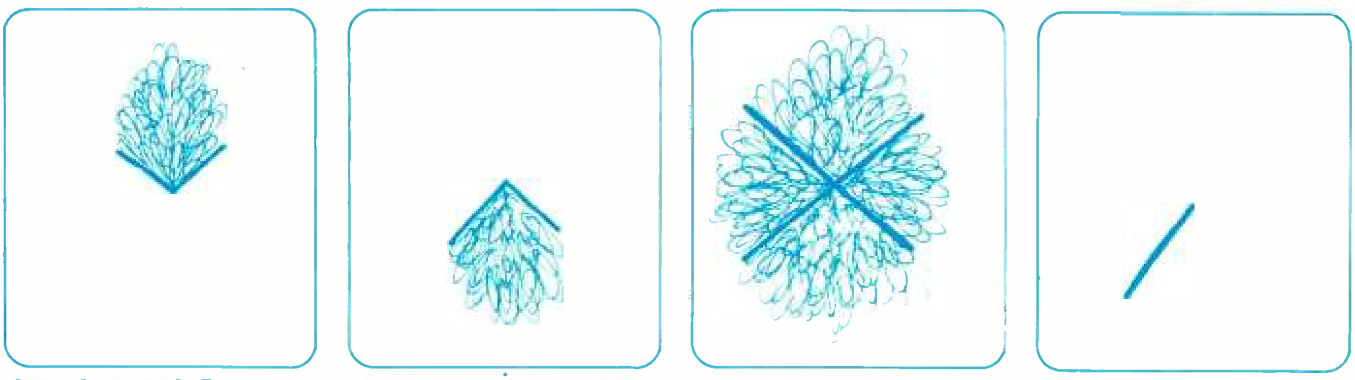
SAME BROADCAST RECEIVED BY 2 DIFFERENT ANTENNA SYSTEMS.
A. RABBIT EAR FM ANTENNA.
B. OUTDOOR ROOF ANTENNA (NOTE OVERLOAD). THIS WAS CLOSE LINE-OF-SIGHT DEVELOPING 0.3V INPUT TO TUNER.

2 STATIONS WITH SAME SIGNAL STRENGTH
A. MONAURAL
B. STEREOPHONIC
C. BEND AT TOP OF PIP INDICATES STEREO PILOT

FIG. 1—TYPICAL PANORAMIC DISPLAYS observed on the Sequerra tuner.

FIG. 2—TUNING AND MULTIPATH indications observed on the Sequerra tuner.

FIG. 3—TUNER VECTOR TRACES observed in this mode of scope operation.

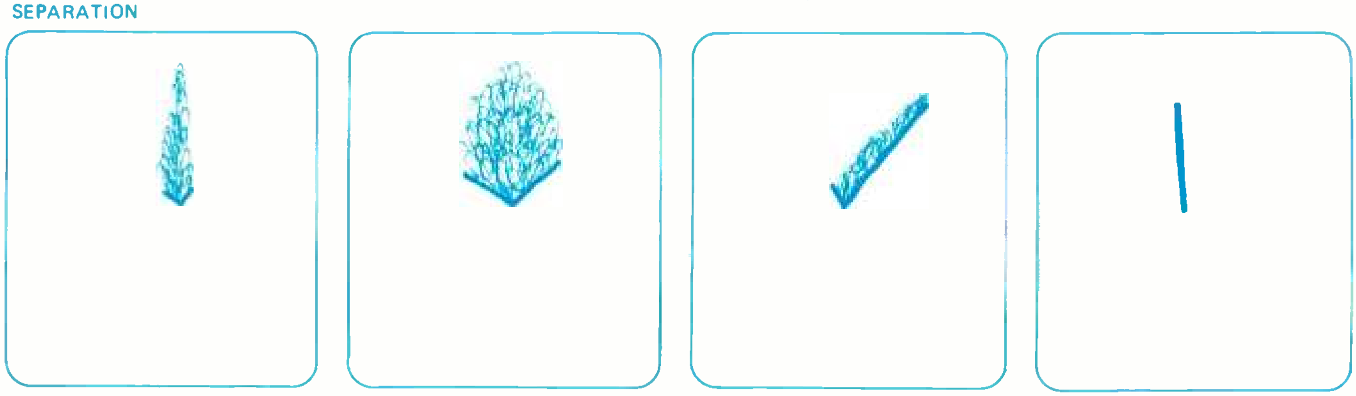


STEREO L&R FRONT INPUTS ONLY. (SAME AS STEREO FOR TUNING VECTOR) MAXIMUM SEPARATION

STEREO L&R REAR INPUTS ONLY MAXIMUM SEPARATION

4 CHANNEL—MAXIMUM SEPARATION BETWEEN CHANNELS

REAR LEFT CHANNEL ONLY



LITTLE SEPARATION BETWEEN CHANNELS (SUCH AS CENTRALLY PLACED SOLOIST)

MAXIMUM SEPARATION BETWEEN CHANNELS

IMPROPER BALANCE TO THE RIGHT

NO SEPARATION BETWEEN CHANNELS (MONOPHONIC)

curve is more linear) up to 33 volts to cover the necessary tuning range. The effective change in capacitance works out to about 11-pF using this stacked arrangement.

This is a differential system that provides significant common-mode noise rejection as well as an excellent third-order intermodulation rejection factor. Readers familiar with the advantages of a push-pull amplifier in audio circuitry (higher overload capability, symmetrical clipping, etc.) will appreciate that the same advantages are obtained from this totally balanced push-pull rf system. In order to maintain these advantages throughout the front-end, the mixer too must be of a balanced form. The mixer takes the form of a pair of balanced grounded-gate FET's with pi-networks in each drain circuit. The output transformer of the mixer stage feeds two separate i.f. systems: the usual 10.7 MHz i.f. system of the FM tuner, and the i.f. system of the panoramic sweep display.

The FM i.f. system consists of an 18-pole Papoulis filter. It incorporates a limited-gain amplifying system which enables the filter system to realize its wide dynamic range. Alternate channel selectivity (400-kHz away from the center frequency) measures greater than 130-dB, according to Sequerra!

The FM limiter system consists of a


2:39:03
DIAGONAL
"Electro-Lab" is a registered trademark of the Bell & Howell Company
Simulated TV picture/test pattern.

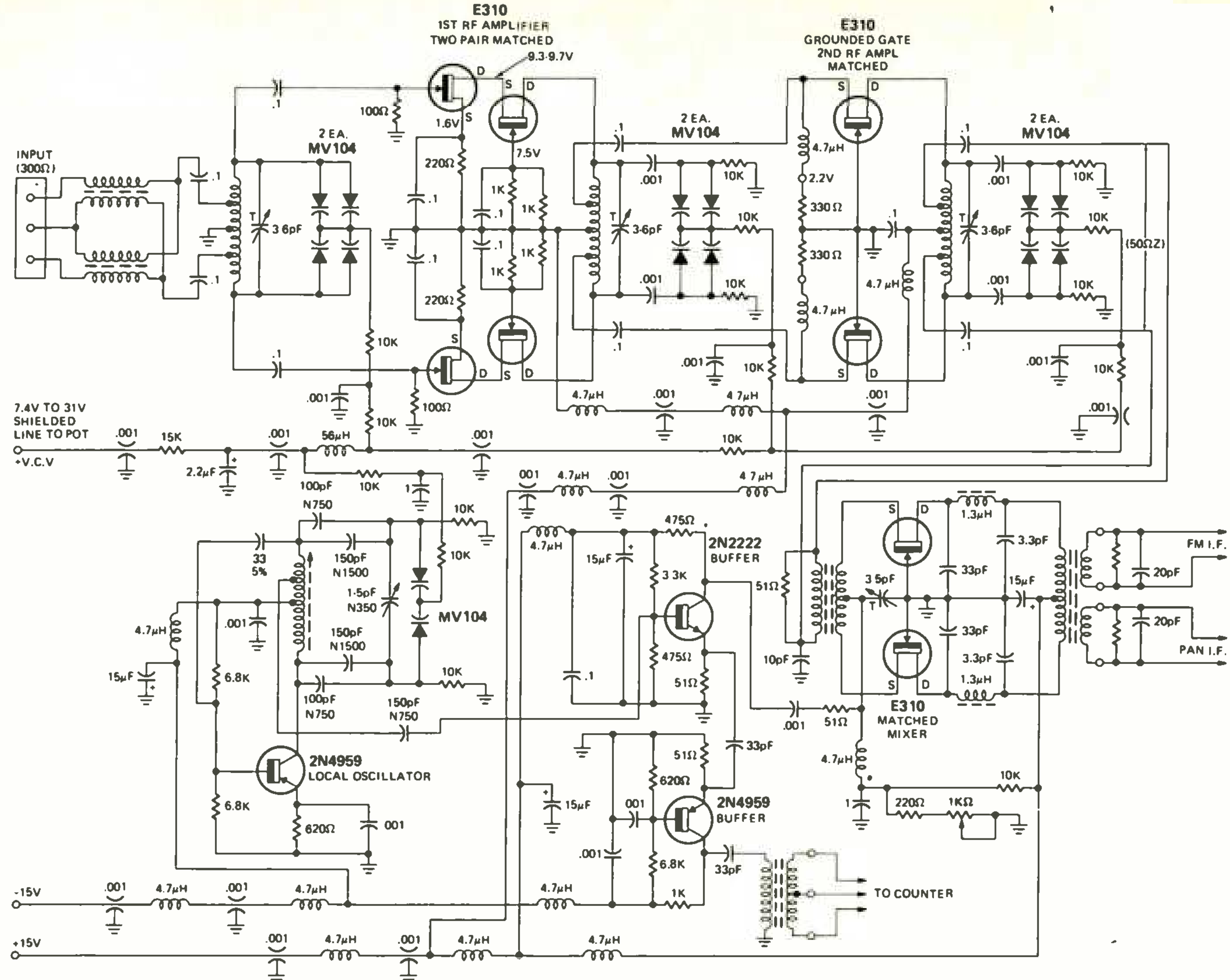


FIG. 4—FRONT END SCHEMATIC diagram shows a balanced rf amplifier and FET mixer.

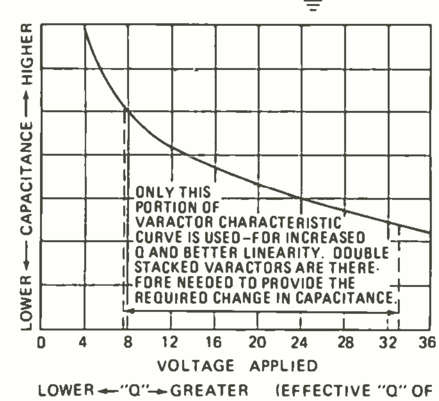


FIG. 5—TYPICAL VARACTOR CHARACTERISTIC shows the portion used in the Sequerra tuner.

6-stage wide-band differential RC-coupled amplifier. Each stage provides a gain of 20-dB. This system is also used to derive the vertical tuning display voltages.

The FM detector is a multiplying phase-discriminator design, called a Travis-Smith detector. This stage takes the information contained on the zero-axis-crossing from the limiter and converts that time displacement into an audio signal. The detection system is designed for maximum linearity with significant AM rejection capability. AM rejection, measured on the basis of 30% AM modulation simultaneous with 100% FM modulation at any audio frequency, is greater than 70 dB!

Panoramic display

The panoramic display section of the tuner may well be thought of as a tuner within a tuner. The input from the mixer of the front-end is fed, via balanced grounded-gate isolation stages to a balanced hot-carrier diode mixer bridge. A local oscillator, sweeping in frequency from approximately 12-MHz to 14-MHz is also fed to this mixer. The center-frequency of the mixed combination will be 2.3 MHz (13 MHz less 10.7 MHz from the front end output). In addition, frequencies up to a full 1-MHz above and below that center frequency will also be amplified by the series of i.f. stages which follow this secondary mixing process and which include 8-poles of double-tuned filtering in a push-pull differential circuit arrangement.

Other circuits generate the necessary ramp voltage for sweeping the scope trace horizontally across the face of the tube, total sweep corresponding to ± 1-MHz about the center frequency to be observed. The output of this secondard i.f. system feeds 6 stages of limiting, not unlike the limiters in the main FM i.f. section of the tuner previously discussed. An extremely accurate logarithmic detector with a total gain of 120-dB supplies the signals for the display. The display has a dynamic range extending from 10-μv all the way up to 3V—a range of 90-dB from weakest to strongest signal displayed.

The multiplex decoder section is one of the most elaborate circuits of the entire tuner, in terms of number of parts and circuit complexity. No attempt has been made to reproduce the entire circuit here, for reasons of space limitations. Briefly, the input circuit to the multiplex decoder separates the 19-kHz pilot signal and removes any 67-kHz signals (SCA) which might be present in the composite signal. The uniquely designed filter section used for this purpose precisely controls the phase-amplitude relationships of both the

(continued on page 78)

One-Sided Noise Reduction System

New noise reduction system reduces noise from any program source by 6 to 14 dB. The new system does not require the original program material to be encoded! Here's how this innovative system works

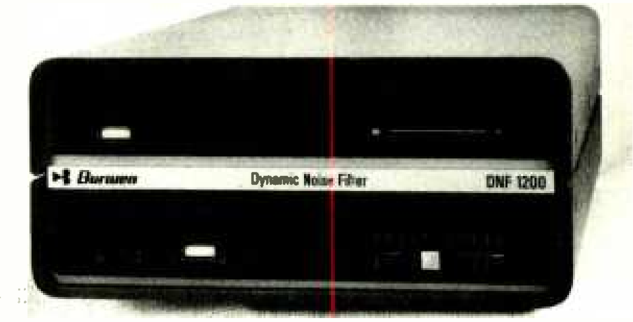


FIG. 1—CONSUMER VERSION of Burwen's dynamic noise filter.

by LEN FELDMAN
CONTRIBUTING
HIGH-FIDELITY EDITOR

WE HAVE BEEN INVESTIGATING SOME OF THE METHODS USED to reduce noise in high-fidelity component systems and program sources in recent issues of **Radio-Electronics.** So far, the systems we have explored all require "two halves". Something must be done to the program *before* it is recorded or broadcast, and something else must be done at the receiving end to restore dynamic range, proper frequency response, or combinations of both parameters. Thus, when Dolby FM broadcasts are transmitted (or, when Dolby tape recordings are made), high-frequency content is progressively accentuated at lower and lower listening levels so that upon playback, an appropriate Dolby circuit can progressively attenuate the highs at lower and lower instantaneous listening levels, restoring "flat" frequency response and reducing audible high frequency noise at the same time.

Other compress-expand systems, such as the **dbx** system, compress the entire musical program during the record process and require a suitable expander at the listening end to restore dynamic range. In the **dbx** process it can approach a full 100 dB from softest soft to loudest loud. This process reduces background noise level too.

But what about all the old records and tapes that you might own that have not been subjected to either of these "two sided" processes at the time they were made? Is there any way to improve signal-to-noise ratio on noisy discs, tapes or even old 78-rpm recordings you like to listen to without severly cutting into the high-frequency content of these older program sources?

The Burwen noise reduction system

Richard S. Burwen of Burwen Laboratories in Burlington, Massachusetts thinks there is a way to fight noise even when it is already part of the program source. The *Burwen DNF-1201 Dynamic Noise Filter* in Fig. 1 reduces noise by 6 to 14 dB on any program material without previous encoding. It is basically a low-pass filter whose cutoff frequencies vary with each musical note or speech syllable. It cuts off the frequencies to reduce hiss whenever the spectral content of the program does not require wide bandwidth.

When there is enough high-frequency content in the program source to mask hiss, it extends its bandwidth. The presence of loud high-frequency musical content tends to mask the hiss and the ear does not notice hiss when it is masked by music in this way. According to Burwen, the bandwidth variations that are continuously taking place are gradual in proportion to the frequency and amplitude of the high-frequency content of the program so that sufficient high-frequency content is present when needed. In the presence of sharp transients, however, the bandwidth can increase rapidly to a full 30 kHz in 400 μs.

The predecessor of the *DNF-1201,* the professional *Model 1000 Dynamic Noise Filter,* and for that matter, several other products in Burwen's line are made for broadcast and recording studio use. They use both high- and low-pass filters, as many as 15 integrated circuits and a great many precision resistors and capacitors to meet tight tolerances. They also cost anywhere from $700.00 to $3800 dollars *Per channel!* The new consumer version, *DNF-1201* sells for $299.95 and is a 2-channel device. In order to affect such substantial cost savings, the consumer version eliminates the low-frequency filter, thereby eliminating nearly half the circuit components. The new circuit also uses a new generation of IC's, several of which can be clearly seen in the internal view of the finished product in Fig. 2. Tolerance of parts has been loosened slightly so that parts selection is no longer required and the entire circuit for both stereo channels has been spread out on an easy-to-build printed circuit suitable for large quantity production. In addition, the range of bandwidth variation has actually been increased to provide meaningful "noise

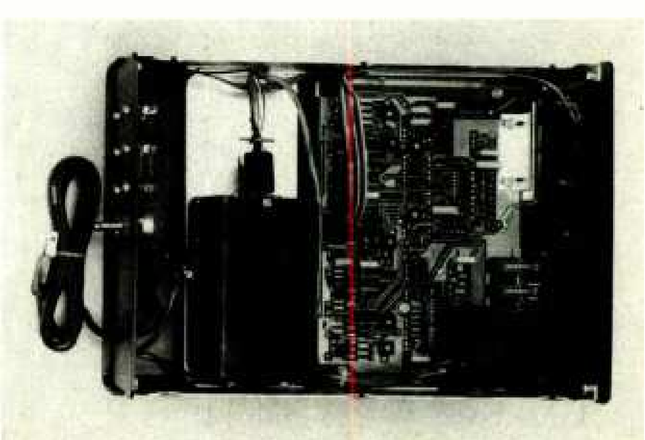


FIG. 2—INSIDE VIEW of the Burwen DNF-1201, Dynamic Noise Filter.

reduction" for old 78-rpm records—a requirement which was not considered in the more expensive professional versions of the product.

Degree of noise reduction

The maximum noise reduction available on the DNF-1201 is 14 dB, and the filter cut-off slope is at the rate of 9 dB per octave. The frequency response curves of the unit are shown in Fig. 3. Cut-off frequency is defined as the frequency at which response is down 3 dB. It can vary anywhere in the range from 500 Hz to 30 kHz according to the requirements of the program source. When cut-off is instantaneous at lower frequencies, the response has corner peaking of about 0.6 dB which helps somewhat to maintain "presence" even though most of the high frequencies are attenuated. The 9-dB-per-octave slope has been found by Burwen to be about optimum from a subjective point of view since it still allows some of the high-frequency content on the slope of the curve to be heard. At maximum bandwidth, response is flattened to within 0.3 dB out to 20 kHz.

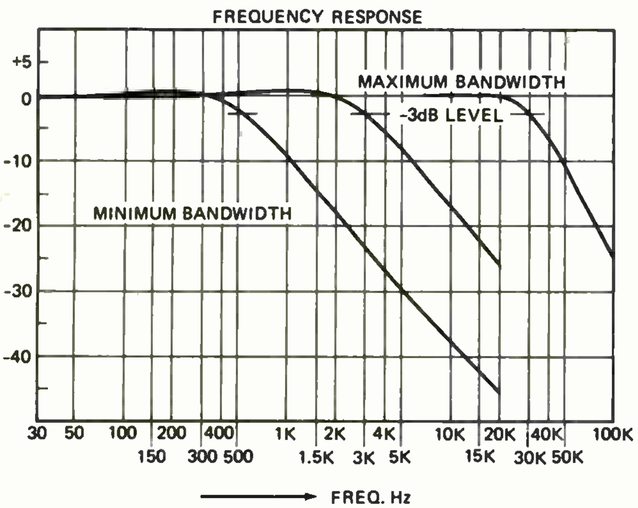


FIG. 3—RANGE OF BANDWIDTHS obtainable with the Burwen DNF-1201.

In actual use the bandwidth hardly ever contracts down to its lowest extreme of 500 Hz. Noise in the program source may limit the minimum bandwidth to 1 to 2 kHz. In all cases, however, whether playing very high quality program material or old 78-rpm records, maximum bandwidth can open up to a high of 30 kHz.

How it works

The relationship between instantaneous bandwidth and frequency and amptitude of the incoming program signal can be understood by referring to Fig. 4. Each of the left and right signal channels consists of a buffer amplifier and a voltage-variable low-pass filter. This filter provides any of the frequency response curves shown in Fig. 3 in proportion to a dc control voltage generated by the bandwidth control system.

The bandwidth control system receives as its input the sum of the signals from buffer amplifiers A1 and A2. These signals are then amplified in an active equalizer which emphasizes the high frequencies. The gain of the bandwidth control system is adjusted by means of the SENSITIVITY control which determines the relationship between bandwidth and signal level. The output of the SENSITIVITY control is further amplified by means of an active low-pass filter which attenuates signals above 10 kHz so that the system will not be actuated by the 19 kHz subcarrier products often found in the output of a stereo FM tuner or receiver. A full-wave peak rectifier converts the ac output from the active filter to dc. This dc voltage is then filtered in a multi-stage non-linear low-pass filter. Normally, the output of this filter follows the signal smoothly, but when a sharp transient occurs, the output can rise rapidly. The output of the low-pass filter is then shaped in a dc function generator to provide the dc control voltage for both left and right channels. The purpose of the function generator is to compress the dc signal so the bandwidth will vary more slowly than in direct proportion to the incoming ac (audio) signal. A pair of red and green LED indicators labelled SUPPRESSION and WIDEBAND indicate respective minimum and maximum dc control voltage to aid in using and setting the front-panel sensitivity control.

Using the DNF-1201

Normally, the *DNF-1201* is connected between the TAPE MONITOR jacks on a preamplifier, integrated amplifier, or receiver. Since this procedure uses up the tape-monitoring facilities of hi-fi equipment that does not have such facilities in duplicate, the *DNF-1201* is equipped with a spare set of output jacks to which the tape recorder's line inputs can be connected. Outputs from the tape recorder would then have to be connected to a pair of AUX jacks on your amplifier. If full tape monitoring is desired, an external stereo selector switch (such as *Switchcraft 668P1*) would have to be used to permit you to select either the *DNF-1201* or the tape recorder while recording is in process.

To operate the noise reduction system, the appropriate pushbutton is selected in accordance with the type of program source and the sensitivity control is adjusted for best listening results. If the sensitivity is set too low, the filter will not open wide enough and a distinct loss of "highs" will be evident. With the sensitivity adjustment set too high the noise may extend the bandwidth and some "swishing" effects may be heard with some program material. The pushbuttons determine the attack time of the peak rectifier circuit in the block diagram of Fig. 4.

When the TAPE pushbutton is selected, the bandwidth controller will provide full output and bandwidth will extend out to 30 kHz in less than 400 μs. The TAPE position provides the best fidelity and is intended for use with all types of better program material—even records when record groove "ticks" or "pops" are not a problem. In the PHONO setting, the attack time of the peak rectifier is reduced somewhat so that the bandwidth will not have time to open up as much in response to a fast "tick" or pop. In the PHONO 78 position, the attack time is slowed even further for reduced susceptibility to ticks and scratches. In addition, when this position is used, the frequency response of the active equalizer section is cut-off at 6 kHz so that scratches on typical 78-rpm records will have less tendency to "open up" the bandwidth.

With none of the pushbuttons depressed, the voltage-variable bandwidth filter is still in the circuit but is maintained at maximum bandwidth by a dc voltage inserted into the non-linear filter section shown in Fig. 4. Under these conditions, the performance is the same as would occur when the bandwidth controller is operating with a large signal input.

Harmonic distortion of the *DNF-1201* is typically under 0.02% at mid- and low-frequencies, increasing to about 0.1% at 10 kHz at an input and output level of 3 Vrms. Internal noise level of the unit is down to −90 dB or more in the wideband mode and better than 95 dB in any of the operating modes—well below the kinds of noise level and dynamic range capability that it is trying to audibly create for the various program sources with which it is used. The system has an input impedance of 50K and an output impedance of only 50 ohms and includes short-circuit protection. Although rated for a load of 5000 ohms or higher, the dc coupler output stage is capable of delivering more than 8 mA of signal to lower impedance loads such as 600-ohm headphones. Gain at 1 kHz is nominally 0 db but can be adjusted to provide gain of as much as 10 dB.

Listening tests

We had an opportunity to listen to the Burwen *DNF-1201* unit at the recently held Audio Engineering Society convention in New York City. A variety of program material was demonstrated for our benefit and we found that the unit performed most impressively with old 78-rpm records and with newer LP's that had been somewhat abused. In the case of old 78's, which lack high-frequency content

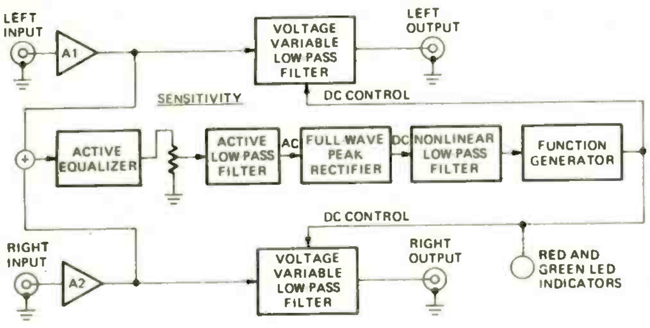


FIG. 4—BURWEN DNF-1201 block diagram.

to begin with, the effect is amazing. Quiet "background" was restored to otherwise unlistenable old discs and we detected no loss of high whatsoever. What a blessing this will be for the collectors of these old vintage discs. In the case of newer LP's having some moderate amount of surface noise, the effect was not quite as impressive and we found it necessary to play with the sensitivity adjustment until we obtained just the right compromise between bandwidth and noise suppression. Once the "best" setting was found, however, the effective noise reduction was much better, and less sacrificing of musical high-frequency content than we experienced with even the very best (12 dB per octave passive "high filters" or "scratch filters" normally found on better amplifiers and receivers. Those filters were never satisfying to our ear, since no matter how well planned (and no matter where cut-off is set) they always "bite into" musical content and we are always conscious of the sacrifice.

Under certain conditions of musical programming, we could audibly detect the action of the *DNF-1201*, but when you stop to think of it, what other solution is there for program material that is already noisy but that you still enjoy enough to listen to from time to time? As Dick Burwen points out, the design of the *DNF-1201 Dynamic Noise Filter* is based on established engineering and acoustic principles, but the final choice of values in the circuits was made after many hours of listening tests on a wide variety of program material. It would have been relatively easy to design a device of this sort that works well in theory and on paper but that sound bad. The *DNF-1201* does what it was designed to do and does it very well indeed, and until someone else makes a better one-sided noise reduction system (and no doubt others are working on this important problem), we remain impressed with the performance and operation of this device. **R-E**

MacBain, Blowey, win Gernsback Award

Robert J. MacBain, of Cottage Grove, OR, a student of Bell & Howell Schools, is the most recent winner of the Gernsback Scholarship Award. (The Award is a $125 grant made annually in memory of Hugo Gernsback to a student in each of eight leading home-study schools of electronics.)

Mr. MacBain, 38, lives in the countryside near Eugene, Oregon, where he

and his wife are working hard to prepare themselves to open their own TV repair business by Spring 1975. The MacBains are formerly from San Francisco and have two daughters, 5 and 11 years old.

MacBain believes his television background and his interest in hi-fi and tape systems will allow him to operate an efficient general service plus a specialized stereo (or more!) service to the people in and around Cottage Grove.

Clayton W. Blowey, 43, of Waldron, KS, is recipient of the WV-529A service VOM donated by RCA to the runner-up

each month. Bell & Howell reports that he is specially deserving because of his motivation to learn electronics in spite of handicaps.

Mr. Blowey is confined to a wheel chair, paralyzed from the waist down. He is unemployed, though he has specialized in watch repair and occasionally gets work in that skill. He believes that after completing his course he will be able to find employment in the communications field.

10-point program for NESDA

The National Electronic Service Dealers Association (NESDA), at last summer's convention in Kauai, Hawaii, drew up a 10-point program, resolving during the coming year to:

1. Increase membership by 30 per cent.
2. Institute data processing at headquarters.
3. Increase efforts to solve the problems of extended warranties; parts and service data unavailability; unworkable state and local regulations; lack of business statistics; low profits.
4. Extend casualty and workman's compensation insurance programs to a majority of NESDA members.
5. Give strong support to ISCET and its projects; CET, serviceability, service data evaluation, technician training programs.
6. Introduce a new service industry news and education publication.
7. Expand dealer management schools. Increase the number of dealers who receive NESDA management school diplomas from the 856 of the 1973-74 period to at least 2,000 dealers in the 1974-75 period.
8. Cooperate closely with suppliers and their associations.
9. Continue strong activities with federal government agencies, and expand relationships with other government and industry national groups.
10. Take stronger action to reduce the phony "TV repair exposes" now blanketing the country.

Bell patents "alphabet" for speech synthesis

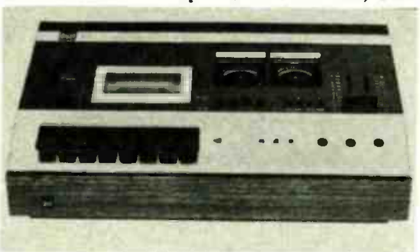
Patent No. 3,828,132 has just been issued to three Bell Labs scientists for a system of "Speech Synthesis through Concatenation of Formant-Encoded Words." This title means that the scientists have been able to analyze words in their *formants*, or the natural resonances produced by the vocal tract when people talk. These are then strung together (concatenated) by the computer, with the proper pitch, duration and amplitude to produce speech.

This relatively new format is running a close second to the reel-to-reel format. If things continue the way they're going, it looks like its going to get a lot closer

by FRED PETRAS

els staying at −45-dB, with an occasional set reaching −46 to −48-dB.

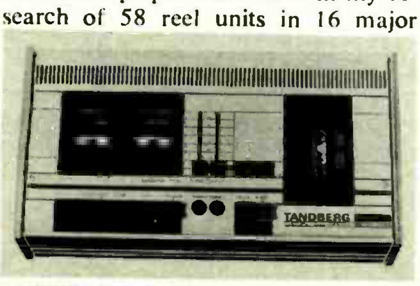
Today's stereo cassette deck is somewhat better. A check of 56 current stereo decks in 22 top brands shows 29 with readings of −50 to −54-dB (manufacturer's specs). Of course, bet-



DUAL 901

ter tape formulations must be taken into consideration for the superior readings — accounting for improvements of two to three decibels.

In both categories, Dolby noise reduction circuitry raises the S/N figure markedly—anywhere from six to 10-dB. The top spec uncovered in my research of 58 reel units in 16 major



TANDBERG TCD-310

brands was −73-dB at zero VU for a Dolbyized four-track stereo reel model from Tandberg, Model 9200XD.

The top spec in the cassette deck area was −65 dB for Tandberg's Model TCD-310—when using chromium dioxide tape. Eight different Dolbyized machines of the 56 checked offered readings of 60-dB. NOTE: Few reel models are Dolbyized—the need is less. About half of today's better quality cassette decks are available in Dolby versions. Industry crystal-ballers envision an acceleration of Dolbyized cassette models.

Flutter readings of under 0.25% are no longer exclusively in the open reel category. A check of the 56 cassette machines shows readings of 0.12, 0.13, 0.15% to be quite common, with Teac Model 360S, Sony TC137SD and 3M/Wollensak 4765 achieving a superb .07% flutter spec.

TECHNICS RS-676US

In reel recorders, the best figure noted among the 58 study units was .03% at a speed of 7½ ips for Sony Model TC55. Over 40 models had flutter readings substantially under 0.1%.

Even highly critical listeners would be hard put to *actually hear* the difference between the best flutter readings of equipment in the two formats.

The predictions are that manufacturers will continue to strive for even better flutter specs, in line with sophisticated consumer demand.

On the score of frequency response, at first glance it would appear that there is not much difference between the two formats. In my check of the better quality cassette instruments, the most frequent reading was about 30-Hz to 13-kHz. In reel decks it was 30-Hz to 20-kHz. I say "not much difference" because most people don't hear beyond 13-kHz anyway.

YAMAHA TB700

But an explanation is in order here. Just as optimum signal-to-noise ratios can be derived using certain bases, so too, can response readings. The difference is substantial in the case of response specs. Teac, in its "White Paper on Tape Technology" states: "When you see tape deck frequency response numbers or curves, the *level* at which these curves were recorded is seldom shown. Cassette curves are measured at levels of −20-dB or lower. Most reel-to-reel manufacturers also show their 3¾-ips curves at these levels. Obviously, one of the reasons curves are shown at these levels is that if they were recorded at −10-

THE BATTLE

Reel-To-Reel

The oldtimer is still the top-of-the-line format. But for how long? What are the major advantages with this format and is it worth the added cost? These questions should be considered before buying new equipment

THE BATTLE BETWEEN THE OPEN REEL recorder and tho cassette recorder has been going on for a full decade. Neither is anywhere near victory, and the battle continues. But *both* sides are winning.

This may seem like a contradiction, but there is plenty of evidence to substantiate the point. Step back in time

CROWN 700

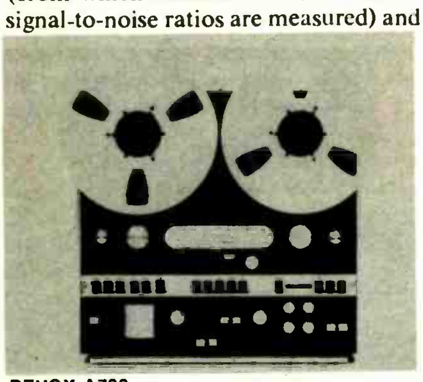
Anyone seeking tape equipment and wondering whether to buy it in reel or cassette form faces a tougher series of decisions today than a few years ago. Earlier, the advantages/disadvantages of each format were clear-cut; today they are less so. Today the buyer of tape equipment has more features to take into account, more options, more *nuances*. Essentially the choice boils down to a person's needs, his priorities. Is ease of operation a prime concern, or *ne plus ultra* sound? Will the equipment serve primarily for playback or recording? Or will it be an even mixture of both? Will a re-

Specifications

A decade ago, a signal-to-noise ratio of 50dB at zero VU was considered to be the point at which a consumer-type four-track stereo reel recorder could be called "professional." As equipment technology advanced, as tape formulations improved, S/N figures moved up—to −55, then −58, then on up to −60 dB. The latter figures notwithstanding, −55 dB is generally regarded as the jumpoff point for today's consumer reel recorder to be considered in the professional quality realm.

A decade ago the stereo cassette deck was not yet born—it came along about two years later. Initial S/N specs for a typical stereo cassette deck of

dB (the transitional reel-to-reel level), suddenly the cassette and 3¾ speeds wouldn't look so good." Len Feldman, noted industry writer—and contributor to **Radio-Electronics**, in a recent *Rolling Stone* article on cassette frequency response, said, "Try making the same tests at zero VU readings on the meter (from which reference those excellent signal-to-noise ratios are measured) and



REVOX A700

you'll be lucky if you get a response much above 10 kHz!" (as opposed to readings of out to 16-kHz or better at − 20 to −30 dB on the level meters).

Essentially then, frequency response specs of cassette equipment should be taken with a grain of salt when considering what to buy.

The quest for wider frequency response will go on—in both formats. Better tape heads will help. Better electronics will help. And so will better tape formulations.

Features

Automatic reverse, once strictly a reel-to-reel feature, is beginning to appear in cassette form and the situation will accelerate. "Now you can record on a Dolby cassette deck for two

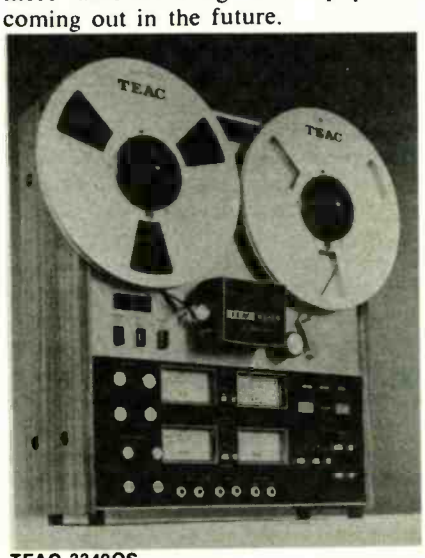
CONCORD CD-1000

straight hours without flipping the tape," proclaims an ad for Toshiba's Model PT490. Another ad says, "Akai takes a giant step backward and forward . . . 3 hours continuous record and playback with the 'hands off' wizardry of Akai GXC-75D." Claims the copy in the Akai ad: "Now you can tape an entire collection, your favorite station or a live performance *without missing a beat.*" (Italics ours.) The Akai unit also protects the absent-minded user who may set it for two-way continuous operation in the record mode—it switches out of "continuous" operation once both sides have been recorded, to prevent erasure during the next tape pass.

In addition to the above auto-reverse machines, there are the new Dual 901, Panasonic's RS-272US, Radio Shack's Realistic SCT-7, and the Uher CR134. In a special category is the Panasonic RS-296US, a play-only changer deck with a "carousel" that holds 20 cassettes for several hours of uninterrupted playback.

You'll find more automatic reversing equipment in reel form, with Akai, Pioneer and Sony the major proponents. A few years ago most auto-reverse reel decks were play-only types. Today many are auto-play/record models, permitting unattended recording on both sides of a reel.

At one time auto-reverse was considered to be a gimmick, of appeal primarily to "amateur" recordists; thus "professionals" shunned it. Today, auto-reverse in reel equipment is accepted by the sophisticated recordist as a valuable feature which has an important place in the total recording capability of his gear. Expect to see more auto-reversing reel equipment coming out in the future.



TEAC 3340OS

Not long ago the open reel recorder could boast of being superior to the cassette recorder because it had monitoring facilities. No more! Monitoring is now possible from a handful of sophisticated three-head cassette decks, with more on the way. Nakamichi with its models 1000 and 700 priced at $1,100 and $690 respectively, and Technics with its Model 279US at $499.95 started the ball rolling with this benefit. It is also available in Sony's Model TC-177SD at $699.95, Teac's Model A-850 at $1,000 and in Kenwood's upcoming C-1000 at $1,000.

Other manufacturer's are delving into the complexities of producing such machines at lower prices in the not too distant future.

Tape decks with mic/line mixing, formerly the province of professional reel equipment such as that produced by Crown, are available in both formats. At this writing there are 13 reel units and 10 cassette machines with this feature. Companies with reel units featuring mic/line mixing are Revox, Akai, Sony, Pioneer, Dokorder and Teac. In cassette equipment the companies are Sony, Sansui, Kenwood, Yamaha and Teac.

As tape huffs get more and more sophisticated, as their recording activities expand into a higher realm, they will be demanding more models with mic/line mixing. Be assured that manufacturers will develop them.

Today's state-of-the-art reel and cassette recorders share some interesting,

TANDBERG 3600XD

useful—and sometimes gimmicky—features. One is tape speed adjustment, sometimes called "pitch control," enabling the user to, for example, slow down or speed up a recorder slightly (up to four percent) for perfect pitch in playback of recordings made on another machine. That feature also permits him to "tune" the recorder to a musical instrument if the instrumentalist wants to play along with the music on a recorded tape. You'll find this feature on several deluxe machines. In the reel category it's on the Sony 854-4S, at $1,795, and Two Teacs—Model A-7300 and 7340, priced at $979.50 and $2,200 respectively. Speed adjustment is also offered as an extra-cost option on the $899 Revox A-77 and the $1,695 A-700.

In cassette decks you'll find pitch control at high and medium price levels. It appears in the Nakamichi 700 at $690, the Nakamichi 1000 at $1,100, Teac's Model A-850 at $1,000 and Yamaha's TB-700 at $340.

The above are currently available variable-speed machines; by the time this appears in print several more models may be on the way.

Not long ago the reel recorder was exclusive in terms of offering bias/equalization control. That advantage has been wiped out by today's new breed of medium and deluxe cassette models. Since a cassette recorder's performance is more critically related to the kind of tape used, manufacturers have provided many instruments with two and three-position switches to accommodate standard, high energy and/or chromium dioxide tapes. Thus, the equipment is "matched" to the tape, for optimum performance with each type of tape.

More and more machines—both cassette and open reel—equipped with bias/equalization controls will be appearing in electronics stores, reflecting recordists' awareness of the importance of this feature.

Accurate recording level — VU — meters were once only available in top notch equipment. Again, the situation has changed. Many of today's cassette units feature professional quality recording level meters, namely peak-reading types which display an equalized signal. Available in sets such as Tandberg's TCD-310, Dual 901, as well as others, the meters show far more accurately what is being fed to the tape. Tandberg, for example, claims that its meters respond five times faster than traditional VU meters, and that their extra speed, sensitivity and range make them easy to use as a true guide for setting recording levels. They allow the user to maximize the signal and control distortion.

The foregoing covers the major areas in which reel and cassette equipment have a lot in common and in which they are on reasonably equal footing. But some of the basic differences still apply. Despite all the advances in their technology, cassettes are hard to edit because of the narrow tape width and the tape encasement. Further, there is a need for extreme precision in editing because of the slow speed at which the tape moves, with the taped sound impulses crowded much closer on a tape. In regard to editing capability and flexibility, the reel recorder has a whopping advantage. With even a moderately priced unit you can produce near-professional tapes, whose quality permits them to be used as "masters" from which to make fine-sounding copies. The cassette does not offer that degree of professionalism—even in high priced models.

Today's reel recorder in quadraphonic versions, offers the finest form of four-channel sound reproduction—discrete quad. If surround-sound is your hunger, the reel is a natural choice. The cassette is not a four-track medium, although it is possible to record matrixed four-channel sound into cassettes and play them back through appropriate equipment. However, the results of matrix recording in cassette form are highly variable; you seldom get the same sound you recorded, as regards instrument and voice placement, etc.

The cassette is still at the top of the hill as an ideal playback medium, offering a convenience of use that the reel has failed to attain—despite many attempts by current and departed manufacturers to achieve it. Loading a reel recorder is still an "all-thumbs" proposition for many music lovers. Loading a cassette into a machine is a one- or two-second matter. Further, with some new units, such as Sharp's RT-480, which offers automatic program finding on recorded tapes, the cassette becomes an even more convenient medium for playback where you want quick access to a specific piece of music. (More equipment with the equivalent feature is on the way to fill the demands of sophisticated consumers).

The cassette—despite a lack of easy editing capability—is also at the top of the hill as a *convenient* recording medium, offering a quality of end product that no one envisioned when it was put on the market a decade ago. While not as fine as a recorded reel tape, a well-recorded cassette will satisfy all but the most snobbish listener.

The cassette also has the edge as a convenient playback medium in other ways. Suppose you want to hear music tapes in your car. If you do, the cassette is an inevitable choice, permitting you to enjoy recorded music indoors on home equipment, and on the road as well, via a car player.

What your dollars will buy

Just as the listings of specifications show that the reel and cassette formats are coming closer together in terms of performance and features, so too, are they coming closer in terms of what you get for your money. Following are two examples.

Within the Akai line, a comparison of its Model 1721W/L reel recorder at $314.95 and its Model GXC-46D cassette deck at $319.95, shows a similar frequency response of 30-18-kHz, plus-minus 2 dB, a THD of 2% for both models, flutter of 0.14% for the reel machine and 0.12% for the cassette machine, and a similar signal-to-noise ratio of −50-dB, the reel unit using a reference of 0 VU, the cassette with no reference given and using Dolby noise reduction circuitry.

At a higher price level, a comparison between the Teac 2300S reel deck at $469.50 and the Technics RS276US cassette deck at $459.95, reveals matched flutter readings of .08 percent, THD of 1% for the reel unit and 2% for the cassette unit. In frequency response the figures are 30-28 kHz at ±3 dB for the reel set and 40-13 kHz at ±2.5 dB for the cassette model. The signal-to-noise ratio was −58 dB for the Teac. It was −58 dB for the Technics when the unit was operated with its Dolby noise reduction circuit.

To conclude, in many areas the choice is close. If ultimate quality sound, easy editing, master-quality tape capability, and four-channel sound are your needs—reel equipment will be your choice. If excellent quality sound and utmost convenience are your needs, you should settle on cassette equipment. **R-E**

UHF BUT NO VHF!

Here's an odd one for you. This Curtis-Mathes 10M093 has a fine picture, with good sound on uhf, but nothing on VHF! I checked the tuner but couldn't find anything. I need a hint.–C.F., Glenshaw, PA.

In this type of combination vhf/uhf tuner, if the uhf is working, then at least *part* of the vhf tuner must be, When you switch to uhf, the vhf tuner is also switched so that it acts as a 40 mHz i.f. amplifier. So, this tells us that the tubes, voltages, etc. on the vhf tuner have to be OK.

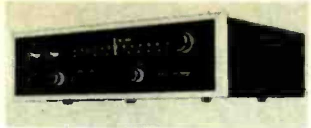
The most likely suspect for this kind of reaction would be something which does not work in the *uhf* position. The only thing I can think of would be the vhf oscillator. Check that circuit, and the switching, etc. The rf amplifier and mixer should be OK.

REPEATED TUBE FAILURES

My friend from Lake Tahoe, Monty Huckle, sends this one along. Clip it out and put it up over your bench!

The problem was repeated breakdown of the 12DW4 damper, 30KD6 horizontal output and 23JS6 pulse regulator tubes in Sears 562.10521 color TV chassis. We corresponded about it for quite a while; in the meantime, the sets were happily demolishing these tubes about once every three weeks.

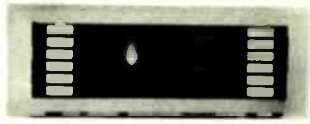
Monty found the answer. The 23JS6 tube has +280 volts on its *cathode*. This shorts to the heater, blowing out the other tubes (series string). The 23JS6 tube has a heater-to-cathode breakdown rating of only *100 volts*. Questioning the company finally brought the solution. The Los Angeles Service Manager for Toshiba advised that the 23JS6 tube used in this was a *special type with a 300 volt breakdown rating. A standard U.S. 23JS6 will not work in this chassis.* These types can be ordered from Toshiba America, 3727 W. Olympic Blvd., Los Angeles, CA 90019. **R-E**



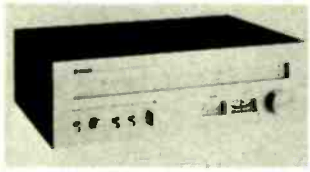
SANSUI MODEL TU-9500

KENWOOD 700-SERIES

SONY MODEL ST-5150



SEQUERRA MODEL 1

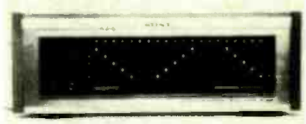


YAMAHA MODEL CT600

ACCUPHASE MODEL T-101

FM Tuner

There are many FM tuners on the from the inexpensive to the connoiseur's and features. Here's a roundup article



SONY MODEL ST-5555

CAMBRIDGE T75X AND P140X

BACK IN THE EARLY AND MID-FIFTIES, REGARDED AS THE "dawn" of hi-fi, a typical audio system consisted of a tuner, an integrated amplifier, a record player and a speaker system. Once stereo took hold at the end of the decade, a typical audio system consisted of a tuner, preamp, two power amplifiers, a record player and a pair of speakers. That was just too much for many consumers and the sales of hi-fi soon reflected this resistance. Manufacturers, ever alert to consumer attitudes, decided to do something about the mish-mash of individual units and all the wiring needed to join them. Lo, the stereo receiver was born, effectively combining tuner, preamp, and two amplifiers all in one convenient housing that took up far less space than the rig of old—and which looked a lot neater. Consumers began to smile and happiness reigned—in the home, in the hi-fi factories. . .

Today, the situation is slowly reversing. Individual components—tuners, preamps, power amplifiers and integrated amplifiers—are enjoying a new popularity. There are several reasons for this:

- Today's audio buffs are a lot more sophisticated than those of a decade and a half ago. Many are more concerned with *nuances*, whose totality is the perfection of sound they are seeking. They are more likely to find them in individual components than receivers.
- The sound sleuths have found that receivers are sometimes "uneven" in terms of the quality/efficiency of their individual sections, with the amplifier sometimes inferior to the tuner section, and vice versa.
- Systems made up of separate tuner, preamp, amplifier, etc., can offer the audio buff greater control and flexibility than many receivers.
- Audio buffs are aware that the refinements and improvements they want are expensive. They have learned this in the course of owning one, two, perhaps a half dozen receivers down through the years. In trading up they have taken substantial losses. By buying separates, they can trade up at less cost, more frequently, have the best, and be more *au courant* with technological progress.

Two of the first things that strike the buff looking into what's available in tuners today, are the wide variety of units/brands, and the wide range of prices. While we've limited ourselves in this article, to a study of 53 models in 20 nationally known brands plus three newcomers, there are still more. As for prices, you can buy for as little as $109.95 (Heath *kit*) or lay out as much as $2,500 (Sequerra). And in between these two extremes, you're bound to find a model that fits your needs and budget precisely.

(NOTE: All specifications listed in this article were obtained from the manufacturer's literature.—Editor)

During the big popularity phase of the stereo receiver, a number of manufacturers introduced FM-only models, as a concession to quality-sound-conscious listeners and for a slight pricing edge in the marketplace. They found, generally, that the number of sales of such units barely justified their manufacture, and many were dropped. While 10 of the 23 manufacturers involved in this survey are still coddling the super-sophisticates with FM-only tuners, there are far more models in the market with FM *and* AM capabilities.

One of the reasons for including AM in so many models is that the industry has moved ahead a bit in AM technology. For many years manufacturers figured they were "locked in" within the then limits of AM technology. But along with trying to improve the capability of their FM circuits, they spun off some advances in FM technology into the AM side of their equipment. While the AM sections of today's combination tuner is frequently not as good as the FM section—by virtue of AM's basic limitations—it is markedly better than before, and good quality music reproduction is available in the AM mode thanks in part also to advances in solid-state technology *per se*. One company, Dynaco, goes so far as to say its engineers have developed an AM section (for its Model AF-6 at $299.95, kit at $199.95) "Which can rival FM, with broad frequency response, low distortion, low noise and exceptional selectivity."

Specifications of available tuners

A fact that makes a solid impression on today's tuner buyer is the excellent signal-to-noise ratios apparent in models at all price levels. With three exceptions, all of the 53 sets I examined had a signal-to-noise ratio of at least 65 dB, considered to be a good spec for a first rate tuner. Seven of the sets had an s/n ratio of 75 dB—truly "top-drawer." While most of the tuners achieving this figure were in the $300 and up bracket, it was also listed for a Lafayette unit—Model LT-725B, at $149.95.

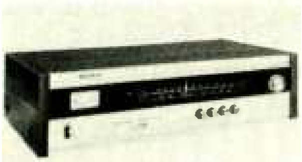
Today's FM tuners are also impressive with regards to another important specification—selectivity. When tuner sensitivity is high, the tuner must be able to reject adjacent stations or stations two channels apart on the dial. Check-

JVC MODEL VT-900

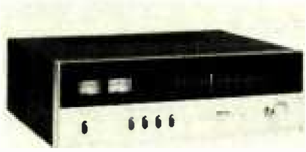
PIONEER MODEL TX-9100

KENWOOD MODEL KT-6007

DYNACO MODEL AF-6



SONY MODEL ST-5066



NIKKO MODEL FAM-500

Roundup

market today. They range in price
delight. They differ widely in performance
that includes a specification chart.

by FRED PETRAS

MARANTZ MODEL 115B

NIKKO MODEL FAM-220

ing through spec sheets reveals, using a guide of 50 dB as the minimum selectivity "number", that only four of the 53 sets did not make the grade. Most ranged from 60 to 70 dB. Nineteen models offered selectivity of 80 to 100 dB. The top figure, an incredible 140 dB, was listed for a $950 model from SAE (Scientific Audio Electronics, Inc.).

A third spec of concern to the sophisticate is capture ratio—the ability of the tuner to "capture" the stronger of two stations on the same frequency. Today's tuners have reached a high state-of-the-art in this regard. Of the 53 survey models, only four ranked mediocre—with figures of 2.5 to 3 dB. (Such ranking is relative; a few years ago such figures were considered tops.) All the rest claimed 2 dB and under. Nineteen offered 1.5 dB capture ratio. Eleven models were rated at 1 dB. JVC in its Model VT-700 at $249.95 and VT-900 at $399.95 and Kenwood in its 700-T at $749.95, listed a figure of 0.8 dB. The best reading was for a new company, Cambridge Audio, an English firm whose products are handled by CM Corp. of Norwalk, Conn. Cambridge's T75X, priced at $350, is rated at 0.5 dB—the best capture ratio figure I've seen so far.

IHF sensitivity—the ability of a tuner to receive weak or distant FM signals and translate them into listenable audio—is high on the list of specs a buff is concerned with. It is an important spec, but less so than the foregoing three. Using a cutoff point of 3 μV (at 30 dB of quieting—the IHF spec) as a minimum for satisfactory operation, only two of the 53 models checked failed to meet that criterion, with readings of 3.5 and 4 μV. Fifteen were rated in the 2 to 2.8 μV range. The rest all stated ratings of 1.9 or better; eight with a figure of 1.5 μV, and one a superb 1.4 (Marantz, Model 120 at $429).

The fifth of the "big five" specifications is total harmonic distortion—THD. With one exception all 53 sets listed less than 1 per cent THD at 100% modulation in the *stereo* mode—quite satisfactory. More than half, in fact, had readings of 0.5% or better. The ultimate figure—0.2%—was attained by newcomer Accuphase in its Model T-100 at $450. (Accuphase is the brand name for products from Kensonic Laboratories, marketed in the United States by TEAC Corp.)

The surveyed group of tuners by and large rated high in other electronic specification areas such as frequency response, stereo separation, AM suppression, etc. Space considerations preclude their delineation.

Operating features

And what are the operating features that today's audio sophisticate might be looking for? What are the "goodies" for which he is hungering? A study of the spec sheets shows that the audio buff has good pickings among significant features.

FM muting is a feature that even a less-than-sophisticate will insist on. In general, it is part of worthy tuner design. It makes tuning a lot more pleasant, especially if you tend to listen at high levels and don't like to turn down the volume level when you tune. Virtually all the tuners in this survey have muting—from $130 on up. Two models in the Yamaha line—CT800 at $370 and CT7000 at $1200—offer *variable* muting (from 3 to 30-μV signal level) to match reception conditions.. The Accuphase T-100, the Rotel RT-1220 at $329.95, and the Kenwood 700-T all offer two-step muting.

All but one of the tuners has a tuning meter of some sort. Lower priced units tend to use a signal-strength type, while the higher priced models generally offer the more desirable center-tuning type. However, there are exceptions; in some models you'll find combination meters that function as both types—as center-tuning in the FM mode, as signal-strength in the AM mode. The majority of sets checked offer both types of meters.

One model, the Accuphase T-100, offers not only the traditional two types of tuning meters, but an additional meter—for multipath indication and FM antenna orientation. Harman-Kardon in its FM-only Citation 15 and 14 at $395 and $525 respectively, offers a center-tune meter plus a patented meter which measures signal-to-noise ratio of the incoming signal instead of its strength. This enables a listener to tune for lowest noise and to adjust the antenna rotor for optimum reception.

Kenwood in two of its tuners offers a triple-function meter—for signal-strength, multipath detection, and deviation—at the push of a button. In one Kenwood and one Sansui model the signal-strength meter doubles as a multipath detection meter. Marantz in its Model 120 offers a built-in oscilloscope for tuning and multipath indication. Another model with built-in oscilloscope is the SAE Mark VI at $950.

Scott in its FM digital T33S at $999.95 offers a signal-

(chart on pages 50 & 51; text continues on page 52)

MANUFACTURER'S SPECIFICATIONS

FM STEREO

MANUFACTURER	MODEL	FREQUENCY RESPONSE Hz ± 1dB	S/N RATIO dB IHF	THD @ 100Hz % IHF	THD @ 1 kHz % IHF	THD @ 6 kHz % IHF	IM DISTORTION % IHF	SENSITIVITY µV IHF	SIGNAL FOR 50dB QUIETING µV IHF	CHANNEL SEPARATION dB @ 50Hz	CHANNEL SEPARATION dB @ 1 kHz	CHANNEL SEPARATION dB @ 10 kHz	CHANNEL SEPARATION dB @ 15 kHz
ACCUPHASE	T101	20-15K	70	0.2	0.2			20	45		45	30	
	T100	20-15K	70	0.2	0.2			20	45		45	30	
DYNACO	AF-6	20-15K	65	0.9	0.9	0.9	0.9	1.75	5.0	30	40	30	
	FM-5	20-15K	65	0.9	0.9	0.9	0.5	1.75	5.0	30	40	30	
HEATH	AJ-15	20-15K			1.0					30	40	25	20
	AJ-29	20-15K			0.5					35	45	30	25
	AJ-1214	20-15K			0.75						40		
	AJ-1510A	20-15K			0.35						40	30	25
JVC	VT-700	20-15K	65	0.5	0.5	0.5		1.7	9.0	25	41	35	25
	VT-900	20-15K	65	0.5	0.5	0.5		1.7	8.0	25	42	35	25
	JT-V8	20-15K	70	0.5	1.2	0.5		2.0	4.0	35	40	30	
KENWOOD	700-T	20-15K	71	0.20	0.20	0.20	0.3	FM AUTO MODE 8.0	40	40	45	40	40
	KT-4007	20-15K +0 dB -2	61	0.4	0.4	0.7	0.7	FM AUTO MODE 20	40	35	40	30	25
	KT-6007	20-15K +0.5 dB -2.0	66	0.2	0.2	0.5	0.5	FM AUTO MODE 10	35	40	45	38	31
	KT-8007	20-15K +0.5 dB -2.0	71	0.2	0.2	0.5	0.5	FM AUTO MODE 10	30	40	47	38	33
LAFAYETTE	LT-825	30-12K	60	0.6	0.4	1.0		12	30	25	35	15	10
	LT-D10	30-13K		0.4	0.3	0.8		10	20	30	40	25	12
MARANTZ	112	30-15K	64	0.5	0.5	0.6			37	28	40	28	25
	125	30-15K	65	0.3	0.3	0.4			35	32	42	29	29
	150	30-15K	65	0.3	0.3	0.4			30	35	45	30	30
NIKKO	FAM-220		60				0.5	2.3			38		
	FAM-500		60				0.5@ 1000 Hz	2.0			38		
ONKYO	T-4055	20-13K	67	0.4	0.3	0.3	0.4	10	45	33	40	25	20
PILOT	211	30-15K	60		0.7			5.0	50	25	38	25	

FM MONO

MANUFACTURER	MODEL	FREQUENCY RESPONSE Hz ± 1dB	S/N RATIO dB IHF	THD @ 100Hz % IHF	THD @ 1 kHz % IHF	THD @ 6 kHz % IHF	IM DISTORTION % IHF	SENSITIVITY µV IHF	SIGNAL FOR 50dB QUIETING µV IHF	SELECTIVITY dB IHF	CAPTURE RATIO dB IHF	IMAGE REJECTION dB IHF	IF REJECTION dB IHF	AM SUPPRESSION dB IHF	CARRIER SUPPRESSION dB IHF	SCA SUPPRESSION dB IHF	SPURIOUS REJECTION dB IHF	MUTING
ACCUPHASE	T101	20-15K	75	0.1	0.1		0.2	2.0	4.5	55	2.0	80	100	55		60	100	FIX.
	T100	20-15K	75	0.1	0.1		0.2	2.0	4.5	70	1.5	90	100	60		60	100	VAR.
DYNACO	AF-6	20-15K	65	0.5	0.5	0.5	0.5	1.75	5.0	65	1.5			58		80		FIX.
	FM-5	20-15K	65	0.5	0.5	0.5	0.5	1.75	5.0	65	1.5			58		80		FIX.
HEATH	AJ-15	20-15K	65		0.5		0.5	1.8		70	1.5	90	90	50	55	50	100	VAR.
	AJ-29	20-15K	60		0.5		0.4	1.8		70	1.5	90	90	50	55	55	90	FIX.
	AJ-1214	20-15K	60		0.5		0.5	2.0		60	2.0	50	75	50	60	55	70	NONE
	AJ-1510A	20-15K	65		0.3		0.1	1.8		95	1.5	90	90	60	60	60	90	VAR.
JVC	VT-700	20-15K	67	0.3	0.3	0.3		1.7	5.0	70	0.8	90	90	60	50	50	100	VAR.
	VT-900	20-15K	65	0.3	0.3	0.3		1.7	4.0	70	0.8	90	90	65	55	55	100	VAR.
	JT-V8	20-15K	70	0.3	0.3	0.3		2.0	4.0	60	0.8	55	80	55	60	70	80	
KENWOOD	700-T	20-15K	73	0.15	0.15	0.2	0.2	2.0	4.0	100	0.8	100	110	65	65	65	110	VAR.
	KT-4007	20-15K +0 dB -2	65	0.2	0.2	0.4	0.4	2.0	4.5	60	2.0	50	90	55	45	60	90	FIX.
	KT-6007	20-15K +0.5 dB -2.0	70	0.15	0.15	0.3	0.3	1.7	2.4	70	1.3	85	100	58	65	60	90	FIX.
	KT-8007	20-15K +0.5 dB -2.0	75	0.15	0.15	0.3	0.3	1.5	2.1	100	1.0	100	100	65	65	60	110	VAR.
LAFAYETTE	LT-825	30-12K	65	0.4	0.25	0.8		2.2	3	40	2.5	55	90	50	50	60	65	FIX.
	LT-D10	30-13K		0.3	0.2	0.4		1.5	2.0	65	1.5	75	100	60	55	70	90	FIX.
MARANTZ	112	30-15K	70	0.3	0.3	0.3		2.2	3	65	1.5	80	90	60			95	VAR.
	125	30-15K	73	0.2	0.2	0.2		1.8	2.5	80	1.1	100	100	63			100	VAR.
	150	30-15K	75	0.15	0.15	0.15		1.7	2.0	85	1.0	105	105	65			105	
NIKKO	FAM-220									40	3.0	50	80			50		
	FAM-500									50	2.0	80	100					
ONKYO	T-4055	20-13K	70	0.4	0.2	0.3	0.3	1.7	3.0	80	1.2	90	95	55	70	60	110	FIX.
PILOT	211	20-15K	65		0.4			1.8	5.0	70	1.5	80	90	40	60	70	95	FIX.

AM

MANUFACTURER	MODEL	FREQUENCY RESPONSE Hz ± 3dB	HUM AND NOISE dB IHF	THD % IHF	IM DISTORTION %	IMAGE REJECTION dB @ 600 kHz	IMAGE REJECTION dB @ 1400 kHz	IF REJECTION dB @ 1000 kHz	SENSITIVITY µV PER METER	SELECTIVITY dB @ ± 2.5 kHz	SELECTIVITY dB @ ± 10 kHz	AUDIO OUTPUT VRMS	OUTPUT IMPEDANCE OHMS	NUMBER OF INDICATORS
ACCUPHASE	T101	← NO AM SECTION →											200	3
	T100			0.5									200	3
DYNACO	AF-6	40-4.5K 40-2.0K 40-1.5K	40	2.0		60	60	70			20	2.0 VAR.		3
	FM-5	← NO AM SECTION →										2.0 VAR.		3
HEATH	AJ-15	← NO AM SECTION →										4.0 VAR. 1.5 FIXED	100 VAR. 9000 FIXED	3
	AJ-29		35	2.0		60	45	50	200			1.0 FM 0.6 AM FIX.	2000	3
	AJ-1214		35	2.0		75	65		100			1.0 FM 0.6 AM FIXED	3000-FM 1000-AM	1
	AJ-1510A	← NO AM SECTION →										1.0 FIXED	4700	2
JVC	VT-700		50			45	45		15			1.0 VAR.		2
	VT-900	← NO AM SECTION →										1.0 VAR.		3
	JT-V8		50			45	45	45	50			VAR.		2
KENWOOD	700-T		50	0.5	0.5	70	70	70	13		40	1.5 VAR.	100	2
	KT-4007		50	0.5	0.5	50	50	35	20		30	1.5 VAR.	1.8K	2
	KT-6007		50	0.5	0.5	70	70	70	13		35	1.5 VAR.	1.8K	4
	KT-8007		50	0.5	0.5	70	70	70	13		35	1.5 VAR.	100	4
LAFAYETTE	LT-825	30-2.5K	45	1.3		60	50	75	280		25	1.0 FIXED	4.7K	1
	LT-D10	30-3.5K	45	0.5		69	55	70	280	2.0	22	1.12 FIXED	680	2
MARANTZ	112	40-5K		0.7				60	20µV IHF	2.0		1.3 VAR.	1000	1
	125	40-5K		0.6				60	20µV IHF	2.0		1.7 VAR.	1000	2
	150	40-5K		0.6				60	20µV IHF	2.0		1.7 VAR.	1000	1
NIKKO	FAM-220		50					40	250		25		300 BAL.	1
	FAM-500		50					40	150		25	1.0 FIXED		2
ONKYO	T-4055	25-1.2K	50	0.5	0.5	37	47	33	150		32		2.5K FIX. 1.5K VAR.	2
PILOT	211	20-2.5K	45	2.0		60		65	250	3	35	2.0 VAR.	10K	3

MANUFACTURER	MODEL	TYPE OF INDICATORS	FEATURES	PRICE
ACCUPHASE	T101	SIGNAL STRENGTH METER TUNING METER MULTIPATH METER		450.00
	T100	SIGNAL STRENGTH METER TUNING METER MULTIPATH METER		650.00
DYNACO	AF-6	SIGNAL STRENGTH METER STEREO INDICATOR LIGHT TUNED INDICATOR LIGHT	AM 3-POSITION BANDWIDTH SWITCH (SEE FREQ RESPONSE) FM DYNATUNE	250 KIT 350 ASSBLD.
	FM-5	SIGNAL STRENGTH METER STEREO INDICATOR LIGHT TUNED INDICATOR LIGHT		175 KIT 279 ASSBLD.
HEATH	AJ-15	STEREO SIGNAL STRENGTH, TUNING	STEREO-ONLY MODE STEREO THRESHOLD NOISE FILTER PHASE CONTROL	239.95 KIT LESS CASE
	AJ-29	STEREO SIGNAL STRENGTH, TUNING	BLEND CONTROL 75 OR 300Ω FM ANTENNA	199.95 KIT LESS CASE
	AJ-1214	STEREO LIGHT	PLL-MPX 75 OR 300Ω FM ANTENNA	104.95 KIT LESS CASE
	AJ-1510A	STEREO LIGHT SIGNAL STRENGTH & MULTIPATH METER	DIGITAL READOUT DIGITALY SYNTHESIZED TUNING VARIABLE AGC OSCILLOSCOPE OUTPUT, MORE	559.95 KIT LESS CASE
JVC	VT-700	METERS	FM DETECTOR OUTPUT JACK	249.95
	VT-900	TUNING METER STEREO LIGHT TUNED LIGHT	SCOPE OUT JACKS FM DETECTOR OUT JACKS DIGITAL READOUT	399.95
	JT-V8	SIGNAL STRENGTH, TUNING	PHASE-LOCKED-LOOP	199.95
KENWOOD	700-T	SIGNAL STRENGTH, MULTIPATH		749.95
	KT-4007	SIGNAL STRENGTH, TUNING		229.95
	KT-6007	SIGNAL STRENGTH, TUNING, MULTIPATH, DEVIATION		319.95
	KT-8007	SIGNAL STRENGTH, TUNING, MULTIPATH, DEVIATION		419.95
LAFAYETTE	LT-825	SIGNAL STRENGTH METER	FM DETECTOR OUTPUT	149.95
	LT-D10	SIGNAL STRENGTH METER TUNING METER	DOLBY B PLL MPX DECODER FM DETECTOR OUTPUT	269.95
MARANTZ	112	DUAL PURPOSE METER (AM SIGNAL STRENGTH AND FM TUNING)	PHASE-LOCKED-LOOP FM DE-MODULATOR, 25µs/75µs FM DE-EMPHASIS	199.95
	125	SIGNAL STRENGTH, TUNING	PHASE-LOCKED-LOOP FM DE-MODULATOR, 25µs/75µs FM DE-EMPHASIS	329.95
	150	3-IN. OSCILLOSCOPE (2 & 4 CHANNEL DISPLAY, SIGNAL STRENGTH, TUNING, MULTIPATH)	PHASE-LOCKED-LOOP FM DE-MODULATOR, 25µs/75µs FM DE-EMPHASIS	599.95
NIKKO	FAM-220	TUNING METER		129.95
	FAM-500	SIGNAL STRENGTH METER TUNING METER	4-CHANNEL FM ADAPTABLE	159.95
ONKYO	T-4055	SIGNAL STRENGTH, TUNING		219.95
PILOT	211	FM PILOTUNE POINTER FM CENTERTUNE METER AM SIGNAL STRENGTH	FM DETECTOR OUTPUT 75/300 OHM ANTENNA SELECTABLE AFC MULTIPLEX FILTER	199.90

		FM STEREO												FM MONO																	AM															
MANUFAC-TURER	MODEL	FREQUENCY RESPONSE Hz ± 1dB	S/N RATIO dB IHF	THD @ 100Hz % IHF	THD @ 1 kHz % IHF	THD @ 6 kHz % IHF	IM DISTORTION % IHF	SENSITIVITY µV IHF	SIGNAL FOR 50dB QUIETING µV IHF	CHANNEL SEPARATION dB @ 50Hz	CHANNEL SEPARATION dB @ 1 kHz	CHANNEL SEPARATION dB @ 10 kHz	CHANNEL SEPARATION dB @ 15 kHz	FREQUENCY RESPONSE Hz ± 1dB	S/N RATIO dB IHF	THD @ 100Hz % IHF	THD @ 1 kHz % IHF	THD @ 6 kHz % IHF	IM DISTORTION % IHF	SENSITIVITY µV IHF	SIGNAL FOR 50dB QUIETING µV IHF	SELECTIVITY dB IHF	CAPTURE RATIO dB IHF	IMAGE REJECTION dB IHF	IF REJECTION dB IHF	AM SUPPRESSION dB IHF	CARRIER SUPPRESSION dB IHF	SCA SUPPRESSION dB IHF	SPURIOUS REJECTION dB IHF	MUTING	FREQUENCY RESPONSE Hz ± 3dB	HUM AND NOISE dB IHF	THD % IHF	IM DISTORTION %	IMAGE REJECTION dB @ 600 kHz	IMAGE REJECTION dB @ 1400 kHz	IF REJECTION dB @ 1000 kHz	SENSITIVITY µV PER METER	SELECTIVITY dB @ ± 2.5 kHz	SELECTIVITY dB @ ± 10 kHz	AUDIO OUTPUT Vrms	OUTPUT IMPEDANCE OHMS	NUMBER OF INDICATORS	TYPE OF INDICATORS	FEATURES	PRICE
PIONEER	TX-6200	20-15K			0.4					30	40	30			70		0.2			1.9		60	1.5	60	90	50	60		75	FIX.		50			40	40	50	15			1.8 VAR.	2.5K	1	TUNING METER		139.95
	TX-7100	20-15K			0.4					30	40	30			70		0.2			1.9	7.5	60	1.0	80	100	55	65		100	FIX.		50			45	45	55	15			2.0 VAR.	300/ 4.7K	2	SIGNAL STRENGTH, TUNING		199.95
	TX-8100	20-15K			0.4					30	40	30			70		0.2			1.8	5.0	80	1.0	85	100	55	65		100	FIX.		50			65	65	85	15			2.0 VAR.	300/ 4.7K	2	SIGNAL STRENGTH, TUNING		249.95
	TX-9100	20-15K			0.3					30	40	30			75		0.2			1.5	4.0	90	1.0	110	110	65	65		110	VAR.		50			65	65	85	15			2.0 VAR.	300/ 4.7K	2	SIGNAL STRENGTH, TUNING		349.95
	TX-9500	20-15K	75	0.2	0.2				35	35	40	35			80	0.15	0.15	0.15		1.5	2.5	85	1.0	110	110	55	65		110	VAR.		50			65	65	65	15			2.0 VAR.	3.5K/ 5.0K	2	SIGNAL STRENGTH, TUNING		399.95
SANSUI	TU-505				0.8						35			30-15K	65		0.6			2.5		50	2.5	50	60				60	FIX.							80			25	1.0 FIX.		2	SIGNAL STRENGTH METER STEREO INDICATOR LAMP	AM/FM NOISE SUPPRESSOR SWITCH TWO PAIRS OUTPUTS	179.95
	TU-5500				0.4						40			20-15K	70		0.3			1.9		60	2.0	55	80				34	FIX.							80			30	0.775 VAR.		3	SIGNAL STRENGTH METER TUNING METER STEREO INDICATOR LAMP	DISCRIMINATOR OUTPUT 50/75µs FM DE-EMPHASIS MPX NOISE CANCELLER TWO PAIRS OUTPUTS	279.95
	TU-4400				0.4						40			30-15K	70		0.3			2.0		60	2.0	55	80				70	FIX.							80			30	0.775 VAR.		3	SIGNAL STRENGTH METER TUNING METER STEREO INDICATOR LAMP	DISCRIMINATOR OUTPUT 50/75µs FM DE-EMPHASIS	199.00
	TU-7700				0.3						40			20-15K	75		0.2			1.8	3.0	80	1.5	75	90				34	FIX.							80			30	0.775 VAR.		3	SIGNAL STRENGTH AND MULTIPATH METER TUNING METER STEREO INDICATOR LAMP	DISCRIMINATOR OUTPUT 50/75µs FM DE-EMPHASIS MPX NOISE CANCELLER TWO PAIRS OUTPUTS	329.00
	TU-9500				0.3						40	30		30-15K	75		0.2			1.7	3.0	80	1.5	100	100				100	VAR.							100			25	1.0 VAR.		3	SIGNAL STRENGTH METER TUNING METER STEREO INDICATOR LAMP	DISCRIMINATOR OUTPUT FM MULTIPATH OUTPUT TWO PAIRS OUTPUT	349.00
H. H. SCOTT	T33S	20-15K	68		0.3			3.7	20	30	40	22	18	20-15K	70		0.25			1.9	9	75	2.0	82		75	80	70	85	VAR. (INT. ADJ.)	← NO AM SECTION →										1.5 VAR. (REAR PNL.)	600	5	SIGNAL STRENGTH METER MULTIPATH METER, SEP'RT. FUNC. LIGHTS FOR STATION, STEREO, CARD PROGRAM	DIGITAL FREQ., SYNTHESIS NIXIE TUBE READOUT, STATION SELECTION BY MAN'L, MONO/STEREO SCAN	999.95
	T311S	25-12K ± 2.0 dB	50		2.0			5.0	1000					25-12K ± 2.0 dB	60		0.8			2.5	5.5	50	3.5	60	65			55		FIX.	30-1.8K							150	2.5	30	0.8 FIX			SIGNAL STRENGTH METER STEREO LIGHT	300 OR 75Ω FM ANTENNA	169.95
SEQUERRA	MODEL 1	20-15K ± 0.2 dB	75	0.11	0.12	0.3		4	40	53.5	53	40	36.5	20-15K ± 0.2 dB	75	.042	.085	.175		2.0	3.0	130	0.7	70		70	75	75	90	VAR.	← NO AM SECTION →										1.0 VAR.	750		SCOPE (OPTIONAL $500 PANARAMIC DISPLAY)		2,000.00
SHERWOOD	SEL-300	20-15K	62	0.3	0.3	0.5		7	45	35	40	34	30	20-15K	70	0.15	0.15	0.2		1.5	3.0	85	1.5	80	110	65	60	65	100	VAR.	← NO AM SECTION →										1.0 VAR.	600	2	SIGNAL STRENGTH METER TUNING METER		499.00
	S-2400	20-15K	62	0.3	0.3	0.6		5	45	25	40	35	25	20-15K	70	0.25	0.25	0.5		1.8	3.0	65	1.5	85	100	60	60	65	90	FIX.	20-3K	50	1.0		70	70	80	50	4	30	1.0 VAR.	3K	2	SIGNAL STRENGTH METER TUNING METER		229.95
SONY	ST-4950			0.4	0.3	0.9				30	40	30		20-15K	70	0.3	0.15	0.2		1.9	4.0	80	1.0	70	100	53	60	60	100	FIX.			0.5				35	251			2.0 VAR.	3K	2	SIGNAL STRENGTH METER TUNING METER	PHASE-LOCKED-LOOP MOS FET LED POINTER	350.00
	ST-5055				0.6						35			30-15K ± 2.0 dB	68		0.4			2.2		70	1.0	45	95	45			75	FIX.			0.5		70	45	65	316			1.5 VAR.	1.8K	1	SIGNAL STRENGTH METER		210.00
	ST-5066				0.8						35			30-15K ± 2.0 dB	68		0.5			2.2		55	1.5	45	95	45			75	FIX.			0.6				40	251			1.5 FIXED	3.3K	1	SIGNAL STRENGTH METER		170.00
	ST-5130			0.4	0.3	0.6				25	42	30		20-15K	75	0.2	0.2	0.4		1.5	2.3	100	1.0	100	100	60	60	55	100	FIX.			0.6		45	40	41	316			2.0 VAR.	1.8K	2	SIGNAL STRENGTH METER TUNING METER	INS NOISE SUPPRESSOR	370.00
	ST-5150			0.5	0.5	0.9				30	40	20		20-15K	70	0.3	0.3	0.5		2.0	2.7	70	1.0	70	90	56	60	55	90	FIX.			0.6		45	40	40	316			2.0 VAR.	1.8K	2	SIGNAL STRENGTH METER TUNING METER		280.00
	STC-7000			0.5	0.3	0.5				35	40	20		30-15K	70	0.3	0.2	0.5		1.7	2.5	100	1.0	90	100	60	60	65	100	FIX.			0.8		45	40	41	447			2.0 FIX.	1.8K	2	SIGNAL STRENGTH METER TUNING METER	WITH CONTROL AMPLIFIER	590.00
SUPERSCOPE	T-220	30-15K	55	0.5	0.5	1.2	2.0	10	20	32	33	30	24	30-15K	65	0.3	0.35	1.0	2.0	3.0	5.0	45	3.5	45	70	40	53	75	85	FIX.	15-3.5K	60	1.0	1.5	27	43	42	300		22	0.5 VAR.	47K	2	SIGNAL STRENGTH STEREO LIGHT		179.95
TOSHIBA	ST-500	20-15K			0.5						35			20-15K	66		0.2			1.8		80	1.5	80	80	50			100	FIX.		45	1.0		70	70	70	15			2.0 VAR.		2	SIGNAL STRENGTH METER TUNING METER		239.95
	ST-910	20-15K ± 0.5 dB			0.1						40			20-15K ± 0.5 dB	75		0.1			1.8		85	1.5	100	100	65			100	VAR.	← NO AM SECTION →										2.0 VAR.	1K	23	LED		1800.00
	ST-410	20-15K ±3 dB									40			20-15K ± 3 dB	66		0.3			2.0		60	1.5	75	80	50			100			40	1.0		30	30	35	300			1.5 VAR.	10K	2	SIGNAL STRENGTH, TUNING		239.95
YAMAHA	CT-600		66											50-10K	70					2.0		75	1.5	90													70									270.00
	CT-800		72	0.3						35	35	35		50-10K ± 0.5 dB	75					1.7		80	1.0	90	100	55	80	80	100	VAR.			0.8				70						3 LED / 2 MTRS.	POWER, AFC, STEREO / SIGNAL STRENGTH, TUNING		370.00
	CT-7000		75	0.5	0.5	0.5			50	35	35	35		30-15K +0.5 -1.0 dB	78	0.3	0.3	0.3		2.5	4	80	1.0	120	120	60	70	70	120	VAR.	← NO AM SECTION →										70µV-2V VAR.		2 LED / 2 MTRS.	STEREO, AFC / SIGNAL STRENGTH, TUNING		1,200.00

NOTE: BLANK SPACES INDICATE SPECIFICATIONS NOT SUPPLIED BY MANUFACTURER.

strength plus multipath meter. Sony in its deluxe FM spectrum scanner tuner at $1699.50 has a 5-stage signal-strength indicator. Signal-strength indication is shown in progressive steps, with lights representing input signals at 5, 30, 100, 300 and 1,800 μV. The Yamaha FM-only CT7000 offers a center-tuning meter plus a signal-strength type which additionally functions for multipath indication.

The "with-it" audio buff knows the importance of a good antenna for top FM and FM stereo reception. He also knows how important it is for the antenna to be properly oriented. Hence, he often buys a rotator with at-set control. In addition to providing the best signal, the rotator permits easy antenna adjustment to avoid multipath distortion. The audio sophisticate with such an antenna rig is the one on the lookout for tuners that have some form of antenna orientation indicators.

Onkyo in its T-4055 at $219.95 provides an audible multipath control switch that enables the listener to position the FM antenna by listening to a noise signal. The circuit also has terminals on the tuner's back panel to permit using a scope for more precise antenna orientation. Pioneer in its TX-7100 at $179.95 and TX-8100 at $229.95 provides multipath output terminals on the back panel for attaining optimum antenna direction adjustment when used with a scope or a stereo display unit such as the Pioneer SD-1100. Sansui in its TU-7700 uses the signal meter for multipath reading and antenna orientation, along with a terminal for scope observation. Sansui's TU-9500 at $349.95, Yamaha's CT-7000 and three Sony models, among others, permit using a scope to check for multipath.

Some of today's tuners furnish headphone listening via a front panel jack. Such a tuner can fill a specialized need, eliminating the use of a separate amplifier. Such a tuner might be an ideal "block" in a total system put together in "building-block" fashion on a long range basis due to budget or other considerations. This type might also be of special appeal to the sophisticate who is looking for the most direct connection with a broadcast station—the "straight wire with gain" approach.

Nine of the survey models have headphone listening. Of those, six offer separate level controls for the headphone output. Those tuners are Kenwood 700-T, Pioneer TX-8100, Rotel RT-1220, Sherwood SEL-300 at $499, Sony ST-5130 at $369.50, and Sony ST-5555.

Another feature of value to some audio buffs is direct recording capability from a tuner, to bypass the amplifier in a total component system. In some cases a front panel tape jack is provided, in others, the connection is made at the rear panel. Lafayette supplies both types of connection in its LT-725B and LT-D10, the latter at $269.95. A dozen companies of the survey group have tape outputs in their tuners.

A few manufacturers have been anticipating the future via the addition of built-in Dolby noise reduction circuitry for improving FM and FM stereo reception. While only a handful of stations are now broadcasting Dolbyized programs, more will be doing so at an ever accelerating pace, according to industry seers. It is to the broadcasters advantage to do so; Dolbyized broadcasting virtually doubles a station's coverage, a significant factor where station competition for listening audiences is keen. For the listener, not only does the Dolby circuitry produce an improved s/n ratio, but in effect it doubles the signal power picked up by the antenna.

To our knowledge, Harman/Kardon was the first company to sell Dolby tuners. Its Citation 14 is Dolbyized. Built-in Dolby is also available in the Lafayette LT-D10 and the Sequerra Model 1 at $2500.

Several companies are also anticipating the future on another front—four-channel discrete broadcasting. While the Federal Communications Commission is still weighing the merits of some half dozen discrete broadcasting systems, audio manufacturers are getting ready for the day when one of the systems will be approved by the FCC and the go-ahead is given for discrete 4-channel broadcasting. The following firm's tuners furnish output jacks for a discrete 4-channel adaptor: Harman-Kardon, JVC, Kenwood Lafayette, Marantz, Nikko, Onkyo, SAE, Sherwood, Superscope, Toshiba, and Yamaha.

Deluxe tuners

Regarded by sophisticates as the *ne plus ultra* (for operational as well as "status" reasons) are the so-called "computer" tuners featuring digital readout. One of this breed is the SAE Mark VI. SAE claims it is the industry's first FM tuner that features a direct numerical readout of the assigned frequency in MHz of the FM station tuned. The unit further contains a 3-inch rectangular oscilloscope for the display of tuning and audio signals. Among its functions, the scope accurately displays the presence of multipath distortion, center-of-channel tuning, and relative signal strength.

H. H. Scott in its T33S at $999.95 gives digital readout of FM stations, automatic tuning, and preselection by punched cards. The company claims it was the first in the world to demonstrate the digital frequency synthesis technique (used in this unit) in its Model 433 back in 1970. The digital synthesizer portion has been designed to make the channel spacing 100 kHz—so it will work equally well in North America and Europe.

The most expensive tuner on the market today as far as we know, is the Sequerra Model 1, priced at $2500 including a $500 optional panoramic display, Dolby circuitry, and a full five-year warranty. (Sequerra is one of the three newcomers in the tuner business, as noted earlier.) Featured in the Model 1 is a 4½-inch flat face oscilloscope that shows four functions. One is a panoramic view of all broadcasting FM stations located 1 MHz above and 1 MHz below the tuned frequency. (This panoramic display is the $500 option.) The second is a fine tuning display showing the instantaneous carrier deviation of the tuned FM station against the derived signal strength plus AM products of multipath. The third is a stereo display showing left and right stereo channels along a perpendicular axis. It is used to check separation and phase characteristics of stereo program material. Fourth is a display showing external information of mono, stereo or quad sources. It depicts phase characteristics, amplitude, separation, etc. The tuner's station frequency is displayed on a digital readout.

Next in line on the cost scale—$1,699.50—is Sony's ST-5555, an FM-only tuner whose computer circuitry automatically tunes in stations with a claimed 99.995% accuracy. Its most obvious feature is its array of 100 illuminated push buttons—one for each of the hundred FM channels from 88.1 through 107.9 MHz—which allow instant selection of any FM channel. Tuning is controlled by a quartz reference frequency oscillator and phase-locked-loop circuitry. The unit may also be set to automatically sweep the entire FM band, stopping automatically at all receivable stations, or its scanning circuitry may be programmed to skip certain stations, as desired.

Heath in its Heathkit AJ-1510 at $579.95 provides FM and FM stereo reception via what it calls "an all-electronic computer keyboard. Lightly touch the keys (10) and a state-of-the-art digital frequency synthesizer does the tuning —with the channel frequency accuracy better than 0.005%! Four glowing readout tubes show you exactly where you are." An AUTO-SWEEP button causes the synthesizer to automatically scan the FM spectrum—stopping at those stations with a listenable signal, or only stereo stations, as preferred. The unit allows selection of one of three pre-programmed stations at the touch of another button. Computer-type punch cards are used to place the stations of choice into the tuner's memory. R-E

all about curve tracers

This article tells what to look for when purchasing a curve tracer; how to test different solid-state devices, and how to interpret the resulting waveforms

by CHARLES GILMORE*

THE CURVE TRACER HAS BEEN IN USE for some time in the research laboratory and most recently it has been turning up in the service shop. There are two reasons for this. Until recently there was no real need for analysis of active circuit components in the service business. Devices were few and simple in nature (vacuum tubes, diodes, and simple transistors). Second, curve tracers have been expensive.

Time and instruments have changed. Electronic equipment no longer contains only a few active devices whose characteristics are well known. Instead, they have many different devices of disparate characteristics to be replaced, substituted for, or matched to properly service the product. Solid-state devices cause these service problems because they come in many different types, and most importantly, the characteristics of devices with identical parts numbers will vary by factors of two to one or more. This often means service by substitution, not exact replacement.

The curve tracer can help solve many service problems. If a device is to be replaced and there is a question as to the proper replacement, the curve tracer can be used to determine the exact characteristics of the new device. If you don't know the type number of a particular device, the curve tracer will reveal the unique identification curves of the component, and so its suitability.

Because of increased demand and improved electronic technology, prices on curve tracers and curve-tracer adaptors have dropped from many thousands of dollars to less than one hundred dollars for adaptors and complete curve tracers are available for less than one thousand dollars. The problem is no longer the acquisition of a curve tracer or a curve tracer adaptor; it is now learning how to use the instrument to provide maximum return on the investment.

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Fundamentals

The curve tracer draws a graph that is a picture of how the output current of a device varies with changes of input voltage (or current) and output voltage. The user controls the input signal and the output voltage, the curve tracer draws the resulting graph. This graph has output current as the vertical axis and output voltage as the horizontal axis. A new curve is drawn for each input variation desired. The result is a family of curves, such as those shown in Fig. 1 for a simple npn transistor.

Figure 2 is a simplified block diagram of a curve tracer. The vertical amplifier, horizontal amplifier and the crt form a simple low-bandwidth oscilloscope. The curve-tracing sections are the sweep supply and the step generator. In this example an npn transistor is being tested. The sweep voltage provides increasing voltage across the transistor (between the collector and emitter) and is used to deflect the oscilloscope beam from left to right. Generally, this voltage is a full-wave rectified signal derived from the line via a transformer. A switch sets various voltage ranges and a variable control selects the sweep voltage value within this range. Sweep voltage is applied to the transistor through limiting resistor R_{IL} to protect the device. Note that the scopes horizontal deflection signal is connected so that beam deflection represents the actual voltage being impressed across the

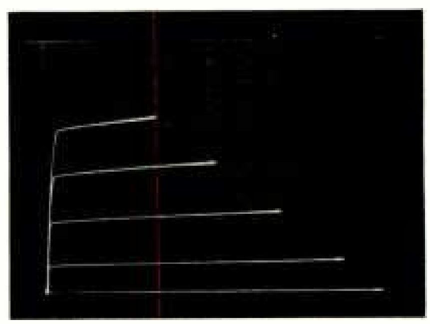


FIG. 1—THIS FAMILY OF CURVES was produced for an npn transistor using the equipment shown in the photo at the top of this page.

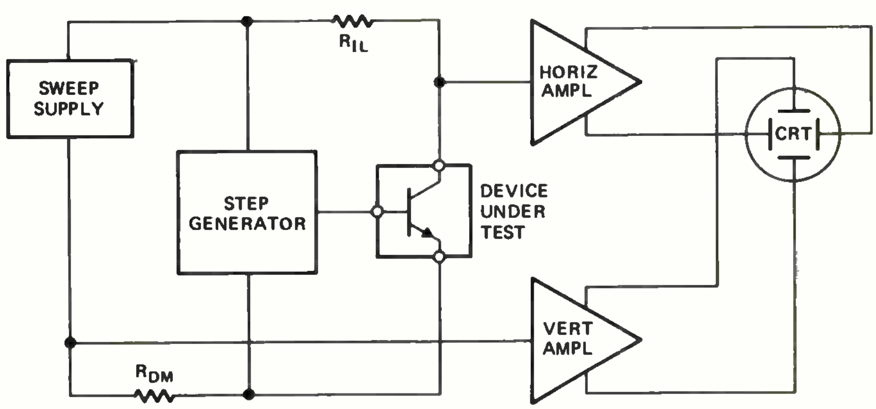


FIG. 2—SIMPLIFIED BLOCK DIAGRAM OF A CURVE TRACER. The sweep supply and step generator develop the special waveforms used to exercise the device under test. The horizontal and vertical amplifiers and the CRT comprise the display. R_{IL} consists of a number of switch selected current limiting resistors and R_{IM} is a current sensor in series with the sweep supply, that creates a signal proportional to the sweep current.

device. After each complete cycle of the sweep voltage, the current (or voltage) of the step generator is advanced to the next higher step. Resistor R_{IM} in series with the sweep supply converts the sweep current to a voltage. This voltage is applied to the scope's vertical amplifier to provide vertical deflection proportional to sweep current.

During the first sweep, an increasing voltage is applied to the collector of the transistor; but there is no base current, as the step generator is at the zero step. As the sweep voltage is increased to its peak value and then returned to zero, the spot on the crt, that was initially positioned at the lower left hand corner of the tube face, moves across the crt face to the lower right hand corner and then returns to the lower left hand corner. Assuming that breakdown voltages of the transistor are not exceeded and that there are no large leakage currents, there will be no collector current flowing through the transistor during this first sweep, so there will be no vertical deflection, and a straight line will be drawn (Fig. 3-a).

When the first sweep is complete, the step generator advances from the zero step to a level of current selected as the step value. As the sweep moves the spot across the crt and applies voltage to the collector of the transistor under test, collector current flows (because there is base current). This causes a voltage drop on current sensing resistor R_{IM}, that causes vertical scope deflection during this second sweep. This trace is in Fig. 3-b. Note that under very low collector voltage (to the left of the knee), current through the transistor is limited by the "on" resistance of the device and the applied collector voltage. After the collector voltage has increased sufficiently, the current drawn depends upon the beta of the device and is essentially constant.

Succeeding sections of Figure 3 (Fig. 3-c and 3-d) show how each individual curve in the family of curves is generated as the step generator increases its value by one current unit after each sweep. Because each of these curves is being generated in 1/120th of a second, the eye cannot see them being individually created. The result is the composite picture in Fig. 3-d.

The sweep generator, current limiting resistors, and step generator values can be selected over a wide range to accommodate a variety of semiconductor devices. (This is discussed in more detail later.) The step generator and the sweep generator both have polarity reversal capability so npn and pnp devices can be examined. The step generator may be changed from current steps to voltage steps to test field-effect devices.

Curve tracers come in two forms—as complete units, or as adaptors. The

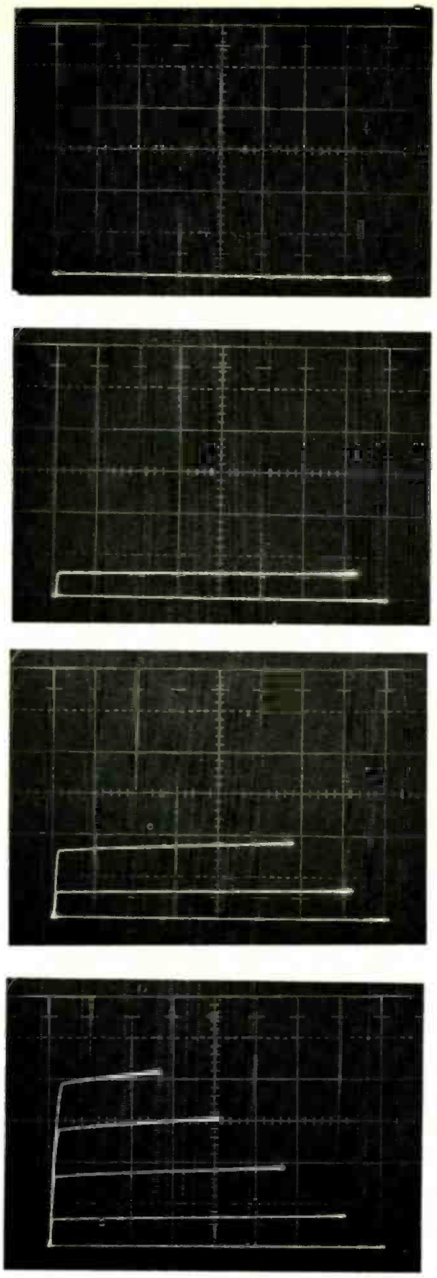


FIG. 3—THE SEQUENTIAL DEVELOPMENT of a family of curves. The curve tracer settings are: step current, 0.02 mA/step; collector series limiting resistance, 1000 ohms; horizontal sensitivity, 2 volts/cm; and vertical sensitivity, 5 mA/cm. A. Base current at zero step. B. Base current is 0.02 mA/step. C. Base current is 0.04 mA step. D. All steps shown. 0, 0.02, 0.04, 0.06, and 0.08 mA.

adaptor plus a low cost simple scope makes a complete curve tracer. The primary advantage of the adaptor is cost. The scope is not committed to the curve tracer when the curve tracer is not being used. For small shop, experimenter, or infrequent user, this often represents the most economical way to get curve tracing capability. The disadvantage of the adaptor are the reassembling of the curve tracer configuration each time it is to be used, and its lack of portability. The question of curve tracer vs. curve tracer adaptor is primarily one of shop economics.

Specifications

To properly select and use a curve tracer, the specifications must be understood. Specifications define the limits of measurement that can be made with a certain curve tracer, such as voltage ranges, power limits, and current resolution.

1. Sweep (Collector) Supply—The two primary characteristics of the sweep supply are its voltage ranges and current capabilities. The more complete (sophisticated) curve tracers have a number of voltage ranges, each with a maximum current level for that range. The less complex instrument usually has at least two voltage ranges. One of them should give reasonable resolution for small signal and medium power devices. The other range should deliver enough voltage to make breakdown tests. Typical minimum ranges might be 0 to 40 volts at 1 amp and 0 to 200 volts at 0.2 amp. More sophisticated tracers will give ranges to the 1000 or 1500 volts. Some curve tracers provide a dc mode of operation where a sweep voltage of filtered dc is obtained. The dc mode allows special low-current measurements for situations where the sweeping action of the full wave-rectified signal is not desirable. To measure npn/n-channel as well as pnp/p-channel devices, the sweep voltage must be able to provide positive voltage sweeps as well as negative ones.

2. Sweep limiting resistors—To limit current through the device under test to a reasonable maximum for the particular device, a set of series limiting resistors is provided. These usually range from zero ohms to some upper value that is a function of the highest sweep voltage that may be obtained.

3. Horizontal sensitivity—Indicates the amount of sweep voltage (applied to the device under test) required to cause one division of horizontal deflection on the crt of the curve tracer display. The range of sensitivities required is bounded on the upper end by the maximum sweep voltage, so that a curve tracer with 0 to 200-volt sweep and an 8 by 10-division screen would need a minimum sensitivity of 20 volts per division. The maximum sensitivity should allow a full horzontal presentation of no more than a volt, giving a lower boundary of 0.1 volt per division. Both horizontal and vertical sensitivities are usually adjustable in a 1–2–5 sequence to yield the best resolution at all settings. 1–10–100 sequences usually will not provide enough resolution for signals in the 3 to 7 unit range.

4. Vertical sensitivity—Specifies the the amount of current that is required to cause one division of deflection in the vertical axis. Again, the upper bound of this sensitivity is governed by the amount of current that the sweep generator can supply. If the curve tracer can supply 1-amp and the scope screen is 8 × 10 divisions, then the minimum verticle sensitivity must be at least 1 amp/8 division or 125mA/cm. However, as noted before, a 1–2–5 sequence is usually kept on the vertical axis and, therefore, a minimum sensitivity of 200 mA/division would be used. The maximum sensitivity should give full screen deflection with a few milliampers. The better the curve tracer, the greater this sensitivity will be. Typical values run from 500-μA/division to 1-μA/division. Most work done with small-signal discrete devices can be done with a 0.5 mA/division (500 μA/division) sensitivity. However, design and evaluation work on integrated circuits requires sensitivities in the 1-μA region.

The maximum sensitivities of the curve tracer can be improved if an adaptor is being used and the scope's deflection sensitivity is better than that required by the adaptor. For example, let's say we have a curve-tracer adaptor that requires a scope with a 100 mV/cm vertical sensitivity. If this adaptor has a maximum vertical sensitivity of 500 μA/cm, it can be improved to 50 μA/cm by setting the scope deflection to 10 mV/cm.

5. Step generators—In curve tracers they can usually operate in one of four modes. These are: a. Positive current steps; b. Negative current steps; c. Positive voltage steps; and d. Negative voltage steps. In the more elaborate curve tracers, the zero-step voltage or current may be offset from zero volts or amps by some positive or negative dc value. Step ranges depend upon the type of devices that the user expects to measure. A typical spread of steps to give fair measurement capability would be 2 μA to 10 mA per step in a 1–2–5 sequence. Voltage steps tend to be less numerous than current steps, as most measurements are confined to a smaller dynamic range. A typical range of voltage steps on a low-cost unit is 50 mV to 1V per division, again in a 1–2–5 sequence.

6. Accuracy—In the curve tracer, accuracy is generally similar to that expected when using an oscilloscope. Accuracies of ±3% to ±5% are typical of the vertical and horizontal amplifiers, and the step generator. There is usually some additional degrading of the accuracies involved when a horizontal or vertical magnifier is used. Accuracy of the curve tracer measurements is not the most important factor to consider, as the relative measurements and the shapes of curves are far more important.

7. Features—Additional features that may or may not be available with a curve tracer or a curve-tracer adaptor make certain measurements easier or more difficult. Features that simplify making measurements are:

a. Dual sockets or test positions, with an A/B switch allow the user to test two similar devices for difference characteristics or to connect a device to the curve tracer for testing and then disconnect it quickly. This is frequently used when matching semiconductor devices.

b. External connections to the E, B, and C terminals allow connecting clip leads to the curve tracer, permitting in-circuit measurements of devices or even large sections of the circuit itself.

c. Special clips that permit the quick connection of devices, especially diodes, for large quantity testing.

d. Magnifiers, either horizontal or vertical, allow the user to expand the trace (usually by a factor of 5 or 10) and examine a particular area in more detail.

e. Safety covers. On certain curve tracers the device being tested is placed in a socket contained in a small box whose cover must be closed before energizing the sweep voltage. This is done as a safety feature, as the sweep voltages can become quite high. It should be noted at this time that care must be observed when testing semiconductors on a curve tracer, as very high voltages may be present on the device.

Device and circuit testing

There are basic operating connections for different classes of semiconductors and curves on the curve tracer that should be familiar to the user. These basics can then be extended to other similar devices or circuits. To simplify the setup procedure for common devices, use the set-up table for determining connection, polarity, types of steps, etc. Succeeding sections will familiarize the user with common semiconductor devices.

1. Diodes—Although the curve tracer is designed to test transistors, tubes, etc., it can also test diodes, resistors, etc. If a positive voltage is applied to the anode of a diode, a current flows through the diode. If a negative voltage is applied to the anode of a diode, no current will flow. Figure 4 shows the forward conduction characteristics of a 1N4149 small signal/silicon diode, along with the required curve tracer settings. Connect the diode between the collector (anode) and the emitter (cathode) terminals of the curve tracer. As for any 2-terminal device, the step generator is not required. The curve on the crt is a current versus voltage plot. The sweep voltage provides the variable (voltage) and the current resistor monitors variations in sweep current as a function of the sweep voltage.

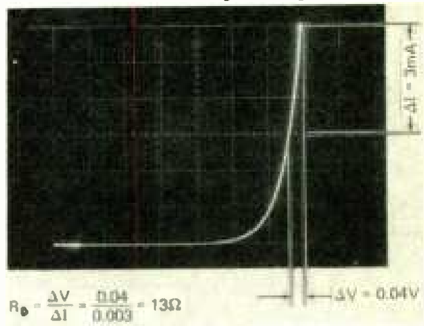


FIG. 4—THE FORWARD CHARACTERISTICS of the 1N4149 silicon small signal diode. The curve tracer settings are: anode series limiting resistance, 1000 ohms; horizontal sensitivity, 0.1 volt/cm; vertical sensitivity, 1 mA/cm. The step generator is not used in a two-terminal measurement.

On the diode curve, not much, if any, current flows below approximately 0.7 volt. At that voltage the diode begins to conduct, and thereafter the current versus voltage becomes a straight line whose slope is the resistance of the conducting diode. The dynamic resistance of the diode during conduction is calculated by selecting a portion of the curve that is nearly linear, determining a change in voltage (ΔV), and the change in current (ΔI) caused by this change in voltage. The dynamic resistance of the diode at that point is then determined by:

R_D = ΔV/ΔI =   /   =   ohms

It is interesting to note that at the knee (the point where the diode begins to conduct) the diode is definitely not linear. This nonlinearity is often used for special functions, such as logarithmic amplifiers. Germanium diodes differ from their silicon cousins primarily in the forward voltage value at which they begin to conduct. Figure 5 shows how the "on" characteristics of the germanium diode (1N191) differ slightly from those of the silicon diode.

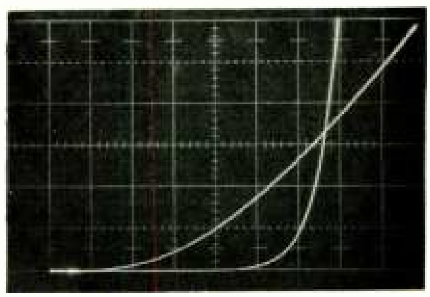


FIG. 5—THE FORWARD CHARACTERISTICS of the 1N191 germanium small-signal diode superimposed on the characteristics of a 1N4149 silicon diode. Settings are: anode series limiting resistance, 1000 ohms; horizontal sensitivity, 0.1 volt/cm; vertical sensitivity, 1 mA/cm. Note the difference in the slope and break point of the germanium diode compared to those of the silicon diode.

(to be continued)

TV TYPEWRITER II

by ED COLLE

Build this new TV Typewriter. It has many new features including plug-on option boards

IN LAST MONTH'S ISSUE OF **Radio-Electronics**, we presented the schematic diagram and a generalized description of the TV Typewriter II. This month, the article will continue with a technical description of how the circuit works plus some of the foil patterns for the circuit boards.

The entire circuit is built on one double-sided printed circuit board with the exception of the memory and option boards that plug perpendicularly onto the main board. The total size including the plug-on options is 12" long × 9¾" wide × 3½" high. The circuit boards are double-sided, with plated-through holes, eliminating a good many jumpers. It is not the sort of project to be attempted by the inexperienced beginner, but the experienced hobbyist should have little trouble.

How it works

The entire screen of the video display has been arranged for 16 lines of 32 characters each. Although the second page of memory allows twice as many characters to be stored in memory, only one page can be displayed at a time. Each character displayed is actually an array of 35 dots arranged in a 5 × 7 pattern—5 horizontal and 7 vertical dots. The 2513 character generator decodes the binary ASCII data provided at its input terminals from memory into the correct dot patterns for the character to be displayed. The dots are selected and used one character row at a time since television receivers sweep the trace horizontally one video line at a time. Horizontal spacing between characters is provided by displaying a blank dot column between each displayed character and vertical spacing is provided by sweeping three blank video lines between each set of seven "character dot video" lines. This means our vertical data is 10 lines/character × 16 character row = 160 "character-dot video" lines. Our television or video monitor also requires a vertical and horizontal sync pulse in addition to the actual video data, so the TV typewriter must generate these signals too.

The timebase oscillator initiates the horizontal sync pulse and starts the chain of events that generate one line of video data to be displayed. The circuit itself is a phase-locked-loop (PPL) used as a frequency multiplier. IC1 is used as an astable voltage controlled oscillator with bipolar transistors Q3 and field effect transistor (FET) Q4 along with C12 forming a sample-and-hold circuit that feeds IC1's voltage control input through FET Q5. The sample-and-hold in this case is being used as a phase comparator providing an output voltage pro-

portional to the phase difference of the 60-Hz power line and the multiplied output frequency of IC1. The actual amount of frequency multiplication is equal to the amount of frequency division between the output of the oscillator IC1 and the input reference frequency. As we will see later, the value of the frequency divider is 262, and since our reference is 60 Hz the f_o = 60 Hz × 262 or 15720 Hz which is very close to the horizontal oscillator frequency of a standard television set.

The output of IC1 is fed via inverter IC20-d to IC9-a and b where among other things a 4-μs horizontal sync pulse is generated. From here the pulse is routed to IC17-a where it is OR'ed with the vertical sync pulse which will be described in detail later.

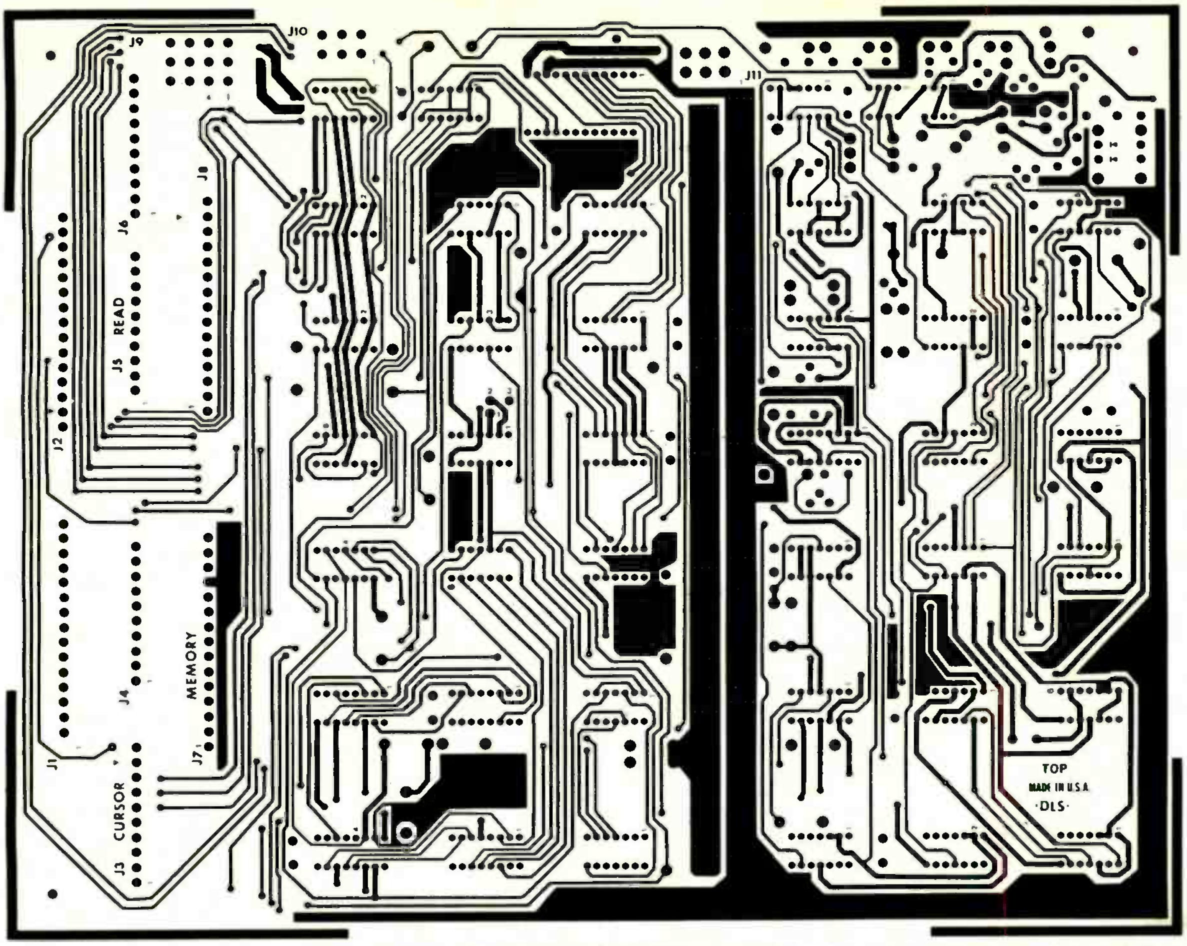
The falling edge of this sync pulse at the output of IC19-b triggers IC18-a, a one shot, which puts out a positive pulse on pin 4 that can be adjusted by potentiometer R4 from 4 to 20 μs. The delay pulse creates a lag between the television's start of video sweep and the TV Typewriter's generation of data, thus giving an adjustable left margin. Pin 4 of IC18-a inhibts dot oscillator IC18-b through AND-OR-INVERT gate IC11-a. Pin 13 resets IC21 and IC14, the 16-bit counters that keep track of the selected horizontal character. Since we are just starting a new line, we must first clear the counter to prepare it for incoming data. At the end of a high-to-low transistion of pin 4, IC6, the row counter is incremented and if there is a RIPPLE CARRY, IC7, the line counter is incremented as well.

The row counter, IC6, is a decade counter that keeps track of each of the ten horizontal lines forming a character row. Remember, we said earlier that each character would be formed by 7 vertical dot rows and three blank lines for vertical spacing, well, IC6 has a distinct BCD output for each of these 10 lines and tells the rest of the circuitry which of the 10 lines it is generating.

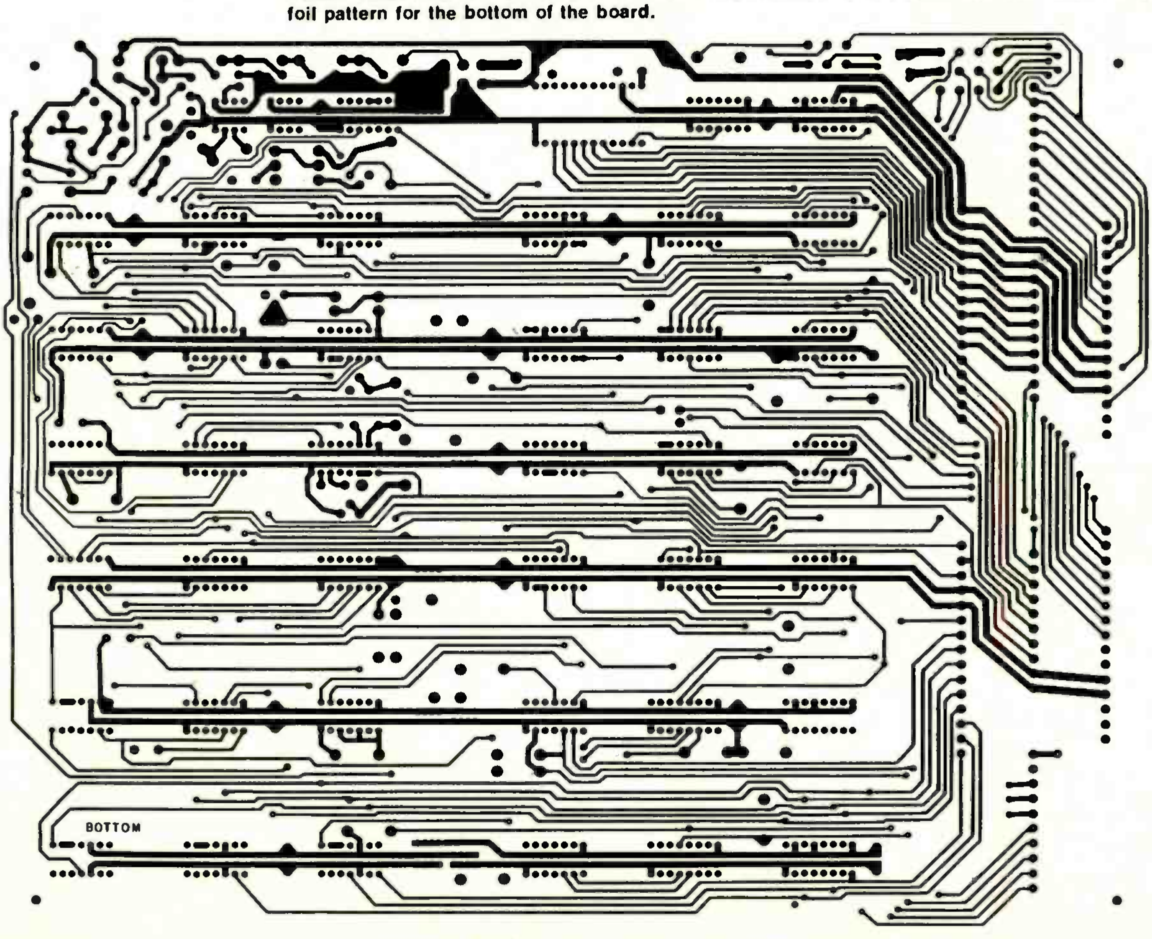
Since we also have 16 sets of these ten lines, one for each of the 16 character rows, we must have the 16-bit counter, IC7, to tell the rest of the circuitry which of the 16 character lines it is displaying. Together, IC6 and IC7 provide a unique BCD code for each of the 10 × 16 = 160-dot video scan lines.

Now for those of you who are familiar with television circuits, you probably know that we need more like 262 lines and not 160 for a complete frame and since our scan line counter composed of IC6 and IC7 is only good to 160, we let it continue to count past 160 which is essentially the same as resetting the counter at 160 since the bit pattern is the same. Flip-flop IC4-b has been in the Q output = 1 state during the last 160 video data lines and is now toggled through AND gate IC5-a and NAND gates IC19-c and IC13-a. When IC4-b toggles the Q output goes low which instigates a sample command for the sample-and-hold portion of the timebase oscillator which was described earlier. It also activates the video blanking circuit feeding the 2513 character generator. This simply forces the generation of all blanks from the character generator as long as the Q output of IC4-b is low.

This mode continues line by line until the line counter reaches a count of 40. Lines 40 through 50 are then used to generate the vertical sync pulse required by the TV set. NAND gate IC13-b along with inverters IC20-a, b, and c perform the actual line number decoding. Note that the output of the timebase generator is NAND'ed as well in IC13-b along with the line counter data. This chops the vertical sync signal as required by the television. The output of IC13-b is then fed along to IC17-a where it is combined with the horizontal sync signal to form the composite sync signal at the output of AND gate IC17-a. At line 50, the vertical sync generation is stopped and the line and row counters continue to count to 102 which is decoded by IC13-a. Note that the Q output of IC14-b is NAND'ed as well by the decoder IC13-a, since the 102 count is not significant when in the



MAIN CIRCUIT BOARD FOIL PATTERN shown half-size. This printed circuit board is a double sided board. The foil pattern for the top of the board is shown above. Below is the foil pattern for the bottom of the board.



"display dot video" mode. The output of IC13-a in turn generates a positive clock pulse to IC4-b through AND gate IC5-a, making the Q output of IC5-a high again; as it was when we started. The same signal from the output of IC13-a resets row counter IC6, and line counter IC7, back to 0, thus completing the 262-line/frame cycle of 160 lines of video, 40 lines of blanking, 10 lines of vertical sync, and 52 more lines of blanking.

Now let's get back to the horizontal portion of the circuit again. We left off earlier by saying that one-shot oscillator IC18-a, provided an adjustable delay between horizontal sync pulse and the generation of data to provide a left margin. We also said that astable oscillator IC18-b, inhibited during this delay phase via IC11-b, is the dot generator that actually clocks off the dots for each line of video which form the character. So from here we may continue by saying that potentiometer R6 sets the cycle time for this oscillator from 150 to 300 ns, and that in turn sets the horizontal width of the characters displayed. The "DOT CLOCK" output however is not the output of IC18-b but rather the output of AND-OR-INVERT gate IC11-a. Its output is normally high, but goes low for about 30 ns each time IC18-b resets. This 30-ns pulse time is set by the propagation time of IC18-b and IC11-a and is very hard if not impossible to see with most oscilloscopes. This "DOT CLOCK" is used to toggle "dot bit" shift registers IC23 and IC24.

The horizontal dot data for each character is composed of five dots and one blank for spacing on each video scan line for each of the seven vertical character data lines. Then three completely blank lines are scanned for vertical spacing followed by the next set of character data scan lines. The video dot data for the horizontal portion of each character is parallel loaded from the 2513 character generator into 4-bit shift registers IC23 and IC24 with zero, bit 1, bit 2, bit 3 going into IC23 and bit 4, bit 5, zero, and a one going into IC24.

The serial input of IC24 is tied high to load one's into the shift register in place of the character data as it is shifted bit by bit out of the register. IC25 monitors the parallel output of the dot register and goes low when six hits have heen clocked out. It senses by detecting the one's that have been shifted into the register serially while the significant dot data was being clocked out by the "dot clock." This low transistion on the output of IC25 which is inverted hy IC12-b changes the dot register from the shift-up to the parallel-load data mode. The same pulse also increments the character counters, IC21 and IC14.

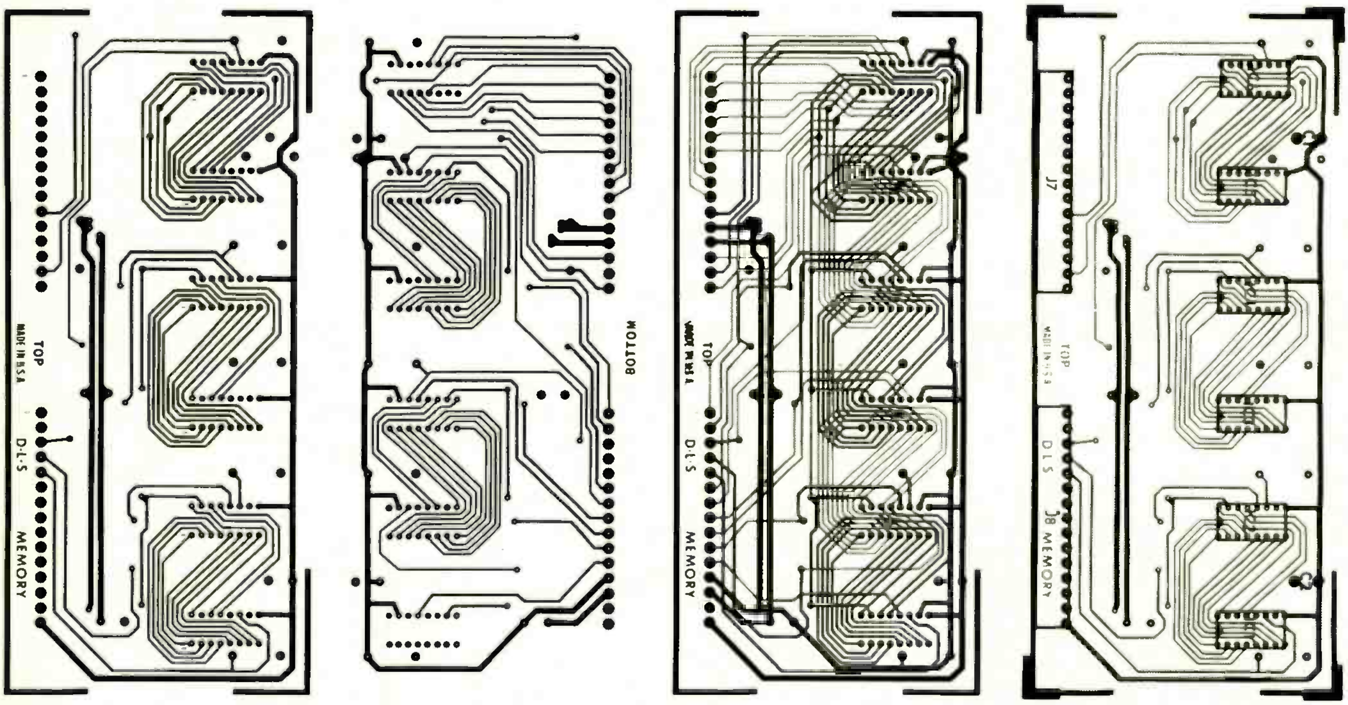
The dot data itself is shifted out bit by bit, at the rate set by the dot clock, from pin 10 of IC23 to IC17-b where it is mixed with the horizontal and vertical sync pulses to form the composite video signal, which is then buffered by emitter follower Q1 and fed to a television or a video monitor.

As mentioned earlier, there are three blank scan lines displayed between each row of characters to provide vertical spacing. The first line, a BCD "0," is generated by having the row counter, IC6, feed zero bits to the row select of the 2513 character generator. Then as the row counter counts off rows 1 thru 7, rows 1 thru 7 of the character are decoded and processed, but when IC5-h sees the 8 and 9 counts of the row counter through IC12-a, its output goes low thus enabling the video blanking circuitry which forces all zeros to the row select of the 2513 character generator creating the other two blank lines.

Going back to the dot register now, note that each time pin 6 goes high and the dot register is set up to parallel load, new data and IC14 is incremented as well thus keeping track of which of the 32 horizontal character positions we are working with.

Next month, the article concludes with the technical description of the circuits and the construction details. The schematic diagram of the memory circuit will also be given.

(continued next month)



HALF-SIZE FOIL PATTERNS OF THE MEMORY circuit board. The patterns are, going from left to right, the top, bottom, combination, and component layout.

The following items are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX.

#CT-1024 Terminal System Kit with 1024 Memory Card — less cabinet or power supply. $175.00 postpaid.

#CT-E Screen Read Plug-in Card kit. $17.50 postpaid.

#CT-M Manual Cursor Control Plug-in Card kit. $11.50 postpaid.

#CT-P Power Supply for CT-1024 — 115-230 Volt Primaries. $15.50 postpaid.

#KPD-2 Keyboard Kit — 53 Keys. $39.95 postpaid.

Build this IC Breadboard System

Use it to design your own circuits. It contains its own power supplies, signal generator and LED monitor. It's a lab-quality instrument that can save many hours

by C. D. WADSWORTH

VERSATILE IC BREADBOARDING SYSTEM will aid you in designing your own circuits. Here is the second part in this series of articles describing how to build your own. Last month we presented the schematic and a technical description. Now for the construction details.

Construction

Be sure to read all of the construction information before you start and then break it up into parts (i.e.: cabinet preparation, PC board, wiring, etc.) that best suit your situation. A wrong step here can cost time and money—if you drill holes for the specified LED's and then find something better but the holes are too large.

All of the circuits for this project are laid out on one printed circuit board and shown in Fig. 7 with the parts layout shown in Fig. 8. Figure 9 shows the circuit board divided into the various circuits. The layout is rather tight so rather than the standard assembly procedure of installing the resistors and capacitors first, it is suggested you leave the capacitors until last. Of course, additional care should be taken when soldering the capacitors to prevent excessive heat on the IC's and semiconductors.

The resistors in the LED driver circuitry are ¼W and mounted on end. Although this procedure doesn't seem to conserve a great deal of space, the space that is saved is critical and allows all of the circuitry to be placed on one pc board. For this reason it is strongly suggested you use the pc layout provided rather than attempt construction using standard perforated board.

All wiring interconnections for the function generator should be kept as short as possible, to 2 inches if you can. Capacitor C2 is utilized to reduce the inherent problems of longer wiring runs, but nothing works as well as short wire.

In this construction it might be beneficial to lay out the entire cabinet, drill all the holes, deburr the holes, repaint the cabinet to cover any imperfections, lay on the lettering or legends, spray the cabinet with clear plastic to protect the letters and legends, and then attach switches, meters, breadboard sockets, etc. A little planning will make a much more professional looking finished product. It is a real pleasure to work with well designed equipment and it improves your work attitude and consequently improves the circuits you are designing.

The cabinet shown in the accompanying pictures is a BUD cabinet #SC-12101 and measures 2⅞ in. high by 12 in. wide by 10 in. deep. This allows enough room for the PC board, transformers, etc. but there isn't too much space left over so it is suggested you place the transformers and circuit board in the cabinet as far to the rear as possible and then mark the cabinet base for drilling. Don't forget, the leads to the function generator should remain as short as possible so you will want to position the PC board so the function generator section is going to be close to the function generator control switches on the cabinet top. Also, the power cord and fuse holder will be in the rear of the cabinet and inside space must be allowed for these items.

Two types of outputs are provided on the cabinet for the two dual power supplies. Six 5-way binding posts so these supplies can be used for projects other than breadboarded circuits, and 18 low profile feed-through pins for breadboarding connections. These low profile pins are rather expensive but ideal for this purpose as they reduce cabinet clutter and direct wire connections can be made without the need for alligator clips. These pins are also used for the outputs from the function generator, pulse generator, and the inputs to the LED displays. These pins can be forced into a .136" hole (No. 29 drill) that provides a secure fit without further worry.

The plastic encapsulated LED's were mounted in the cabinet the same way as the low profile pins. Drill a .201" hole (No. 7 drill) then press fit the LED up from inside the cabinet. I used a long narrow strip of perforated board (0.1 centers) to keep the LED leads separated and for stability and support.

When you mount any of the multi-deck switches and the meters on the front panel, remember the panel is at an angle so you will have to drill your holes high enough so the lowest point of the switch or meter inside the cabinet will clear the bottom of the cabinet after assembly.

The pass transistors for the dual power supplies are mounted on the back panel of the cabinet which acts as a reasonably good heat sink for these transistors. Remember, the case of the transistor is the collector connection so don't forget to use your mica insulators and your plastic or mylar washers on the machine screws. A good heat transfer compound is recommended.

There is a considerable amount of wiring in this project and lacing the different wiring sections is almost a must, especially if you ever plan to repair the unit or if you are justifiably proud of your work and like to display your efforts (including the inside). We separated the wires into sections in relation to their output destination and this seemed to work pretty well.

Section: All inputs and outputs to the LED displays.

Section: All outputs from the ±5 to ±18 volt power supplies to the meter switch.

Section: To the pass transistors in the power supplies on an individual basis.

Section: Each input-output switch or potentiometer from the function generator on an individual basis.

Section: Voltage adjustment pots on the power supplies (Together if they are ganged with separate controls on the same shaft.)

Lacing wires together so they look nice, even, smooth and, professional is not difficult. In case you have never had the opportunity to learn this procedure, it is shown in Fig. 10. Lacing cord is available from almost any electronic parts house and is a valuable asset in making your projects look professional. Keep your knots an equal distance apart and in a straight line.

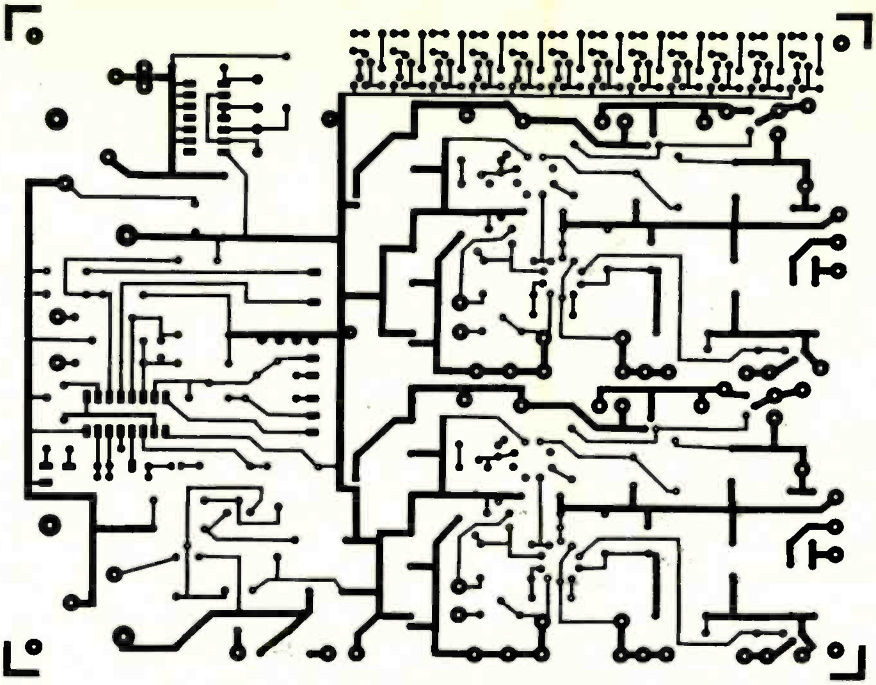


FIG. 7—FOIL PATTERN for circuit board. The pattern should be enlarged to 7⅝" wide.

Calibration

The calibration procedure for the function generator is as follows: To minimize distortion of the sinusoidal waveform set switch S6 to position 2, set switch S5 to position 1, set potentiometers R64 to mid-range and R52 for maximum output swing. Now, using an oscilloscope or distortion analyzer, adjust R56 for minimum distortion. At higher values of R56 the waveform is triangular and at lower values for R56 the peaks are clipped and appear more like a square wave. At some midpoint between these two extremes there is a point where the output will pro-

PARTS LIST

All resistors ¼ watt 10% unless noted

*R1—220 ohms
*R2, *R11—68 ohms, 1 watt
*R3, *R4, *R13, *R14—0.56 ohm, 2 watts, 5%
*R5—2200 ohms
*R6—3300 ohms
*R7—5100 ohms
*R8—1000 ohms, trimmer resistor
*R9, R52—10,000 ohms, ½ watt, linear taper potentiometer
*R10—820 ohms
*R12, R63—1000 ohms
*R15, *R17—9100 ohms, 5%
*R16—2500 ohms, trimmer resistor
R18, R47, R48—1000 ohms, ½ watt
R19—1800 ohms, ½ watt
R20—1500 ohms, ½ watt
R21—2200 ohms, ½ watt
R22—0.75 ohms, 2 watts, 5%
R23, R25, R27, R29, R31, R33, R35, R37, R39, R41, R43, R45—22,000 ohms
R24, R26, R28, R30, R32, R34, R36, R38, R40, R42, R44, R46—56 ohms
R49, R53, R54—100,000 ohms
R50, R51—5000 ohms, 5%
R55—15,000 ohms
R56, R57—5000 ohms, trimmer resistor
R58—330 ohms
R59—1500 ohms
R60—10 ohms, ½ watt
R61—3900 ohms
R62—5000 ohms, ½ watt, audio taper potentiometer
R64—5000 ohms, ½ watt, linear taper potentiometer
*C1, *C6, *C8, *C10, C12—1000-μF, 35V, electrolytic
*C2, *C9—100-μF, 50V electrolytic
*C3, *C5—0.02-μF, 100V, ceramic disc
*C4—0.001-μF, 50 V, ceramic disc
*C7, *C11—1-μF, 50 V, electrolytic
C13—50-μF, 35 V, electrolytic
C14—0.22-μF, 16 V, paper
C15—10-μF, 12 V, electrolytic
C16, C18—0.1-μF, 100 V, paper
C17—20-pF, 100 V, ceramic disc
C19, C20—10-μF, 25 V, electrolytic
C21—1-μF, 25 V, electrolytic
C22—2-μF, 15 V, Mylar
C23—0.68-μF, 15 V, Mylar
C24—0.2-μF, 15 V, Mylar
C25—0.068-μF, 15 V, Mylar
C26—0.02-μF, 15 V, Mylar
C27—0.0068-μF, 15 V, Mylar
C28—0.002-μF, 15 V, Mylar
C29—680-pF, 15 V, Mylar
*D1 thru *D6, D9, D10—1N4003
*D7, *D8—1N914
D11—6.2V 400 mW Zener diode, 1N753 or equiv.
*Q1, *Q3, Q6—2N3055
*Q2, *Q4—2N4898 or 2N4918
*Q5—2N5366
Q7, Q8—2N697
Q9 thru Q32—2N718
*IC1—μA723 voltage regulator
*IC2—μA741 op amp
*IC3—LM309K voltage regulator
IC4—7400 quad NAND gate
IC5—XR-205 (Exar Integrated Systems 733 North Pastoria Ave. Sunnyvale, CA 94086)
LED1 thru LED12—Motorola MLED650 or equiv.
S1, S3—SPST toggle switch
S2—rotary switch, 4 decks, 2 poles per deck, 4 positions per pole, non-shorting, (Centralab PA-2027 or equiv.)
S4—SPST toggle or momentary contact (see text)
S5—rotary switch (Centralab PSA-207 or equiv.)
S6—rotary switch (Centralab PSA-201 or equiv.)
T1—transformer, 117V primary, 26.5V CT @1A secondary (Triad F-40X or equiv.)
T2—transformer, 117 primary, 24VCT @ 1A secondary (Triad F-45X or equiv.)
F1—2A standard fuse
M1—panel meter, current, 0-150 mA (Shurite model 850 stock 8308Z or equiv., see text)
M2—panel meter, voltage, 0-25Vdc (Shurite model 850 stock 8109Z or equiv., see text)

*Two each of the components are required to construct both of the dual power supplies.

HARDWARE PARTS LIST

Item	Quantity	Part No.	Supplier
Cabinet	1	SC-12101	
Sockets	3 3	59S 59B	Continental Specialties Corp., 325 East Street New Haven, Conn. 06509
or	3	SK-10	E & L Instruments Inc. 61 First Street Derby, Ct. 06418
Feed-through pins	50	BP-22	E & L Instruments Inc. 61 First Street Derby, Ct. 06418
Breading pins	50	BP-24	E & L Instruments Inc. 61 First Street Derby, Ct. 06418
Printed Circuit Board (G-10 glass epoxy etched & drilled)		PC-47	Electronic Products Co. 4911 Kenneth Ave. Carmichael, Calif. 95608 ($16.20 + .60c postage) Calif. res. add sales tax.

Panel mounted fuse holder, power cord, grommet, ½" stand-offs (spacers) for mounting pc board, 4-40 flat head machine screws for mounting breadboard sockets, 6-32 machine screws for transformers and pc board, NE-2 lamp & socket for power supply indicator, heat transfer compound.

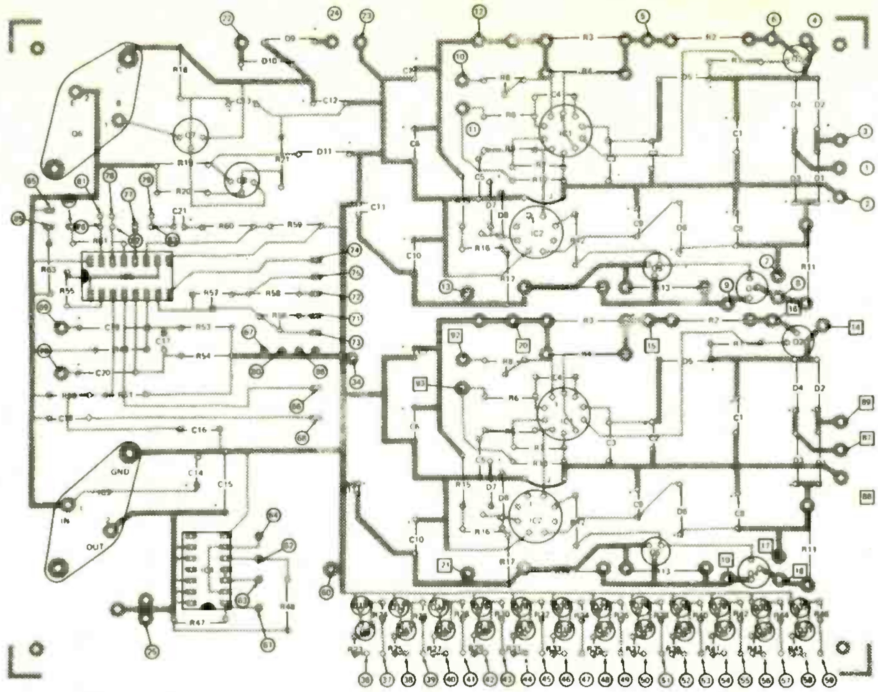


FIG. 8—PARTS LAYOUT of circuit board shown from component side of board. Interconnection points are shown with circled numbers. Interconnections for dual power supply #2 is denoted by numbered squares.

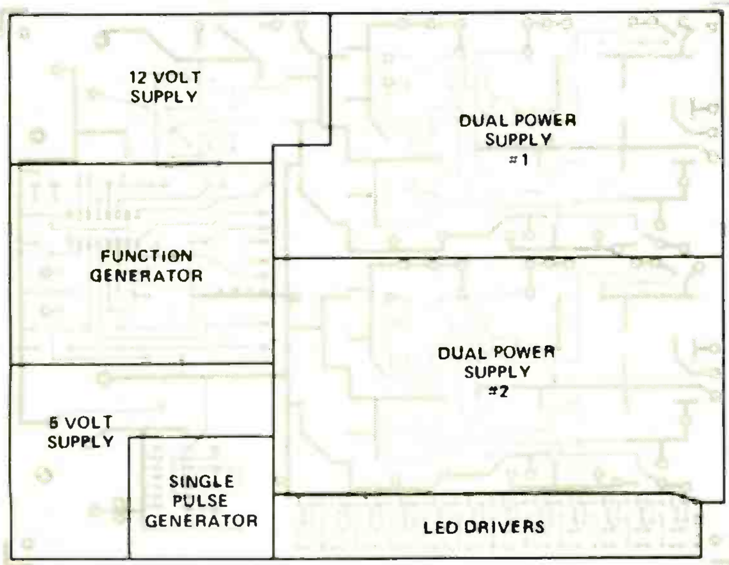


FIG. 9—CIRCUIT BOARD shown from component side is divided into the different circuits which comprise the breadboarding system.

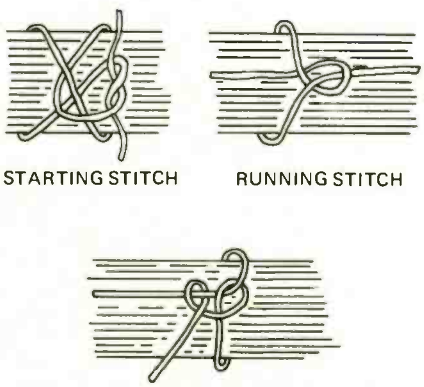


FIG. 10—SHOWS THE CORRECT METHOD of stitching a wiring harness together. This will give your project a professional appearance.

vide an excellent sinewave with minimum harmonic distortion.

For the triangle output set switch S6 to position 2, switch S5 to position 2, potentiometer R64 to mid-range, potentiometer R52 to maximum swing, and adjust R57 for the best output. The adjustment for R56 and R57 is a one time setting and need not be changed for other frequency settings.

The final adjustments for the dual power supplies are as follows:

The voltage divider network R5 and R7 form the reference for the low level output (+5) for the supply. The 10% tolerance specified for these components can give a small variation away from this +5 volts. If you need this voltage to be exact I suggest you start by determining the low level output of the supply (accuracy of your test equipment will determine your final success). Any error in a output variation away from +5 can be corrected by placing a resistor in parallel with either R5 or R7. The difference should be small so start with about a 47K resistor.

Trimmer R8 is used to adjust the high level output of the supply. Set potentiometer R9 for the maximum desired output voltage and then adjust R8 for the precise level desired.

Trimmer R16 is used to adjust the negative side of the supply so it will exactly match the positive side. This can be done at any point within the voltage range of the supply. Measure the voltage output of the positive side then connect your VOM to the negative side and adjust R16 for the exact same reading. Be careful here with your VOM when going from positive to negative—your meter could be damaged if you don't change both leads.

Other possibilities

Here are a couple of ideas that passed through my mind when I was planning this project and might be more appropriate to your needs.

Will the amount of breadboarding space provided be enough to meet future needs? PC connectors could be mounted on the cabinet and the breadboarding sockets could be mounted on printed circuit boards. If you had 4 PC connectors (using feed-through pins for interconnection) it is conceivable to have 4 times the amount of breadboarding space.

Should I have added one more position on the switch decks controlling the voltage and current meters along with several more 5 way binding posts for input-output? This would have allowed the use of these meters for any outside function desired. Of course you can have so many posts, plugs, sockets, switches, meters, etc. that the unit becomes very difficult to use.

Should I have placed a PC connector where I have the 5 way binding posts located so I could build up certain component test circuits on PC boards and then have them ready with an easy way to interconnect? There are a number of places where untested IC's and transistors can be purchased at a very good price (ie. IC's @ 3.00/C, transistors @ 1.50/C) and if these units check out at 50% good, then its worth the time.

There are two ways to make interconnections on the breadboarding sockets. Use #22 solid wire and bend to make the runs as close as possible to the way they would be on a printed circuit layout. Use the BP-24 breadboarding pins indicated in the hardware parts list and solder to the ends of #22 stranded wire of various lengths. These BP-24 pins are also good for mounting parts whose leads are too large for the breadboarding socket. I have used both of the above methods and will probably continue to do so, however, on several occasions the solid wire has broken inside the insulation so that I was getting a "sometimes" connection which can be frustrating. R-E

Build 3 Unique Clocks

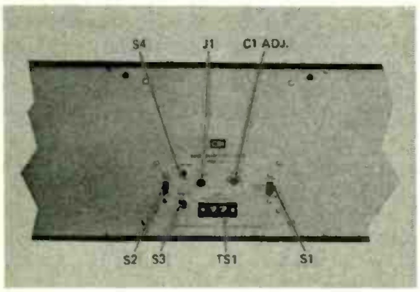
Here are the construction details for the wall clock. This clock has 3½-inch high LED readouts and is crystal controlled.

by CHARLES CARINGELLA and MICHAEL ROBBINS

HERE IS THE FINAL PART OF THIS SERIES of construction articles describing three unique digital clocks. This month, the construction details, foil patterns and inside views of the giant wall clock are presented. The full schematic of this clock appeared in the January 1975 issue of **Radio-Electronics**.

The giant 6-digit wall clock is housed in a simulated-walnut cabinet that is 21 inches wide, 8 inches high and 3 inches deep! The cabinet window material is 1/16-inch thick red sheet acrylic. Using the red material allows only the lit LED's to be seen, and not the unlit ones.

An inside veiw of the completed Wall Clock is in Fig. 14. The display panel is attached to the rear panel with two sheet-metal rails, 1¾ inches wide x 18¼ inches long, thus forming one rigid assembly, which then slips into the walnut cabinet. Spacers, ⅝-inch long, along with suitable screws, are used to mount the wall clock control-board assembly to the rear panel. Directly under the control board, but on the rear panel, are all of the switches, oscillator output jack J1, and terminal strip, TS1.



REAR VIEW OF THE WALL CLOCK showing location of the various controls and the power terminal-strip.

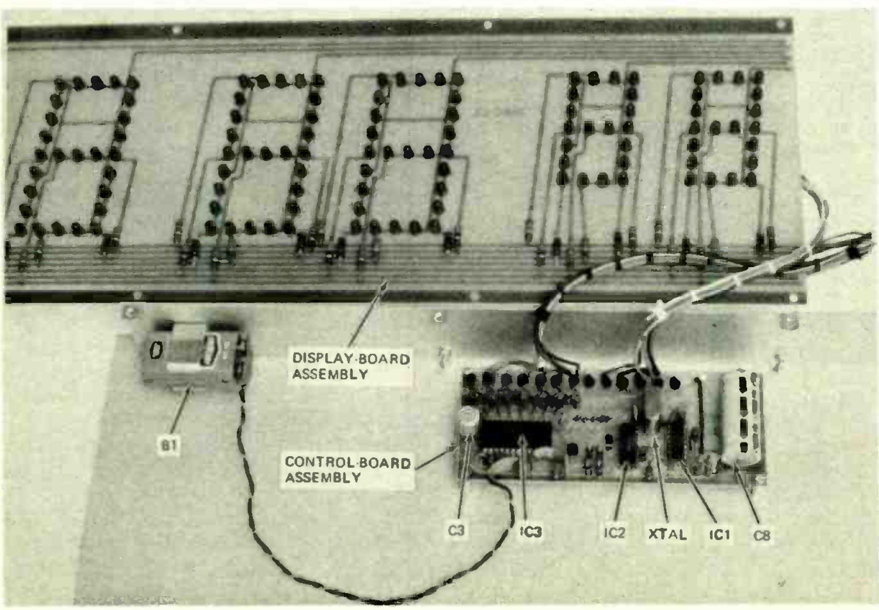


FIG. 14—INSIDE VIEW of the completed wall clock.

The complex electronics circuitry of the wall clock has been greatly simplified by the PC control board, shown in Fig. 15. Install all jumpers on the PC board first. Then install Molex pins to serve as sockets for the three IC's. Be careful when handling the CMOS IC's, as they can be damaged by static electricity. Do all your soldering with a small pencil iron and use only a good grade of rosin-core solder.

Carefully observe the orientation and polarity of the diodes, transistors, and the electrolytic capacitors. Mount diode D5, as well as diodes D10 to D15, flat against the PC board. Then mount all remaining diodes vertically. Diode D9 is not on the PC board, but rather, is installed between the appropriate terminals on S3 and S4, which are located on the rear panel. All resistors are mounted vertically on the PC board.

After all of the components have been mounted on the top side of the control PC board, flip it over and solder trimmer capacitor C1 to the copper-foil side of the board. C1 should be mounted perpendicular to the PC board. Access to the trimmer's adjustment screw is made through a hole on the rear panel.

Diodes D16 to D20 are not used. You will have to solder an insulated jumper wire from hole **H** to hole **I** on the PC board. If the display is too bright for your installation, remove the jumper and

PARTS LIST

B1—9-volt (Eveready 216 or equal)
C1—4 to 40-pF trimmer (Arco 403 or equal)
C2, C10—0.01-μF disc ceramic
C3—100-μF, 16-volt, PC-type electrolytic
C4, C6, C11—0.001-μF disc ceramic
C5—180-pF, N2200 negative temperature coefficient, disc ceramic (Sprague 10TCY-T18 or equal)
C7—0.1-μF disc ceramic
C8—1000 or 2200-μF, 16-volt electrolytic
C9—0.02-μF disc ceramic
D1 to D5, D8—1N4001
D6, D7, D9 to D15—1N914
D16 to D20—not used (see text)
IC1—CD4001AE (RCA) CMOS Quad NOR gate
IC2—CD4020AE (RCA) CMOS 14-Stage Binary Counter/Divider
IC3—MM53149 (National) MOS Digital Clock
J1—Phono jack
LED1 to LED148—Light-emitting diode (Chicago Miniature Lamp CM-73-010 or equal) selected for 3:1 light-intensity range and chip centering, (see text)
Q1 to Q6—2N4403 pnp
Q7 to Q14—MPSA20 npn
R1, R6, R9, R17 to R23—10,000 ohms, 10%, ½ watt
R2—68,000 ohms, 10%, ½ watt
R3, R4, R8—100,000 ohms, 10%, ½ watt
R5—22 megohms, 10%, ½ watt
R7—1000 ohms, 10%, ½ watt
R10 to R16—2200 ohms, 10%, ½ watt
R24, R27, R28, R31, R34, R35, R38, R41, R42, R45, R48, R49, R52, R55, R56, R59, R62, R63—150 ohms, 10%, ½ watt
R25, R30, R32, R37, R39, R44, R46, R51, R53, R58, R60, R65—56 ohms, 10%, ½ watt
R26, R29, R33, R36, R40, R43, R47, R50, R54, R57, R61, R64—100 ohms, 10% ½ watt
S1, S2—spst slide switch
S3, S4—spdt pushbutton switch
TS1—2-lug terminal strip
XTAL—491.520-kHz crystal, HC/6 holder, 0.005% tolerance at room temperature
MISC—Printed circuit boards, suitable cabinet, solder, wire, etc.

NOTE—The following are available from Caringella Electronics, Inc., P.O. Box 327, Upland CA 91786: PC board, etched and drilled, No. MDC-1-1, at $7.95 postpaid; PC board, etched and drilled, No. DWC-1A, at $14.95 postpaid; Set of 148 selected LED's for display panel at $60.00 postpaid; Complete kit of all parts including cabinet, hardware, UL approved plug-in stepdown transformer No. LVT-1, wire, solder, step-by-step instructions, etc., No. DWC-1 KIT at $159.95 plus $3.50 handling and shipping. California residents add 6% sales tax on all items.

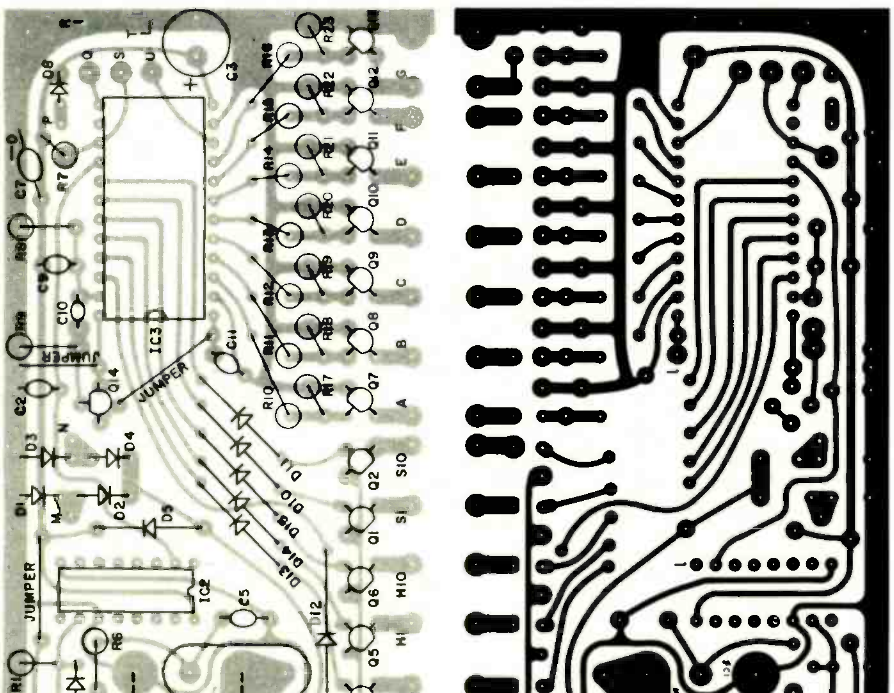


FIG. 15—ACTUAL SIZE FOIL PATTERN OF THE WALL CLOCK control board (above-right) as viewed from the foil side. X-ray view of the same board (above-left) showing the location of all components mounted on the top side of the board. C1, the trimmer capacitor, is mounted on the foil side of the board.

install one diode at a time (use a 1N4001 silicon rectifier) until you get the display brightness you desire.

Figure 16 illustrates the display PC board pattern. Install all of the resistors flat against the display board first. Next, install all of the LED lamps flush against the board. Make sure all of the LED's are oriented properly, and that all the lamps in each segment form a "straight" line. We strongly recommend using the lamps specified in the Parts List, since they have been selected to produce the most uniform display. Avoid using "bargain basement" LED's, as they will vary greatly in light-output from lamp to lamp, and may also have poor chip centering and viewing angle. (Of course, if the faults mentioned are tolerable, you can save several dollars with "surplus" LED's.—*Editor)*

The wall clock display-board assembly is wired to the control-board assembly with two interconnecting wiring harnesses. One wiring harness is used to connect holes **A** through **G** on one board to the corresponding holes on the other board. Likewise, the other wiring harness is used to connect holes **S1** through **H10** on one board, to the corresponding holes on the other board. This completes the wiring of the two PC boards necessary to complete the wall clock.

The wall clock is a little easier to synchronize to the second. To set the time, first set the HOLD-RUN switch to RUN. Press the FAST SET pushbutton for at least one full minute so the hours and minutes digits run through several complete cycles, as in the clocks above. Now, release the FAST SET pushbutton and observe the seconds digits. When the seconds digits read "zero-zero", flip the HOLD-RUN switch to HOLD. Press the FAST SET pushbutton to cycle the hours. Release the pushbutton as soon as the desired hour(s) are indicated on the first two digits. Press the SLOW SET push-

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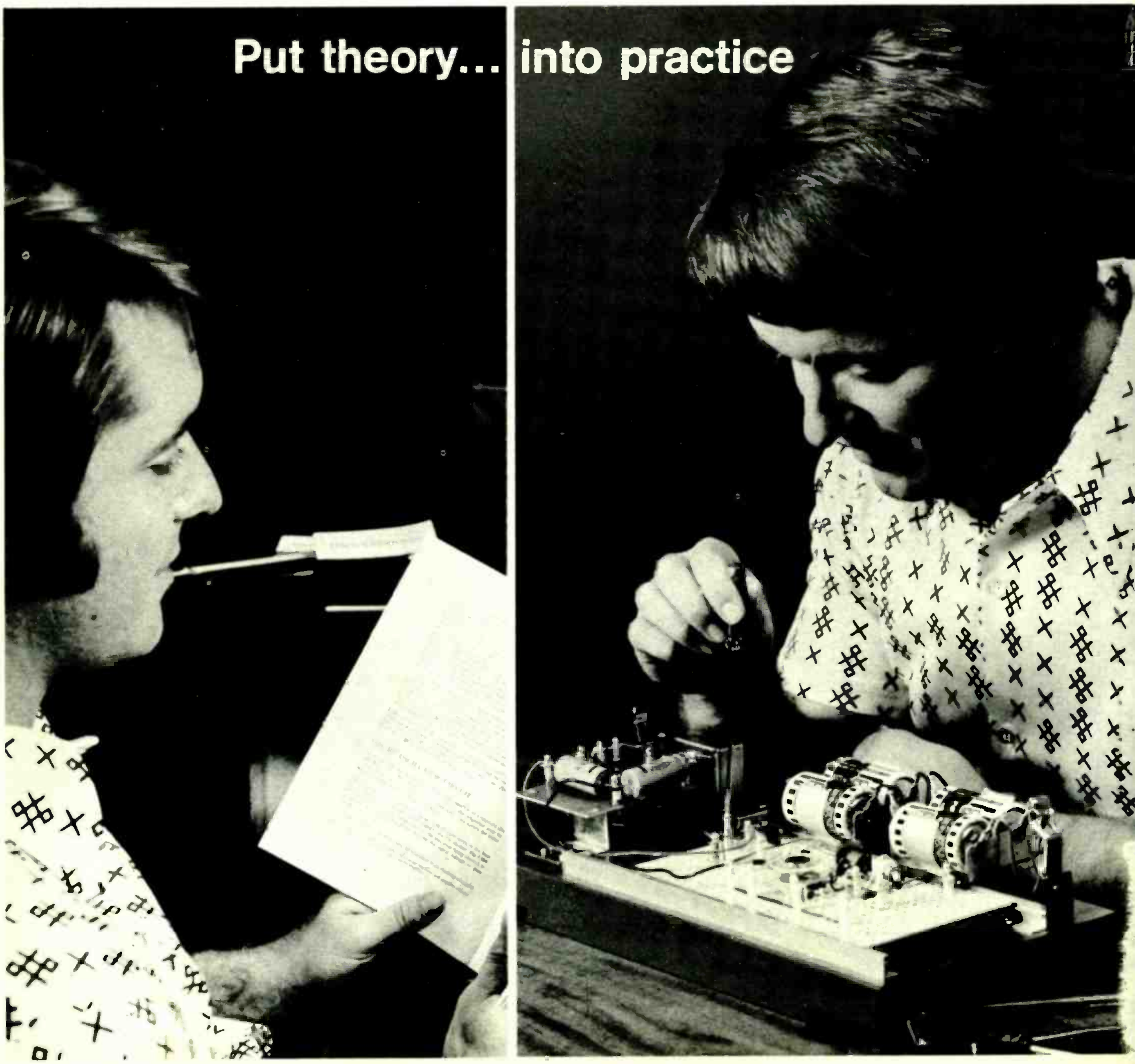


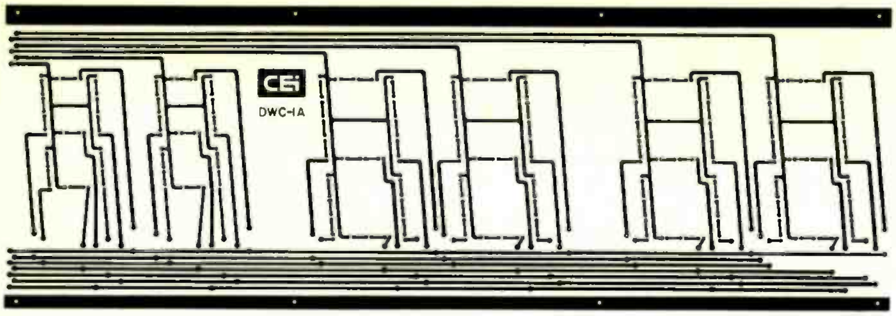
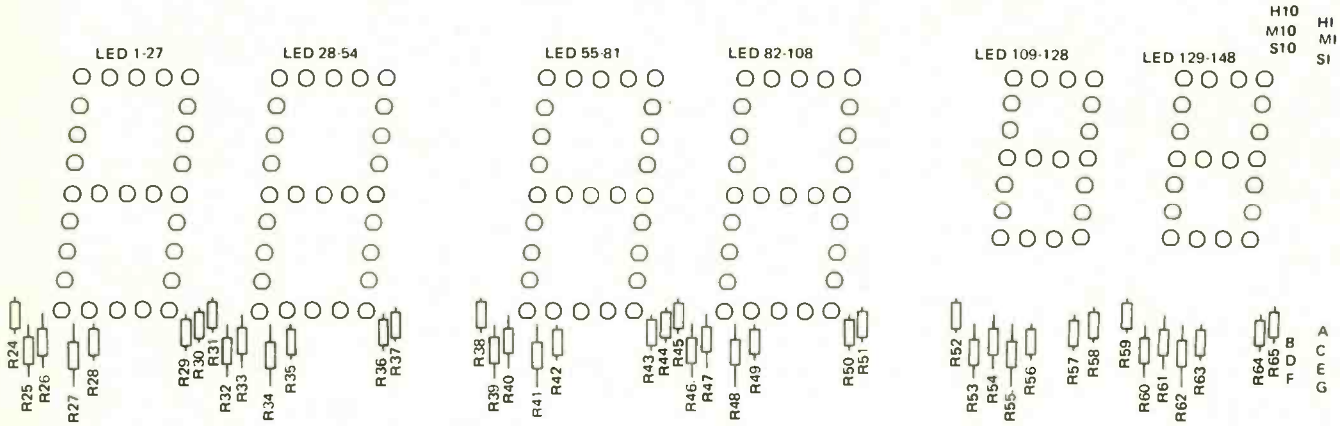


FIG. 16—THE PATTERN OF THE WALL CLOCK DISPLAY BOARD (left) as viewed here from the foil side, is shown one-half actual size. The actual size board measures 18¼ x 6¼ inches! X-ray view of the same board showing the location of all the resistors and individual light-emitting diodes mounted on the top side of the board.



button to cycle the minutes. Release the pushbutton as soon as the desired minutes appear on the second two digits. As soon as the "announced" time corresponds to the time indicated on the clock display, flip the HOLD-RUN switch to RUN.

The accuracy of the wall clock is determined by the quartz-crystal oscillator. Indoors, in a room where the temperature is thermostatically controlled and held to a constant temperature within approximately ± 5°, the clock should be accurate to about 1-second per week, or about 5-seconds per month. To get this accuracy, you must set the oscillator frequency exactly to 491.520-KHz, at the mean temperature. This can be done with a frequency counter, or by trial and error, if you don't have a counter. If the clock runs fast and gains time, turn the adjustment screw clockwise a fraction of a turn, let the clock run for 24-hours, and observe the time. Repeat this until you get correct timekeeping. If the clock runs slow and loses time, turn the adjustment screw counter-clockwise, and repeat the above procedure.

Install a standard 9-volt transistor radio battery in the wall clock to provide "power failure protection". This way you will always be insured of the correct time. You can even unplug the clock from one outlet and plug it into another outlet, and not lose the correct time. You can even change the battery while the clock is running, and not upset the time. So theoretically, once you set the time, you can forget it!

The three digital clocks described in this article should provide the builder with years of trouble-free service, and about all the maintenance that will be required is the periodic cleaning of the cabinet exteriors! **R-E**

NESDA asks FTC for practice rule on in-warranty service compensation

The national Electronic Service Dealers Association has submitted to the Federal Trade Commission a proposal calling for manufacturers to pay reasonable compensation for in-warranty repair work, NESDA Executive Vice President Dick Glass reports. The compensation would be based on prevailing rates for similar out-of-warranty repair work.

The proposal—originated by W. H. Harrison of Coastal Electronics, Norfolk, VA—spells out details of the compensation to be granted and procedures that should be followed in handling warranty work. It includes basing compensation on what the dealer charges for out-of-warranty repair work, reimbursement for parts and materials and for the necessary physical and clerical labor in handling them.

A proviso for holding defective parts a reasonable time for the manufacturer's inspection and for supplying the manufacturer with information, copies of bills, etc., on the work done is included in the proposal, as well as a section enjoining the manufacturer against requiring unreasonable proof to establish reasonable compensation, against discriminating against any dealer in applying warranty policy, and delaying payments on valid claims.

Mr. Glass pointed out that though several States have legislation to protect the servicer in the electronics and other consumer product fields, it would be almost impossible to obtain effective and reasonably similar laws in all 50 States, and that the logical path would be to obtain a nation-wide FTC trade practice regulation to cover this national problem. **R-E**

R-E's Substitution guide for replacement transistors

PART XXIV

by ROBERT & ELIZABETH SCOTT

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

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

G-E—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

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

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

MAL—Mallory Distributor Products Co., 4760 Kentucky Ave., Indianapolis, Ind. 46241

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

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

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

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

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

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

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

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N5508*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5509*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5510*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5511*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5512*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5513*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5514*	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5525	NA	TS-9100	GE-64	ICC-S9100	IRTR-69	PTC 153	HEP-S9100	NA	NA	ECG 172	WEP-WS9100	ZEN 128
2N5527	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-3002	NA
2N5531	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-3002	NA
2N5543	NA	T-801	NA	NA	NA	NA	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5544	NA	T-801	NA	NA	NA	NA	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5548	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N5550	RS276-2008	TS-0005	NA	ICC-S0005	NA	NA	HEP-S0005	NA	NA	ECG 194	WEP-712	NA
2N5551	RS276-2008	TS-0005	NA	ICC-S0005	NA	NA	HEP-S0005	NA	NA	ECG 194	WEP-712	NA
2N5555	NA	TF-0021	GE-FET-2	ICC-F0021	NA	PTC 152	HEP-F0021	NA	NA	NA	NA	NA
2N5556	NA	T-801	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5557	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5558	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5559	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5561	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5562	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5563	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5569	NA	SR-1751	NA	ICC-R1751	NA	NA	HEP-R1751	SK 3508	NA	ECG 5673	NA	NA
2N5570	NA	SR-1752	NA	ICC-R1752	NA	NA	HEP-R1752	SK 3508	NA	ECG 5675	NA	NA
2N5573	NA	SR-1783	NA	ICC-R1783	NA	NA	HEP-R1783	SK 3520	NA	ECG 5673	NA	NA
2N5574	NA	SR-1785	NA	ICC-R1785	NA	NA	HEP-R1785	SK 3520	NA	ECG 5675	NA	NA
2N5581	NA	TS-3001	GE-20	ICC-S3001	NA	NA	HEP-S3001	NA	RT-114	ECG 195	NA	NA
2N5582	NA	TS-3001	GE-20	ICC-S3001	NA	NA	HEP-S3001	NA	RT-114	ECG 195	NA	NA
2N5583	NA	TS-3001	NA	ICC-S3001	NA	NA	HEP-S3001	NA	NA	ECG 195	NA	NA
2N5589	RS276-2009	NA	GE-28	ICC-S3005	NA	NA	HEP-S3005	NA	RT-154	NA	NA	NA
2N5590	NA	NA	GE-66	ICC-S3007	NA	PTC 128	HEP-S3006	NA	RT-154	NA	NA	NA
2N5591	NA	NA	NA	ICC-S3007	NA	NA	HEP-S3007	NA	NA	NA	NA	NA
2N5592	NA	NA	NA	NA	NA	PTC 152	NA	SK 3116	RT-176	ECG 132	NA	NA
2N5593	NA	NA	NA	NA	NA	PTC 152	NA	SK 3116	RT-176	ECG 132	NA	NA
2N5594	NA	NA	NA	NA	NA	PTC 152	NA	SK 3116	RT-176	ECG 132	NA	NA
2N5597	RS276-2025	T-702	GE-69	ICC-702	NA	PTC 113	HEP-702	NA	RT-155	ECG 218	WEP-700	NA
2N5598	NA	T-241	GE-66	ICC-241	NA	PTC 112	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
2N5599	RS276-2025	T-702	NA	ICC-702	NA	PTC 113	HEP-702	NA	NA	ECG 218	WEP-700	NA
2N5600	NA	T-241	NA	ICC-241	NA	PTC 112	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
2N5601	RS276-2025	T-702	NA	ICC-702	NA	PTC 113	HEP-702	NA	NA	ECG 702	WEP-700	NA
2N5602	NA	T-241	NA	ICC-241	NA	PTC 112	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
2N5604	NA	T-241	NA	ICC-241	NA	PTC 148	HEP-241	SK 3131	NA	ECG 175	WEP-241	NA
2N5605	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	ECG 183	WEP-5005	NA
2N5606	NA	T-241	GE-66	ICC-241	NA	NA	HEP-241	NA	NA	ECG 175	WEP-241	NA
2N5607	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	ECG 183	WEP-WS5005	NA
2N5608	NA	T-241	NA	ICC-241	NA	PTC 110	HEP-241	NA	NA	ECG 175	WEP-241	NA
2N5610	NA	T-241	NA	ICC-241	NA	PTC 110	HEP-241	NA	NA	ECG 175	WEP-241	NA
2N5612	NA	T-241	NA	ICC-241	NA	PTC 110	HEP-241	NA	NA	ECG 175	WEP-241	NA
2N5613	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	ECG 219	WEP-WS7001	NA
2N5614	NA	T-247	GE-66	ICC-247	TR-30	NA	HEP-247	NA	RT-131	ECG 130	WEP-247	NA
2N5616	NA	T-704	NA	ICC-704	NA	PTC 140	HEP-704	NA	NA	ECG 130	WEP-704	NA
2N5618	NA	T-704	NA	ICC-704	NA	PTC 140	HEP-704	NA	NA	ECG 130	WEP-704	NA
2N5621	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	RT-148	ECG 218	WEP-WS7001	NA
2N5622	NA	T-247	NA	ICC-247	TR-26	NA	HEP-247	NA	RT-131	ECG 130	WEP-247	NA
2N5623	NA	TS-7001	NA	NA	NA	NA	NA	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5624	NA	NA	NA	ICCp704	NA	NA	HEP-804	NA	NA	ECG 130	WEP-704	NA
2N5625	NA	NA	NA	NA	NA	NA	NA	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5626	NA	T-704	NA	ICCp704	NA	NA	HEP-704	NA	NA	ECG 130	NA	NA
2N5629	NA	NA	GE-75	NA	NA	NA	NA	NA	NA	ECG 162	NA	NA
2N5632	NA	T-707	GE-75	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5633	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5634	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5636	RS276-2009	TS-3005	NA	ICC-S3005	NA	NA	HEP-S3005	NA	NA	NA	NA	NA
2N5637	NA	NA	GE-66	NA	NA	NA	NA	NA	NA	ECG 152	NA	NA
2N5639	NA	T-802	NA	ICC-802	NA	PTC 151	HEP-802	NA	NA	ECG 132	WEP-802	ZEN 123
2N5640	NA	T-802	NA	ICC-802	NA	PTC 152	HEP-802	NA	NA	ECG 132	WEP-802	ZEN 123
2N5641	RS276-2009	NA	NA	ICC-S3005	NA	NA	HEP-S3005	NA	NA	NA	NA	NA
2N5642	NA	NA	GE-66	NA	NA	PTC 128	NA	NA	RT-154	ECG 152	NA	NA
2N5644	RS276-2009	NA	GE-28	ICC-S3005	NA	NA	HEP-S3005	NA	RT-154	NA	NA	NA
2N5645	NA	NA	GE-28	ICC-S3006	NA	PTC 128	HEP-S3006	NA	RT-154	NA	NA	NA
2N5646	NA	NA	GEp66	ICC-S3006	NA	PTC 128	HEP-S3006	NA	RT-154	NA	NA	NA
2N5648	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5649	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	NA	NA
2N5650	RS276-2011	T-709	NA	ICC-709	NA	PTC 132	HEP-709	SK 3117	RT-113	ECG 161	WEP-709	ZEN 105
2N5651	RS276-2011	T-709	NA	ICC-709	NA	PTC 132	HEP-709	SK 3117	RT-113	ECG 161	WEP-709	ZEN 105
2N5652	RS276-2011	T-709	NA	ICC-709	NA	PTC 132	HEP-709	SK 3039	RT-113	ECG 161	WEP-709	ZEN 105
2N5654	NA	TF-0021	NA	ICC-F0021	NA	PTC 152	HEP-F0021	NA	NA	NA	NA	NA
2N5655	NA	T-244	GE-32	ICC-241	IRTR-60	PTC 124	HEP-241	SK 3103	RT-135	ECG 157	WEP-244	ZEN 201
2N5656	NA	T-244	GE-32	ICC-244	IRTR-60	PTC 124	HEP-244	SK 3103	RT-135	ECG 157	WEP-244	ZEN 211
2N5660	NA	TS-3021	GE-32	ICC-S3021	NA	PTC 104	HEP-S3021	NA	RT-128	ECG 191	WEP-WS3021	ZEN 208
2N5661	NA	NA	GE-32	ICC-S3021	NA	PTC 104	HEP-S3021	NA	RT-128	ECG 191	WEP-WS3021	NA

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N5784	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	SK 3024	RT-154	NA	WEP-WS3002	NA
2N5785	NA	TS-3010	GE-86	ICC-S3010	NA	NA	HEP-S2010	SK 3024	RT-154	NA	WEP-WS3003	ZEN 207
2N5786	RS276-2025	T-242	GE-28	ICC-242	NA	PTC 142	HEP-242	SK 3024	RT-154	ECG 186	WEP-242	NA
2N5787	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5400	NA	NA
2N5788	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5401	NA	NA
2N5789	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5402	NA	NA
2N5790	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	ECG 5404	NA	NA
2N5804	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5805	NA	T-707	NA	ICC-707	NA	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5806	NA	SR-1473	NA	ICC-R1473	NA	NA	HEP-R1473	SK 3509	NA	ECG 5543	NA	NA
2N5807	NA	SR-1475	NA	ICC-R1475	NA	NA	HEP-R1475	SK 3509	NA	ECG 5545	NA	NA
2N5808	NA	NA	NA	NA	NA	NA	NA	SK 3509	NA	ECG 5546	NA	NA
2N5809	NA	NA	NA	NA	NA	NA	NA	SK 3509	NA	ECG 5547	NA	NA
2N5810	RS276-2009	T-53	GE-20	ICC-53	NA	PTC 136	HEP-53	NA	RT-100	ECG 123A	WEP-53	ZEN 102
2N5811	RS276-2021	T-51	GE-67	ICC-51	NA	PTC 127	HEP-51	NA	RT-101	ECG 129	WEP-51	ZEN 101
2N5662	NA	TS-3021	GE-32	NA	NA	NA	NA	NA	NA	ECG 198	WEP-WS3021	ZEN 208
2N5662	NA	NA	GE-32	NA	NA	NA	NA	NA	NA	ECG 198	WEP-WS3021	NA
2N5668	NA	T-802	GE-FET-1	ICC-802	NA	PTC 152	HEP-802	SK 3116	RT-175	ECG 133	WEP-802	ZEN 123
2N5669	NA	T-802	NA	ICC-802	NA	PTC 152	HEP-802	SK 3116	RT-175	ECG 133	WEP-802	ZEN 123
2N5670	NA	T-802	NA	ICC-802	NA	PTC 151	HEP-802	SK 3116	RT-175	ECG 133	WEP-802	ZEN 123
2N5679	NA	TS-3031	NA	ICC-S3031	NA	NA	HEP-S3031	NA	NA	ECG 191	WEP-WS3031	NA
2N5681	NA	T-714	NA	ICC-714	NA	NA	HEP-714	NA	NA	ECG 190	WEP-WS3031	NA
2N5682	NA	T-714	GE-32	ICC-714	NA	NA	HEP-714	NA	NA	ECG 190	WEP-WS3031	NA
2N5687	NA	TS-3001	GE-28	ICC-S3003	NA	PTC 158	HEP-S3003	NA	RT-114	NA	WEP-WS3003	NA
2N5688	RS276-2009	NA	GE-28	ICC-S3005	NA	NA	HEP-S3005	NA	RT-154	NA	NA	NA
2N5689	NA	NA	GE-66	NA	NA	NA	NA	NA	RT-154	ECG 152	WEP-WS3020	NA
2N5690	NA	NA	GE-66	NA	NA	NA	NA	NA	RT-154	ECG 152	WEP-WS3020	NA
2N5697	RS276-2009	T-75	GE-28	ICCp75	NA	PTC 158	HEP-75	NA	RT-114	NA	WEP-243	NA
2N5698	NA	NA	GE-28	NA	NA	NA	NA	NA	RT-154	ECG 186	NA	NA
2N5699	NA	NA	GE-28	ICC-S3006	NA	NA	HEP-S3006	NA	RT-154	NA	NA	NA
2N5700	NA	NA	GE-66	ICC-S3007	NA	NA	HEP-S3007	NA	RT-154	NA	NA	NA
2N5701	NA	NA	GE-66	ICC-S3007	NA	NA	HEP-S3007	NA	RT-154	NA	NA	NA
2N5702	RS276-2009	T-75	NA	ICC-75	NA	NA	HEP-75	NA	RT-114	NA	WEP-243	NA
2N5703	NA	NA	GE-28	ICC-S3006	NA	NA	HEP-S3006	NA	RT-154	NA	NA	NA
2N5704	NA	NA	GE-66	ICC-S3006	NA	NA	HEP-S3006	NA	RT-154	NA	NA	NA
2N5705	NA	NA	GE-66	ICC-S3007	NA	NA	HEP-S3007	NA	RT-154	NA	NA	NA
2N5710	RS276-2009	T-75	GE-28	ICC-75	NA	PTC 158	HEP-75	NA	RT-154	NA	WEP-243	NA
2N5712	NA	NA	GE-66	NA	NA	NA	NA	NA	RT-154	ECG 152	WEP-WS3020	NA
2N5713	NA	NA	GE-66	NA	NA	NA	NA	NA	RT-154	ECG 152	WEP-WS3020	NA
2N5716	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5717	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5718	NA	NA	NA	NA	NA	PTC 152	NA	SK 3112	RT-175	ECG 133	WEP-801	NA
2N5719	NA	SR-1002	NA	ICC-R1002	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N5720	NA	SR-1003	NA	ICC-R1003	NA	NA	HEP-R1003	NA	NA	ECG 5402	NA	NA
2N5721	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	ECG 5404	NA	NA
2N5724	NA	SR-1002	NA	ICC-R1002	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N5725	NA	SR-1003	NA	ICC-R1003	NA	NA	HEP-R1003	NA	NA	ECG 5402	NA	NA
2N5726	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	RCG 5404	NA	NA
2N5729	NA	TS-3002	NA	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP-WS3002	NA
2N5732	NA	TS-7000	NA	ICC-S7000	NA	NA	HEP-S7000	NA	RT-149	ECG181	WEP-WS7000	NA
2N5737	NA	T-248	NA	ICC-248	NA	PTC 149	HEP-248	NA	RT-165	ECG 219	WEP-WS7001	NA
2N5738	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5739	NA	TS-5002	NA	ICC-S5002	NA	NA	HEP-S5002	NA	NA	ECG 183	WEP-WS5005	NA
2N5740	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	ECG 180	WEP-WS5005	NA
2N5741	NA	NA	NA	NA	NA	PTC 149	NA	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5742	NA	NA	NA	NA	NA	NA	NA	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5744	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
2N5745	NA	NA	NA	NA	NA	NA	NA	NA	RT-148	ECG 180	WEP-WS7001	NA
2N5754	NA	NA	NA	NA	NA	PTC 123	NA	Sk 3506	RT-114	ECG 5640	NA	NA
2N5755	NA	NA	NA	NA	NA	PTC 123	NA	SK 3506	NA	ECG 5641	NA	NA
2N5756	NA	NA	NA	NA	NA	PTC 123	NA	SK 3506	NA	ECG 5642	NA	NA
2N5757	NA	NA	NA	NA	NA	NA	NA	SK 3519	NA	ECG 5643	NA	NA
2N5758	NA	T-707	NA	ICC-707	IRTR-61	PTC 149	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5759	NA	T-707	NA	ICC-707	IRTR-61	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5760	NA	T-707	NA	ICC-707	IRTR-61	PTC 118	HEP-707	NA	NA	ECG 162	WEP-707	ZEN 204
2N5763	RS276-2021	T-708	NA	ICC-708	NA	NA	HEP-708	NA	NA	ECG 159	NA	NA
2N5764	NA	NA	GE-28	ICC-S3006	NA	PTC 128	HEP-S3006	NA	RT-154	NA	NA	NA
2N5765	NA	NA	GEp66	ICC-S3006	NA	PTC 128	HEP-S3006	NA	RT-154	NA	NA	NA
2N5766	NA	NA	GE-28	NA	NA	PTC 128	NA	NA	RT-154	ECG 186	NA	NA
2N5767	NA	NA	GE-28	NA	NA	PTC 128	NA	NA	RT-154	ECG 186	NA	NA
2N5768	NA	NA	GE-66	NA	NA	PTC 128	NA	NA	RT-154	ECG 152	NA	NA
2N5769	NA	NA	NA	NA	NA	PTC 136	NA	NA	NA	NA	NA	NA
2N5781	NA	TS-3003	NA	ICC-S3003	NA	NA	HEP-S3003	SK 3025	NA	NA	WEP-WS3003	NA
2N5782	NA	TS-3003	GE-29	ICC-S3003	NA	NA	HEP-S3003	SK 3025	RT-155	NA	WEP-WS3003	NA
2N5783	RS276-2025	T-242	GE-29	ICC-242	NA	PTC 142	HEP-242	SK 3025	RT-155	ECG 129	WEP-242	NA

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

NA = NOT AVAILABLE

(continued next month)

RE's Service Clinic

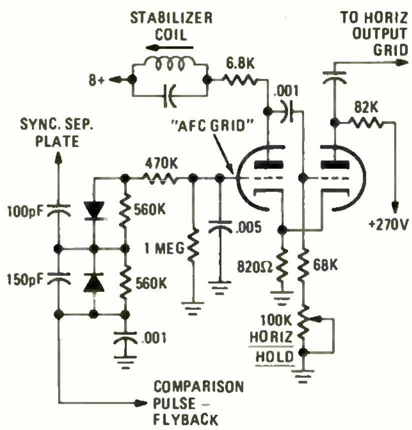
The horizontal oscillator

Symptoms, causes, tests, and cures

by JACK DARR
SERVICE EDITOR

THE CLINIC MAIL LATELY HAS SHOWN quite a few complaints about horizontal oscillator trouble. So let's run over a few practical hints on ways of checking them. They're simple if you know how they work. Contrary to an old belief (which *I* held for too long), this is not a complicated circuit. If you know it and know what the *normal* reactions are, you can locate the trouble with only a few simple tests. Very little test equipment is needed. In fact, for the basic tests, you don't even need a scope. Just look at the picture.

The simplest, and perhaps the most common circuit is the cathode-coupled multivibrator with a stabilizing coil,



shown in Fig. 1. The circuit uses two tubes, usually combined in a twin-triode. Its cathodes are tied together and returned to ground through a common resistor. The resistor is part of the feedback loop. The plate of one triode is coupled to the grid of the other through a capacitor to complete the feedback loop.

The R-C time constant of the coupling capacitor and grid resistor is the *only* thing that determines the operating frequency of this oscillator. The stabilizing coil only stabilize's the oscillator. You can shunt it out of the circuit and the oscillator will still run, on frequency.

This leads us to a logical test method. The circuit is actually a servo-loop that controls its own frequency. So to check it, we must break the loop.

Step 1; kill the afc by grounding the afc-grid of the tube. This lets the oscillator free-wheel.

Step 2; shunt the stabilizer coil. Don't ground it; there is high dc voltage here. Just connect a short clip-lead across the coil terminals. This takes it out of the circuit. (Note: If the oscillator will not run with the coil shorted, check the value of the plate resistor between the stabilizer coil and tube plate. If it is about 8000 ohms, lift one end and tack in a 15K resistor. You need more impedance in this plate circuit. Put the original back in when you are finished.)

Now, what have we got left? Just a "bare" multivibrator oscillator. Will it run? You're darn right. If all of the parts are good, you can't keep it from running. By adjusting the hold control, you should be able to make it run on frequency.

How can we determine this? Just look at the picture on the TV screen. If you see only *one* picture, the oscillator is running at precisely the right frequency. The sides must be straight, and the picture should be almost stationary. With no sync, the picture will float slowly from side to side. If you can make it stop even temporarily, fine. (To get a better idea of how this works, try it out on a set that is working.)

This is the most important step in the whole process. You MUST get this reaction. Otherwise, the problem is in another circuit. The free-wheeling oscillator frequency must be very close to the correct value, or the afc won't be able to hold it at all.

What if the oscillator won't run like this? Easy. You've got a bad part. Since there are only about 5 parts, including the tube after shunting and shorting things, it shouldn't take long to find the bad one. If the oscillator will run but won't reach the right frequency, one of these parts has *changed value*.

The most common cause is a change of the key parts; coupling capacitor or grid resistor. The grid resistor is actually in two parts; a fixed resistor and a variable, used as the horizontal hold control. The resistors can drift from heat or old age, or the capacitor can develop leakage. Normally, a paper or ceramic capacitor won't change in *value*. All it can do is leak or open. There is also the chance that someone has replaced it with the wrong value. It has happened.

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

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

After you get the bare oscillator working normally, take the shunt off the stabilizer coil. If the picture promtly falls out of sync, tune the coil until you get it back again. *Do not move the hold control*. If adjusting the coil will not make the picture come back, check the resonating capacitor across it. It may be leaky or it may have been replaced with the wrong value. The coil itself seldom causes trouble, unless it has been damaged by a shorted tube. (If everything else seems all right but the coil refuses to tune, run the core all the way out and check it. It may have broken off and have only half the effect it should. This, too has happened.

Now we're ready for the finishing touch. Take the short off the afc grid of the tube. The grid is called afc grid because that's what it is. Its main purpose is to help control the oscillator frequency by determining the firing point of the multivibrator. Applying a small dc voltage will change the frequency. (Is this a "VCO"; voltage controlled oscillator? You bet. There's nothing new.)

When you take the short off, the afc should lock the picture in tight. For the best test, turn the channel selector off-station then back. The picture should snap in, tightly locked. If it flutters and makes slanting lines for a second or two, touch up the hold control just a little, and recheck.

If the picture falls *out* of sync when you put the afc back it is telling you that you've still got troubles. Where? Not in the oscillator itself, but in the afc. It's pulling the oscillator off-frequency instead of holding it in. Check out all parts in the afc circuit; especially the dual-diode unit (and be sure to get the same type originally used! Check the schematic; once again someone may have gotten confused.) This causes most of this kind of trouble.

If you have a fairly stable picture, but it falls out of sync the instant you move the hold control in either direction; your oscillator is OK, and the chances are your afc is OK. But you probably do not have horizontal *sync* getting to the afc diodes from the sync-separator. This is a typical symptom. You can lock the picture with the hold control and it will remain locked until something disturbs the sync; you will have practically no range on the hold control. Normal range for any type of hold control is at least a half turn or more.

This can be caused by things like an open coupling capacitor between the sync-separator plate and the afc; an open conductor on a PC board in the same circuit, and so on. Now we can use the scope. Take the afc diode unit out and scope the plate of the sync separator. If the sync is there, follow it to the coupling capacitor and on to the center of the afc diode unit.

I was wiped out not too long ago by a similar reaction. Everything checked out, but I had hardly any range on the hold control. Finally, I stopped and thought and remembered that I saw no effect at all when I grounded the afc grid of the horizontal oscillator tube. (Went right by that without seeing it.) A more careful check turned up the trouble. The afc grid pin of the oscillator tube was *not* making contact, in the socket. A new socket fixed it. So, if you see an *abnormal* reaction like this, don't run over it and keep going as I did. Stop and find out why, and fix it then and there.

For the simple tests, the scope isn't needed. For more of the "beasts", it's essential. For example, if the picture weaves, bends or jitters, though the oscillator tests are good, scope the afc-diode waveforms. Look for a clean sawtooth. If you can see any writhing or signal on the slanting part of the waveform, look out. This is *video* in the sync, and it will cause troubles.

Go back to the sync-separator plate and scope the horizontal sync at this point. If you still see the video, check the *sync-separator*. It isn't clipping the horizontal sync cleanly off. Most likely cause is something in the bias on this stage; a drifting resistor in the plate, etc.

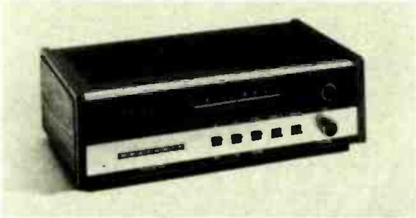
Also check for waveforms in places where they shouldn't be. One of these is the cold end of the afc diode unit. In one set, I found a good sized 6 to 8-volt sawtooth, although there was a .001-μF bypass capacitor there. This should have taken all of the sawtooth out, but didn't. It turned out to be open. The horizontal sync was very jittery and unstable.

While you're there, check the dc voltage supply lines to the horizontal oscillator. A bad electrolytic capacitor in the power supply can allow a feedback loop to set up that will upset things for three feet in all directions. The normal waveform for any dc supply line is nothing; just a straight line.

In a classic example of this, the horizontal oscillator would run perfectly all by itself. I could drive the horizonal output stage with a signal generator and *it* worked. They wouldn't work together, though. An open filter capacitor was allowing so much feedback through the dc supply that it killed the oscillator. **R-E**

For faster service USE ZIP CODE on all mail

AM/FM DIGITAL ALARM CLOCK RADIO KIT, *GR-1075*. All-electronic unit reads out time in bright orange digits that dim automatically in darkened rooms. A 24-hour alarm cycle feature means you can go to bed at 9:00 and set the alarm for 10:00 without being awakened in an hour. Alarm can



be set to go off with a controlled volume electronic beep or with music from an FM or AM radio station. A 7-minute snooze cycle is repeatable up to an hour.

Another feature is an internal standby battery supply (batteries not supplied) that takes over in the event of a power failure. Entire unit (including clock) contains four IC's, 41 transistors and 35 diodes. $129.95. —**Heath Company,** Benton Harbor, MI 49022.

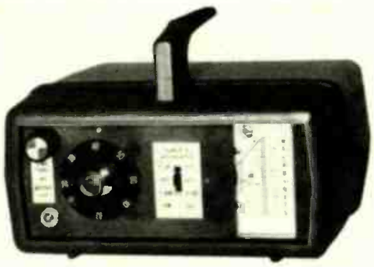
Circle 31 on reader service card

VHF TV FIELD STRENGTH METER, *FSM-V*, measures video carrier and interfering ad-

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

jacent channel sound carrier. No zero or balancing adjustments—all compensation is automatic—no external adjustments required.



Features include electronic tuning, electronic attenuators, stable local oscillator, integrated self-protecting FET rf stage, IC amplifiers, linear product detector, protective meter-driver amplifiers, transistor-regulated power supply, linear voltmeter (logarithmic dB scale), built-in battery test circuit, tuner and amplifier micro-circuit modules shielded for negligible stray pick-up, inputs for both 75 ohms and 300 ohms (no external transformers, baluns or pads).

Measure 6.5 x 6.5 x 3.25 in.; 2.5 lbs with batteries and transformer. Wall plug-in transformer for 120 Vac included. $119.95.—**Castle TV Tuner Service, Inc.**, 5715 North Western Avenue, Chicago, IL 60645.

Circle 32 on reader service card

AUTOMATIC TRANSISTOR & FET ANALYZER, *TF30 Super Cricket* is two-step tester that first determines a transistor good or bad using patent pending test. Cricket test is 99.9% reliable for any transistor or FET check in or out of circuit without use of any set-up information. You simply connect test leads in any order and push buttons. Six pushbuttons coupled with npn-pnp switch test transistor in all possible basing configurations. Cricket chirps and meter deflects when correct button is pushed. Test takes

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Circle 69 on reader service card

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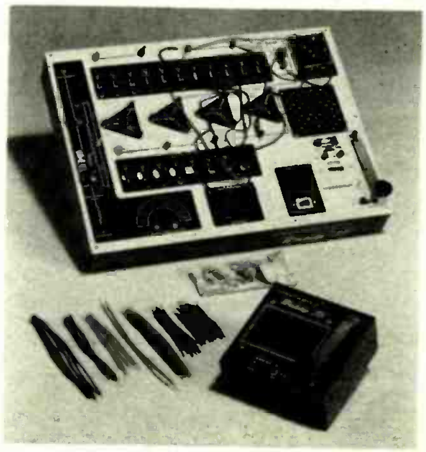
seconds.

Super Cricket portion takes over when exact transistor parameters are required. No set-up information is required. Leads can be connected in any order or by rotating function knob, unit distinguishes a transistor from an FET, then determines all critical transistor parameters of beta, I_{cbo} gm,

I_{gss} plus lead identification and transistor polarity with the push of a button. Eliminates need to zero or unity calibrate tester before each gain measurement. All calibrating is done automatically when test button is pushed. 100% safe; switching circuit applies current to transistor under test only when component is connected in proper basing configuration. $240.00.—**Sencore, Inc.**, 3200 Sencore Drive, Sioux Falls, SD 57107.

Circle 33 on reader service card

ELECTRONIC WORKSHOP, *JK-18A*. Youngsters can build 35 different experiments while they learn the basics of electronics. Connections are solderless spring terminals and power is supplied by four inexpensive safe "D" cells (not supplied). Simple sche-



matic diagrams of each experiment teach circuit and component identification.

Circuits that can be built include: code flasher, continuity tester, battery tester, diode tester, rain alarm, intercom, voice relay, loudspeaker code oscillator, flasher, electronic organ, burglar alarm, siren, light meter, code transmitter, voice transmitter, etc. $34.95 (less batteries).—**Heath Company**, Benton Harbor, MI 49022.

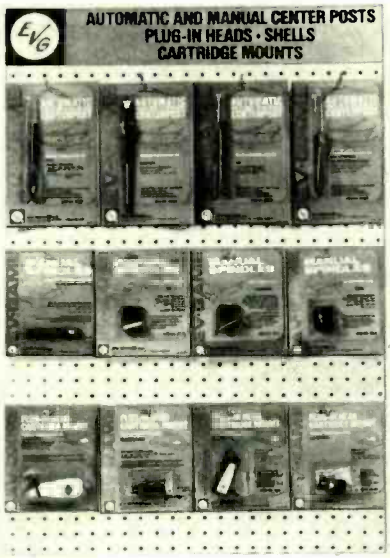
Circle 34 on reader service card

DUAL OUTPUT LAB SUPPLY, *GM412*, has tracking and independent modes. Other features include: fully regulated constant voltage mode (+20 Vdc 600 mA, –20 Vdc 600 mA), dedicated positive and negative outputs, negative output slave and independent modes, protective current limit with indicator, stable for all loads, output protected against external forcing, floating output (±300 dc to ground maximum), 3 meter ranges standard and op-amp control loop. Operating characteristics include: .01%

+1-mV line regulation, 2-mV NL-FL load regulation, ripple and noise of 500 µV rms, tracking accuracy of .1%. 3.65 x 10.56 x 6.44 in.; 6 lbs.; $157.00.—**Grumil Instrumentation**, 4626 Idlewilde Lane, SE, Albuquerque, NM 87108.

Circle 35 on reader service card

PHONO PARTS PROGRAM, *DPP-18 & DPP-58.* Each consists of a balanced assortment of automatic centerposts, manual centerposts and cartridge mounts for record changers. Each blister card has complete cross reference information including changer brand



name, model numbers and manufacturers part number.

DPP-18 consists of an assortment of six types of automatic and manual centerposts and cartridge mounts for a total of 26 pieces. *DPP-58* has six types of automatic and manual centerposts plus nine types of cartridge mounts for a total of 58 pieces. Each program is supplied with a pegboard display.—**EV Game Inc.,** 186 Buffalo Avenue, Freeport, NY 11520.

Circle 36 on reader service card

TEFLON LUBRICANT, *Wonder-Glide.* Non-toxic general-purpose lubricant for TV tuners, switches and other moving parts including telescoping antennas. Also lubricates motors, gears, pulleys, locks and appliances.

Prevents rust; not affected by salt water and is good in temperatures ranging from —25° F to +400°F. In tubes, jars and aerosol spray cans.—**Wonderglide Lube Products Corp.,** 170 Old Country Road, Mineola, NY 11501.

Circle 37 on reader service card

$2500 FM TUNER

(continued from page 36)

L+R signal and the L-R signal. Sequerra describes the system as a quasi-vestigial sideband processing circuit. The separated 19-kHz signal is fed to a frequency doubler which is used to phase-lock a free-running 38-kHz constant amplitude oscillator.

The multiplex peak detection system is driven from the 38-kHz phase synchronized oscillator. It is designed to permit the least possible phase-error in the demodulation process and might properly be called a push-pull peak detector.

The output of the multiplex decoder section is fed into a filter system which inserts the normal 75-μs de-emphasis curve (or the alternate 25-μs curve when the rear jack is shorted for that purpose). Added to this response curve is a roll-off characteristic at around 23-kHz. An additional notch filter is inserted after this point to remove any remaining components of the 38-kHz oscillator. The entire system is capable of signal-to-noise ratios in excess of 70 dB with reference to 100% modulation. This would be considered top performance for monophonic signals, let alone stereo multiplex signals which generally result in poorer ultimate S/N ratios.

Other circuits

The frequency counter displays the frequency of the station to which the set is tuned. A signal from the local oscillator in the front-end is fed into the input of the counter. Since the local oscillator's frequency is always 10.7 MHz higher than the station's frequency, the counter scales this frequency and reads the actual station frequency. The counter uses a 1-MHz crystal as its time-base, and has an accuracy of ±100 Hz with reference to the station's frequency. Incidentally, the digital readout is in increments of 100-kHz, rather than 200-kHz (a channel width). This was done because in some European and Asian countries, channels are assigned to even-numbered MHz decimals. Thus, there might be a station at 101.8 MHz, for example, a condition not possible in the U.S. where all station frequencies end in an odd MHz decimal or tenth of an MHz (101.9, 102.1 etc.)

The Four-Channel Display Computer is a device for separating the phase amplitude components of either a left or right stereo signal or an externally applied stereo or four-channel signal. This system displays in the four-channel quadrants, the phase amplitude characteristics of the input signals as

(continued on page 80)

new lit

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

BOOKS CATALOG. 36-page catalog contains books on television servicing, radio receiver servicing, general electronic servicing, appliance repair, hobby and experiment, audio, hi-fi and stereo, basic electronics technology, communications, test equipment, automotive and engine technology, computer programming and technology, broadcast promotion and advertising, broadcast programming and announcing, broadcast production, films and videotape, broadcast writing, CATV, MATV and much more. Prices are included.—**Tab Books,** Blue Ridge Summit, PA 17214.

Circle 38 on reader service card

DMM BROCHURE. 4-page brochure describes *model 41*—2000 count, 4½ digits, has BCD output for systems applications, five ac and five dc voltage ranges, six resistance ranges and five ac and five dc current ranges. TTL compatible BCD output of reading, function, range and polarity permits unit to be used in conjunction with printers and/or other digital output devices. Headings include features, digital interface, accessories and specifications.—**Data Technology Corp.,** 2700 South Fairview Street, Santa Ana, CA 92704.

Circle 39 on reader service card

$2500 FM TUNER

(continued from page 78)

compared to any of the other three input signals. All vectors have the center of the oscilloscope face as an origin. With no audio signals applied, the bright dot which ordinarily appear at the center of the scope face is automatically dimmed so that it is barely visible, preventing a "burn" from developing at the center of the scope face.

The power supply system provides the necessary regulated voltages to all the other systems. It is short-circuit proof and can be adjusted by the user for either 120-volt or 220-volt operation.

The visual display system of the Model 1 tuner is driven by the 12-Vac power system. It is used to illuminate the main screen, to illuminate the three individual graticule systems in front of the scope face and to light the words "stereo pilot" and "Megahertz" on the front panel. This section is individually fused.

Readers who have followed this admittedly cursory description of the Sequerra Model 1 FM tuner may be inclined to wonder whether the refinements and sophistication built into this product actually produce an audible improvement in FM listening. There is, of course, no clear-cut answer to this question. Obviously, if the only stations that broadcast FM in your area are sloppy in their studio practices and in their transmission, results are going to be limited by the station's own quality of signal transmitted. We suspect that a good many FM stations may want to purchase one of these units, if for no other reason than that it can serve as a monitoring tuner which is better than what they may now be using for that purpose. Much can be learned, for example, just by examining the "pip" displayed on the panoramic display unit. Maximum bandwidth excursion is easily interpreted, as are overmodulation of SCA carriers on the main channel and a great many other operating parameters.

As for the rest of us FM fans, we suspect that there will be enough of us who want what must be the best performing FM tuner ever built to keep Sequerra's company turning out as many of these tuners as production capacity will permit. The fact is, Sequerra confided at the end of our brief visit to his plant that he has been in a "back ordered" position from the time unit number one came off the production lines. This suggests that even if you have your $2500.00 in hand, you may still have to wait a bit to get your hands on your very own Sequerra Model 1 FM Tuner. **R-E**

ISCET inspects 13 TV brands gives serviceability ratings

The International Society of Certified Electronic Technicians, NESDA's technician subdivision, has for the first time inspected simultaneously most of the current model TV receivers for serviceability.

Ratings for the 13 brands inspected are:

Brand	Model	Percentage
1. Panasonic	CT253	75.34
2. Sylvania	CE4181W	75.11
3. Motorola	WL9219	73.1
4. J. C. Penny	2878MF3831	72.43
5. Zenith	F4028W	72.29
6. Magnavox		70.97
7. Gen. Elec.	MC9220MP	67.38
8. Admiral	525931	66.44
9. Sears	52841960304	64.43
10. RCA XL100	FT518WEN	60.3
11. Sony	KV1920	53.14
12. Hitachi		52.9
13. Toshiba	C924BM	34.37

The percentages are based on 100% for a set that would be perfect from the servicing point of view.

The inspection was made in Indianapolis. All brands inspected were 19-inch or larger models. Inspecting technicians were all independent CET's who were not employed at any establishment affiliated with a particular brand.

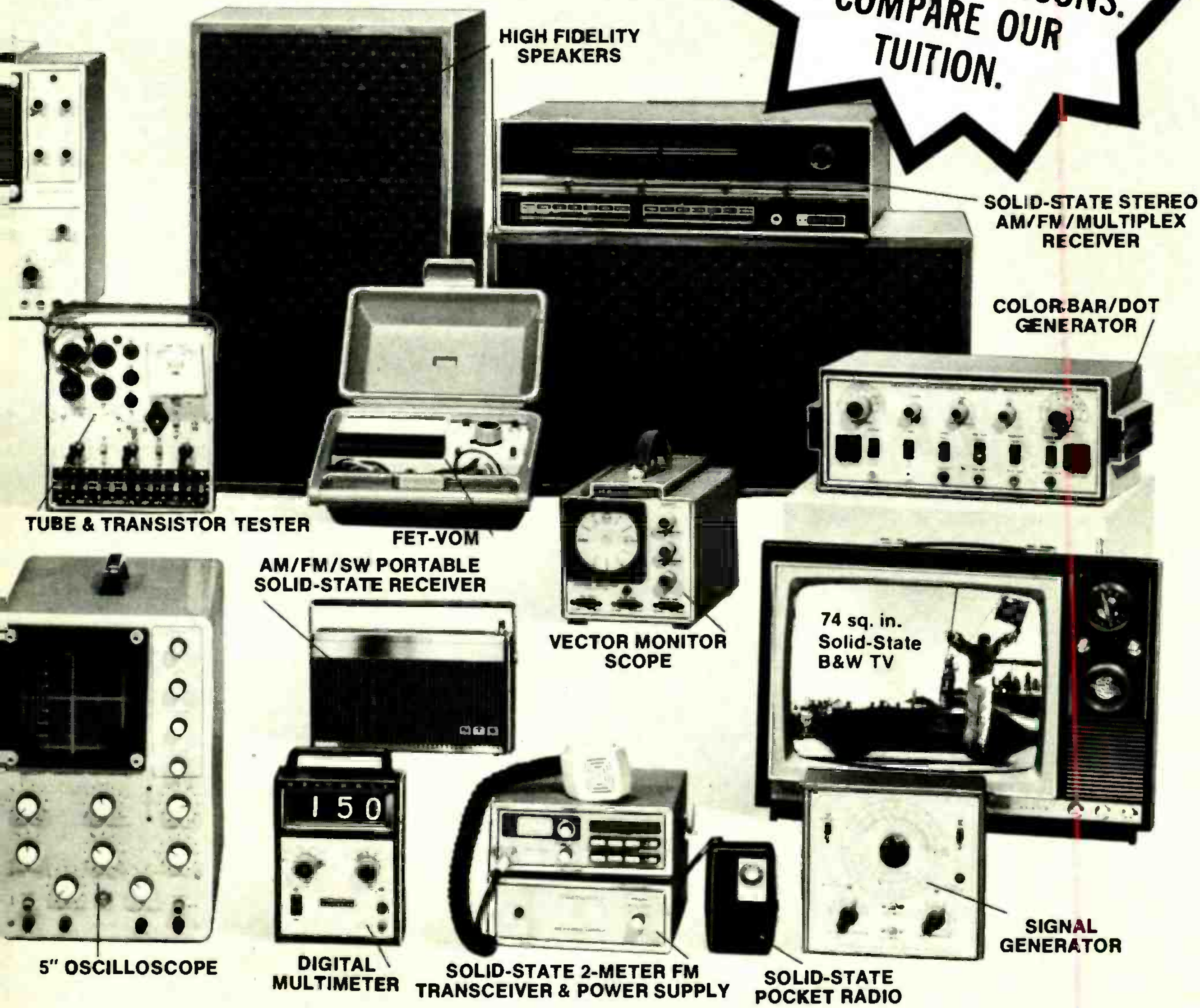
Some points on which the competing receivers lost percentage marks were: failure of back cover interlock to match up readily; back covers that drop down when back is unfastened; model and serial numbers not permanently attached, or illegible; inaccessible hi-voltage compartments; sharp edges on metal parts; field adjustments not identified for replacement or whose component leads are not identified; tuners not removable without removing the chassis; excessive chassis or subassembly mounting devices; chassis and subassemblies that cannot readily be operated on or transported without props; unidentified test points, and wiring patterns on only one side of printed boards.

National health insurance will require privacy guards

A high level of security will be required to guard computer data banks established to administer any national health plan, Robert P. Henderson, vice president of Honeywell's North American computer operations, told a national conference of doctors, lawyers and health-care administrators gathered in Boston to consider the use of computers in the medical field.

"National health insurance cannot operate without the medical computer," he said. He went on to explain that a number of security techniques are available to protect the traditional confidentiality of the doctor-patient relationship. He advised that such safeguards be built into the computer systems at the design stage, when they are more effective and economical. **R-E**

and the equipment be equipped.



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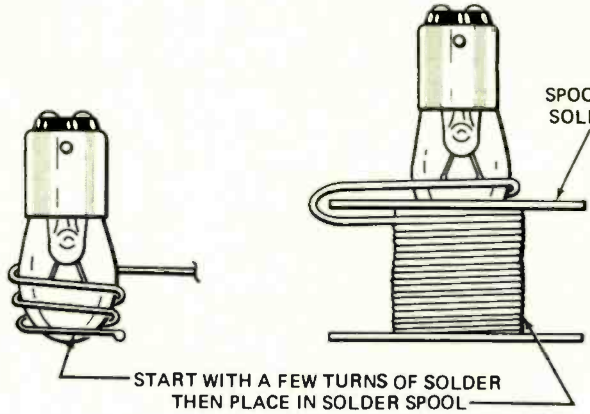
When soldering small fragile components or devices that are not readily grasped with a clip, vise or other clamping device, try using a spool of solder as a third hand. The illustration shows how it works.



For example, when soldering leads or contact strips to a lamp, just wrap a few turns of solder around the glass and then place it in the middle of the spool.—*Alex Billos*

RCA CTC 19D—POOR COLOR CONVERGENCE

The red convergence lines were out of place and could not be brought into place by normal service adjustments.

The trouble was traced to an open selenium rectifier on the convergence board. The part number of the replacement is 118244.—*David Mark*

R-E

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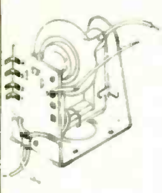

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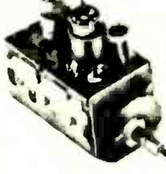
SARKES TARZIAN TUNER 41mc



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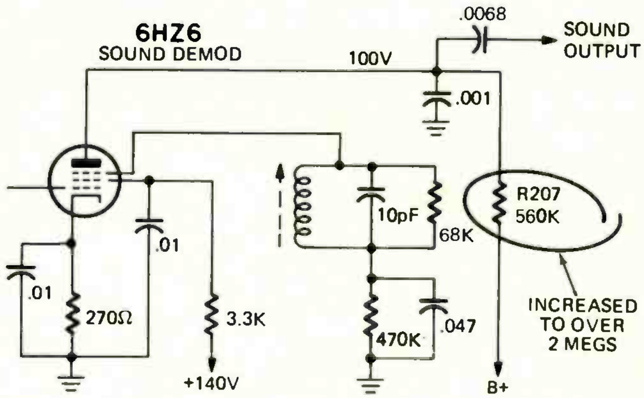
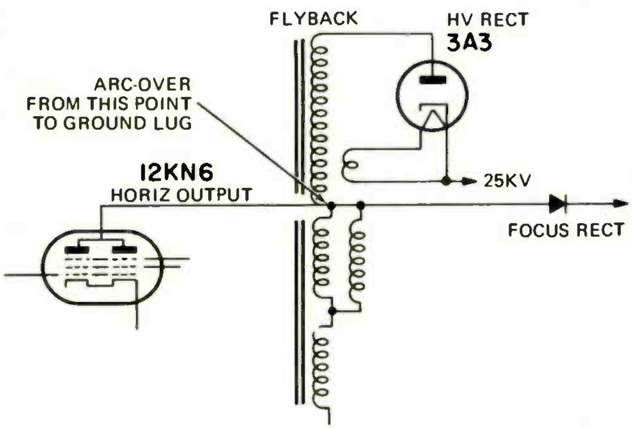


plate load resistor R207 (560K) had increased to over 2 megohms. This same resistor was found to change value in several different TV color chassis.—*David Held*

technotes

SYLVANIA D-03 CHASSIS

The symptom was a vertical stripe about two inches wide down the left side of the screen. This type of trouble is



often caused by arcing in the flyback transformer. Smoke and burned insulation led us to the point of arcing—from a ground lug to the point used for the focus rectifier and plate of the horizontal output tube.—*Homer Davidson* R-E

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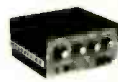

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74H20N	.39
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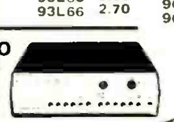
Model 4440



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40636	"	3027	704	TO-3	1.95
2N3714	"	3036	704	TO-3	2.59
2N3715	"	3036	704	TO-3	2.75
2N5320	RF Pwr. Amp.	3512	53002	TO-5	1.65
2N5322 (P)	"	-	-	TO-5	1.75
2N5321	"	3512	53010	TO-5	1.65
2N5323 (P)	"	3513	-	TO-5	1.65
2N5679 (P)	Audio/RF Pwr Driver	-	53031	TO-5	1.70
2N5681	"	-	-	TO-5	1.70
40594	Audio Driver	3024	53002	TO-5	1.45
40595 (P)	"	3025	53031	TO-5	1.65
2N5781 (P)	"	-	-	TO-5	1.75
2N5784	"	-	53002	TO-5	1.75
2N5864 (P)	RF & Audio Driver	-	-	TO-39	1.35
40348	"	3044	243	TO-5	1.72
40544	"	3045	-	TO-5	.79
2N2895	RF & Audio AMP	3024	-	TO-18	1.25
2N930A	Lo-Noise Amp	3039	50	TO-18	.95
2N2219A	Audio-UHF Amp/SW	3024	53001	TO-5	1.05
2N2846	High Speed Sw	3024	-	TO-5	1.55
2N3933	VHF/UHF Amp	3039	56	TO-72	1.55
40894	VHF/UHF RF Amp	3039	-	TO-72	1.10
40895	VHF/UHF Mix, Osc	3039	-	TO-72	.95
40897	VHF/UHF IF Amp	3039	-	TO-72	.90
2N5179	LoNoise, Amp, Osc, Mix, Conv	3039	709	TO-72	1.10
2N918	VHF/UHF Amp Mix, Conv	3039	709	TO-72	.95
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7403	.19	7451	.27	74153	1.29
7404	.22	7453	.27	74154	1.59
7405	.22	7454	.39	74155	1.19
7406	.39	7460	.19	74156	1.29
7407	.39	7464	.39	74157	1.29
7408	.25	7465	.39	74161	1.39
7409	.25	7472	.36	74163	1.59
7410	.19	7473	.43	74164	1.89
7411	.29	7474	.43	74165	1.89
7413	.79	7475	.75	74166	1.65
7415	.39	7476	.47	74173	1.65
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7417	.39	7485	1.39	74176	1.65
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7432	.29	7495	.89	74191	1.59
7437	.45	7496	.89	74192	1.49
7438	.39	74100	1.65	74193	1.39
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74L04	.33	74L72	.49	74L95	1.69
74L06	.33	74L73	.69	74L98	2.79
74L10	.33	74L74	.69	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.69	74L86	.69		

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74H08	.33	74H40	.33	74H62	.39
74H10	.33	74H50	.33	74H72	.49
74H11	.33	74H52	.33	74H74	.59
74H20	.33	74H53	.39	74H76	.59

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8092	.59	8220	1.69	8812	1.10
8095	1.39	8230	2.59	8822	2.59
8121	.89	8520	1.29	8830	2.59
8123	1.59	8551	1.65	8831	2.59
8130	2.19	8552	2.49	8836	.49
8200	2.59	8554	2.49	8880	1.33
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74C04	.75	74C107	1.50	74C164	3.50
74C08	.75	74C151	2.90	74C173	2.90
74C10	.65	74C154	3.50	74C195	3.00
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MAN 6	Red .6" solid seg	4.25
8008	8 bit CPU prime quality	64.50

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5203	2048 bit erasable PROM	24.95
5260	1024 bit RAM Low Power	3.95
7489	64 bit RAM TTL	2.75
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MM5736	18 pin 6 DIG 4 funct	4.95
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MM 5311	28 pin BCD 6 dig mux	6.95
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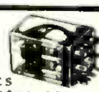

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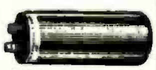
10000	1100	35	1-25/64 x 2-11/64	$1.00
28000	100	350	1-25/64 x 2-11/64	.90
10000	80	400	1-25/64 x 2-11/64	.90



Miniature Cooling Fan

100 CFM, Mfr. Howard Ind.
Model # 1075-10-3369
115 VAC, 60 cycle, 20 watt, 3000 r.pm.
Size: 4" blade, 3" deep.
Complete with blade guard and mounted on a flat metal plate. Features low noise level, high volume of air. Great for cooling electronics and electrical equipment.
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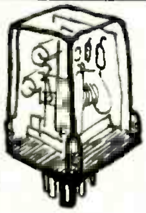
Circle 97 on reader service card

EXOTIC COMPUTER DATA INPUT KEYBOARD and HOUSING

Completely enclosed keyboard, made by HONEYWELL, part of input terminal of local computer manufacturer. 60 keys, magnetic reed type, including alpha & numeric shift keys. TTL encoded in a 7 bit binary code, and output is TTL compatible. We provide a ci chip to easily convert to ASCII, or any other code. Housing is cast aluminum, 12½"x17"x7" high. Display area is 3½"x16½", for readouts of your choice. All circuity data provided, for keyboard and chip.

STOCK NO.R5237 Complete with data. $59.50 Wt. 15 lbs.

TIME DELAY RELAYS



2 TIME DELAY RELAYS,one with fixed delay of 10 seconds, and other with variable delay, from 3 to 10 seconds. Each relay and delay circuitry is enclosed in clear plastic case, with octal socket base. Octal socket supplied. Operates from 24 to 60 VDC. Relay is P & B KA series, DPDT with 10 amp contacts. Time delay is solid state circuitry, using a Unijunction. Data supplied showing how to increase delay, and making fixed delay variable.

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Circle 98 on reader service card

MICROPROCESSORS by Poly Paks

60-WATT STEREO AM-FM-MULTIPLEX

- All Solid State, Printed Circuitry
- Slide Rule Dial
- All Purpose, All Family System!

59.95 ☐ WITH ESCUTCHEON

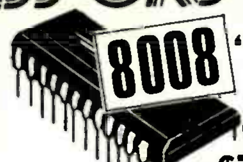
Features: 4-speaker system, built-in FM antenna, record player jacks on separate panel. Another external panel consists of provisions for external FM and AM antenna, "satellite" speakers to provide 4-speaker ground, jacks for connecting a tape recorder to radio tuner or phono of systems to record. Lower inputs for connecting tape deck that will play back thru the internal amplifier for systems. AC jack for phono power connection. RED, GREEN and CLEAR indicators for Phono, AM, and FM respectively. Includes red indicator on front panel for STEREO indicator. Has separate input to plug into mike, guitar and other musical instruments Has front panel controls, PHONO-STEREO-AM-FM, MONO, FM STEREO, GUITAR, TAPE MIKE master control switch. LOUDNESS, BALANCE, TREBLE, BASS controls, with power ON-OFF rocker switch, and AFC ON-OFF. Designed for all audio-philes to use as wall unit in DEN or FAMILY ROOM, or control unit by easy chair in family room, or for those who wish to design their own console or modular system. With 6 ft. 115 VAC cord and plug. Only 13 x 7 x 3½" deep.

- AM-FM-MUX-DIAL indicators!

With knobs.

Shpg. wt. 3 lbs

8008 "THE COMPUTER ON THE CHIP"

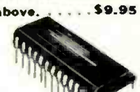


Only ☐ $79.95

Usually called "Microprocessor" — it is a p Channel Si gate MOS 8-bit Parallel Central Processor. A CPU Central Processing Unit on a chip. Features complete instruction decoding and control. Capability to address 16K x 8 bits of memory (RAM, ROM, SR). Build a micro-computer system when interfacing with other chips, such as 1101, 1103, 2102 (RAMS), etc. With spec sheets. 16-pin dip package. $79.95

2102 1000-bit "static" Ram for above. $9.95

16-BIT MICRO PROCESSOR BASIC SYSTEM ☐ Only $149.



The lowest-priced 16-bit system! Outperforms the 8008. The CPU (Central Processing Unit) includes 4-MM5750's, called RALU's, and one MM5751 CROM. RALU — called Register and Arithmetic Logic Unit — is a 4-bit control bus, and the CROM is a Control-and-Read-Only Memory. The four RALU's in parallel form a 16-bit unit. The RALU's are controlled by micro-instructions, stored in the CROM. With spec sheets.

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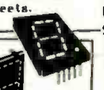
3 for $12. ☐ $4.50 each



Mfgr	Type	Color	Size
☐ Opcoa	SLA-3	Red	0.7"
☐ Opcoa	SLA-3	Green	0.7
☐ Opcoa	SLA-3	Yellow	0.7
☐ "M"	MAN-6*	Red	0.6
☐ Litronix	747	Red	0.6
☐ Litronix	746**	Red	0.6

*All LED, fits standard 14-pin socket
**Plus or Minus 1

- 7-SEGMENT
- Reflective bar
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- TTL compatible
- For giant clocks, DCMs, etc.

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☐ LM302	.69	☐ LM702	.49
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☐ LM307	.31	☐ LM709	.25
☐ LM308	1.05	☐ LM710	.29
☐ LM309H	1.05	☐ LM711	.29
☐ LM309K	1.50	☐ LM723	.61
☐ LM310	1.10	☐ LM725	.69
☐ LM311	.99	☐ LM733	1.75
☐ LM318	1.75	☐ LM741	.31
☐ LM319	1.19	☐ LM741CV	.31
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☐ LM380-8	1.10	☐ CA3065	.59
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3 for $15

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☐ Same as the 9-digit Panaplex Two and the National unit, but 11 digits with socket $6.95

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Manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes 3x2" p.c board with fingers for a FREE edge connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's), and booklet. INCLUDES P.C. EDGE CONNECTOR — FREE!

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☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

* Pin-for-pin MAN-1. ** Pin-for-pin MAN-4. elec. same

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☐ 5.95

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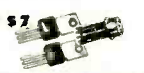
$3.98 ☐ 2 for $7
35 WATT AUDIO AMPLIFIER BASIC



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- TO-220 Case
- 1 Amp
- POSITIVE VOLTAGE

$1.75 Each

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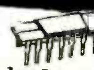
☐ LM-340-06T	6 v
☐ LM-340-08T	8 v
☐ LM-340-12T	12 v
☐ LM-340-15T	15 v
☐ LM-340-18T	18 v
☐ LM-340-24T	24 v

"MEMORY LANE"



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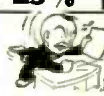
Brand New



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WITH GLASS ESCUTCHEON

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☐ Same as above except amplifier heavy-duty stereo 60 watt unit. ..... $59.95 ☐ **$59.95**

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☐ Same as item #1 except reject, parts may be missing.

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Four Bit Microprocessing Chip **$79.50**

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1000	.20	.45	1.10	2.60

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CD 4009	$ .80	CD 4028	$2.75
CD 4010	$ .53	CD 4029	$4.80
CD 4011	$ .53	CD 4030	$ .65
CD 4012	$ .53	CD 4035	$2.30
CD 4013	$1.00	CD 4042	$2.75
CD 4015	$3.35	CD 4046	$3.75
CD 4016	$1.05	CD 4047	$3.60
CD 4017	$2.70	CD 4050	$1.05
CD 4019	$1.20	CD 4055	$3.20

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MAN-3 READOUT $1.75
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400	1.15	1.50	5.00
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NEC 6003 2048 bit RAM .. $9.50
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7404—	.22	7489—	2.75
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7407—	.37	7492—	.75
7408—	.24	7493—	.75
7410—	.18	7495—	.85
7411—	.30	7496—	.85
7412—	.45	8220—	1.50
7413—	.75	74107—	.50
7416—	.37	74121—	.60
7417—	.37	74123—	1.00
7420—	.18	74125—	1.40
7426—	.30	74126—	1.40
7427—	.33	74150—	1.15
7430—	.18	74151—	.75
7432—	.30	74153—	1.10
7437—	.44	74154—	1.60
7438—	.37	74157—	1.15
7440—	.21	74163—	1.15
7441—	1.05	74164—	1.85
7442—	1.00	74165—	1.85
7445—	1.00	74173—	1.80
7446—	1.15	74175—	1.45
7447—	1.15	74177—	1.80
7448—	1.20	74181—	3.60
7450—	.18	74192—	1.45
7472—	.40	74193—	1.38
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LM 339—QUAD COMPARATOR ... $1.65

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200	.70	1.10	1.75	.60	.70	1.60
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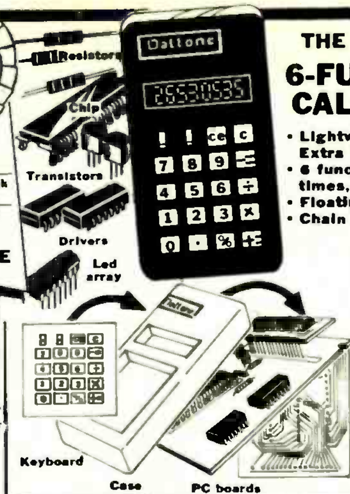

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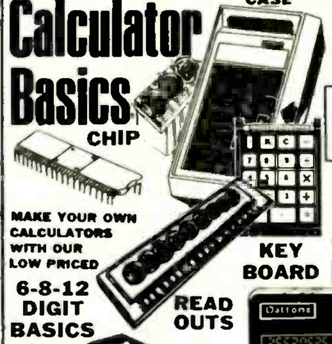

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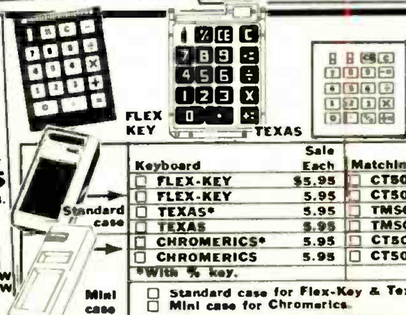

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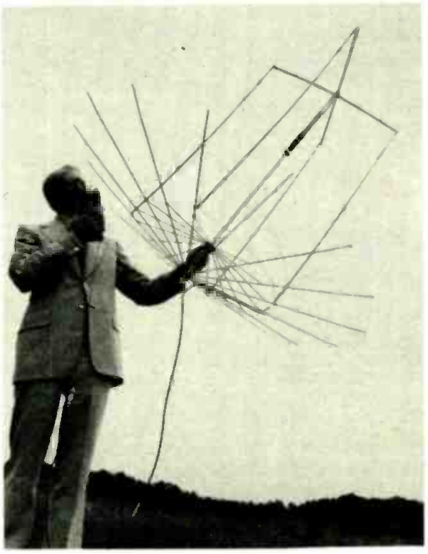
The demonstration, according to engineer Roy E. Anderson, who conducted the test, showed that a person in distress could summon help with such a small unit, plus a collapsible antenna, which could boost the range as much as 10,000 times, to almost any point on earth—given a suitably positioned space satellite.

"Six geostationary satellites could blanket the whole earth, except the polar regions," Mr. Anderson believes.

"The satellites would be monitored by three ground stations that could use range measurements to locate persons in trouble, then dispatch assistance."

The Schenectady station replied by phone, showing that persons in distress could readily receive a reply from a search-and-rescue station, acknowledging the SOS and giving rescue information.



SIMPLE TWO-TURN HELICAL ANTENNA, built on the frame of a golfer's umbrella hooked up to a low-power walkie-talkie, could communicate via satellite with almost any point on earth, GE engineer Roy E. Anderson proves by actual test. Mr. Anderson is not using phone for the test—he is keying the radio with the push-to-talk button and sending pure continuous wave. GE's Radio-Optical Observatory, which received the message, acknowledged by phone, however.

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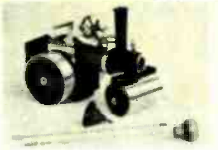

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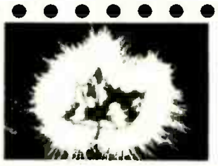

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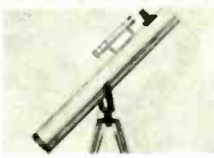

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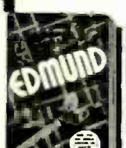

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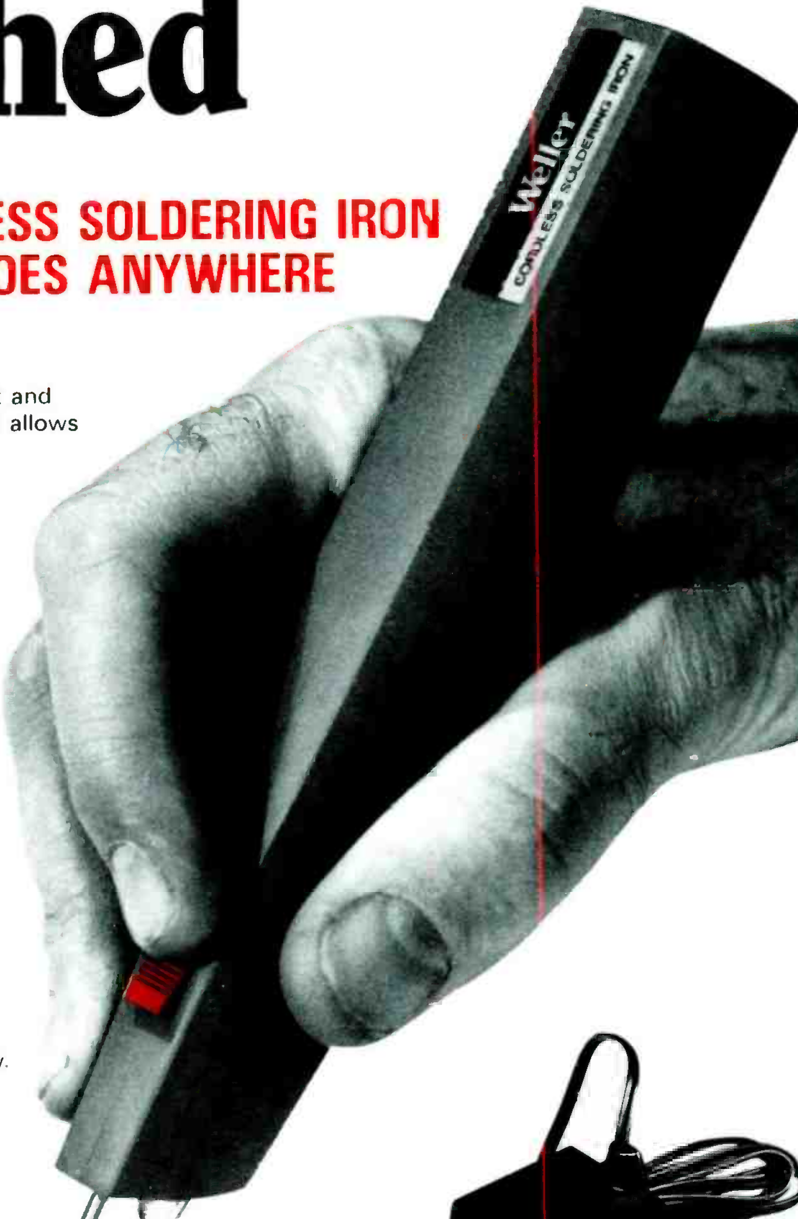

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