Electronics World

JANUARY, 1971
60 CENTS

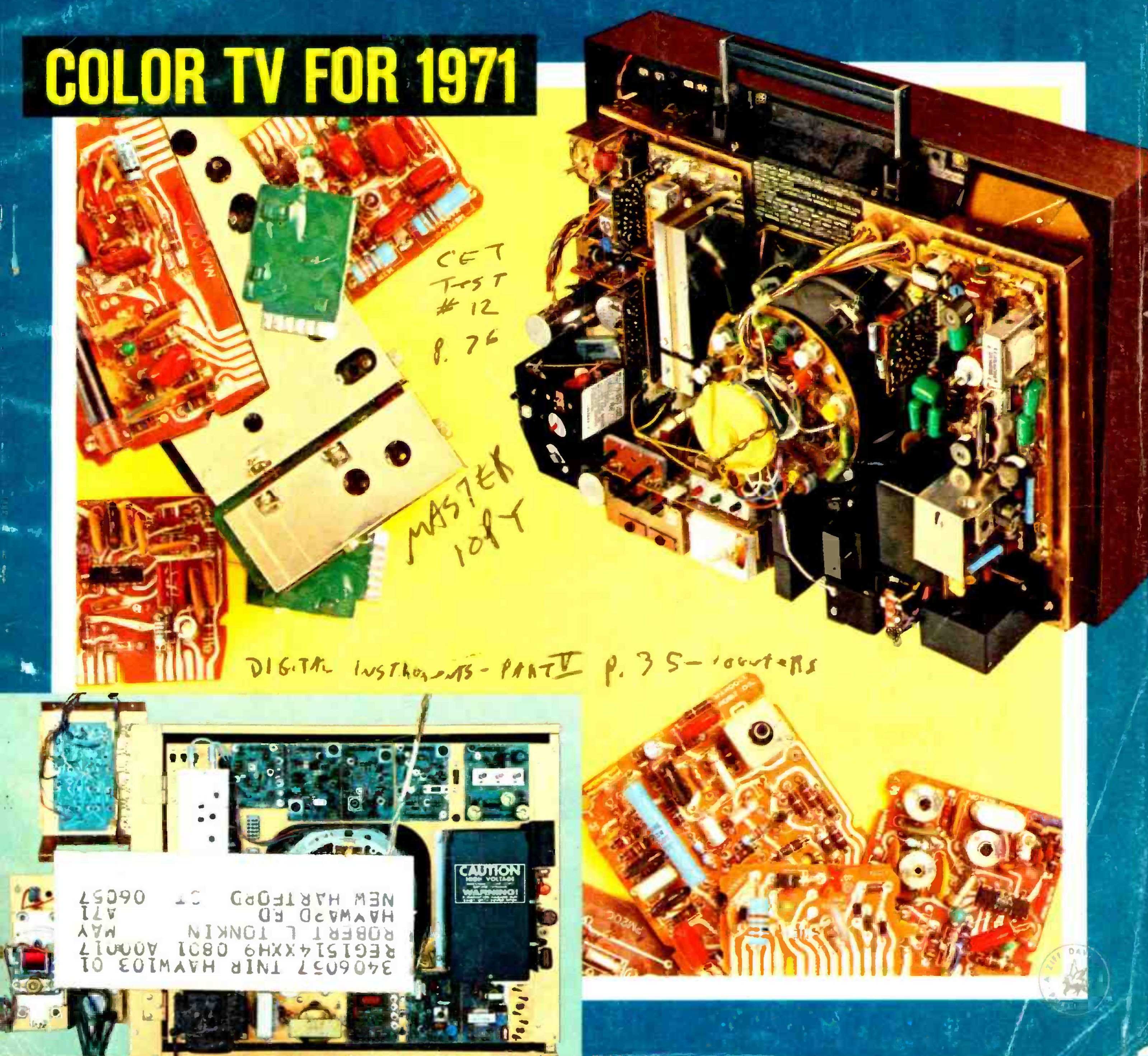
COLOR ORGANS & STROBE LIGHTS FOR HI-FI

INTRODUCTION TO ELECTRONIC COUNTERS

MARINE COMMUNICATIONS UP-TO-DATE—The New Regulations

How to TEST HI-FI EQUIPMENT

COLOR TV FOR 1971



Second fiddle? Hardly.

The Shure M91E cartridge cannot, alas, track as well as the incomparable V-15 Type II Improved, but then, no cartridge can. What the M91E *can* do is out-track everything else. Stereo Review (Feb., '69) said, "The listening quality of the Shure M91E was excellent . . . it virtually matched the performance of the V-15 Type II in its ability to track the highest recorded levels to be found on modern recordings." High Fidelity (July, '69) agreed: "Its sound is about as neutral and uncolored as any pickup we've auditioned; clean, smooth, well balanced across the range . . . a first class 'tracker.'" We at Shure agree. We ought to know, because we introduced the concept of trackability. The M91E for now (only $49.95)—the V-15 Type II Improved later. Shure Brothers Inc., 222 Hartrey Ave., Evanston, Ill. 60204.

SHURE

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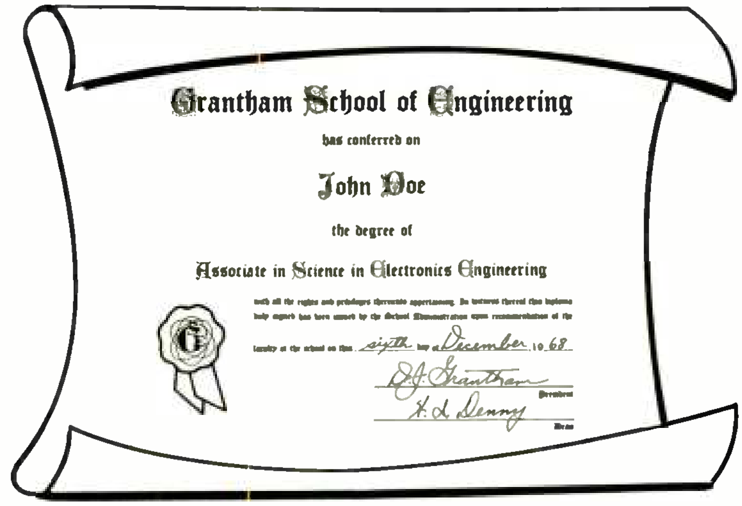

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Electronics World

JANUARY 1971 VOL. 85, NO. 1

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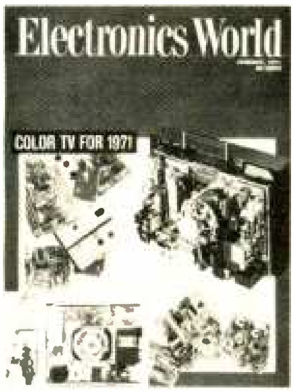
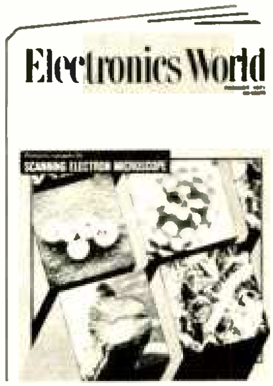


THIS MONTH'S COVER shows two new color-TV sets that employ plug-in modular construction for ease of servicing. At top right is the RCA CTC-49 chassis (Argosy Model EP-506) surrounded by an extra set of most of its plug-in modules. At the bottom left is the new Heath GR-370 chassis color-TV kit. Separate articles on each of these receivers along with a directory of the new 1971 color-TV chassis appear in our issue this month. . . . Cover photograph: Dirone-Denner.

MONTHLY FEATURES

Coming Next Month

Special Feature Article



Circuit Innovations In 1971 Color-TV Sets

In this first of a two-part series, Forest H. Belt discusses some of the unusual circuits that you will encounter in the 1971 lines now being introduced. The customer will have the widest possible choice of models and screen sizes, while technicians will find modules, 110-degree picture tubes, and novel circuitry in sets they service.

Scanning Electron Microscopes

By eliminating the need for very thin specimens—and saving hours of valuable time in preparing them—the scanning-type electron microscope has brought a new dimension to R&D labs. Even "stereoscopic" viewing is possible with these sophisticated research tools.

Selecting a Video Tape Recorder

Educators, operators of cable-TV systems, broadcast personnel will find a wealth of up-to-the-minute information on available units. Sixteen models are covered along with a fact-packed table which permits instant comparisons of features and prices. Don't miss this.

TV Service and Safety

Alert to the possible dangers of carelessly substituted parts, television manufacturers have launched an all-out campaign to see that their sets stay safe over their service life. Ray Herzog of General Electric explains what his firm is doing to insure that parts with critical parameters are brought to the attention of technicians to discourage alterations or bypassing of safeguards.

ITU and How Its Decisions Affect You

The 1971 World Administrative Radio Conference may make a bigger difference in your viewing habits and telephone service than you think. Learn why.

*All these and many more interesting and informative articles will be yours in the **February** issue of ELECTRONICS WORLD . . . . . on sale **January 19th**.*

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212 679-7200
Joseph E. Halloran, Adv. Mgr.

MIDWESTERN OFFICE
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Radio & Television news

By MURRAY SUNTAG/Associate Editor

Video Disc Debut

In the latter part of 1970 another method of presenting TV programming was introduced to the American press—the *Teldec* Video Disc. Created jointly by *British Decca* and *Telefunken*, this thin plastic video disc is capable of storing over 500,000 bits/mm² (100 times storage capacity of an audio disc). Because of the program density attainable on the video disc (up to 3500 grooves/in), a playing time of 5 minutes on a 9-in disc, or 12 minutes on a 12-in disc is possible. Each revolution of the disc represents one complete television picture. Using a video disc player, both video and sound information on the disc can be transmitted to any standard TV set. Although similar to ordinary record player, disc player has no turntable. The video disc, driven by a central carrier at a speed of 1500 r/min, literally floats on a very thin air cushion that forms between disc and a stationary faceplate. This action causes disc to float up against the stylus in a cable-driven pickup cartridge. The stylus, unlike those used in phonographs, rests on top of the frequency-modulated video disc grooves rather than within the groove and senses the "hill and dale" height variations. A pressure transducer converts these variations into electrical impulses. For longer programs, an automatic changer is feasible, although the problem of pauses between discs still has to be solved. All-in-all, this technology promises big things for the future; recording multi-channel stereo programs—two, three, four, or more channels being possible and obsoleting such terms as turntable rumble and anti-skating devices. Although player shown to press produced only black-and-white pictures of good quality, it is anticipated that by the time *Teldec* goes into full production (1972), color units will also be available. It is estimated that black-and-white video disc player will cost between $150 and $250 and a video disc should not be much more expensive than a stereo record. An article elaborating on the technical operation of the video disc is planned for next month's issue.

School for Radio Hams

It's never too early nor too late to become a radio ham—an avocation that claims among its practitioners such pre-eminent personalities as a king (King Hussein of Jordan) and a U.S. Senator (Barry Goldwater). *Lafayette Radio Electronics*, Syosset, N.Y., is offering free radio instruction to all—from the ages of seven to eighty-two, on a first-come, first-served basis. The course, being taught by a licensed instructor, is geared to prepare students for the proper and efficient use of radio communications. Two sessions are offered: one, dealing with Citizens Band equipment and its operation, meets once a week at 7:30 p.m. for four weeks; and a second, which provides intensive preparation for the Novice Amateur Radio License exam (covering both code and theory), meets once a week at 7:30 p.m. for eight weeks.

Those who are interested should contact Frank Morisco, Educational Consultant, *Lafayette Radio Electronics Corp.*, 111 Jericho Turnpike, Syosset, L.I., New York 11791.

A Talent Pool

With defense and space cutbacks and a down economy in general, many professional and skilled personnel have been literally thrown on the open market. Consequently, unlike the years of feast when professionals had their choice, the tables have been turned and employers are doing the picking. But, just a little reminder—the ups and downs in the economy are cyclic and usually the ups are around a lot longer than the downs. For those who are interested, NASA has made available a talent pool of those professionals they reluctantly had to lay off due to budgetary cutbacks. For information, call James R. Miles at NASA's Employment Assistance Center, Area Code 202-962-8696.

TV X-ray Detectors

Two simple, low-cost detection instruments, developed by the HEW Environmental Health Service's Bureau of Radiological Health, now make it economically feasible for all TV service technicians to check home television sets for dangerous emissions of x-rays. According to John C. Villforth, Director of the Bureau, "the instruments will indicate with reasonable accuracy whether a television receiver is emitting x-rays above the maximum of 0.5 milliroentgen per hour allowed by the Federal Standard and also will help locate the source of trouble so repairs or adjustments can be made." One of these instruments, a simple Geiger-Mueller device, has no meter display, therefore obviating need for calibrations and interpretation of results. The other instrument, a more complex Geiger-Mueller device, uses a count-rate meter circuit which indicates relative x-ray intensity. Both instruments can be built from readily available parts. Detailed instructions for making and using new devices are contained in Bureau of Radiological Health report, "Simple X-ray Detection Instruments for Television Service Technician" by Richard K. Stoms and Edward Kuerze. Copies may be purchased ($3.00 each for paper-bound copies and 65 cents for microfiche) by order number (BRH/DEP 70-14, PB 192-377) from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Although the incidence of dangerous x-ray emissions from color-TV receivers is not as prevalent as some reports have indicated, we think—even if only for psychological reasons—x-ray detection devices should become part of every service technician's tool kit. We're sure most people, especially those whose children continuously hover over a TV set, would like to be assured by their TV technician that their set is not spewing forth potentially dangerous x-rays.

Auto Safety Device

A prototype device which virtually gives a driver eyes in the back of his head, has been developed by *Sylvania Electric Products Inc.* The system, designed to be installed in a side mirror or in rear light assembly of a vehicle, automatically warns driver when another vehicle is approaching from his left- or right-rear blind zone. Ultrasonic safety detector responds to noise generated by engines and tires. When it detects a vehicle traveling at least 35 miles-per-hour, that is within 25 feet of car, it automatically flashes a warning light. It is particularly helpful in fog or rain when driver has to exercise extreme visual surveillance to change lanes safely. Currently undergoing field tests, *Sylvania* plans to demonstrate the system to all of the major automobile manufacturers.

Going to Metric System

After 180 years of thinking about going to the metric system (Thomas Jefferson first recommended it in 1789), the United States is finally giving it a try. A directive issued by NASA states that as of November 14, 1970, all measurement values used in the agency's future scientific and technical publications will be expressed in the metric system. Actually NASA's role, as being the first federal agency to do so, is due to its decision to assist the Bureau of Standards in studying the effect that the metric system will have in the U.S. In 1968, the Secretary of Commerce, who was authorized by Congressional Public Law 90-472 to make this study, delegated this responsibility to the Bureau of Standards. Most NASA officials feel that, in the long run, conversion to the metric system will provide benefits to the country, especially in the areas of foreign trade. Among the industrial nations of the world, only the U.S., Great Britain, Canada, Australia, and New Zealand continue to use the English system. However, Great Britain is now converting to the metric system and the Commonwealth nations intend to convert.

New Microwave Oven Standard

Based on results of Federal, State, and local public health agency surveys of microwave ovens, HEW Environmental Health Service's Bureau of Radiological Health imposes new Federal limitation on radiation emission from microwave cooking ovens. Survey showed that 20 to 30 percent of ovens tested emitted radiation in excess of industry standard. New standard under Radiation Control for Health and Safety Act requires that ovens manufactured after October 6, 1971 may not emit radiation in excess of 1 mW/cm^2 prior to sale and may not emit radiation in excess of 5 mW/cm^2 throughout useful life of oven. Both of these limitations are based on microwave power densities measured at five centimeters (about two inches) from any external surface of the oven. The standard also requires at least two safety interlocks with one of them concealed to prevent undue tampering.

Electronic Shorts

Marantz Co., Inc. institutes national plan for analyzing performance of hi-fi and stereo components—*gratis.* Consumer can bring his receiver, amplifier, and preamplifier—no matter what make—into any *Marantz* dealer to be thoroughly analyzed and tested by most modern and sophisticated test equipment . . . . *RCA* receives one of broadcast industry's largest equipment orders to supply complete color-TV studio system for *Oesterreichishcher Rundfunk Gmbh.* (*ORF*), the Austrian broadcasting agency. *RCA* will build and supply color-TV cameras, video tape recorders, TV film systems, and other equipment for installation in huge TV production complex in Vienna where *ORF* is consolidating its operations. . . . Meanwhile, back at home *RCA* has announced a 3 percent average increase in distributor prices on its current line of color and black-and-white television sets. ▲

Electronics World

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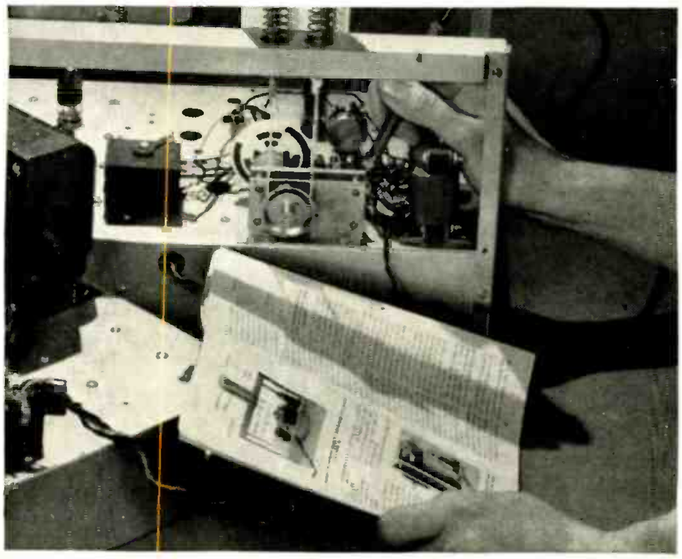

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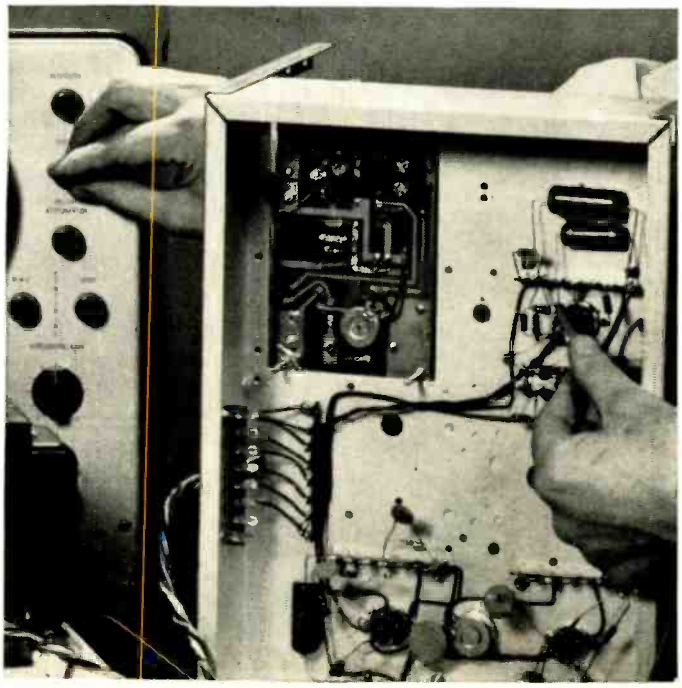

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Senses and recovers the ambient information hidden in your stereo discs, tapes and broadcasts

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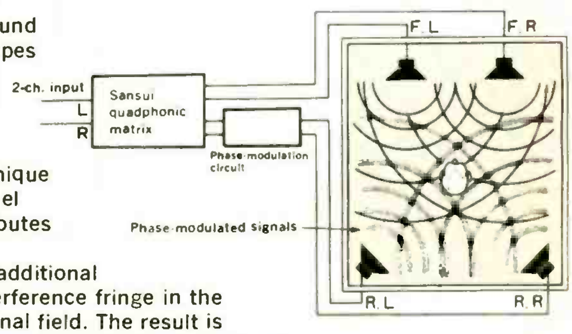
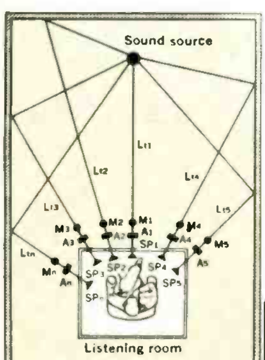


The heart of the Sansui Quadphonic Synthesizer* is a combination of a unique reproducing matrix and a phase modulator. The matrix analyzes the 2-channel information to obtain separate direct and indirect components, then redistributes these signals into a sound field consisting of four distinct sources.

This type of phase modulation of the indirect components, applied to the additional speakers, adds another important element. It sets up a complex phase interference fringe in the listening room that duplicates the multiple indirect-wave effects of the original field. The result is parallel to what would be obtaind by using an infinite number of microphones in the studio (MI through Mn in the accompanying illustration) and reproducing them through a corresponding number of channels and speakers.



The startling, multidimensional effect goes beyond the four discrete sources used in conventional 4-channel stereo, actually enhancing the sense of spatial distribution and dramatically expanding the dynamic range. Also, the effect is evident anywhere in the listening room, not just in a limited area at the center. And that is exactly the effect obtained with live music! This phenomenon is one of the true tests of the Quadphonic system.

The Sansui Quadphonic Synthesizer QS-1 has been the talk of the recent high-fidelity shows at which it has been demonstrated throughout the country. You have to hear it yourself to believe it. And you can do that now at your Sansui dealer. Discover that you can hear four channels plus, today, with your present records and present stereo broadcasts. $199.95.

*Patents Pending

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HI-FI PRODUCT REPORT

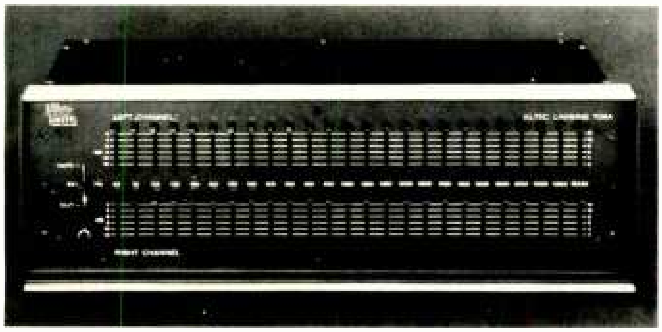
EW LAB TESTED

by Hirsch-Houck Labs

Altec-Lansing 729A "Acousta-Voicette"
B&O SP-12 Phono Cartridge

Altec-Lansing 729A "Acousta-Voicette"

For copy of manufacturer's brochure, circle No. 1 on Reader Service Page.



IN the continuing quest for "flat" frequency response throughout a hi-fi system, the speaker has rightfully received the greatest attention. While there is room for argument as to what actually constitutes "flat" frequency response for a speaker, there is general agreement that undue emphasis or de-emphasis of any part of the spectrum, or the presence of peaks or holes in a measured response curve, are undesirable qualities.

No matter how "perfect" a speaker may be, the characteristics of the listening room have a profound effect on the system response at the listener's ear. Standing-wave patterns and absorption of high frequencies by room furnishings negate much of the speaker designer's efforts.

In recent years *Altec-Lansing* has developed a technique, which it calls "Acousta-Voicing," for modifying the combined response of speaker and room as required for optimum flatness of response at a specified listening position. Originally intended for commercial sound installations, the voicing system employs narrow-band adjustable filters, each covering ⅓ octave, which can remove relatively narrow band response irregularities without affecting adjacent frequencies.

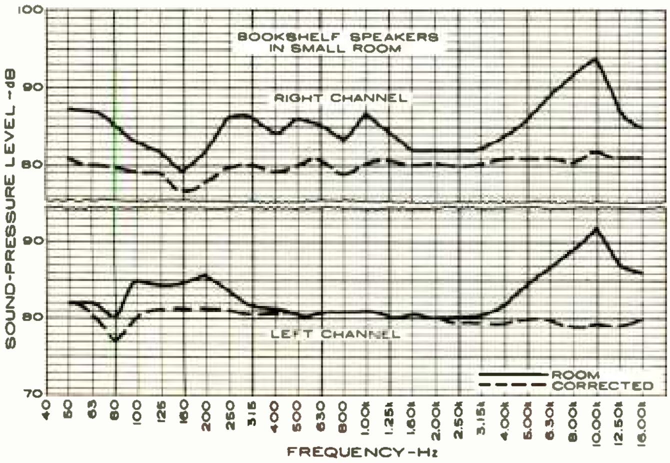
The process is quite complex, and normally makes use of "pink" noise speaker excitation (having constant energy per octave of bandwidth), calibrated pickup microphone, and a real-time spectrum analyzer to display the entire audio spectrum at a glance while making adjustments. Because of the specialized and expensive test equipment required, plus a considerable number of engineering hours, voicing would hardly seem to be practical for the home.

Evidently *Altec-Lansing* thought otherwise and the result was the Acousta-Voicette 729A stereo equalizer. The 729A has two sets of ⅓-octave active filters, 24 for each channel, with center frequencies between 63 and 12,500 Hz. The loss in each ⅓-octave band is adjustable from 0 to 12 dB, with a vertical slider potentiometer. Each stereo channel has a re-insertion gain control, able to add up to 17 dB of gain to compensate for equalization losses.

The 729A is a rather large black box, 18⅜" wide by 6" high by 8" deep. It is inserted in the tape-monitoring circuits of an amplifier or receiver. A switch on its panel cuts the equalizer in or out, or restores the tape-monitoring functions when a recorder is connected to the jacks on the 729A.

Obviously, with 48 equalization adjustments, it is out of the question to balance a system by ear. The best way is still to use a pink-noise signal and spectrum analyzer, and this is the method employed by *Altec* when installing the 729A or its professional counterparts. However, the company has also made it possible to set up the device with a more modest equipment outlay. A special test record is supplied with the 729A. It has ⅓-octave bands of noise, centered at frequencies corresponding to the filters of the 729A, from 50 to 16,000 Hz, plus white- and pink-noise bands. The only test instrument required is a sound-level meter, or (as we used) a wide-range microphone and a.c. v.t.v.m. for reading its output voltage. The final equalization can be no better than the accuracy or flatness of the microphone or sound-level meter, which must be of professional quality. Instruments made by *Bruel & Kjaer, General Radio, Hewlett-Packard,* and *H. H. Scott* are suitable, with prices ranging from about $300 to over $1000. If this seems expensive, consider that the real-time spectrum analyzer used by *Altec* engineers costs about $10,000.

The procedure is simple. One speaker at a time is equalized. The microphone is placed at the preferred listening location. The test record is played, obviously with a pickup and amplifier having essentially flat response between 50 and 16,000 Hz, and sound-pressure readings taken at each test-band frequency. When these are plotted on a special graph supplied with the 729A, the result is what is called



the "house curve"—the actual response of the speaker and room combined, at the listening point.

The equalizer controls corresponding to the major peaks in the house curve are then adjusted to compensate for them, and the test is repeated. Since each adjustment has some effect on adjacent frequency bands, it is necessary to repeat the process several times. In our case, we found three sets of measurements to be sufficient to get a reasonably flat response curve. The other speaker is then equalized in the same manner. It took us about 2 hours to do a complete voicing on a stereo system.

While listening to program material, the two re-insertion gain controls are set for equal loudness when the equalizer is switched in and out, and for channel balance. A transparent plastic cover is then installed over the control panel of the unit to prevent accidental movement of the controls. It is also a good idea to record the control settings for reference.

Electrically, we confirmed the specifications of the 729A. It has unity gain with no re-insertion gain added and its intrinsic harmonic distortion is less than 0.32% up to 1.0 volt output. This increases to 0.66% at 2 volts and to 1% at 3 volts, but few amplifiers require more than 1 volt at their tape inputs for full output.

To evaluate the effectiveness of the 729A, we used it to equalize two very different listening rooms. One (our lab) is a small room, with two compact bookshelf speakers of good quality at one end. The house (room) curve showed a large peak at about 10 kHz, with an amplitude of 12 or 13 dB, and relatively little irregularity at lower frequencies. The final (corrected) response curve shows how the over-all response was adjusted to within ±2 dB from 50 to 16,000 Hz, except for slight dips at 80 and 160 Hz. We probably could have eliminated these, but did not consider it necessary. The response curve of the 729A equalizer which flattened out the house curve is essentially the inverse of that curve.

We were disappointed in the audible results. The system sounded dull and lifeless with the high-frequency peak eliminated. We suspect that this was due to the proximity of the listening position to the speakers (about 6 to 8 feet), which resulted in our flattening out the direct response, approximately on axis, rather than the over-all output of the speakers in all directions, which is what our ears ultimately heard.

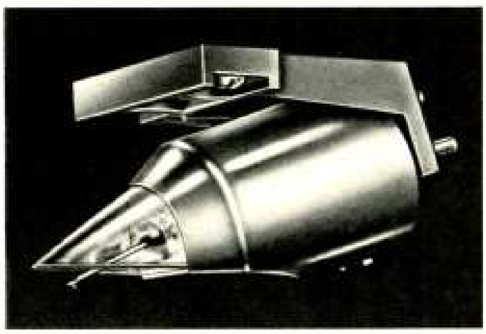
The second installation was more typical. It was in a living room with a pair of good-quality reflected-sound speaker systems. Here the microphone was about 18 feet from the speakers, and very little direct sound reached it. The house (room) curve showed a large peak at about 200 Hz, which had always been audible as a heaviness, or coloration, on male voices. It was due to an unfortunate combination of a smaller speaker peak at that frequency, and a room resonance which reinforced it.

The 729A readily smoothed out the over-all response to within ±3 dB from about 50 to 16,000 Hz. In this case the improvement in sound quality was dramatic, with a neutral character having no trace of "boom" or unnatural heaviness, yet fully supported by a solid low bass when supplied by the program. Although the voicing was done at one point in the room, it seemed equally effective at other positions.

Our conclusion is that the *Altec* 729A can probably clear up most "difficult" hi-fi listening situations caused by room effects. It can, of course, correct some speaker deficiencies, but is a rather expensive way to do this. Priced at $799, it is cheaper than a specially designed listening room and may well be the best alternative to that course. We think it makes economic sense to buy the best speakers you can afford and use the 729A to supply the finishing touches to a really deluxe music system. It is obviously not for everybody, but is not a "gimmick" and it does its job very effectively ▲

B&O SP-12 Phono Cartridge

For copy of manufacturer's brochure, circle No. 2 on Reader Service Page.

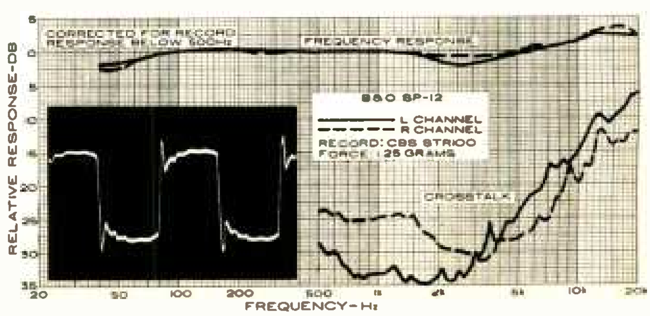


FOR many years, the *Bang & Olufsen* cartridges, made in Denmark, were marketed in this country by *Dynaco*. *B&O* is now distributing the latest version of this distinctive cartridge under its own name, through *Bang & Olufsen of America, Inc.* The cartridge is known as the SP-12 or SP-10, depending on the stylus dimensions. The SP-10 is fitted with a 0.6-mil conical diamond, while the SP-12, which we tested, has a 0.2×0.7-mil elliptical diamond stylus. The styli are interchangeable and easily replaced by the user.

The SP-12 uses the "X"-shaped armature design that has characterized the company's earlier cartridges. All moving parts—stylus, cantilever, and armature—are in the replaceable stylus assembly, which includes a magnetic shield. The main cartridge body contains the magnet and four coils whose pole pieces protrude slightly and are close to the four tips of the armature. The generating system is symmetrical, and is not particularly sensitive to induced hum from external magnetic fields. There is some magnetic attraction between the cartridge and a steel turntable and even though it is not great, the low tracking-force requirement of this cartridge makes it advisable to use it only with non-ferrous turntables (as is virtually every modern turntable).

The *B&O* SP-12 is designed for a 15-degree vertical tracking angle. Its physical shape is such that any appreciable vertical-angle error (on the low side) will cause the cartridge body to contact the record surface. It, therefore, is supplied with a removable plastic wedge that tilts the entire cartridge body by 3 degrees when it is installed in the arm of an automatic turntable. This produces a vertical angle of 18 degrees when playing the first record and 12 degrees when playing the tenth record of a stack. This ±3-degree error is insignificant from a performance standpoint and assures that the cartridge body will clear the record at all times. If it is installed in a *Dual* 1219 or *P-E* automatic turntable, both of which have adjustable vertical tracking angle features, this wedge is not needed, nor is it required with a properly installed manual record-player arm.

Playing the *CBS* STR100 test record, the *B&O* SP-12 had a very uniform response (within ±2.5 dB) all the way to the 20,000 Hz upper limit of the record. Channel separation was 25 to 35 dB at middle frequencies, 15 to 20 dB at



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10,000 Hz, and 10 to 15 dB at 20,000 Hz.

The excellent high-frequency response of the cartridge encouraged us to check it with the *CBS* STR120 record, which sweeps from 500 to 50,000 Hz. On one channel, the response was essentially uniform to 25,000 Hz, and on the other it went to 30,000 Hz. Stereo separation was maintained all the way to the uppermost frequency limits of the cartridge.

The cartridge is rated for tracking forces between 1 and 2 grams. We found 1.25 grams necessary for best tracking of the 1000-Hz 30-cm/s bands of one of our test records. The IM distortion, with the *RCA* 12-5-39 record, was low up to about 17-cm/s velocity with a 1.25-gram force, and up to 23 cm/s at a 2-gram force. The response to the tune bursts on the STEREO REVIEW SR12 test record was excellent, although we could see second-harmonic distortion on bursts in the 10- to 20-kHz range. The output of the cartridge was 4.3 millivolts at 3.54 cm/s. We measured the effect of shunting capacitance on the response, and would judge that total capacitances up to about 300 to 350 pF have negligible effect on the response.

In our largely subjective test of tracking ability, the cartridge acquitted itself well. It ran a close second to two or three of the best cartridges we have tested. At no time did it mis-track seriously—in fact, it was necessary to listen quite carefully to detect the slight mis-tracking that occurred on a few of the highest level bands of the *Shure* TTR101 "Audio Obstacle Course" record.

B&O emphasizes its use of a diamond mounted directly on the cantilever without an intermediate cup or bushing, which would add undesirable mass to the moving system. Its success is obvious from the outstandingly wide range and flat response of this cartridge. Each cartridge comes with its own individually run response curve, which agreed quite closely with our own measurements. In fact, we were pleasantly surprised to find that our tests confirmed every published claim made for the cartridge, even though we used different types of test records. This is not, by any means, a usual occurrence in cartridge testing.

When playing records with the cartridge it is difficult to assign any special character to the sound. This is a logical result of its smooth, wide-range response, which gives it a very neutral quality. This highly desirable property means that the cartridge will reproduce records faithfully, without imposing any of its own characteristics on the sound. The *B&O* SP-12 stereo phono cartridge sells for $59.95. ▲

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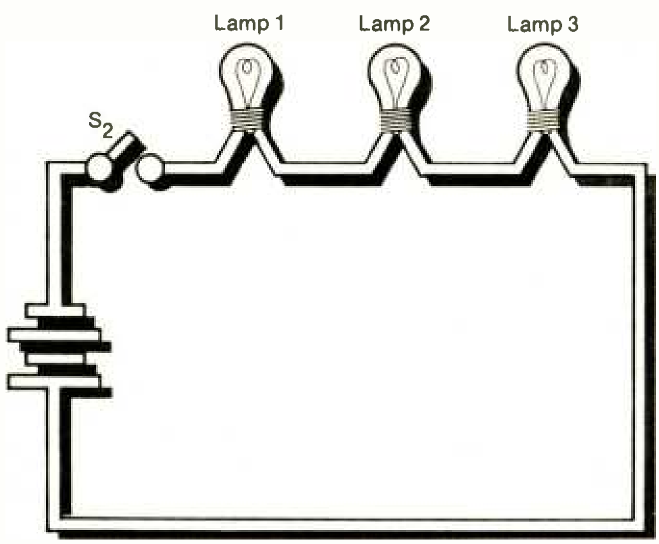
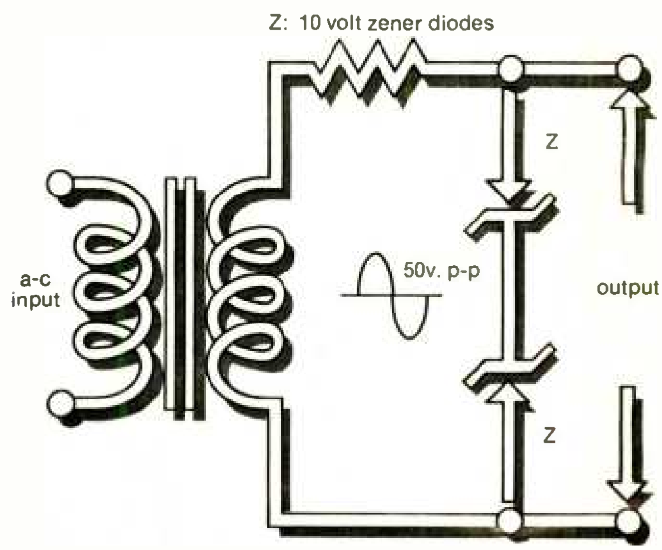
CIRCLE NO. 126 ON READER SERVICE PAGE

Can you solve these two basic problems in electronics?





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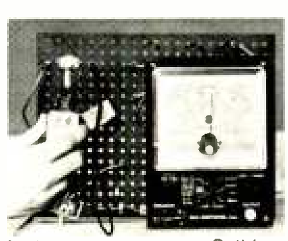

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LETTERS

ELECTRONICS BY HOME STUDY

To the Editors:

Referring to your Sept., 1970 article "Can You Learn Electronics by Home Study?," I say "yes" and I believe in home-study programs. However, these courses are designed for newcomers or technicians wanting to change fields.

What about the established electronics technicians in various fields who need a convenient way to up-date their skills and electronic abilities? What's needed is a refresher course with kit projects reviewing and renewing; projects which can help keep one abreast of electronic circuitry and components. Mass-production could make this need less expensive than by individual purchasing. Many of the fields share in common use of basic circuitry, and a course so designed should find an attractive market for home-study schools.

BEN P. GRISAFI
El Cajon, Cal.

* * *

DIRECT VS REVERBERANT SOUND

To the Editors:

Reverberance and directionality in loudspeaker systems are currently a matter of much interest. I was glad to see your two-part series on this topic ("Is Omnidirectionality Desirable in a Loudspeaker?" by Don Davis, 8/70 and "Direct vs Reverberant Sound for Stereo Speakers" by George Augspurger, 9/70). It is unfortunate that both articles contain a number of inaccuracies.

Mr. Davis states" . . . if you were to listen in an anechoic chamber . . . to a well-made recording taken in a concert hall . . . your ears and brain, having no other distracting aural references, would 'feel' as if they were in the concert hall." This is not so. I have heard music played on several speakers in anechoic chambers, and it sounds very unlifelike. The reason is clear: all the sound comes from the two speakers. The reverberant sound in a concert hall arrives at your ears from different directions and this is directly perceivable.

He says "the desired ratio of direct-to-reverberant sound has been carefully established" in commercial recordings. So it has, with the realization that the recording will be played back *via* speakers in a room with some reverberation of its own, so that the hall reverberation is deliberately controlled in order that the combined effect will be optimal. Binaural-type recordings, made for headphone playback, do not sound proper on speakers.

Mr. Augspurger declares "to replicate the sound field perceived when listening to a live performance would require 30 or 40 channels rather than two or four." To duplicate the total phase and amplitude information throughout a region of space is impossible with any finite number of speakers; to create a sound field at two points (listener's ears) audibly indistinguishable from the original requires a number of channels that is generally agreed to be less than ten.

Still worse, "To reproduce a large sound source, a single large speaker system will do a better job than a single small speaker system, all other factors being equal." Clearly, if all other factors were equal, there would be absolutely no difference in the sound. The only significance of the size of a speaker to its sound is that it is easier to design a large speaker system to have uniform dispersion and wide dynamic range; this in no way prevents a well-designed small system from having equal performance. As for "perfectly balanced stereo" being equivalent to "exactly the same sound everywhere," really now, Mr. Augspurger.

Mr. Davis' technical discussion of directionality and "critical distance" is nearly irrelevant, for no speaker is highly directional at low (below 200 Hz roughly) frequencies. A typical "highly directional" speaker is only so at mid-range and treble frequencies, thus violating Mr. Davis' criterion that "what is desired is a reproducer with a fixed distribution that does not vary with frequency." Furthermore, a much more realistic criterion is that the dispersion into the room be uniform for all frequencies. This establishes requirements on the room acoustics as well as the loudspeaker; it is impossible to design a speaker system to be ideal in all rooms, and difficult to design one to be good even for all likely home listening rooms. Flexibility is a desirable attribute in a loudspeaker system.

For economic and psychological reasons, it is probable that home music systems will be dominated by two-speaker system playback for some time. Within the context of two speakers in a typical home listening room, I think the important question is whether the presence or absence of the spatial effect created by reverberant speakers creates a total effect which sounds more like the original performance.

GERALD D. BLUM, Exhibit Planner
Museum of Science
Boston, Mass.

We have planned some future articles that will shed more light on the topic and continue the debate. Reader Blum's last sentence opens up the entire philosophical question as to whether the home sound system should reproduce the original performance or should it perhaps even improve on it? This "improvement" is certainly attempted in the recording and mastering of pop and rock music groups, though not so much in the recording of classical music. Perhaps anything goes with pop music so long as the listener feels more with the music. With classical music however, we usually tend to respect the original composer-director-orchestra-concert hall performance.
—Editors.

* * *

CODE-BREAKING FOR SUBSCRIBERS

To the Editors:

The item in the October issue (page 77) on breaking your label code interested this "alert," 12-year subscriber to your magazine—despite its error, omission, and incompleteness. "Cryptography, anyone?" it asked. Why not? Here are my contributions.

The error was right at the start after "34" was explained. Your computer will be looking in Chicopee, Mass., not New Milford, N.J., since the 5 digits after the magazine code 34 should be the subscriber's Zip Code. That is what the labels on my "34" magazines tell me.

The omission was in your not telling what the "MTHC" stands for. They represent the first, third, and fifth letters of the subscriber's last name and the first letter of his first name.

Now to the "268N105 01". What is it? Whatever it is, it may have been changed since there is no resemblance on my labels.

FRANK J. MANUS
Long Beach, Calif.

Our astute reader is certainly correct. The Zip Code should appear in the first line along with the subscriber's initials. We hadn't thought this would be of interest to readers so we used fictitious numbers. The coding "268N105 01," tells us the source of the original subscription order, and gives us the microfilm cartridge number to help us locate the subscriber's record. ▲

ABOUT YOUR SUBSCRIPTION

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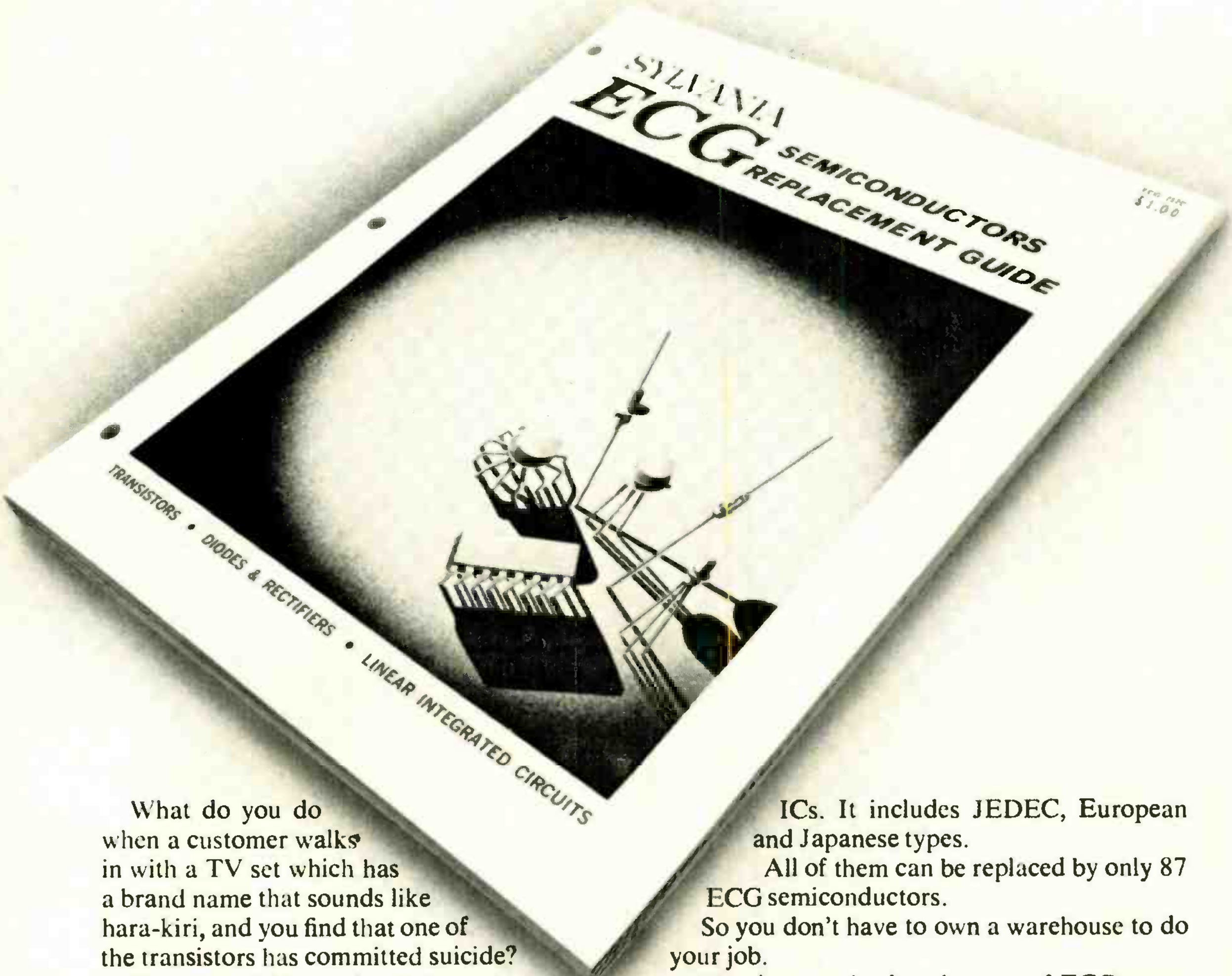

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Marine Communications Up-to-Date

By RICHARD HUMPHREY

Summary of latest and proposed FCC Rules and Regulations that will lead to extensive changes in marine radio. SSB is to be used in the 2-3 MHz band, and there is to be an expansion of the v.h.f./FM marine band.

ON June 26, 1970 the Federal Communications Commission released its Report & Order on FCC Docket 18307 covering the schedule of dates, technical standards, frequencies, and other requirements for the progression to single-sideband in the 2-3 MHz marine band. The Report & Order also affects, to an extent, the already expanded v.h.f./FM marine band and thus, despite certain technical and procedural guidelines to be taken care of in later action, effectively writes *finis* to the most extensive and far-reaching changes in marine communications since their inception.

AM to SSB

As far as the United States is concerned, the decision to move from double-sideband or "AM" to SSB in the 2-3 MHz marine band and also the recent expansion of the v.h.f./FM marine band was prompted by a continuing increase in the number of pleasure craft. As of March 1, 1969, over 166,000 pleasure craft had 2-3 MHz marine radiotelephones (the FCC reports that as of January 1, 1970, vessel stations in all categories in the 2-3 MHz band had grown to 187,500).

No other country has precisely this problem of congestion and interference in the 2-3 MHz marine band as a direct result of a sheer mass of numbers. It was hoped that the creation of 28 channels in the 156-162 MHz frequency band at the 1957 Hague International Maritime Mobile Radiotelephone Conference (this was ratified at Geneva in 1959) might be an answer but it was soon apparent that it wouldn't be. First, this country could only adopt 18 of the 28 Hague channels because of existing allocations mainly in the Public Safety service (police, fire departments, etc.). Second, despite the fact that the

Channel Designator	Frequency (MHz)		Points of Communications	Notes
	Ship	Coast		
16	156.800	156.800	Intership and ship to coast	1
06	156.300		Intership	2
65	156.275	156.275	Intership and ship to coast	3
66	156.325	156.325	Intership and ship to coast	3
12	156.600	156.600	Intership and ship to coast	3
73	156.675	156.675	Intership and ship to coast	3
14	156.700	156.700	Intership and ship to coast	3
74	156.725	156.725	Intership and ship to coast	3
20	157.000	161.600	Intership and ship to coast	3
13	156.650	156.650	Intership and ship to coast	4
15		156.750	Coast to ship	5
17	156.850	156.850	Ship to coast	6
07	156.350	156.350	Intership and ship to coast	7
67	156.375		Intership	7
08	156.400		Intership	7
09	156.450	156.450	Intership and ship to coast	8
10	156.500	156.500	Intership and ship to coast	7
11	156.550	156.550	Intership and ship to coast	7
77	156.875		Intership	7
18	156.900	156.900	Intership and ship to coast	7
19	156.950	156.950	Intership and ship to coast	7
79	156.975	156.975	Intership and ship to coast	7
80	157.025	157.025	Intership and ship to coast	7
88	157.425		Intership	7,9
68	156.425	156.425	Intership and ship to coast	10
09	156.450	156.450	Ship to coast	8,10
69	156.475	156.475	Ship to coast	10,11
70	156.525		Intership	10
71	156.575	156.575	Ship to coast	10,11
72	156.625		Intership	10
78	156.925	156.925	Ship to coast	10,11
24	157.200	161.800	Ship to public coast	12
84	157.225	161.825	Ship to public coast	12
25	157.250	161.850	Ship to public coast	12
85	157.275	161.875	Ship to public coast	12
26	157.300	161.900	Ship to public coast	12
86	157.325	161.925	Ship to public coast	12
27	157.350	161.950	Ship to public coast	12
87	157.375	161.975	Ship to public coast	12
28	157.400	162.000	Ship to public coast	12

NOTES: 1. This channel is the National (not international) Distress, Safety & Calling frequency. Vessel and coast stations are required to maintain a listening watch during their hours of service. Required channel; 2. This channel is the intership safety channel for safety communications only. Required channel; 3. These channels are port operation channels and may be used only in or near a port, in locks, or waterways, with traffic limited to movement of ships and safety of ships and persons. 4. This channel to be used for safety communications pertaining to the movement of ships and is primarily ship-to-ship and secondarily ship-to-coast. 5. This is a "receive-only" channel for the transmission of weather information, local conditions, hazards to navigation, and Notices to Mariners. Operating at this writing only in USCG 7th District (Miami); 6. State Control channel for use by non-Federal government agencies and states for control primarily of recreational boating. May be used by private ship stations; 7. May be used only on commercial vessels for commercial, operational, or economic messages relating directly to ship business; 8. Channel 9 is shared between commercial and non-commercial vessels and traffic; 9. Use limited to commercial ships engaged in commercial fishing. Also may be used for ship-to-aircraft communications where aircraft is associated with fishing operations; 10. For non-commercial (pleasure craft) use for communications relating to the needs of the vessel; 11. Available to marinas, yacht clubs, and organizations offering services and supplies to non-commercial vessels; 12. Public Correspondence (Marine Operator) channels.

Table 1. Listing of U.S.A. v.h.f./FM marine channels, equivalent ship and coastal station frequencies, and any restrictions.

Frequency Band	Conditions	Tolerance Parts in 10^6	Notes
1605-4000 kHz	A3A, A3H, and A3J emissions only	20 Hz	1,2
1605-4000 kHz	Emissions other than A3A, A3H, and A3J	50	1
100-200 MHz	Stations with carrier power under 3 watts	10	3,4
100-200 MHz	Stations/carrier power 3-100 watts	5	3,4
100-200 MHz	Stations/carrier power over 100 watts	2.5	3,4
2000-2850 kHz	A3A, A3H, and A3J emissions only	20 Hz	2,5,6
2000-2850 kHz	Emissions other than A3A, A3H, and A3J	50	5,6
100-200 MHz	Stations with carrier power under 3 watts	10	4,6
100-200 MHz	Stations/carrier power 3-100 watts	5	4,6
100-200 MHz	Stations/carrier power over 100 watts	2.5	4,6

NOTES: 1. For coast stations operating below 515 kHz or the band 1600-27,500 kHz; 2. Tolerance shown in hertz and not in parts per 10^6; 3. For coast stations operating above 30 MHz and for marine utility stations; 4. Applicable to transmitters type-accepted after March 1, 1969, transmitters placed in service after January 1, 1970 and all transmitters after January 1, 1974. Provided: tolerance of 20 parts 10^6 applicable until January 1, 1974 to transmitters type-accepted prior to March 1,1969 and installed prior to January 1, 1970; 5. For coast stations in the maritime fixed services; 6. For marine receiver test stations in the maritime fixed services.

Table 2. Frequency tolerances and explanatory notes for coast stations operating in 2-3 MHz and v.h.f./FM frequency bands.

v.h.f./FM band would obviously serve the nation's pleasure boating communications needs far better than 2-3 MHz, the pleasure boater stubbornly refused to become interested in the new band.

Then, in the fall of 1967, American representatives took two basic ideas to the Geneva World Administrative Radio Conference of the International Telecommunication Union: first to increase the number of channels in the v.h.f./FM marine band, to change from wide-band FM ($\pm$ 15 kHz) to narrow-band FM ($\pm$5 kHz), reduce channel spacing from 50 to 25 kHz, and to add still more pleasure-boat oriented services to the v.h.f./FM marine band and second, to progress from double-sideband (AM) emission to single-sideband (SSB) in the 2-3 MHz marine band.

Three types of SSB were envisioned: A3A ("reduced" carrier with the carrier 16 decibels $\pm$2 dB below peak envelope power), A3H ("full" carrier with the carrier between 3 and 6 dB below p.e.p.), and A3J ("suppressed" carrier with the carrier at least 40 dB below p.e.p.). There were changes scheduled in the maritime frequencies in the 4 to 27.5 MHz spread also, but nothing as all-inclusive as those in the 2-3 MHz and v.h.f./FM marine bands.

Although there was support for these changes, there was a great deal of opposition as well, both here and abroad. Eventually, an *international* schedule of dates for the transition to single-sideband in the 2-3 MHz marine band was worked out. No more *installation* of double-sideband transmitters after January 1, 1973; no more *use* of double-sideband transmitters after January 1, 1982 (for *international* use).

Additionally, the framework for eventually changing from 50-kHz spacing and wide-band FM to 25-kHz spacing and narrow-band FM was adopted. However, the United States with its unique problems could not conform entirely to the international agreements in either band. The "American" v.h.f./FM marine-band channels, points of communications, and applicable notes are given in Table 1.

Most of the opposition to the narrow-banding of the v.h.f./FM band concerned losses in recovered audio and capture effect and possible cross-channel interference. The standard answer from the supporters of the changes was that the v.h.f./FM land-mobile service had been operating under more-or-less the same requirements for years.

The major opposition to the single-sideband transition in the 2-3 MHz band had to do with the schedule of dates. Everyone had agreed for some time that single-sideband was coming, but "couldn't it be put off for a time?" In the FCC's rule-making procedure, it was this schedule of dates that drew the most formal comments (32) and letters (17). These are the dates, effective as of mid-1970:

1. January 1, 1972—no more *new* installations of double-sideband equipment at ship or coast stations
2. January 1, 1977—no more *use* of double-sideband equipment at ship stations
3. January 1, 1972—no more *use* of double-sideband equipment at public coast stations
4. January 1, 1977—public coast stations serving lakes and rivers (with the exception of the Great Lakes and the Mississippi River System) will not be authorized to use 2-3 MHz communications
5. January 1, 1972—new installations of SSB equipment aboard ship stations authorized only when v.h.f./FM is already aboard
6. January 1, 1977—public coast stations must not communicate on 2-3 MHz with ship stations that are within v.h.f./FM range
7. January 1, 1972—ship stations with new SSB installations must not communicate on 2-3 MHz with ship or coast stations within v.h.f./FM range.

The first four of the above dates are straightforward, although the first date (January 1, 1972) specifying "no more *new* installations . . ." requires some explanation. The Commission has provided amortization relief to vessel owners who sell their boats and take their radio equipment with them to their new vessel and to owners of presently licensed and installed *double*-sideband marine radiophones who wish to retain this equipment. In both cases, this double-sideband gear may be used until January 1, 1977 (if licensed and installed prior to January 1, 1972). The owner maintaining his radio on the same boat need only to renew his license at the proper time. The owner who sells his boat and takes his radio equipment (double-sideband) with him need only attach his old license to his application for his new ship license and the FCC will authorize that new license for a period not to exceed January 1, 1977.

The last situation under this "grandfather" clause: a man who sells his vessel after Jan. 1, 1972 and leaves his DSB gear on that vessel leaves the new owner a useless piece of radio equipment even though the radio was installed and licensed prior to January 1, 1972 and the license at the time of the sale was valid. If the new owner wants radio, he must first install v.h.f./FM and then 2-3 MHz single-sideband. "The new purchaser of the vessel," says the FCC Report, "has no earned or implied rights to the use of double-sideband equipment."

Table 3. Frequency tolerances and explanatory notes for ship stations operating in 2-3 MHz and v.h.f./FM frequency bands.

Frequency Band	Conditions	Tolerance Parts in 10^6	Notes
1605-2070 kHz 2080-3500 kHz	A3A, A3H, and A3J emissions only	50 Hz	1,2
1605-2070 kHz 2080-3500 kHz	Emissions other than A3A, A3H, and A3J	200	1
2070-2080 kHz		50	1
2182 kHz	Survival craft stations	200	1
100-200 MHz	Ship and survival craft/ over 27.5 MHz	10	3
100-200 MHz	Survival craft stations on 121.5 MHz	50	3

NOTES: 1. For ship and survival craft in the band 1600-27,500 kHz; 2. Tolerance shown in hertz and not in parts per 10^6; 3. Applicable to transmitters type-accepted after March 1, 1969, transmitters placed in service after January 1, 1970 and all transmitters after January 1, 1974. Provided: tolerance of 20 parts 10^6 applicable until January 1, 1974 to transmitters type-accepted prior to March 1, 1969 and installed prior to January 1, 1970.

Table 4. Listing of new SSB frequencies available on 2-3 MHz band. ▶

However, the requirements specified for the last three dates (items 5-7) have and will continue to be a source of confusion and recrimination. January 1, 1972: you must have v.h.f./FM installed and licensed before you can install and license 2-3 MHz SSB equipment. Opponents of this requirement state that SSB will serve both long-range and short-range communications needs. There is absolutely no need for a vessel station—and, in particular, a station aboard a pleasure boat—to use SSB to communicate for 20 miles or so. The Communications Act of 1934, as well as most experts, echo the "no more power than is necessary to maintain communications" theme.

The last two dates (items 6 and 7) complicate matters. According to the schedule of dates, if a public coast station has telephone traffic for a ship station that is within v.h.f./FM range, the coast station *can* call on 2-3 MHz. This is where complications arise, since the ship station cannot reply on 2-3 MHz (item 6); it must answer on v.h.f./FM. But, the coast station doesn't have v.h.f./FM because it is not required to have it until January 1, 1977 (item 6), although the Commission is "urging" 2-3 MHz coast station licensees to submit v.h.f./FM applications before January 1, 1972. Only if *Bell Telephone* cooperates and implements v.h.f./FM by January 1, 1972 at its existing 2-3 MHz stations will things run smoothly.

To further complicate matters, there will be the uncounted thousands of double-sideband "grandfather" marine radiophones calling anyone, any time, and anywhere they please with no v.h.f./FM—2-3 MHz distance restrictions whatsoever.

Requirements

Technical specifications for the 2-3 MHz SSB operation are substantially the same as for the frequencies above 4 MHz. The authorized bandwidth for the three modes of SSB (A3A, A3H, A3J) is 3 kHz. The frequencies for the two-tone test is to be resolved later since 700 Hz and 2500 Hz offer certain difficulties.

A3A—reduced carrier—had been a bone of contention during the rule-making procedure. The reason for having it is for those stations which employ automatic frequency control (a.f.c.) in their receivers. Comments in regards to A3A were filed by *Collins*, *Motorola*, and the United States Power Squadrons. The FCC itself has stated that it felt A3A should be phased out as soon as possible. But, evidently, now is not the time.

Coast station transition to SSB is as follows: use of double-sideband (A3) emission to cease as of January 1, 1972 and the use of single-sideband, full carrier (A3H) to begin on that date. This progression applies to 2182 kHz *only*. In other words, A3H (sometimes referred to as "compatible single-sideband") is to be the only type of SSB authorized to coast stations on 2182 kHz. On the other authorized frequencies for coast-station use, A3A, A3H, and A3J shall be used after January 1, 1972.

One further point must be mentioned: the concept that marine communications are primarily a safety factor is an old one. All coast and ship stations have long been required to monitor 2182 kHz continuously "during their hours of service." Since September 3, 1968, channel 16 (156.8 MHz) in the v.h.f./FM band has been the *National* (American) Distress, Calling & Safety frequency. This means that all coast and ship stations must monitor this channel (156.8 MHz), while in "American" waters, on the same basis as 2182 kHz.

During the rule-making procedure in Docket #18307, the Coast Guard, whose primary responsibility is search and rescue, strongly supported the requirement that ship sta-

(*Continued on page 83*)

Carrier Frequency	Conditions of Use
2065.0 kHz	Assignment to ship and coast stations will be subject to coordination with Canada. Available only at locations which will not cause interference to use of the same frequency by Canada. Limited to a maximum output power of 150 watts p.e.p. and to emissions 2.8A3A and 2.8A3J.
2079.0 kHz	"
2082.5 kHz	Available to ship stations primarily for intership *safety* communications in the maritime mobile service. On a secondary basis to safety communications, available to ship stations other than those aboard vessels engaged in commercial fishing for commercial (operational) communications. On a tertiary basis, subject to non-interference to ship stations, may be assigned to coast stations for Commercial (Operational) communications with ship stations. Ship and coast stations are limited to a maximum power of 150 watts p.e.p. and to emissions 2.8A3A and 2.8A3J.
2086.0 kHz	Available to ship and coast stations serving vessels operating in the Mississippi River System. Limited to a maximum output power of 150 watts p.e.p. and to emissions 2.8A3A and 2.8A3J.
2093.0 kHz	Available to ship stations for intership communications aboard vessels engaged in commercial fishing. Limited to a maximum output power of 150 watts p.e.p. and to emissions 2.8A3A and 2.8A3J.
2096.5 kHz	Available for use by limited ship and coast stations as provided in Subsections 83.360 and 81.361, except that the provisions of Subsection 81.361(b)(4) do not apply. Limited to emission 2.8A3J and a maximum power output of 150 watts p.e.p.
2203.0 kHz	Available in the Gulf of Mexico only, for assignment to ship stations other than those aboard vessels engaged in commercial fishing. Limited to a maximum output power of 150 watts p.e.p. and to emissions 2.8A3A and 2.8A3J.

NOTE: The Federal Communications Commission will amend the proper sections of Parts 81 and 83 to finalize these frequencies. In the interim, the Commission will assign the above frequencies in order "to avoid delay in making these frequencies available to the public."

Table 5. Suggested v.h.f./FM crystals that should be stocked. ▶

Channel	Frequency (MHz)	Use	Comments
6	156.300	Intership Safety	Required
16	156.800	Distress, Safety & Calling	Required
26	157.300 ship xmt 161.900 ship rcv	Public Correspondence (Marine Operator)	These two frequencies are the most used throughout the country
28	157.400 ship xmt 162.000 ship rcv	"	
12	156.600	Recommended by U.S. Coast Guard for routine (non-Distress) traffic	
14	156.700	"	
–	162.550	U.S. Weather Bureau taped forecasts	Check in your particular area for availability
15	156.750	Environmental channel	Presently operative only in Miami area
13	156.650	Navigational channel	This is the so-called "bridge-to-bridge" frequency
69	156.475	Recreational craft and also coast stations (marinas, yacht clubs, etc)	
71	156.575	"	
78	156.925	"	

NOTE: In addition, one other public correspondence set of crystals. Check in your area to see which channels are operative. One or two sets of Port Operation crystals (see Table 1) are also recommended. While channels 6 and 16 are FCC-required plus "one or more working frequencies," pleasure-boat owners should be encouraged to use the "non-commercial" channels (see Table 1) and not use channel 6 as a routine intership working frequency except for safety purposes. The FCC is currently assigning channel 68 to marinas and yacht clubs along with channels 69, 71, and 78.

Directory of 1971 Color-TV Chassis

By FOREST H. BELT/Contributing Editor

A rundown on what is available in the upcoming model year. An overview of the entire color-TV field along with details on new circuit designs will appear in our next two issues.

MFR.	Chassis	CRT Size (1)	Design (2)	IC's	Fine-Tune Aid	V.H.F. Tuner (3)	Remote Control	Quick Warmup (20)	Degaussing (4)	H.V. Reg.	No. Video I.F.'s	No. Chroma Bandpass (5)	Type Demod. (6)	Color Diff. Amps.	Heaters	Auto. Tint Control
Admiral	–K10	12,14,16	7/24	–	–	xstr.	–	Instant-Play	auto.	pulse	3X	2X	R-Y, B-Y	yes	series	–
	–K16	18,20,23,25	tube (10)	–	a.f.t.	tube	–	Instant-Play	auto.	pulse	3	2	X-Z hi	no	parallel	–
	–K20	23,25	10/25	sound sect.	a.f.t.	xstr.	–	Instant-Play	auto.	pulse	3X	2X	R-Y, B-Y	yes	parallel	Color Monitor
	930 (9)	18	tube (10)	a.f.t.	a.f.t.	tube	–	–	auto.	pulse	3	2	RGB-D	yes	series	–
Andrea	VCX-325	23	tube (10)	sound sect., remote	eye, meter, or a.f.t.	tube	7-function	–	auto.	shunt (11)	3	2	X-Z lo	yes	parallel	–
	VCY-325	23	tube (10)	sound sect., remote	a.f.t. with meter	tube	7-function	–	auto.	shunt (11)	3	2	X-Z lo	yes	parallel	–
	VCZ-325	25	tube	remote only	a.f.t.	tube	7-function	–	auto.	shunt (11)	3	2	X-Z lo	yes	parallel	–
Arvin	60K–	15	tube	–	–	tube	–	–	auto.	pulse (12)	3	2	X-Z lo	yes	(13)	–
	70K–	20	tube	–	–	tube	–	–	auto (14)	pulse	3	2	X-Z lo	yes	series	–
Catalina (White Stores)	751,52,53	25	19/6	–	a.f.t.	tube	–	yes	auto.	pulse	3	2	X-Z lo	yes	parallel	–
Channel Master	913	23	tube	a.f.t.	a.f.t.	tube	–	yes	auto.	pulse	3	1	X-Z hi	–	parallel	–
	6131	15	tube	–	–	tube	–	–	auto.	pulse	3	2	X-Z hi	–	series	–
	6135	18	tube	a.f.t.	a.f.t.	tube	–	–	auto.	pulse	3	2	R-Y, B-Y	–	series	–
	6138	12	tube	–	–	tube	–	–	auto.	pulse	3	2	X-Z hi	–	series	–
Conar (kit)	600	18	tube	–	–	tube	–	–	none	pulse	2	1	R-Y, B-Y	G only	series	–
DuMont	4K16,5K16	18,23	tube	–	a.f.t.	tube	–	Quick-On	auto.	pulse	3	2	X-Z hi	–	parallel	–
	6K20	25	hybrid	sound sect.	a.f.t.	xstr.	–	Quick-On	auto.	shunt	3X	2X	X-Z lo	yes	parallel	–
	120957,8	23	tube	–	a.f.t.	tube	–	Quick-On	auto.	shunt	3	1	X-Z lo	yes	parallel	–
Electrohome	C7	18,19,21,23,25	tube (10)	–	a.f.t.(16)	tube	–	Insta-Vu	auto.	pulse	3	2	X-Z, B-Y D	yes	parallel	–
	C8	23	tube	–	a.f.t.(16)	varactor(17,18)	wired	Insta-Vu	auto.	pulse	3	2	R-Y, B-Y D	yes	parallel	–
	C9	19,21,25	7/45	chroma demod.	a.f.t.(16)	varactor(17,19)	–	Insta-Vu	auto.	pulse	3	2X	RGB-I	in IC	parallel	Electrotint
Emerson	4K16,5K16,6K20,120924	Same as DuMont														
	T10K10	12,16	hybrid	–	–	xstr.	–	–	–	pulse	3X	2X	R-Y, B-Y	yes	series	–
	920,930	18	tube	(930) a.f.t.	(930) a.f.t.	tube	–	–	auto.	pulse	3	1	X-Z D	yes	series	–
General Electric	C1	18,20	12/11	–	a.f.t.	tube	–	Insta-Color	auto.	pulse	3	1	X-Z D	yes	series	–
	G1	14	tube	–	–	tube	–	Insta-Color	auto.	pulse	3	1	X-Z D	yes	series	–
	H3	10	tube	–	–	tube	–	–	manual	pulse	3	1	X-Z D	yes	series	–
	KE-II	23,25	16/7	–	a.f.t.	tube	–	Insta-Color	auto.	shunt	3	IC	X-Z D	yes	parallel	One-Touch Color (24)
	N1	16	13/9	–	–	tube		Insta-Color	auto.	pulse	3	1	X-Z D	yes	series	–
Heath (kit)	GR-180,227,295	18,20,23	tube	–	–	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes	parallel	–
	GR-481,581,681	18,20,23	tube	a.f.t., remote	a.f.t.	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes	parallel	–
	GR-270,370	20,23	xstr.	demod. color osc., sound i.f., a.f.t., remote	a.f.t.	xstr.	6-function	yes	auto.	pulse	3X	3X	RGB I	yes X	–	–
	GR-169	14	xstr.	color osc., demod., sound i.f.	–	xstr.	–	yes	auto.	pulse	3X	3X	RGB I	yes X	–	–
	GR-371	25	xstr.	demod. color osc., sound i.f., a.f.t., remote	a.f.t.	xstr.	6-function	yes	auto.	pulse	3X	3X	RGB I	yes X	–	–

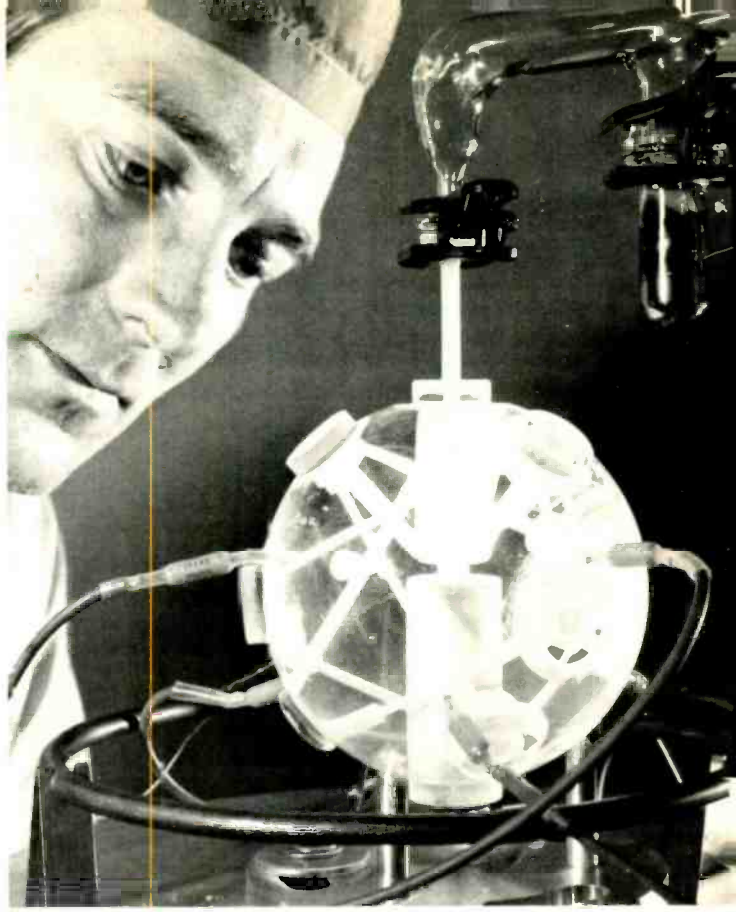
Hitachi	CWA 200	12	xstr.	–	–	xstr.	–	yes	auto.	(22)	4X	2X	RGB D	(23)	–	–
	CWA 210	12	xstr.	–	–	xstr.	–	yes	auto.	–	–	–	–	–	–	–
	CFA 450	14	xstr.	–	a.f.t.	xstr.	–	yes	auto.	(22)	4X	2X	RGB D	(23)	–	–
	CFU 460	14	xstr.	–	–	xstr.	–	yes	auto.	(22)	4X	2X	RGB D	(23)	–	APS(24)
	CSU 690	16	xstr.	–	–	xstr.	–	yes	auto.	(22)	4X	2X	RGB D	(23)	–	–
	CNU 870	18	xstr.	–	–	xstr.	–	yes	auto.	(22)	4X	2X	RGB D	(23)	–	–
	CNU 880	18	similar to CFU 460 with APS circuit													
	CNU 890	18	similar to CFU 460 with APS circuit													
JVC	7208	14	10/26	–	–	tube	–	–	auto.	pulse	3	2	X-Z D	yes	series	–
	7300	16	5/28	–	a.f.t.	xstr.	–	–	auto.	pulse	3	2	X-Z D	yes	series	–
	7408,38	18	12/29	–	(–38) a.f.t.	tube	–	–	auto.	shunt	3	2	X-Z D	yes	series	–
	7500	18	10/31	–	a.f.t.	xstr.	–	–	auto.	shunt	3	2	X-Z D	yes	series	–
	7800	18	12/29	–	a.f.t.	tube	–	–	auto.	shunt	3	2	X-Z D	yes	series	–
Magnavox	T936	14	9/21	sound	–	xstr.	–	Quick-Picture	auto.	pulse	3X	3X	R-Y, B-Y	G only	series	–
	T947	11	13/15	sound	–	xstr.	–	Quick-Picture	auto.	pulse	4X	1,1X	R-Y, B-Y	G only	series	–
	T950	18,19,20,21,23	tube(10)	–	a.f.t.	tube	4-function	Quick-Picture	auto.	pulse	3	2	R-Y, B-Y	G only	series	a.t.c.
	T951	25	tube(10)	–	a.f.t.	tube	8-function	Quick-Picture	auto.	pulse	3	1	X-Z lo	yes	parallel	a.t.c.
Midland	15-211	11	10/23	sound sect.	–	xstr.	–	–	auto.	none	3X	2X	X-Z D	yes	series	–
	15-217	18	tube(10)	–	–	tube	–	–	auto.	shunt	3	2	X-Z D	yes	series	–
	15-218	18	tube(10)	–	–	tube	–	–	auto.	shunt	3	2	X-Z D	yes	series	–
	15-225	15	tube	–	–	tube	–	–	auto.	pulse	3	2	X-Z hi	yes	series	–
MGA (Mitsubishi)	CH-120,140	12,14	hybrid	sound i.f.	–	tube	–	–	auto.	pulse	4X	2	X-Z D	yes	series	–
	CH-180,181	18	hybrid	–	a.f.t.	tube	–	–	auto.	shunt	4X	2	X-Z lo	yes	series	–
	CM-250,251,252	25	tube	–	a.f.t.	tube	–	Instant Play	auto.	pulse	3	2	X-Z lo	yes	parallel	–
Motorola	TS-915	25	xstr.	audio	a.f.t.	xstr.	7-function	yes	auto.	pulse	3X	2X	RGB	(23)	–	–
	TS-924	14	tube(10)	–	–	tube	–	–	manual	pulse	3	2	X-Z D	yes	series	–
	TS-929	16,18	5/40	audio, color demod.	a.f.t.	xstr.	–	–	auto.	pulse	3	2	RGB	yes	parallel	–
	TS-934	18,20,23,25	hybrid	audio, color demod.	a.f.t.	xstr.	–	–	auto.	pulse	3	2	RGB	yes	parallel	–
Olympic	CTC-30,31	22,23	tube	–	eye	tube	–	Rapid-On	auto.	shunt, pulse	3	1	X-Z lo	yes	parallel	–
	CT-400	14	tube	–	–	tube	–	–	auto.	pulse(12)	3	2	X-Z hi	–	series	–
	CT-911	18	tube	–	–	tube	–	–	auto.	shunt	3	2	X-Z hi	–	series	–
Packard Bell	98C32,33	25	11/18	c.w. osc., sound	a.f.t.	tube	yes	Instant Action	manual	shunt	3X	2X	R-Y, B-Y X	yes	parallel	–
	C93266	12	11/26	–	a.f.t.	xstr.	–	–	manual	pulse	3	2X	X-Z D	yes	series	–
	C95242,43,66	15	11/23	–	a.f.t.	xstr.	–	–	manual	pulse	3	2X	X-Z D	yes	series	–
	C96246,48,49	18	21/6	–	a.f.t.	tube	–	–	manual	pulse	3	1	X-Z lo	yes	series	–
Panasonic	CT25P	12	10/24	a.f.t.	a.f.t.	xstr.	–	yes	auto.	pulse	3X	2X	X-Z D	(25)	series	Panacolor (24)
	CT97P	18	20/6	–	a.f.t.	tube	–	yes	auto.	pulse	3	1	X-Z lo	yes	series	–
	CT98O	18	10/24	a.f.t.	a.f.t.	xstr.	–	yes	auto.	pulse	3X	2X	X-Z D	(25)	series	Panacolor(24)
	CT391E	18	20/6	–	a.f.t.	tube	–	yes	auto.	pulse	3	2	X-Z lo	yes	series	Panacolor(24)
	CT601,2	16	10/24	a.f.t.	a.f.t.	xstr.	–	yes	auto.	pulse	3X	2X	X-Z D	(25)	series	Panacolor(24)
	CT991P	9	xstr.	sound sect.	a.f.t., lamp	xstr.	–	yes	auto.	pulse	3X	2X	X-Z D	(23)	–	–
Penncrest (J.C. Penny)	T41,42	20,23	tube	–	a.f.t.(20)	tube	–	yes	auto.	shunt(11)	3	1	X-Z lo	yes	parallel	–
	T50	25	19/6	–	a.f.t.	tube	–	yes	auto.	pulse	3	2	X-Z lo	yes	parallel	–
	2655,56	25	tube(10)	–	a.f.t.(20)	tube	–	Quick-Pic	auto.	pulse	3	2	X-Z lo	yes	series	–
	2853	18	hybrid	a.f.t.	a.f.t.	xstr.	yes	–	auto.	pulse(12)	3X	2X	RGB D	(28)	series	–
	2871,81,85,87	12,14,16	10/28	a.f.t.	a.f.t.(20)	xstr.	–	yes	auto.	pulse	3X	2X	X-Z D	(25)	series	–
	2895,96	–	tube(10)	–	–	tube	–	–	auto.(14)	pulse	3	1	X-Z lo	yes	series	–
Philco Ford	19FT60	14	8/25	c.w. osc.	eye	xstr.	–	–	auto.	pulse	3X	2X	X-Z X	yes	parallel	–
	20HT70,71	16	7/28	c.w. osc.	(71)a.f.t.(26)	xstr.	–	–	auto.	pulse	3X	2X	X-Z X	yes	parallel	–
	20KT40,41	18,23	8/25	c.w. osc.	(41)a.f.t.(26)	xstr.	3-function	–	auto.	pulse	3X	2X	X-Z X	yes	parallel	–
	20QT74,75,76	23	hybrid	c.w. osc.	(75,76)a.f.t.	xstr.	–	–	auto.	pulse	3X	2X	X-Z X	yes	parallel	–
	20QT87,90	23	16/12	–	a.f.t.(26)	xstr.	–	–	auto.	pulse	3X	2	X-Z lo	yes	parallel	–
	21ST90,91	25	16/12	–	a.f.t.(26)	xstr.(27)	–	–	auto.	pulse	3X	2	X-Z lo	yes	–	–

MFR.	Chassis	CRT Size (1)	Design (2)	IC's	Fine-Tune Aid	V.H.F. Tuner (3)	Remote Control	Quick Warmup (20)	Degaussing (4)	H.V. Reg.	No. Video I.F.'s	No. Chroma Bandpass (5)	Type Demod. (6)	Color Diff. Amps.	Heaters	Auto. Tint Control
RCA	CTC22	14	tube	—	—	tube	—	—	auto.	pulse	2	1	X-Z lo	yes	series	—
	CTC36	18	tube	—	—	tube	5-function	—	auto.	pulse	2	1	X-Z lo	yes	series	—
	CTC38	20,23	17/8	a.f.t.	a.f.t.	hybrid	7-function	—	auto.	shunt(11)	3X	2	X-Z D	yes	parallel	—
	CTC39	20,23	17/8	a.f.t., remote	a.f.t.	hybrid	7-function	—	auto.	shunt(11)	3X	2	X-Z D	yes	parallel	—
	CTC41	14	13/17	—	—	hybrid	—	—	auto.	pulse(12)	3X	2	X-Z D	yes	series	—
	CTC42	16	13/17	a.f.t., sound sect.	a.f.t.	hybrid	8-function	—	auto.	pulse(12)	3X	2	X-Z D	yes	series	—
	CTC43	18	13/17	a.f.t., sound sect.	a.f.t.(20)	hybrid	8-function	—	auto.	pulse(12)	3X	2	X-Z D	yes	series	—
	CTC44	23,25	xstr.	a.f.t., sound sect.	a.f.t.	xstr.	10-function	yes	auto.	pulse	3X	5X	RGB D	(23)	—	—
	CTC49	18	xstr.	a.f.t., sound sect., chroma, i.f.	a.f.t.	xstr.	—	yes	auto.	pulse	IC	IC	RGB D	yes	—	—
Selectron (Milovac)	19ZGL	18	tube	—	—	tube	—	—	auto.	shunt	3	2	R-Y, B-Y	yes	series	—
Sharp	C2030	12	12/13	—	—	xstr.	—	—	auto.	pulse	3	2	X-Z D	yes	series	—
	C2010	12	12/13	—	—	xstr.	—	yes(29)	auto.	pulse	3	2	X-Z D	yes	series	—
	C6010	16	12/24	—	a.f.t.	xstr.	—	yes(29)	auto.	xstr.	3	3X	X-Z D	yes	series	—
	C8010	18	13/22	—	a.f.t.	xstr.	—	yes(29)	auto.	xstr.	3	3X	X-Z D	yes	series	—
	C9310	19	13/22	—	a.f.t.	xstr.	4-function	yes(29)	auto.	shunt	3	3X	X-Z D	yes	series	—
	CY61-PC	15	12/21	—	a.f.t.	hybrid	—	yes(29)	auto.	pulse	3	2	X-Z D	yes	series	—
Sony	KV1200	12(33)	xstr.(31)	—	—	xstr.	—	yes	auto.	(30)	3X	2X	X-Z D	(23)	—	—
	KV1210	12(33)	xstr.(31)	—	—	xstr.	—	yes	auto.	(30)	3X	2X	X-Z D	(23)	—	—
	KV1220	12(33)	xstr.(31)	—	Blue-Sky(32)	xstr.	—	yes	auto.	(30)	3X	2X	X-Z D	(23)	—	—
	KV9000	9(33)	xstr.	sound sect., vert. osc.	—	xstr.	—	yes	auto.	(30)	3X	2X	X-Z D	(23)	—	—
Sylvania	D06	20	tube	—	a.f.t.	tube	—	—	auto.	shunt(11)	3	2	X-Z lo	yes	parallel	—
	D11	14	tube	—	a.f.t.	tube	—	—	auto.	pulse	3	2	X-Z lo	yes	series	—
	D12	23,25	9/28	sound i.f.	a.f.t.	xstr.	10-function	Instant-Color	auto.	shunt(11)	3X	3X	X-Z X	yes	parallel	—
	D14	information not available														
	D15	20	5/32	sound i.f.	a.f.t.	xstr.	—	Instant-Color	auto.	pulse	3X	3X	X-Z X	yes	parallel	—
	D16	25	5/32	sound i.f.	a.f.t.	xstr.	—	Instant-Color	auto.	pulse	3X	3X	X-Z X	yes	parallel	—
	E01	25	xstr.	sound i.f.	a.f.t.	varactor	7-function	Instant-Color	auto.	—	4X	3X	X-Z X	(7)	—	—
Toshiba	C7A	15,18	13/18	—	—	xstr.	—	yes	auto.	pulse(12)	3X	2X	RGB D	yes	series	—
	C801,2	18	hybrid	—	a.f.t.	xstr.	(802)yes	yes	auto.	pulse(12)	n.a.	n.a.	n.a.	n.a.	n.a.	—
Webcor	CTV-5118	18	hybrid	—	a.f.t.	tube	—	—	auto.	shunt	3	2	X-Z lo	yes	series	—
Wells-Gardner	T41,42	20,23	tube	—	a.f.t.	tube	—	yes	auto.	shunt(11)	3	1	X-Z lo	yes	parallel	—
	T50 series	25	19/6	—	a.f.t.	tube	—	yes	auto.	pulse	3	2	X-Z lo	yes	parallel	—
Zenith	4B25C19	19	5/22	demod, sound i.f., chroma amp, subcarrier regen.	a.f.t.	tube	4-function	—	auto.	pulse	3X	IC	RGB I	yes X	series	—
	12B8C15	14,16	14/8	demod.	—	tube	—	—	auto.	pulse	3X	IT, IX	RGB I	yes	series	—
	12B9C16	16	14/9	demod.	a.f.t.	tube	—	—	auto.	pulse	3X	IT, IX	RGB I	yes	series	—
	12B14C50,52	23,25	14/14	demod.	a.f.t.	tube	6-function	—	auto.	pulse	3X	IT, IX	RGB I	yes X	parallel	—
	14A9,14A10 C92Z	18	16/10	demod.	(A10)a.f.t.	(A9) tube (A10)xstr.	—	—	auto.	pulse	3X	IT, IX	RGB I	yes	parallel	—
	14A9C50	20,23	16/9	demod.	a.f.t.	tube	6-function	—	auto.	pulse	3X	IT, IX	RGB I	yes	parallel	—
	40BC50	25	xstr.	demod, sound i.f., chroma amp, subcarrier regen.	a.f.t.	varactor	6-function	—	auto.	pulse	3X	IC	RGB I	yes X	—	ATG(21)

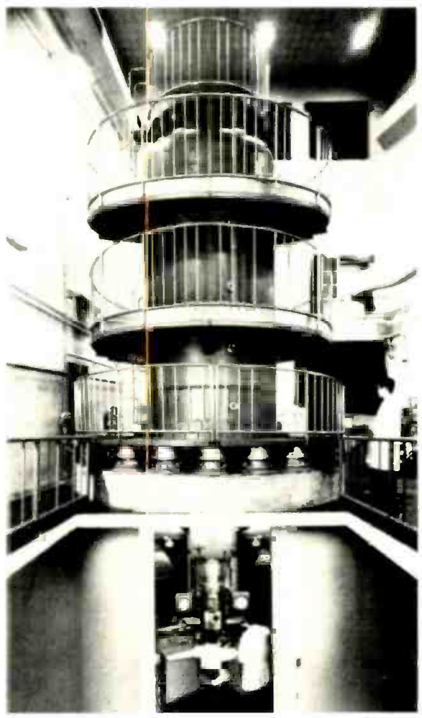
INFORMATION FROM THE FOLLOWING COMPANIES WAS NOT SUPPLIED: Airline (Montgomery Ward); Ambassador (Allied Purchasing); Clairtone; Craig; Curtis Mathes; Electrophonic; W.T. Grant (uses Wells-Gardner chassis); Hayakawa; Norelco (North American Philips); Sears/Silvertone.

NOTES: n.a. = information not available; **1.** viewable diagonal inches; **2.** some hybrids show how many tubes/transistors, including tuners; **3.** all u.h.f. tuners are transistor; **4.** auto. = automatic; **5.** X = transistors instead of tubes; **6.** lo = low level, hi = hi level, D = diodes, X = transistors, I = integrated circuits; **7.** has 3 amps for green, 2 each for red and blue, all transistor; **8.** for private labels only; **9.** made by Cortron, affiliate of Admiral; **10.** uses occasional transistors; **11.** with hold-down diode circuit; **12.** pulse-load type; **13.** mainly series, but some fed in parallel by transformer; **14.** using thermal timer relay; **15.** specially constructed kit for training purposes by National Radio Institute; **16.** called "Electrolok"; **17.** all varactor tuned tuners are solid state; **18.** 18 button "touch" tuner; **19.** slide switch varactor tuner includes 3 u.h.f. positions; **20.** not available on all models using these chassis; **21.** called "Automatic Tint Guard"; **22.** special parallel-reactance regulating circuit; **23.** two transistor stages for each color; **24.** "Automatic Picture Setting" is a way of presenting tint, color, brightness, and contrast; **25.** transistor X and Z amps and tube R, B, and G amps; **26.** called "Auto-lock Channel Tuning" (ACT); **27.** 21ST90 has 6-position detent u.h.f., 21ST91 has 6-position varactor push-button u.h.f.; **28.** xstr. R, G, B amps and tubes R, G, B output; **29.** called "Split-Second Start"; **30.** with small-screen CRT, h.v. regulation is not necessary; **31.** tube h.v. rectifier; **32.** tune by blue band at top of screen; **33.** Trinitron color CRT.

Recent Developments in Electronics



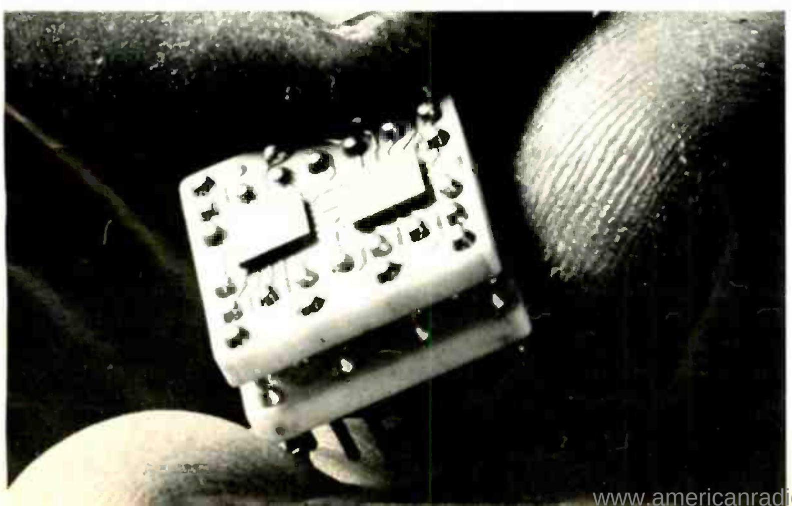
Laser Gyroscope. (Top right) Technician is making final check on this laser gyroscope before separating it from the gas-fill station. The helium-neon laser combines three ring lasers in a quartz sphere. Angular displacement and rates around three orthogonal axes are sensed without loss of accuracy at very high shock and vibration levels. The new gyro, built by Honeywell, will be used in an Army advanced technology flight-test program. The three-axis gyro is the first of its kind produced as a missile attitude-control sensor.

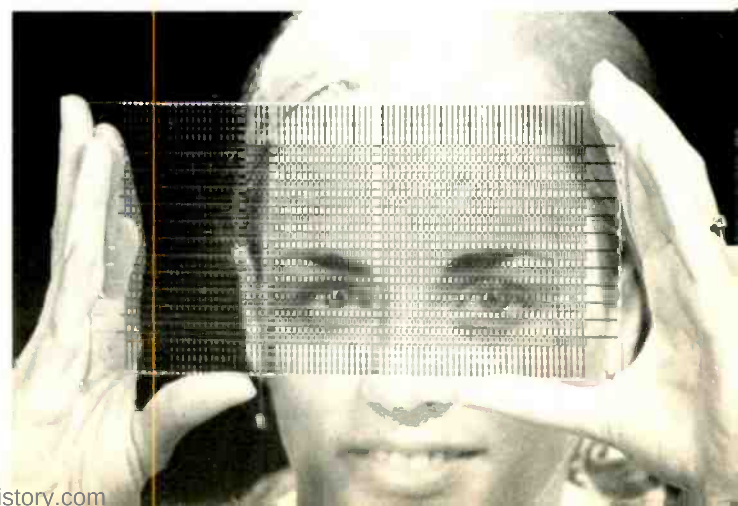


Highest Voltage Electron Microscope. (Center) A 3-million-volt electron microscope, boasting magnification up to 100,000X, is being developed by Hitachi for Osaka University in Japan. The higher voltage allows the electron beam to pass through living specimens of greater thickness than before. Also, a specially designed TV camera is used to pick up low-density electron beams for photomicrograph display. This reduces the possibility of specimen damage. To protect researchers from x-radiation, the observation chamber is shielded with a thick flint-glass window.

Computer Uses All-IC Main Memory. (Below left) The main memory of IBM's new 370 Model 145 computer is the company's first to consist of monolithic circuits rather than ferrite cores in its main memory. More than 1400 circuit elements are contained on a single silicon chip. Two chips are shown here mounted on a memory module held between fingers. Each $1/8$-in square chip has 174 complete memory circuits; four chips are housed in the double-layer module. The main memory of the new computer will store more than a half-million characters, but occupies only about half the space that would be needed for an equivalent-capacity core memory.

Light-Sensitive Thin-Film Computer Card Reader. (Below right) Laid out on glass like a crossword puzzle is this new light-sensitive thin-film circuit. It consists of a flat array of 960 photosensitive elements plus auxiliary components and interconnections, deposited on a 4 $\times$ 8 in plate of glass. The element could one day replace the mechanical or photocell sensors now used to read stationary punched cards for computers. The new device, developed by RCA Semiconductor Device Laboratory, is sort of a coarse version of the photoconductive image-sensor arrays that are being used for experimental solid-state television camera tubes.

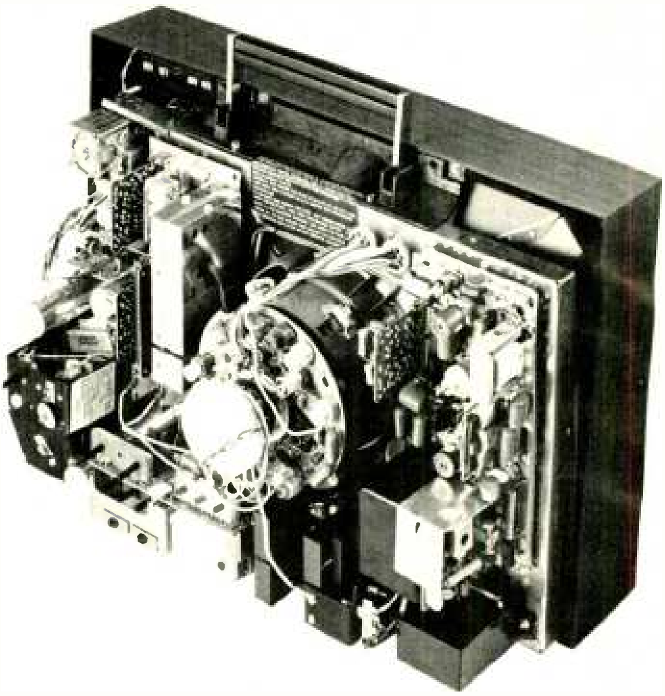




New Modular Color-TV Receiver

By EUGENE LEMKE/Manager
Color-TV Engineering, RCA

RCA's new CTC-49 solid-state chassis represents the greatest single departure for the company from traditional techniques. Plug-in modules, thick-film ceramic circuits, and a new wide-angle picture tube are featured.



Rear view of CTC-49 chassis with all modules plugged in.

THE new CTC-49 solid-state color-TV chassis represents perhaps the greatest single departure by *RCA* from traditional circuitry and techniques. The primary purpose has been to reduce the total circuit to small, easily identifiable, independently aligned and, therefore, totally interchangeable functional modules.

A number of significant factors have influenced the ultimate decision as to what circuits should constitute an integral module and the total number of modules that should be used in a color receiver. The modules must maintain a minimum identifiable performance function so that one can readily isolate a defective unit by certain performance deterioration or malfunction, thus reducing some of the skill required in servicing. At the other extreme, the module should not become so large as to burden the user with excessive replacement costs. In fact, the user cost should be low enough to preclude the repair in favor of replacement. Additional size limitations are imposed by considerations of interaction of circuits, radiation, and capacitive limitations in high-gain, high-frequency circuits.

Long-term goals have to be taken into account when designing modules in order to provide for improved techniques in the future, while retaining the same module terminal technique. Already the extensive development of specialized monolithic and ceramic circuit techniques for color TV have had significant influence on module design.

The CTC-49 features a total of eleven pluggable circuit modules (shown in color, Fig. 1). All modules are positioned in the chassis to face rearward and are easily and independently accessible for removal. Except for the low-voltage power-supply module, the rest are plugged into phenolic master boards utilizing specially designed edge connectors. *(Editor's Note: Refer to our lead photo for a rear view of the chassis with the modules plugged in. This is shown in color on our cover, along with an extra set of the plug-in modules.)*

The whole TV chassis can be considered to be divided into five distinctive assemblies, as follows: (1) The tuner assembly contains both the v.h.f. and u.h.f. tuners which are both automatically fine-tuned, as well as the primary customer controls—color, tint, brightness, on-off, volume, a.f.t.-defeat switch, and continuously variable sharpness control. The total assembly can be easily removed through plug connectors. (2) The complete signal-processing assembly (Fig. 2), consisting of one master board and eight modules. (3) The deflection master board with its vertical and horizontal oscillator function modules (Fig. 3). (4) The chassis proper, on which the miscellaneous heavier components are assembled. These include the low-voltage transformer, deflection output devices and their heat sinks, solid-state high-voltage quadrupler, and a small auxiliary circuit board containing picture-tube set-up controls and the less-used horizontal hold, vertical hold, and contrast controls. (5) The remaining assembly constitutes the picture tube itself, its deflection and convergence yokes, convergence waveshaping circuitry and its controls, purity and blue lateral assembly, and degaussing shield and coil.

Here is a brief description of the chassis circuitry, high-

What Does it Mean to the User?

RCA's modular approach to color-TV circuitry, as exemplified by the CTC-49 chassis (Argosy—Model EP-506), is a major step toward "instant replacement" servicing in the home by the technician of vital circuit components. Just as the older tube sets could be serviced by tube replacement in the home, in this new receiver, the solid-state plug-in modules are readily replaceable.

The chassis employs eleven plug-in "AccuColor" circuit modules, including three ceramic circuits, five silicon integrated circuit chips, and an easily replaced tuner assembly.

All of the plug-in modules are covered by the company's warranty program for a period of one year from original purchase of the set. The user has the option of selecting the service agency. *RCA Service* branches will maintain an inventory of all the various plug-in modular units. Independent service technicians will either maintain a similar inventory or be able to obtain replacement units through the nearest *RCA* branch. A national network of regional offices is being set up to implement this program and make replacement modules readily available at the consumer level. The regional offices will be supplemented by district offices in key cities across the country.

Initially, circuit modules will be replaced under the warranty program by new factory units. Eventually, the program will involve replacement by factory-rebuilt units under the same sort of set-up that prevails in the automotive and other consumer businesses. The most obvious advantage to the consumer is a far higher percentage of "in-home" servicing, resulting in faster and less-expensive repairs.

lighting the most important differences compared to previous receivers.

The tuner assembly follows very closely the practices employed in the company's previous solid-state chassis. It uses a four tuned circuit wafer switch v.h.f. tuner with MOSFET r.f. amplifier, a cascode-type mixer and a.f.t.-controlled local oscillator. Most significant variation is the elimination of the familiar "link circuit." In its place is a terminated coaxial line which interconnects the tuner and the i.f. amplifier input independent of each other and the length of the interconnecting cable is no longer critical. This results in total interchangeability of the tuner and i.f. assemblies without requiring subsequent realignment of tuned circuits as has been the case in the past.

The total signal-processing circuitry is connected from the tuner-assembly output to the picture-tube socket. Five monolithic integrated circuits are used, replacing a substantial number of discrete circuit components. The pix i.f.-a.f.t. module is completely self-contained, and the heart of the module is a new complex integrated circuit specifically designed for this purpose and used for the first time in TV receivers. This IC performs the total amplification at the picture i.f. passband, with outputs for the 4.5-MHz intercarrier sound signal, low-level video, and color information. Another output provides reference for the now rather conventional automatic fine tuning (a.f.t.) integrated circuit, which is also contained on this module.

The video output from the i.f. module is fed into the video/sync module. The functions of luminance delay, vertical and horizontal retrace blanking, control of contrast, and control of video peaking are performed in the first video amplifier transistor. The second video amplifier is an emitter-follower stage which provides an impedance match between the first video amplifier and the three parallel-driven picture-tube drive modules.

The tuned color input is fed into the first chroma module. As is the case with the pix i.f. module, a specialized IC has been developed for this circuit and used for the first time.

(Continued on page 77)

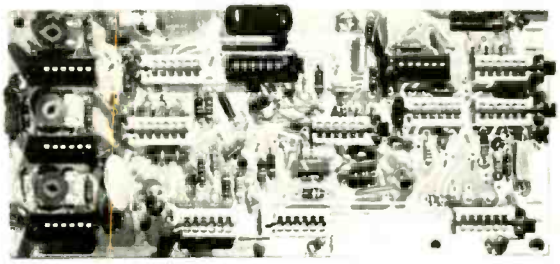


Fig. 2. The signal-processing assembly board is shown here without its eight plug-in modules. Each of these modules is plugged into one or more specially designed edge connectors.

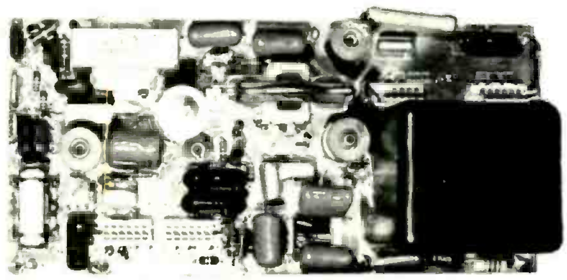
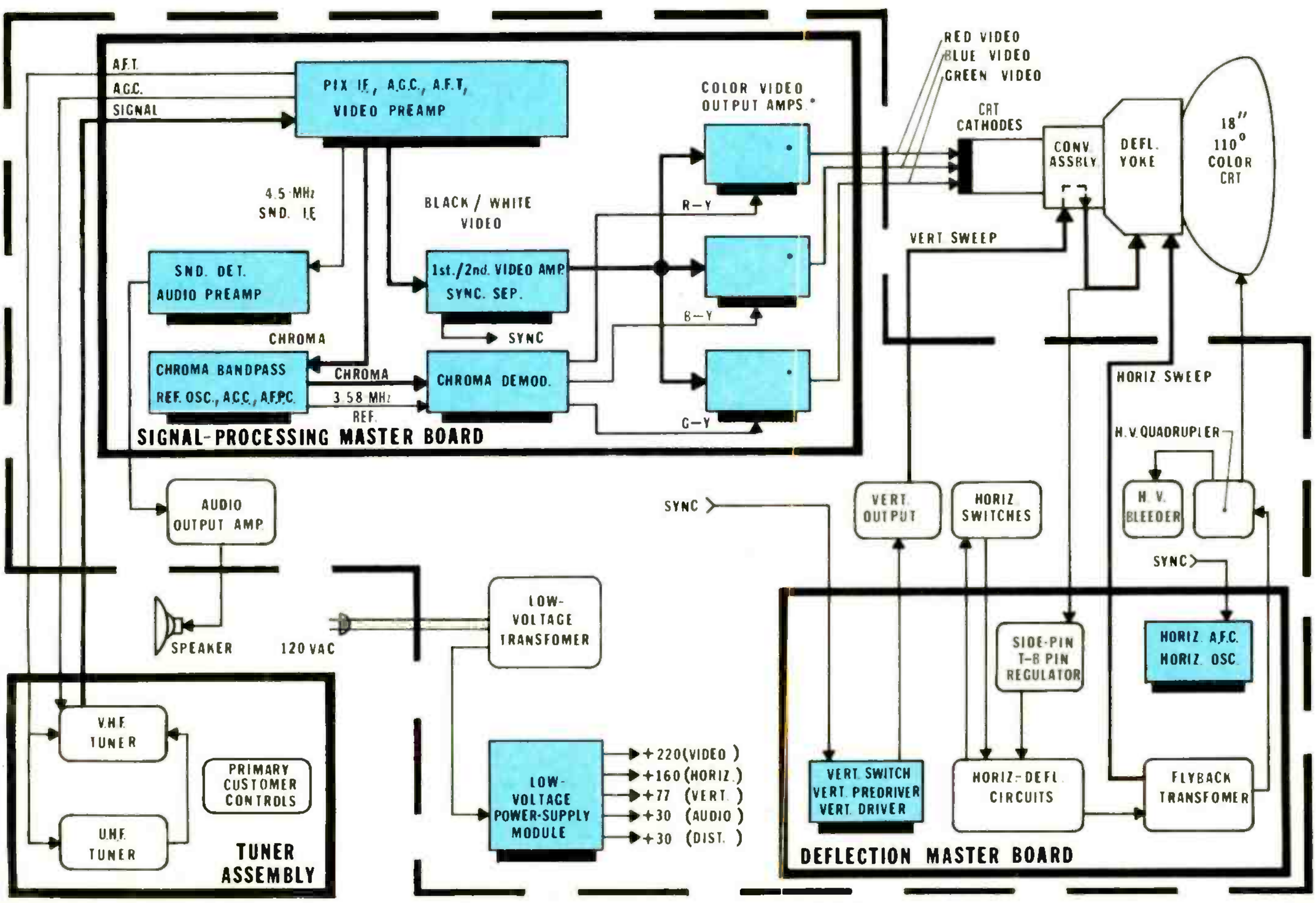
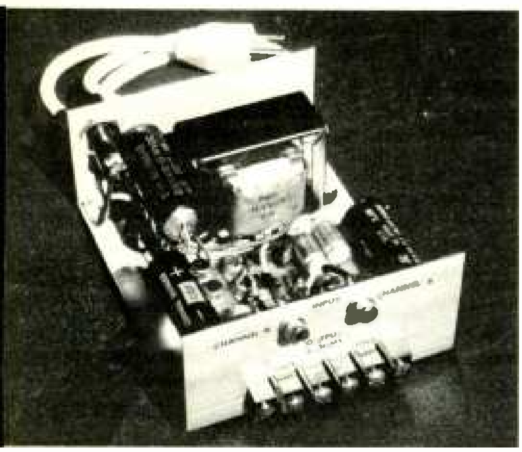


Fig. 3. The deflection master board without its two modules.

Fig. 1. Block diagram of the receiver which consists of five main assemblies that include eleven plug-in modules (in color).





Small-Size Hi-Fi Stereo Amplifier

By WALTER W. SCHOPP

Delivers a clean 3.7 watts per channel into 8 ohms without heat sinks or overheated power transistors.

A LOW-wattage amplifier offers some fringe benefits its high-power cousins do not. One is reduced cost of construction. By operating at lower voltages, the cost can be reduced by using lower voltage rated components. Another benefit is reduced physical size of the components due to the lower working voltages. The smaller capacitors and lower wattage resistors allow construction of a complete two-channel stereo power amplifier on a circuit board measuring only 2¼" × 3¾".

This miniature amplifier packs a real punch in the performance department. It will produce a clean 3.7 watts continuous power across an 8-ohm speaker load without heat sinks or overheated output transistors. Its response of 15 Hz to over 30 kHz leaves little to be desired as far as the ear is concerned.

The high input impedance allows the amplifier to be driven directly by a crystal phonograph cartridge if a suitable volume control is added across the input.

By departing from the conventional complementary-symmetry output stage, balancing or biasing diodes are eliminated. The combination of silicon output transistors, *Q5* and *Q6*, with their respective germanium drivers, *Q3* and *Q4*, is unique. With this approach, the output transistors are biased off except for the small base current due to the inherent leakage of the drivers, *Q3* and *Q4*. This allows the drivers to be turned on by very low signal levels without a trace of crossover distortion. The germanium drivers are biased by the voltage drop across resistor *R7*. This voltage is about half the supply voltage. This configuration is responsible for the extremely low "no-signal" current, which is on the order of 1 to 2 milliamps.

The input stage is "bootstrapped" with the feedback network consisting of resistors *R6* and *R2* and capacitor *C1*. This network raises the input impedance to 500,000 ohms.

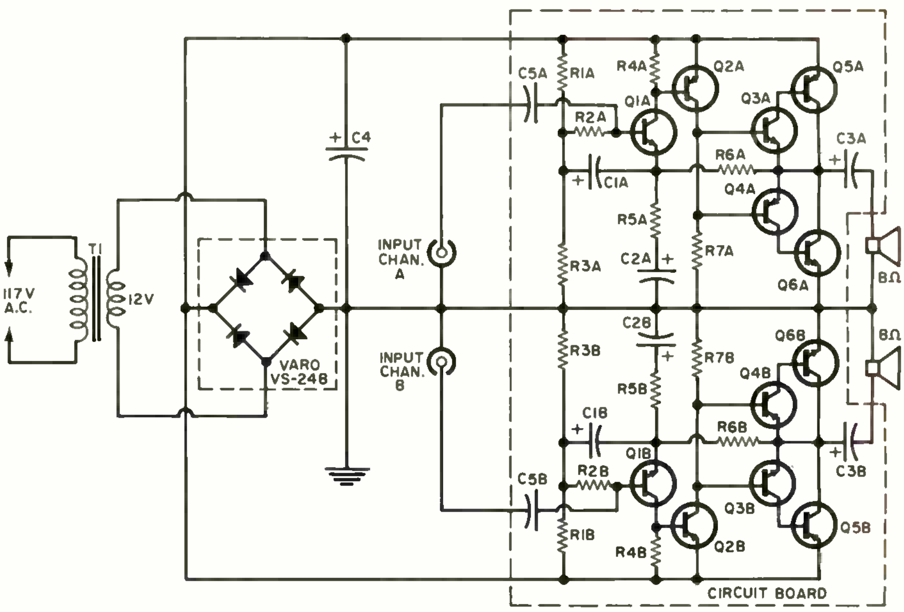
The components were chosen for their low cost, without sacrificing amplifier performance. They are readily available and no special or hard-to-get items were used. Construction of the amplifier was simplified, and chances of wiring errors reduced, by using an etched-circuit board. Using the components specified in the parts list assures the builder that the circuit board holes will be in the correct places to match the components. The circuit can also be hand-wired in the conventional way as no part of the circuit is critical. The etched, tinned, and drilled circuit board can be purchased (see parts list).

After construction, check the voltage on the collector of transistors *Q2A* and *Q2B* (Channels A and B). If the amplifier is operating properly, the voltage on these collectors should be half the supply voltage with no input signal to the amplifier. ▲

Power Output	3.7 watts continuous into 8 ohms
Frequency Response	15-30,000 Hz
Voltage Gain	50
Quiescent Current	1-2 mA per channel
Operating Temp.	40°-125° F
Input Impedance	500,000 ohms
Output Impedance	8 ohms

Table 1. Specs of the compact amplifier.

Fig. 1. Complete schematic diagram and parts listing of unit.



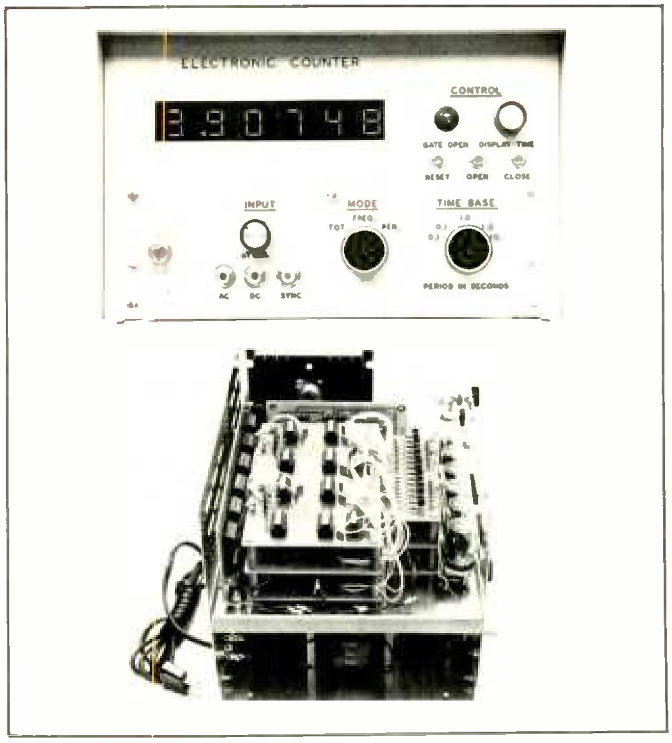
R1—33,000 ohm, ¼ W res.
R2—39,000 ohm, ¼ W res.
R3—56,000 ohm, ¼ W res.
R4—12,000 ohm, ¼ W res.
R5—470 ohm, ¼ W res.
R6—22,000 ohm, ¼ W res.
R7—15,000 ohm, ¼ W res.
C1, C2—20 μF, 15 V elec. capacitor (Sprague TE1157)
C3—1000 μF, 15 V elec. capacitor (C-D CDE-1000-15)
C4—2000 μF, 25 V elec. capacitor (C-D CDE-2000-25)
C5—0.1 μF, 20 V elec. capacitor (Centralab UK-20-104)
T1—12 V at 2 A power trans. (Stancor P-8130)
Q1—2N3704, 2N3705, or 2N3706
Q2—2N3702 or 2N3703
Q3—2N1302, 2N1304, 2N1306, or 2N1308
Q4—2N1303, 2N1305, 2N1307, or 2N1309
Q5—2N5322 or 2N5323
Q6—2N5320 or 2N5321
1—Etched and drilled circuit board. Available from Nielsens, 934 Miranda Way, Livermore, Calif. 94550. $2.95 postpaid.

Digital Instruments

Part 5 - Introduction to Electronic Counters

By DONALD L. STEINBACH/Research Engineer, Sr.
Lockheed Missiles & Space Co.

Discussion of general electronic counter design considerations followed by construction details on a simple three-mode electronic counter that uses 60-Hz power line as the timing reference.

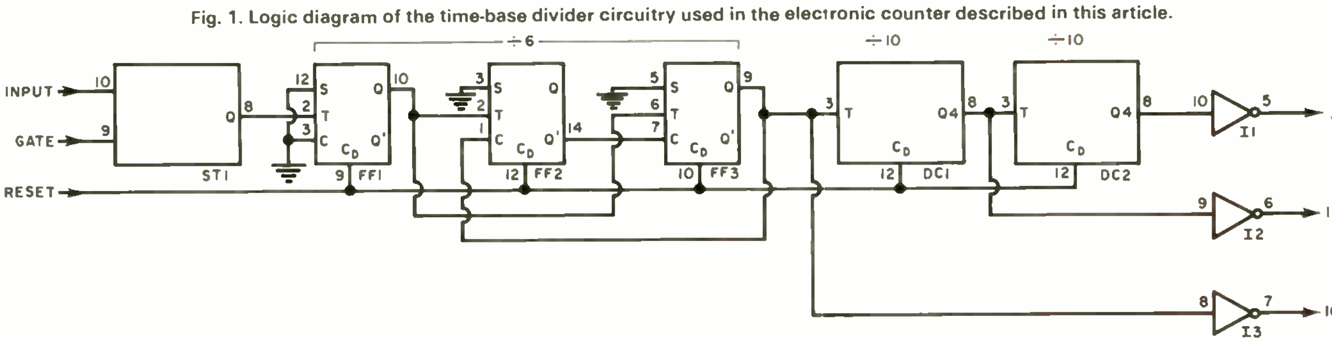


Two views of the electronic counter built by the author showing (above) the front-panel arrangement of controls described in article and (below) inside of the chassis.

A TYPICAL electronic counter consists of a series of cascaded decade counter and display units, a gate through which the data to be counted must pass in order to reach the first of the decade counters, circuits to shape and condition the input data waveform, control circuitry, and an accurate and stable time reference. These elements that make up an electronic counter may be interconnected in various ways to achieve eight different modes of operation. Those eight modes are defined as follows:

1. Scaler mode: A trivial mode, where the display is not required and the decade counters serve as dividers to provide output events at some decade submultiple of the input events, scaling the time or frequency of the input events by some factor of ten.
2. Totalize mode: The decade counters count and display the total number of events that occur at the input to the counter, without regard to the time relationships among those events.
3. Ratio mode: The decade counters count and display the number of events that occur at one input during the interval between successive events that occur at the other input. The counted events must occur at a higher repetition rate than the gate controlling events. All of the modes that follow are variations of the Ratio mode.
4. Frequency mode: The decade counters count and display the number of events that occur during a preselected time interval, derived from the time base. This mode is normally used to measure the frequency of a periodic waveform.
5. Period mode: The decade counters count and display the elapsed time, derived from the time base, between successive events. This mode is normally used to measure the period of a periodic waveform.
6. Time Interval mode: The decade counters count and display the elapsed time, derived from the time base, between two independent occurrences. This mode is similar to the Period mode, except that the gate controlling events (open and close) are usually not both derived from the same signal.
7. Multiple Period mode: This mode is the same as the Period mode, except that the unknown period is lengthened, usually by some multiple of ten. The averaging effect of this mode of operation generally provides more accurate period information than the Period mode.
8. Rate mode: This mode is the same as the Frequency mode except that the gate controlling signal is variable (in discrete steps) in increments other than multiples of ten. This mode is often used to convert frequency measurements to a display of more practical units (*e.g.*, to convert pulses per revolution to revolutions per minute).

Fig. 1. Logic diagram of the time-base divider circuitry used in the electronic counter described in this article.



DC1, DC2—Decade up counter (Motorola MC780P)
FF1—JK flip-flop (Motorola MC723P)
FF2, FF3—½ dual JK flip-flop (Motorola MC790P)

I1, I2, I3—⅙ hex inverter (Motorola MC789P)
ST1—¼ quad Schmitt trigger (Motorola MC9709P)

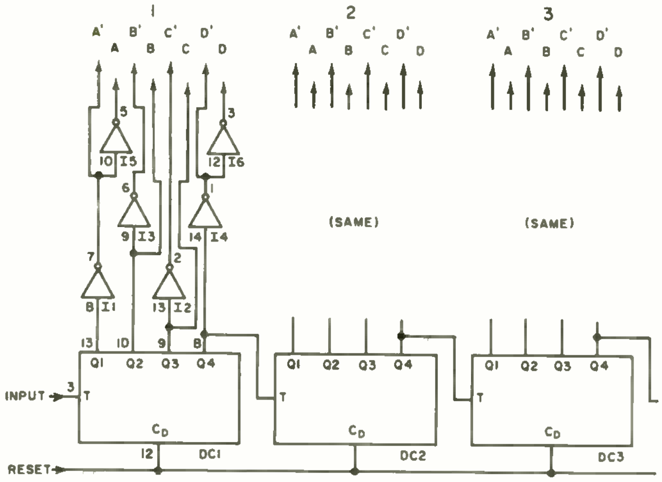


Fig. 2. Logic diagram showing three stages of six-stage counter used in electronic counter. Each stage is Motorola MC780P decade up counter. Motorola's hex inverter MC789P (I1-I6), is used to generate complement of each data output and make BCD outputs compatible with input requirements of display decoders.

The Totalize configuration can be considered the minimum electronic counter configuration, since an electronic counter without a visual display is actually a scaler rather than a counter. Nearly every electronic counter is designed to operate in the Frequency and Period modes, and most include the additional mode switching for the Totalize mode as well. Flexibility and cost increase hand-in-hand and few electronic counters are designed to operate in all eight modes.

A complete electronic counter system consists of six major functional blocks: (1) the counters and storage registers, including the counter output circuitry for the Scaler mode; (2) the decoders, display drivers, and displays; (3) the input channels; (4) the time base, including divider gating for the Multiple Period mode and a variable modulo divider for the Rate mode; (5) control logic circuits for controlling the counter gate and supervising the over-all sequence of counter operations; and (6) mode-switching circuits to interconnect the various functional blocks in the configuration required for each of the eight operating modes.

All gated measurements are subject to a ±1 count uncertainty when the gating signal is not coherent with the input signal (the usual case). The effect of this ambiguity is reduced as the number of events counted is increased. Time-base accuracy and stability, and trigger errors, limit the ultimate measurement accuracy of the counter.

A Practical Design

The remainder of this article describes a simple three-mode electronic counter designed around RTL IC's and utilizing the 60-Hz commercial power-line frequency as the timing reference. The six-digit readout displays frequency, period, and total events. Although designed for a maximum counting frequency of 4 MHz, the author's design prototype has operated at frequencies in excess of 24 MHz under carefully controlled conditions.

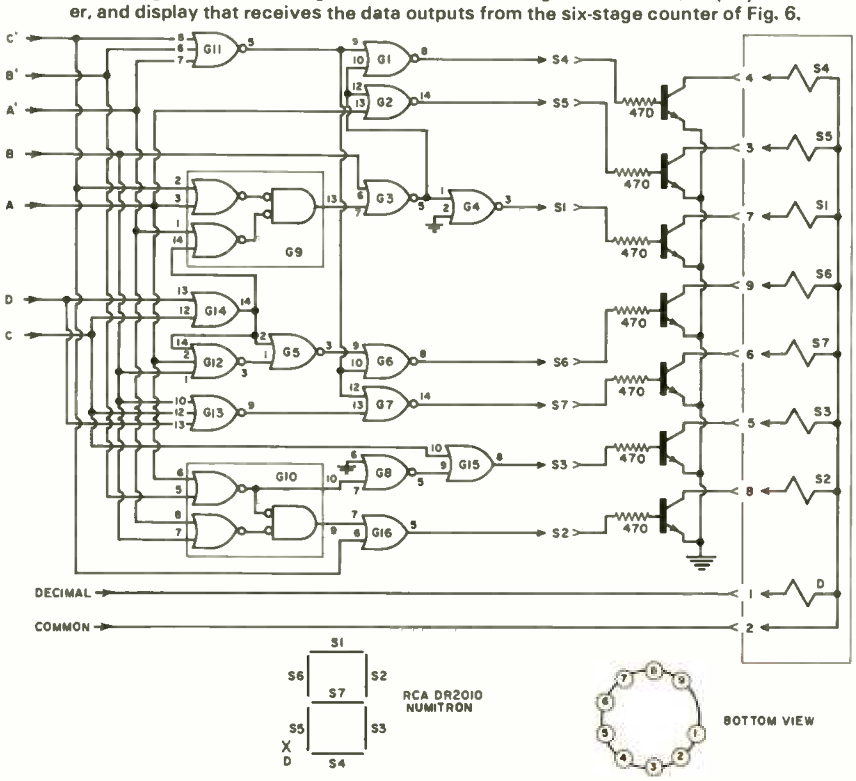
The Time Base (Fig. 1) for the electronic counter consists of a Schmitt trigger to condition the 60-Hz power line sine wave, three JK flip-flops in a divide-by-six configuration to provide a 10-Hz output, and two decade divider packages to derive the 1-Hz and 0.1-Hz outputs. Three buffer elements standardize the time-base output levels, increase the available drive level, and isolate the divider stages from external wiring capacitance.

The Schmitt trigger, described in the September issue, responds to signals at the "Input" line only when the "Gate" line is at the logic "0" level. A logic "1" level on the "Reset" line resets all of the Q outputs of the FF's and decade dividers to the logic "0" level, providing a means of initiating a zero-time reference.

Using the 60-Hz power-line frequency as the timing reference reduces the cost of the electronic counter, but limits the period and frequency measurement accuracy to about 0.1%, and limits the period timing resolution to 100 milliseconds. Measurement accuracy can be improved by using a crystal oscillator for the timing reference and the timing resolution can be increased by utilizing a higher timing reference frequency and bringing out the higher frequency components (100 Hz, 1000 Hz, etc.) available at the outputs of the decade divider stages that must be added. The time-base generator used in the digital clock described in the November issue is indicative of the type of system that might be employed. Suitable crystal oscillators are available in the *International Crystal* EX/OX and OE lines.

Six *Motorola* MC780P decade up counter IC's make up the six-stage counter section in Fig. 2. Each of the decade counters advances one count with each clock pulse (a 1-to-0 transition) that arrives at its "T" input. A logic "1" level applied to the "Reset" line resets the four Q outputs of each of the six counters to the logic "0" level. Utilizing the decade counter IC's rather than decade counters constructed from four JK flip-flops and a gate reduces system cost, simplifies counter layout, and reduces assembly time. The decade counters are rated to operate at up

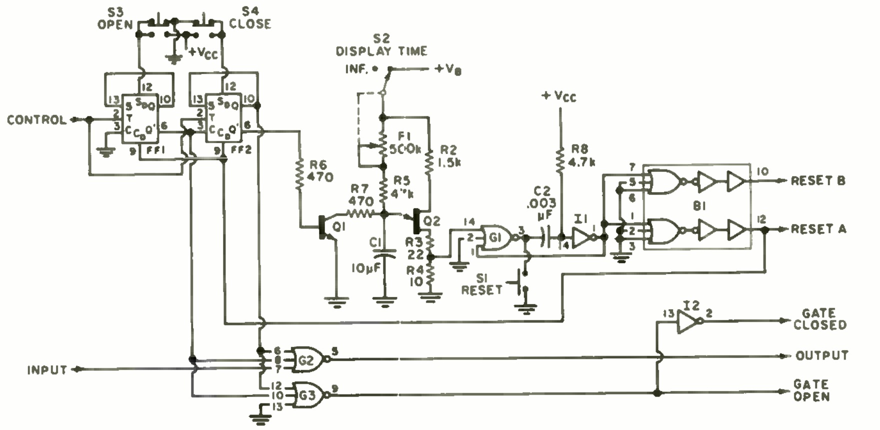
Fig. 3. Logic/schematic diagram of BCD-to-seven-segment decoder, display driver, and display that receives the data outputs from the six-stage counter of Fig. 6.



G1, G2, G3, G4, G5, G6, G7, G8—¼ quad 2-input gate (Motorola MC717P)
G9, G10—½ dual half adder (Motorola MC775P)
G11, G12, G13—⅓ triple 3-input gate (Motorola MC793P)
G14, G15, G16—¼ quad 2-input "or" gate (Motorola MC9715P)
Transistors—Motorola MPS 5172

to 4 MHz, although most of them will perform satisfactorily at higher speeds. The *Motorola* MC789P hex inverter package associated with each stage of the counter generates the complement of each data output and increases some of the output drive levels so that the counter BCD data outputs are compatible with the input requirements of the display decoders.

The data outputs (A, A', B, B', C, C', and D) from each stage of the counter are connected to the corresponding inputs of a companion decoder, display driver, and display stage (Fig. 3). The BCD-to-seven-segment decoder, assembled here with five IC packages, is the same as that described in the August issue. The seven output lines from each decoder stage are connected to low-cost ($14.00 per 100) *n-p-n* silicon transistors which complete the return paths for the seven segments contained in each of the *RCA* DR2010 Numitron display tubes (see the July issue for complete details on these and other readout devices).



R1—500,000 ohm pot with sw. S2 (Centralab B-59 with KR-1 sw.)
C1—10 µF elec. capacitor (Centralab EA30 10)
C2—0.003 µF elec. capacitor (Centralab CPR-3000J)
FF1, FF2—JK flip-flop (Motorola MC726P)
B1—Dual 3-input buffer (Motorola MC788P)
G1, G2, G3—⅓ triple 3-input gate (Motorola MC792P)
I1, I2—⅙ hex inverter (Motorola MC789P)
S1—Push-button switch (Switchcraft 951)
S3, S4—Push-button switch (Switchcraft 953)
Q1—Motorola MPS 5172
Q2—Motorola HEP 310 or 2N4871

Fig. 4. Logic/schematic diagram of control logic circuitry (7005071) used in the electronic counter to open and close the counter gate, control the display time, and for resetting system logic prior to each new measurement interval.

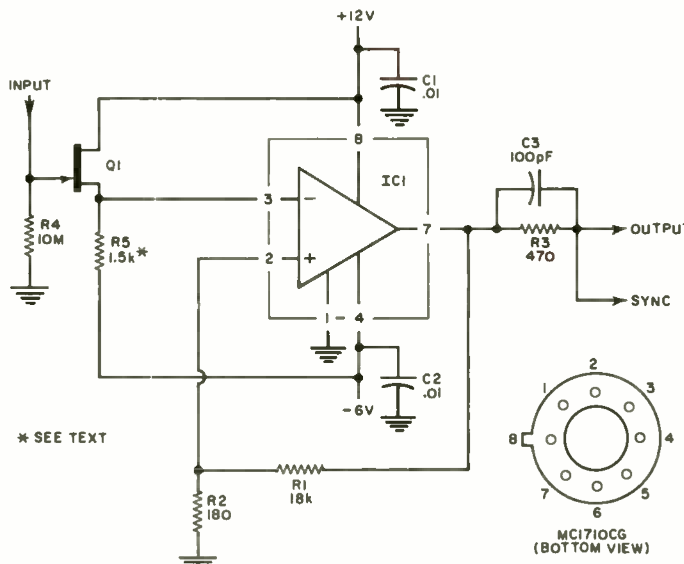
The control logic circuitry in Fig. 4 is responsible for generating the counter "housekeeping" functions, namely (1) opening and closing the counter gate, (2) controlling the display time, and (3) resetting the system logic prior to each new measurement interval. Control flip-flops *FF1* and *FF2* open and close the counter gate (*G2*), *G3* and *I2* indicate the gate status. *Q1* and *Q2* make up the display reset generator, *Q1* and *I1* form the reset pulse generator, and *B1* increases the reset pulse drive capability to accommodate the system reset loading. The first clock pulse on the "Control" line opens the counter gate, allowing signals on the "Input" line to appear on the "Output" line. The next clock pulse on the "Control" line closes the counter gate, driving the "Output" line to "0." After a variable time delay, set by *R1*, a reset pulse is generated resetting the entire counter system (and clearing the displayed count to all zeros).

Immediately after receipt of a reset command (either manually *via S1* or automatically *via S2-G1-I1*) both *FF1* and *FF2* are in the "0" state where the *Q* outputs are at the logic "0" level and the *Q'* outputs are at the logic "1" level. The outputs of *G2* and *G3* are at the "0" level and the "Output" line remains at "0" independent of any excursions on the "Input" line. The "Gate Closed" line is at the "1" level, signifying that the counter gate (*G2*) is closed. Transistor *Q1* conducts, holding the emitter voltage of UJT *Q2* near zero, and both reset lines ("Reset A" and "Reset B") are at the logic "0" level. When the next clock pulse arrives *via* the "Control" line, *FF1* toggles (*FF2* does not) opening the counter gate. Any signal on the "Input" line appears (inverted) on the "Output" line while the gate is open. The next clock pulse on the "Control" line causes *FF2* to toggle (*FF1* does not) closing the counter gate and removing the forward bias from the base-emitter circuit of *Q1*. Capacitor *C1* is now free to charge toward $+V_B$ through *R1* and *R5* (*R5* controls the display time). When the emitter voltage of *Q2* reaches the UJT peak-point voltage, *Q2* delivers a positive-going pulse to the input of *G1*. This pulse initiates the monostable multivibrator (*G1*, *C2*, *R8*, and *I1*) timing cycle, causing a 10-microsecond pulse to appear on the "Reset A" and "Reset B" lines. The reset pulse also resets the control flip-flops, *FF1* and *FF2*, enabling them to initiate another measurement cycle. When *FF1* and *FF2* reset, *Q1* conducts and prevents the generation of additional reset pulses until the gate opens and closes again.

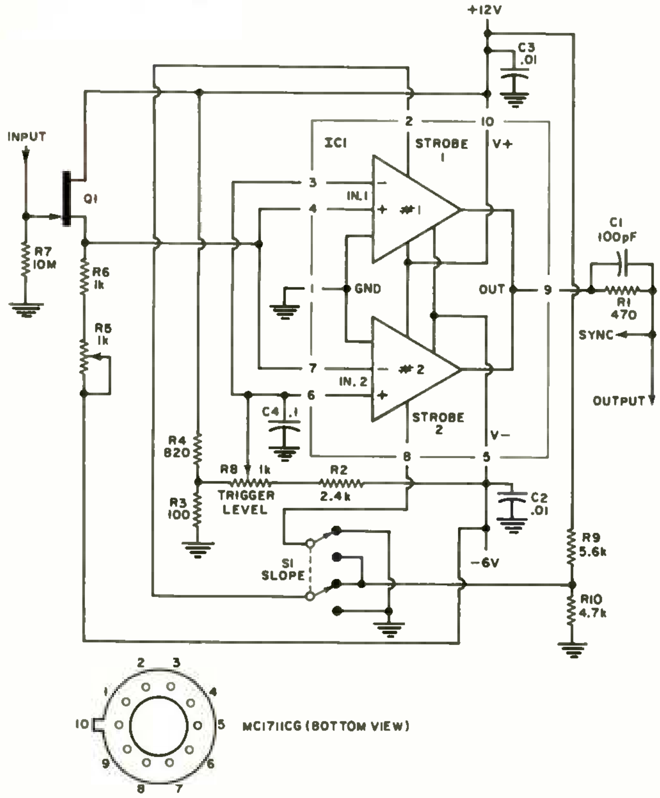
The UJT peak-point voltage is a function of the UJT supply voltage (V_B) and the UJT intrinsic stand-off ratio. The elapsed time from gate closure to the initiation of the reset pulse is adjustable from less than 1 second to more than 5 seconds with the components specified.

The input amplifier and shaper conditions the input signal so that it meets the amplitude and transition-time requirements of the system JK flip-flops and decade counters. One version, shown in Fig. 5, uses an IC differential voltage comparator (the *Motorola* MC1710CG) connected as a Schmitt trigger. The fast regenerative switching action is a result of the feedback path from the output terminal to the non-inverting input terminal (+), *via R1* and *R2*. A 1-to-0 transition occurs at the output as the input signal crosses the upper trip point (about +7 millivolts) in a positive-going direction. The trip points (neglecting hysteresis) are a function of the reference voltage applied to the lower end of *R2*—ground or 0.00 V d.c. in this case. The source-follower input stage (*Q1*) minimizes the loading of the input sig-

Fig. 5. Schematic of one version of an input amplifier and shaper circuit (7006041) that can be used to condition input signal to the electronic counter to meet amplitude and transition-time requirements of system JK flip-flops and the decade counters.



IC1—Differential voltage comparator (Motorola MC1710CG)
C1, C2—0.01 µF capacitor (Centralab UK25-103)
Q1—"n" channel FET (Motorola HEP 802)



R5—1000 ohm pot (Centralab T-1000)
R8—1000 ohm pot (Centralab B-5)
C2, C3—0.01 μF elec. capacitor (Centralab UK25-103)
C4—0.1 μF elec. capacitor (Centralab UK16-04)
IC1—Dual differential comparator (Motorola MC1711CG)
S1—D.p.d.t. switch (Centralab 1462)
Q1—"n-" channel FET (Motorola HEP 802)

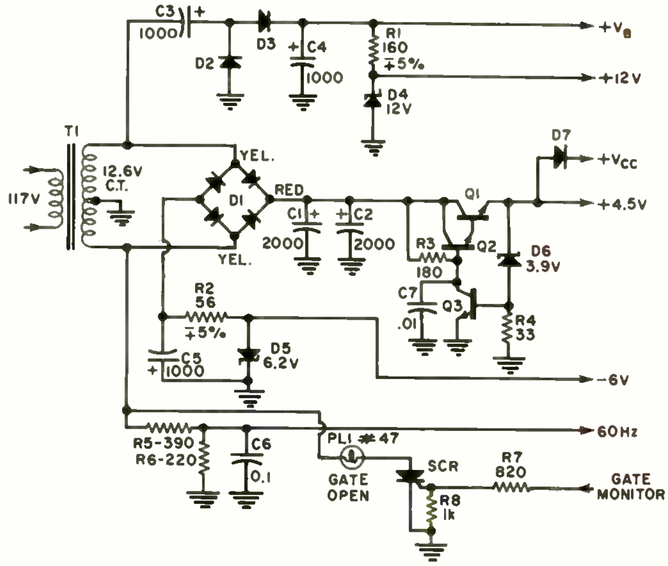
Fig. 6. Schematic diagram of a second type of input amplifier and shaper circuit (7005141) that can be used to condition the input signal to the counter described in the article. This circuit, however, is not as well suited for processing low-frequency, low-amplitude waveforms as circuit shown in Fig. 5.

nal and presents a low source impedance to the comparator inverting input. Resistor *R5* in the source lead of *Q1* is selected so that the source-to-ground voltage is 0.00 V d.c. when the signal input is 0.00 V d.c. The exact value of *R5* must be determined experimentally, and will lie between 1000 and 2000 ohms. The hysteresis of the Schmitt trigger is a function of *R1*, *R2*, and the output voltage swing and is given by:

$$V_{hysteresis} = [R2/(R1+R2)]\,(V_{pin\,7\,(max)} - V_{pin\,7\,(min)}).$$

The hysteresis of the circuit shown is approximately 20 millivolts. The comparator will tolerate up to ±7 volts on either input terminal and a differential input voltage (measured between pins 2 and 3) of up to ±5 volts. Both ratings must be observed simultaneously. Resistor *R3* limits the comparator steady-state output current and shunt capacitor *C3* reduces the effect of *R3* on the system transient response. Bypass capacitors *C1* and *C2* must be located as close to the comparator as possible.

A second version of an input amplifier and shaper circuit appears in Fig. 6. It includes provisions for selecting both the trigger level and trigger slope, but depends on the high-voltage gain of the comparator rather than Schmitt-trigger action to condition the input waveform. Therefore, it is not as well suited for processing low-amplitude, low-frequency waveforms as the circuit of Fig. 5. The *Motorola* MC1711CG dual differential voltage comparator used in Fig. 6 is approximately equivalent to two MC1710CG comparators with their outputs connected together. Either half of the dual comparator may be disabled by grounding the associated "strobe" terminal. The potentiometer (*R5*) in the source of *Q1* is adjusted so that the source-to-ground voltage is 0.00 V d.c. when the signal input voltage is 0.00 V



C1, C2—2000 μF elec. capacitor (Centralab EA15-2000)
C3, C5—1000 μF elec. capacitor (Centralab EA15-1000)
C4—1000 μF elec. capacitor (Centralab EA30-1000)
C6—0.1 μF capacitor (Centralab UK16-104)
C7—0.01 μF capacitor (Centralab UK25-103)
T1—Filament transformer (Stancor P-8358)
D1—Bridge rectifier (Motorola MDA 952-1)
D2, D3—1N4001 rectifier diode
D4—1N4742A or 1N3022B zener diode
D5—1N4735A zener diode
D6—1N5228B zener diode
D7—1N4719 rectifier diode
Q1—2N3055 transistor (mounted on HEP500 or MS-10 heat sink)
Q2, Q3—MPSA20 transistor
SCR1—Silicon controlled rectifier (Motorola 2N5061)

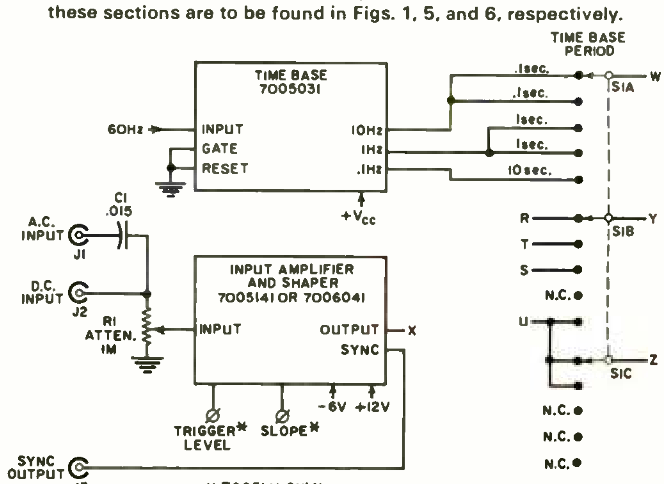
Fig. 7. Schematic diagram of the power-supply circuit that is used to satisfy all the electronic counter power requirements.

d.c. Resistor *R2* is selected for a voltage of −1.0 V d.c. at the junction of *R2* and *R8*. The other end of *R8* is held (by *R3* and *R4*) at +1.0 V d.c.; thus, the trigger level is adjustable from +1.0 V to −1.0 V. Switch *S1* selects the trigger slope by simply disabling the undesired half of the comparator.

All of the electronic counter power requirements are satisfied by the power-supply circuit of Fig. 7. The "+ V_B" output provides about +16 V d.c. (unregulated) for the control logic UJT circuit, and zener diode regulated "+12 V" and "−6 V" outputs supply the input amplifier and shaper voltages, and the "60-Hz" output (about 4.2 V p-p) becomes the time-base input signal. The well-regulated "+4.5 V"

(Continued on page 56)

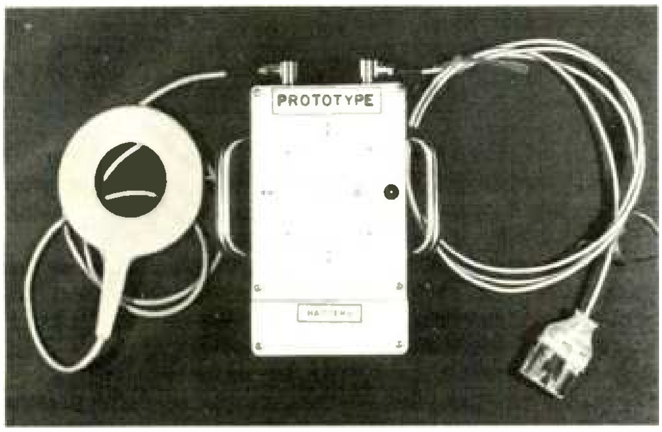
Fig. 8. Electronic counter system block diagram showing time base and input amplifier and shaper sections. Schematics for these sections are to be found in Figs. 1, 5, and 6, respectively.



R1—1 megohm pot (Centralab B-69)
C1—0.015 μF disc ceramic capacitor (Centralab DD-153)
S1—4-pole, 5-pos. switch (Centralab PA-1013)
J1, J2, J3—Phono jacks (Switchcraft 3505F)

Myo-Cybernetics

By FRED W. HOLDER



New medical technology, still in an experimental stage, holds promise for those heretofore doomed to bedridden existence. Using pacemaker-like device, patient's muscles are stimulated into action.

Prototype myo-cybernetic unit consists of transmitting coil (left), power pack (center), and the heel-switch cable (right)

EACH day 100 people in Los Angeles County, California are felled by paralyzing strokes. Another large number are paralyzed from other causes, such as spinal cord and head injuries. In the past, many of these people were doomed to be bedridden or confined to nursing homes for the rest of their lives. For many, little could be done to help them resume an independent and productive life. Now, there is hope. A small group of physicians and engineers at Rancho Los Amigos Hospital in Downey, California are pooling their talents to improve methods of treatment.

They're making progress, too, with a marriage of electronics and medicine. They are using an electronic device similar to the cardiac pacemaker (covered in the February, 1970 issue of ELECTRONICS WORLD) to help partially paralyzed stroke victims walk more effectively. To date, the device has been used successfully on over 20 patients in the stroke-rehabilitation program at Rancho Los Amigos Hospital. Unfortunately, the device is still experimental and will not be available for general use in the near future.

The physician-engineering team working on this program is made up of Drs. Vernon Nickel, Vert Mooney, and William Wilemon, who are supplying the medical expertise, and Drs. Jim Reswick and Don McNeal, who are providing the technical "know-how." Drs. Nickel and Reswick are working together to set up an "Engineering Center Complex" which will be devoted to developing methods of applying technology to the treatment and rehabilitation of chronic ailments. Drs. Wilemon, McNeal, and Mooney are more directly and technically involved in the current application and development work. Dr. Reswick is credited with coining the word, *myo-cybernetics*, for this new medical technology; *myo* meaning muscle and *cybernetics* meaning control system.

The team is working in close cooperation with *Medtronics* of Minneapolis, one of the largest suppliers of cardiac pacemakers in the country. The Los Amigos team is supplying some of the technology being applied to equipment that *Medtronics* is building for them.

Electrical Stimulation of the Nerve

According to Dr. Nickel, the device they are currently using is most applicable to a patient who cannot lift his foot off the floor to walk. Its operation is based on electrical stimulation of the *peroneal* nerve, which activates the muscles that lift the foot to take a step. The patient using the device wears a power pack on his belt, which controls a transmitter attached to the inner thigh. The transmitter sends impulses to a tiny receiver implanted under the skin of his leg. The receiver sends an electrical impulse along a wire to stimulate the *peroneal* nerve and start the walking motion.

The transmitter is triggered by a tiny Microswitch located in the heel of the patient's shoe. Dr. Nickel stressed that this switch provides for appropriate timing of the system to enable the patient to develop a good walking rhythm.

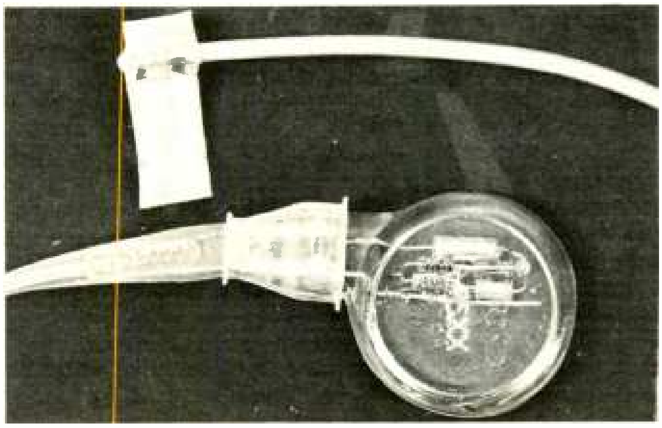
To start the walking process, the patient simply lifts his heel to activate the switch. This, in turn, triggers the transmitter to pulse the receiver and stimulate the *peroneal* nerve, causing the wearer to lift his foot off the floor for a step. As his heel again strikes the floor, the transmitter is turned off, relaxing the muscles and allowing the foot to rest flat on the floor. The system remains inactive until the wearer again lifts his heel.

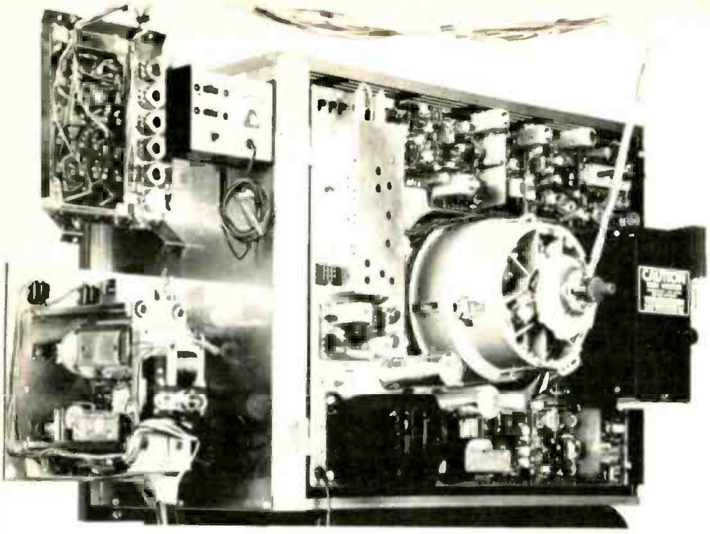
The doctors indicated that this new technology may find applications whenever the brain is no longer able to supply the motivational signals to stimulate the muscles. When this occurs, a tiny implanted radio receiver can take over the job. Of course, it will not be able to perform the complex interaction and data processing that takes place among the muscles, nerves, spinal cord, and brain during any normal physical action. It will, however, be able to provide those gross signals necessary to assist the patient in performing physical tasks such as walking and perhaps, one day, breathing.

At this time, applications are very limited and highly experimental, but the results look quite promising, according to Dr. Nickel. The experiments have been most successful

(Continued on page 57)

Close-up view of the receiver which is implanted under the skin and used to stimulate nerves, causing specific physical activity.





Rear view of assembly. There are actually two chassis available (the only difference being picture-tube size); one has 227 square inches (20-in diag.) viewing area, other 295 square inches (23-in diag.) viewing area. Both are solid-state, using total of 45 transistors, 55 diodes, four IC's, two SCR's, and two tubes (the picture tube and a high-voltage rectifier tube).

New Color-TV Kit

By WILLIAM STOCKLIN/Editor

Heath's new line of solid-state color-TV sets have many unusual features. Modular design simplifies construction and final test procedures; helps assure top performance.

IT'S been several years now since the *Heath Co.* first contemplated developing a color-TV kit. Our first reaction at that time, considering the price they had projected, was that it would be a foolish venture. There wasn't any price differential then and there really isn't any today between the color kits they sell and what one can pay for an already-assembled receiver. Obviously there are other reasons besides saving money that make a person want to build a product of this type, since the sales of these kits have far exceeded the company's own expectations.

There are many individuals who just enjoy building something themselves. It is therapeutic in that it takes one's mind off other problems. And there certainly is personal satisfaction in having the set work upon completion. (Of course, it could be very frustrating too, should the set not work.)

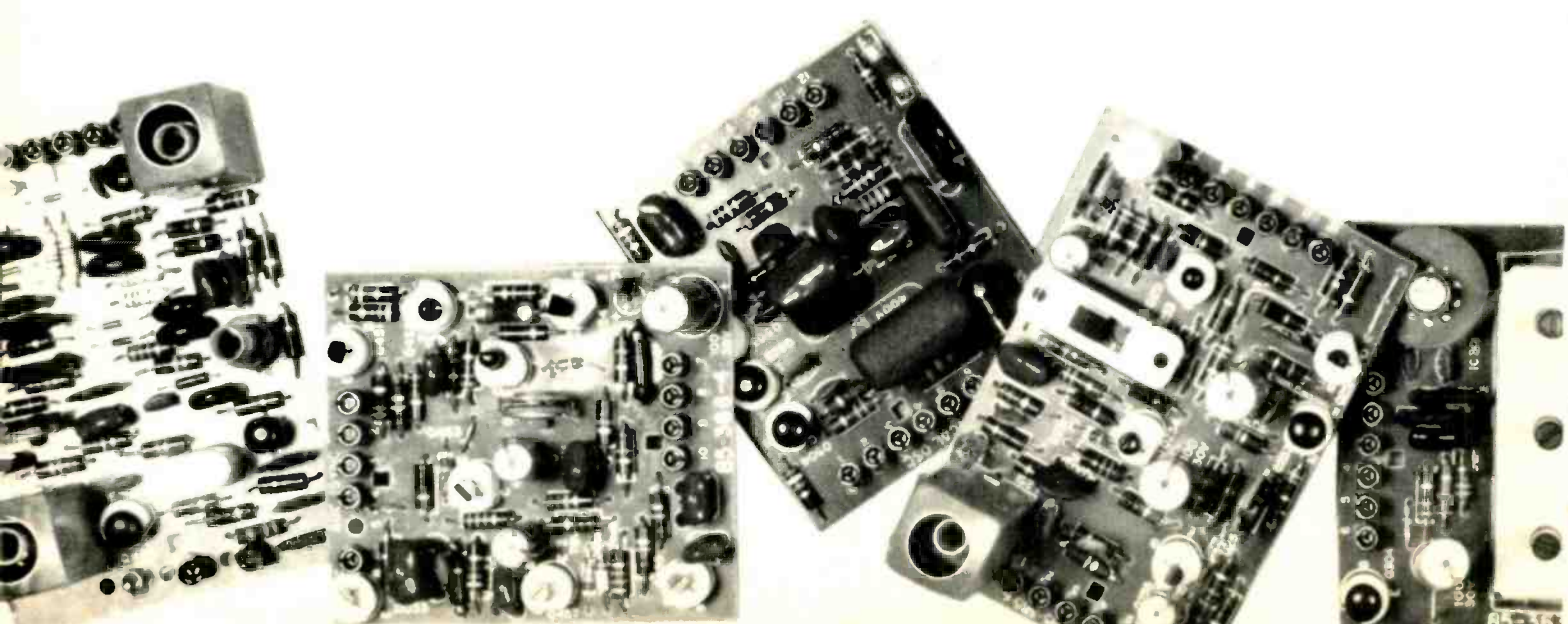
There are other good reasons; building any kit is educational if you really want to make an effort to study the product and circuit analysis that accompanies any kit. We would think that every electronics technician either taking a correspondence course or going to school, or even an electrical engineer going for a degree, would want to build a color-TV set to learn analog circuitry and also build a digital counter of some kind to learn digital techniques. Just to build a kit in itself and learn the techniques of wiring, soldering, and assembling various electronic components is something that any student should try in order to find out if it is what he likes. It's also a good way to get practical experience.

Still another good reason that should not be overlooked is that after completion one should be able to service and maintain the set with a minimum of effort, thereby eliminating expensive servicing costs. The plug-in, modular design used in the newest color-TV kit simplifies major service problems in that individual sections can be readily isolated. Any board can be easily removed and any module will be repaired at any one of *Heath's* 21 different service centers, after the 90-day free warranty period, at a cost of only $5 per panel. The centers will work on a 48-hr turnaround cycle.

We built the GR-370 kit and although it took us some 29 hours we enjoyed every moment. We ended up with several unsoldered connections, a soldering short on the a.g.c. board, and an improperly mounted transistor, but we had no difficulty in isolating these problems. The troubleshooting guide supplied with the kit is almost foolproof. Correct resistance and voltage measurements are given for almost every connection including all transistor terminals. After final alignment, the set worked as was expected; it compared favorably with the best color sets we have seen.

Design Details

Such features as automatic fine tuning (a.f.t.); solid-state v.h.f. tuner with MOSFET for greater sensitivity; solid-state u.h.f. tuner using hot-carrier diode; R-Y, B-Y color demodulators; adjustable video peaking; SCR sweep circuits; and many other features are incorporated. They follow much the same pattern as many of the color sets in the industry.



What makes the *Heath* sets different are the unusual features built into them.

There are two new color-set chassis available, the GR-270 and the GR-370. The only difference between them is the size of the picture tube which is either a 20-in or 23-in type. Both are solid-state. We understand by the time this copy gets into print *Heath* will also have two additional models in this series. Basically the circuits are similar, the only major difference being that one will be a portable set using one of the new 14-in picture tubes. The other will be a 25-in picture-tube version using the new square tube.

One of the greatest features—and it is sort of a trademark for the company—is that these color sets include a built-in dot generator and gun-shorting switches. These are used not only in the final convergence of the assembled kit but also as a self-servicing aid; you can perform convergence and color purity adjustments on these color-TV sets periodically if required. A very inexpensive voltohmmeter is also included in the kit for checking resistance and voltage. There is no need for any other test equipment. For those who are familiar with alignment techniques and have the necessary equipment, the company includes complete alignment procedures in one of the booklets accompanying the kit.

A rather unusual feature is that the sets include power tuning. You can scan through all v.h.f. and one pre-selected u.h.f. channel at the push of a button. An automatic motor-driven tuner advances one channel at a time. This ties in nicely with their remote-control unit, should you care for this added feature. The remote control consists of a transmitter that sends out an ultrasonic signal, a microphone that picks it up, and a receiver that produces the correct function in the set. There are 9 functions that can be controlled this way—TV on; TV off; reduced volume; further reduced volume; v.h.f. channel selector; tint clockwise and counterclockwise; color clockwise and counterclockwise.

It's getting to be relatively common practice to provide antenna inputs for both 300- and 75-ohm antennas on hi-fi equipment but the trend has not extended to the TV industry as yet. These *Heath* sets, though, do have provision for 300-ohm balanced or 75-ohm coaxial lead-ins for v.h.f. and a 300-ohm balanced input for u.h.f. One of the instruction manuals accompanying the set includes a comprehensive section on antenna problems. Complete details are given on how to build your own attenuator pads if you are in too strong a signal area and the proper use of preamplifiers if you are in a fringe area.

To some, a rather important feature is the fact that the a.c. power input is adjustable for low or high line voltages. You have a choice of connecting the set for use with either 120 or 130 volts, 60-Hz a.c. sources. This is important for those living in areas where the line voltage is high.

In addition to the conventional picture-tube degaussing coil, the sets also have provision for connecting an external coil (which is supplied) that can be used periodically to degauss the various elements. This is most important after completion of the set and even later should such devices as vacuum cleaners get too close to the set.

"Instant-On," while not that fast, is a theme promoted by *Heath*. This certainly prolongs tube life and permits the set to come on a little faster. *Heath* has two "on/off" switches—one shuts the entire set off should it be used only on rare occasions; the other can be used to shut off all voltages other than to the picture-tube filament, thus providing the "Instant-On" operation.

IC's are no longer a novelty since they are appearing in all types of consumer products. The four used in these sets are in the sound section, chroma demodulator, the 3.58-MHz color oscillator, and the automatic fine-tuning control (a.f.t.). No doubt IC's will become increasingly popular in time, eventually being used throughout the entire set.

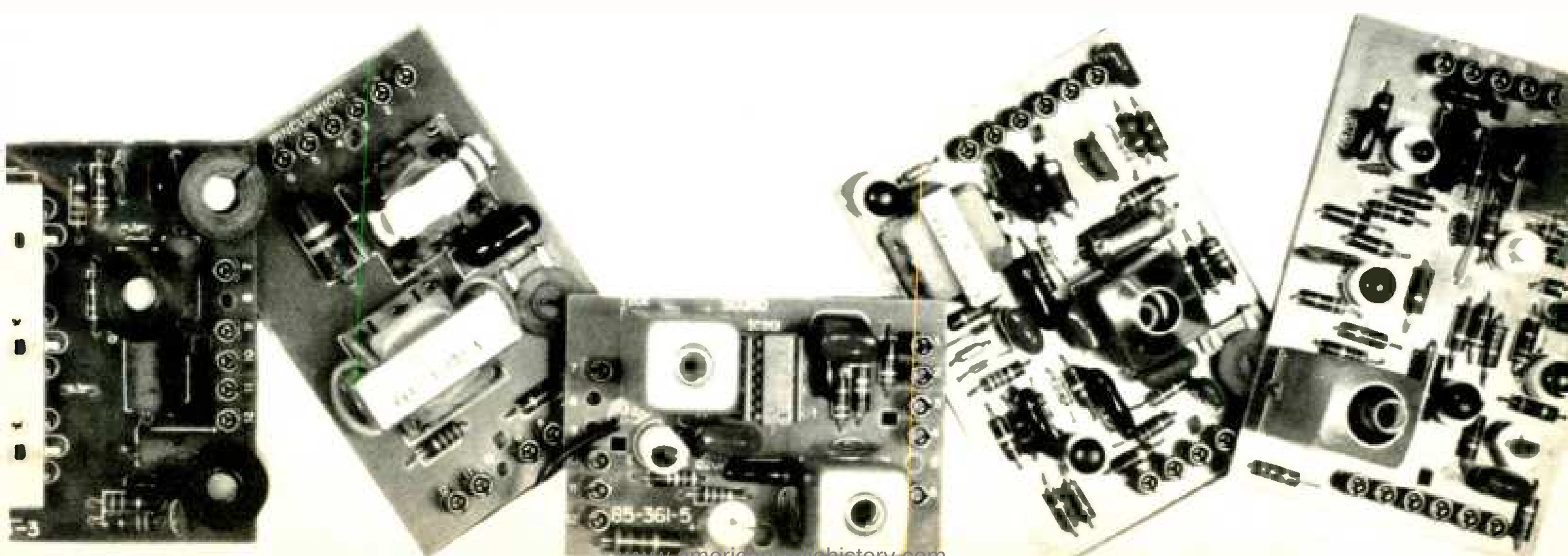
In covering what we believe are some of the most important, unusual features, we should mention the company's exclusive "Magna-Shield," which consists of metal panels that completely surround the picture tube on all sides and a metalized chassis in the rear (which, incidentally, is hinged and can be swung out for servicing). The shield prevents stray magnetic fields from distorting or affecting the television picture.

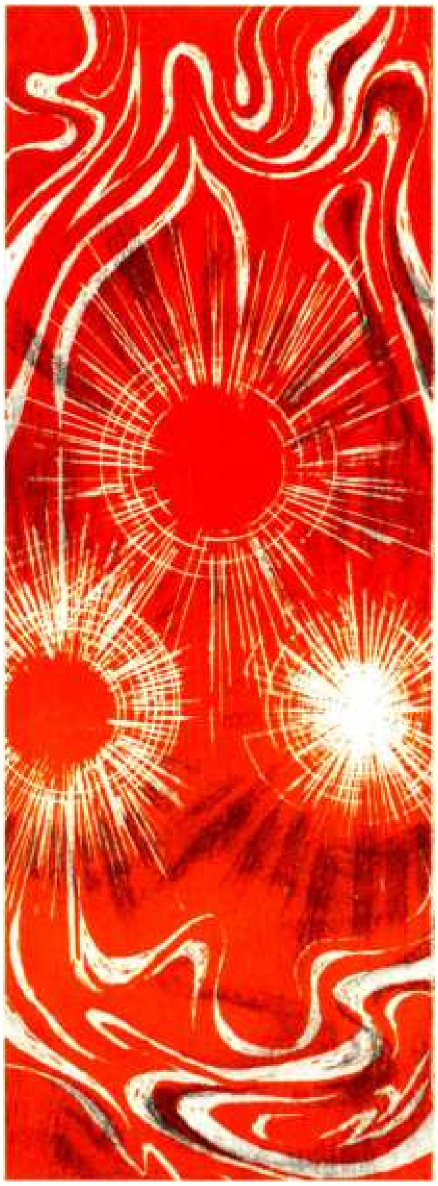
In addition to normal 4- or 8-ohm speaker outputs the set has a separate hi-fi output directly off the emitter-follower ahead of the audio-output stages. This provides a .3-volt r.m.s. signal across 1000 ohms with a response of 30-10,000 Hz ±1 dB. Harmonic distortion is quoted at less than 1% at 1000 Hz.

Plug-in, modular construction is, in our opinion, one of the greatest features of these sets. Much military as well as computer equipment uses this technique. The greatest problem that arises with this type of construction is contact failures between panel assemblies. In realizing this, *Heath* has done a remarkable job of assuring failure-proof operation with extremely sturdy contacts. Their philosophy of reliability extends beyond this; each component has a very generous safety factor. It was quite obvious that the quality of individual components was not affected by any cost-cutting attempt and we believe, from the viewpoint of reliability, that these television sets are superior to all other color-TV sets on the market.

(For more specific technical details on the company's complete line of color sets, see page 28.) ▲

Design is based around ten separate plug-in modules (from left to right): 3.58-MHz osc.; a.g.c./sync; vertical osc.; luminance; video output; pincushion; sound; horizontal osc.; chroma; and (not shown) convergence circuit board. Additional circuit boards are used in the pre-assembled and pre-aligned u.h.f./v.h.f. tuners, the three-stage i.f. amplifier, the high-voltage and automatic fine tuning (a.f.t.) assemblies





Color Organs & Strobe Lights Enhance Music

By FRED W. HOLDER

These light displays add to emotional impact of music. Here are operating principles, capabilities, and a listing of what's available.

IT'S unlikely that Bainbridge Bishop of New Russia, New York could visualize the elaborate light displays available today when he patented the first color organ on January 16, 1877. After all, Mr. Bishop's "attachment for keyboard musical instruments for typifying musical sounds by the display of colors" preceded the development of the incandescent lamp by two years.

Typical 3-channel color organ (Eico Model 3440) with built-in electronics and display screen is ready to be plugged in and connected directly across a high-fidelity loudspeaker.

One particularly striking light display is owned by Mike McLane, an Altadena, California artist. McLane teamed his artistic talents with the electronics "know-how" of Larry Simms, a space-program engineer. Simms designed and built the electronic circuitry needed to control the light display from McLane's tape deck. The artist arranged the lights for the greatest emotional impact. The resulting visual effect is a striking display of red, yellow, and blue lights flashing on and off in close synchronization with the music: red for the low, yellow for the middle, and blue for high-frequency tones. The 40 blue lights extend from the upper left of the two- by four-foot display to the lower right in a random band that intersects the uneven line of 20 red lights scattered between the lower left and upper right hand corners. The intersection occurs slightly off center of the display. The eight yellow lights are arranged horizontally across the unit, around the perimeter of the reds and blues. The lights are covered with a patterned, translucent plastic of the type used in shower doors. When all lights are on, the effect is similar to that of a non-objective painting.

The display was built in 1966; the same year that Leon Wortman of Palo Alto, California received a patent on his light display. Mr. Wortman has written several construction articles for ELECTRONICS WORLD on a display he calls the "Photorhythmicon." (*These back issues are no longer available from us.—Editor)*

In his patent application, Wortman said one of the objects of his invention was "to create the effects of motion of light in different dimensions, singly or simultaneously. These dimensions include lateral, vertical, diagonal, circular, and forward and backward from the observer." He said the effects of the invention do not depend upon the use of color, but color "may enhance the effect of motion." When color is used, he recommends blue in the low channel, red in the middle channel, and green in the high channel. You will note the deletion of yellow from his recommended colors although he had used it in some of his earlier work.

According to Wortman, the spacing of the light bulbs within the display is related to the effects of optical motion. When the spacing between bulbs is increased beyond an optimum value, he said, "the effects of motion may become so pronounced and appear to be so staccato-like that some observers may actually experience unpleasant effects, popularly referred to as motion sickness." The spacing requirements for the bulbs limit the minimum size of the display to a four-inch cube containing three bulbs. "However," he said, "the optical effect is fully realized with a display approximately 20 inches across the front and 9 inches high. As the display is enlarged to become a 'wall-to-wall' installation, the visible motion becomes exceptionally dramatic and emotionally exciting."

	CHAN.	WATTS/CH.	LIGHT DISPLAY**	LIST PRICE
Bowman Leisure Industries Corp.				
116 South Avenue	3	n.a.	Red, Blue, Green	$ 39.95*
Garwood, N.J. 07027	1	1000	No	12.95*
CoSco Research, Inc.	3	200	No	99.50
3524 N. Tejon Street	1	200	No	24.50
Colorado Springs, Colo. 80907	4	500	No	199.50
Edison Instruments, Inc.	4	250	No	65.00
46 Liberty Street	4	600	No	100.00
Brainy Boro Station	4	1000	No	200.00
Metuchen, N.J. 08840	3	300	No	29.95
Edmund Scientific Co.	3	n.a.	Red, Green, Blue	49.95
555 Edscorp Bldg.	1	750	No	16.00
Barrington, N.J. 08007	3	200	No	39.95
	3	500	No	34.95
	4	500	No	195.00
Eico Electronic Instrument Co., Inc.				
283 Malta Street				
Brooklyn, N.Y. 11201				
Model 3465	3	400	No	69.95
Model 3460	1	500	No	39.95
Model 3440	3	n.a.	Blue, Red, Green	79.95
Model 3445	4	n.a.	Blue, Amber, Red, Green	99.95
Model 3450	4	n.a.	Blue, Amber, Red, Green	109.95
Knight-Kit (Allied Radio Shack Div.)				
2617 W. 7th Street				
Fort Worth, Texas 76107	3	n.a.	Red, Green, Blue	34.95*
Realistic (Allied Radio Shack)				
Div. Tandy Corp.				
2617 W. 7th Street				
Fort Worth, Texas 76107	1	600	No	14.95*

*Kit price; n.a. = not available; **order of colors indicates frequency-range order, from low to high.

Table 1. Listing of some commercially available color organs. New companies are coming into field almost daily.

Color Organs

The emotional impact of dancing lights and color when synchronized with rhythmic music explains the current popularity of the color organ, the "grand-daddy" of musical light displays. A number of articles have been written on color organs and similar light displays over the past decade. Now, you can also choose from several models of commercially available color organs. (See Table 1.)

Most of the commercially available color organs have three or four frequency channels. The output of each channel is used to drive a bank of different colored lights; red, blue, green, yellow, or amber are the colors most often used. Frequency range is selected, normally, by an *RC* filter.

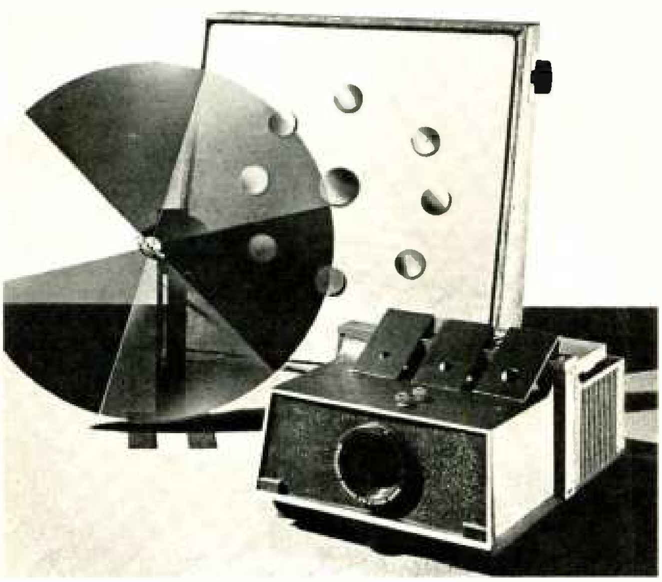
Eico, among others, makes several models of color organs. Its Model 3440 is a three-channel device which operates from any 3.2- to 16-ohm loudspeaker line. The color frequencies of the unit are blue for low frequencies, red for medium frequencies, and green for high frequencies. The unit is provided with a sensitivity (gain) control and "on/off" switch and boost controls for the red and blue frequencies. The unit is all solid-state, uses *RC* filters for channel selection, and transistor output drivers.

The company's Model 3450 color organ may be connected across any 3.2- to 16-ohm loudspeaker. The unit features four channels, which drive blue (150 Hz), green (800 Hz), red (1700 Hz), and amber (3000 Hz) lights. The unit has a sensitivity control and "on/off" switch, a color-balance control, and threshold controls for all four channels. It features solid-state construction with *RC* filters that are used to select channel frequencies, and SCR channel-output control.

Edison Instruments, Inc. manufactures several different models of three- and four-channel color organs. Actually, these are control units which translate musical tones into light of different colors and patterns in synchronism with the beat, volume, and frequency content of the music. All of the color organs feature silicon semiconductors. The four-channel, 2400-watt unit has triac power-output stages and *RC* filters. Each channel can drive 600 watts of lighting for a total power output of 2400 watts. The rugged steel cabinet has eight outlets, two per channel, located on the rear panel. Each channel is individually fused. The unit may be operated by connecting it across any loudspeaker or by using an accessory microphone to actuate the unit by direct sound pickup. The frequency ranges of the four channels are: Channel I (60-350 Hz); Channel II (330-1000

An audio-actuated strobe light, such as this Eico 3475, produces intense flashes of light in time with music.

Some manufacturers, such as Edison Instruments, supply just the electronics and leave the choice of light display up to user.



These components, from Edmund Scientific, create dynamic display on a screen or wall. A light projector, a color wheel, and a special loudspeaker actuating vibrating mirrors are employed.

Hz); Channel III (500-1750 Hz); and Channel IV (1100-8000 Hz).

The manufacturer recommends strings of Christmas-tree lights behind plastic diffuser panels to create many beautiful effects, limited only by the creative imagination of the user. The company also suggests use of colored spot lights, viewed either directly or reflected, by themselves or in combination with diffuser panels and strings of smaller lights to provide a dazzling display.

Table 2. Typical commercially available strobe lights.

Manufacturer or Distributor	Tube	Flash Rate	List Price
CoSco Research			
PS-50	50 watt-sec.	1 to 10 Hz	$ 49.50
PS-100	50 watt-sec. (2)	1 to 10 Hz	99.50
PS-250	125 watt-sec. (2)	1 to 10 Hz	149.50
MS-400	200 watt-sec.	1 to 10 Hz	179.50
Edmund Scientific	G-E #PXA 144	1 to 12 Hz	365.00
Eico			
Model 3470	FT106	Variable	39.95 24.95*
Model 3475	FT106	Variable	59.95 39.95*
*Kit price.			

A photographic mission in mid-December 1966 added another form of light display to those being used to enhance rock and roll music. Photographer Paul Slade was doing some fashion shots at "The Cheetah," a teenage club in New York, for *Paris Match*. He was using six *Thomas-Balcar* electronic flash units for lighting. *Thomas Instruments Co.* sent its chief technical consultant, Frank Smith, to supervise the installation of the units.

After the picture-taking session, Smith, a classical-music fan, sought revenge on this alien environment. He began flashing the extremely bright lights in time with the music. To his dismay, Smith found the dancers not only accepted this new lighting effect, but accepted it as the highlight of the evening. Their cries for more, as Smith disconnected the unit, caused club owner, Olivier Coquelin, to order an installation of the units for non-photographic use. Since then, the strobe has become quite popular.

Strobe Lights

The effects of the strobe light can be quite dramatic as illustrated by an experiment conducted by Larry Simms. Simms placed a strobe in each corner of the room. His strobes are triggered by an oscillator, a digital counter, and computer-type logic circuitry. He adjusted the circuitry to fire the strobes in sequence around the room. The effect was deadly for a moth placed in the center of the room. The moth flew rapidly in a 4-inch circle until it fell to the floor exhausted. The effect of this arrangement on people was similar to "sea sickness."

There are several commercial strobes on the market (see Table 2). For example, *Eico* has two models: the Model 3470 variable-speed strobe light and the Model 3475 sound-actuated strobe light. The Model 3470 strobe light uses a simple *RC* timing circuit and an SCR to fire the xenon tube; it has an "on/off" and speed control knob on its front panel. The Model 3475 may be actuated by sound or music levels from a radio or amplifier or it may be operated independent of audio signal. The unit features a sensitivity control and threshold control. By balancing these two controls, it is possible to make the unit flash at the rate desired or to make it flash only at certain signal levels from your amplifier or radio. The unit uses a unijunction transistor oscillator to drive an SCR, which in turn fires the xenon tube.

The small strobe light manufactured by *CoSco Research Inc.* has a variable flash rate adjustable from 1 to 10 flashes per second. The unit features a 50-watt-second strobe lamp with a specially engineered reflector. It uses all solid-state electronic circuitry with a unijunction transistor oscillator and SCR driver to trigger the flash tube. The company also makes a larger strobe, which features two 125-watt-second xenon lamps that flash alternately to improve lamp life. The unit has all solid-state electronic circuitry and a variable frequency of from 1 to 10 flashes per second. This unit also uses a unijunction transistor oscillator and SCR output driver. A relay is used to switch the firing signal between the two xenon tubes.

An interesting aspect of the combination of pop music and randomly flashing lights is the "mind effect;" the viewer's mind synchronizes the music and lights. This effect led to the development of a very simple, but dramatic light display by Mike McLane. McLane's display has nine 12-inch-square compartments with four flashing Christmas-tree lights in each compartment. The front of the display is covered by a diffuser panel. The effect is a dramatic, randomly changing display that enhances the music so popular today.

Edmund Scientific Co. of Barrington, N.J. carries an extensive line of light displays. One of the more interesting, called "MusicVision," is created from a simple arrangement of components. A light beam passes through a revolving color wheel to the face of the "Motiondlizer"—a speaker

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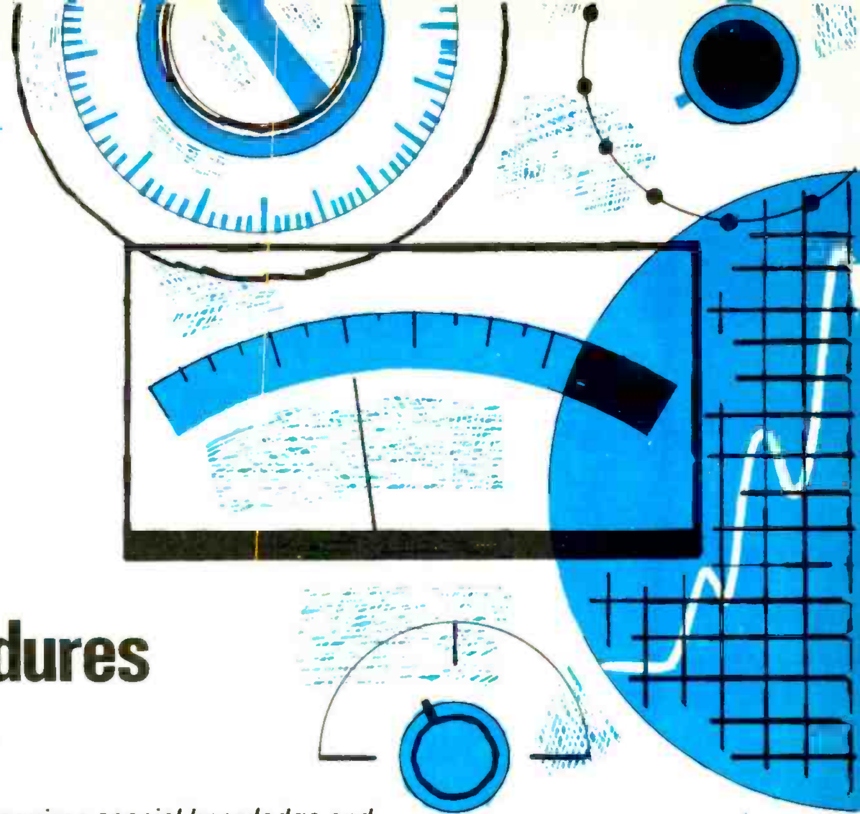
Testing Hi-Fi Equipment



Part 2-Test Procedures

By JULIAN D. HIRSCH/Hirsch-Houck Laboratories

This potentially lucrative servicing market requires special knowledge and attention to quality of equipment performance. Here are the actual test procedures required, along with hints on avoiding some common testing errors. Simplified techniques, with minimum of test equipment, are included.

ANY service shop specializing in hi-fi components or doing a substantial business in that field should be equipped to test and verify performance of the components which they have repaired or aligned. It is reassuring, both to the customer and the service technician, to know that a repaired unit meets the manufacturer's original performance specifications. Last month we discussed the test instruments required, pointing out how they differ from conventional radio and TV service instruments. We listed some specific makes and models of test equipment that we have found suitable.

This month the specific procedures and test setups will be described. Wherever possible, they conform to Institute of High Fidelity (IHF) or other recognized standards but, in some cases, the techniques are those we have found to be useful and practical in our testing of hi-fi components.

FM Tuners

The basic test setup for FM tuner sensitivity and distortion measurements is shown in Fig. 1. These measurements are made with a standard modulating frequency of 400 Hz, which is built into most FM signal generators. If the generator lacks this feature, or if other modulation signals are required (as in stereo channel separation tests), external modulation is applied as shown by the dashed line in Fig. 1.

A dummy-antenna network is required to terminate the 50-ohm signal-generator output and provide a 300-ohm source impedance for the tuner antenna input. Different dummy-antenna configurations are used for unbalanced and balanced inputs, as shown. Most tuners use a balanced input, but there are enough with unbalanced inputs to warrant making up both types of network. They can be packaged in small cans or plastic boxes. Shielding is not important but the lead lengths between the generator's 50-ohm termination and the tuner antenna terminals should be kept to a minimum.

Both dummy-antenna configurations have a 6-dB insertion loss, so that the generator output must be set to *twice* the desired value. In other words, if the tuner measurement is to be made with 1000-μV input, the generator output is set to 2000 μV.

For sensitivity, mono distortion, and signal-to-noise ratio measurements, either channel output of the tuner can be used. If possible, disable the tuner's multiplex circuits by switching to mono. The tuner audio output (or the Tape Output of an integrated receiver) goes to an a.c. v.t.v.m. (or transistor voltmeter) and a distortion analyzer. A scope should also be used, initially to view tuner output and later residual distortion and noise from the distortion analyzer.

The IHF usable-sensitivity test is made with a carrier deviated ±75 kHz at a 400-Hz rate. It is usually sufficient to measure sensitivity at mid-band, between 98 and 100 MHz, although it may vary slightly across the FM band. A rough check at 90 MHz and 106 MHz can also be made as a test of front-end tracking. Since you will not be operating in a screened room, tune the receiver to a frequency where no broadcast signal is received. The scope should show only "grass" or random noise with no visible modulating signals.

Set the signal-generator output moderately high (50 to 100 μV) and tune it for maximum output from the tuner. Reduce the generator level until some noise or distortion appears on the output waveform. With the distortion analyzer, null out the 400-Hz fundamental, reading the residual as a percentage of the fully modulated output. If it is less than 3.2%, reduce the generator output and repeat the measurement; if it is more than 3.2%, increase the generator output and repeat the measurement. With each change of output, a slight re-adjustment of the generator frequency may be necessary to minimize distortion. If the re-tuning is sufficient to materially affect the receiver's tuning-meter reading, this indicates incorrect i.f. or discriminator alignment.

The signal input, in microvolts, which results in 3.2% distortion (–30 dB) is the IHF usable sensitivity. Remember,

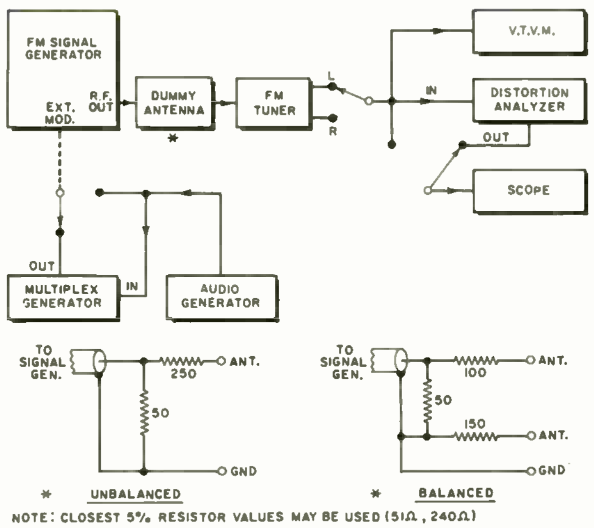


Fig. 1. Set-up for FM tuner sensitivity, distortion checks.

this input is half the output setting of the signal generator.

Set the generator output to 2000 μV (1000 μV at the tuner input) and measure the distortion in the tuner output. Re-tune the generator frequency slightly for minimum distortion. The scope, connected to the distortion-analyzer output, will identify the distortion as second or third harmonic, or as power-supply hum. Even laboratory-grade signal generators cannot be relied upon for accurate distortion measurements below 0.5%. An FM tuner with a measured distortion of 1% or less can be considered satisfactory. If it is much more than 1%, the i.f. and/or detector circuits are probably misaligned or there may be other faults in the tuner.

The image response of an FM tuner will normally occur at a frequency higher than the signal by twice the i.f. frequency. With the tuner set at 98 MHz, the image response is at 119.4 MHz. The initial output reading, at 98 MHz, should be with the signal generator output set at the IHF usable-sensitivity level, using 75-kHz deviation at 400 Hz. Then, tune the generator to 119.4 MHz, using its maximum output, and locate the point of maximum output from the tuner. Reduce the signal-generator level until the audio-output voltage from the tuner equals that measured in the usable-sensitivity test. Record the generator output at this point.

Image response is the ratio of generator outputs at image and signal frequencies, for equal tuner output, and is expressed in decibels: *Image Ratio* $= 20 \log E_{image}/E_{signal}$.

Specified image ratios are usually between 60 and 90 dB. If the measured value is appreciably less than rated, it indicates a possible front-end misalignment.

The i.f. rejection is measured in the same manner, except that the test is made at the i.f. frequency of 10.7 MHz instead of the image frequency. Many FM signal generators do not cover this frequency but this test can usually be omitted, since only a gross misalignment would materially affect i.f. rejection and this would almost certainly be revealed by sensitivity and image-rejection tests.

For stereo channel separation measurements, the signal generator should be modulated by an external multiplex generator, unless a stereo test generator with an internal r.f. source is used. With the left channel modulated at 400 Hz (do not use more deviation than necessary—30 kHz should be adequate) and an r.f. level of 1000 μV to the tuner, measure its left-channel audio output. Then connect the v.t.v.m. to the right channel and read the crosstalk. Re-adjust the signal frequency slightly for minimum crosstalk. The amount of re-tuning should not be sufficient to affect tuning-meter indication. Use the dB scales of the v.t.v.m. and its attenuator or range switch to determine the stereo separation—the difference between the two readings—in decibels. Repeat this measurement with the right channel modulated, measuring crosstalk in the left channel. It is convenient to wire up a switch for connecting the meter to the desired channel without changing cables. Do not re-tune the signal generator if it has been optimized for the other channel. Commonly, the two crosstalk figures differ somewhat, but they can be averaged to obtain mid-band channel separation.

Channel separation or crosstalk should also be measured at a high audio frequency. Some loss of separation is normal at the high and low frequencies, but an excessive loss at the high end may indicate a serious misadjustment of the multiplex circuits. If possible, use a 10-kHz modulating frequency for this test. If a service-type stereo generator is used, maximum usable frequency may be only 5 kHz.

Although some FM tuners have rated mid-band stereo-separation figures of 40 dB or more, many signal generators are not that good. In general, if the measured separation is greater than 20 dB at 400 Hz and 10 to 15 dB at 10 kHz, the tuner may be considered satisfactory in this respect. Once the separation exceeds about 10 to 15 dB, the ear perceives little change in the stereo "spread," other than a slight shift in apparent speaker spacing.

Dial calibration should be checked to verify the receiver's local-oscillator tracking. Signal-generator frequency calibration, usually good to 1%, is not adequate for this purpose. Use FM-broadcast signals of known frequency. If there are insufficient signals available, or they are not at suitable frequencies, a crystal-controlled marker generator may be used (this facility is built into some low-cost stereo multiplex signal generators).

If you wish to verify the frequency response (mainly the accuracy of the tuner's de-emphasis curve), it is only necessary to check a few frequencies. Modulate the signal generator at 400 Hz, with about 22-kHz deviation, and measure the output of either channel. Repeat the measurement with 50 Hz and 10 kHz modulation, maintaining the same deviation. With an ideal de-emphasis characteristic, the 50-Hz and 400-Hz levels should be identical, while the 10-kHz output should be down 13.8 dB. A tolerance of ±2 dB about the ideal response curve is satisfactory.

Amplifiers

The test setup for amplifier measurements is shown in Fig. 2. The frequency-response measurements, made on the preamplifier section of an amplifier or receiver, are performed at a low level. In most cases, a reference output of about 1 volt across 8-ohm speaker loads, or about 0.1 volt across a high-impedance load connected to the preamplifier or tape-output jacks, is satisfactory. The reference frequency for all amplifier measurements is 1000 Hz.

IHF standards call for all amplifier gain controls to be at their maximum settings. We have found that some amplifiers become unstable when the tone and volume controls are all at their maximum settings (which is an abnormal operating condition in practice). Before measuring tone-control characteristics check the amplifier under these conditions, using the scope to show any ultrasonic or sub-sonic instability. If it occurs, reduce the volume-control setting until the amplifier becomes stable. Be sure that any loudness-compensation circuit is disabled. On some receivers, the loudness compensation (bass boost) is always operative; in this case, the volume control must be at maximum for frequency-response measurements.

Phono-preamplifier equalization should be measured, if possible, at the tape outputs of the amplifier. Set the audio-generator level to deliver a 0-dB reference output at 1000 Hz. Most audio v.t.v.m.'s are calibrated for 0 dB at 0.78 volt (actually 0 dBm), which is suitable for this purpose. Maintaining a constant input level, measure the outputs at 3 kHz, 5 kHz, 10 kHz, and 15 kHz. They should be down from the 1000-Hz level by 4.8 dB, 8.2 dB, 13.8 dB, and 17.1 dB, respectively, if the amplifier is correctly equalized for the RIAA characteristic. Return to 1000 Hz and reduce the input level by 20 dB. Measure the output at 300 Hz, 100 Hz, and 50 Hz. It should be higher than the 1000-Hz level by 5.5 dB, 13.1 dB, and 16.9 dB, respectively. Deviations of ±2 dB from the ideal response are acceptable. Normally only one channel need be checked fully, but spot checks can be made on the other to check their similarity.

Since the tone controls and filters usually follow the tape-monitoring outputs, their characteristics must be checked across the speaker leads. It is not necessary to plot the full response curve of the amplifier, unless it has some unusual characteristics. Tone-control measurements at 100 Hz, 1000 Hz, and 10 kHz are usually adequate.

With the tone controls set to their mid-positions, supply a 1000-Hz signal to the Aux or other high-level input and adjust for an output of 0 dB (0.78 volt) across the 8-ohm load resistors. Set both controls (bass and treble) to their maximum and minimum positions and note the variation in output. It should be no more than ±3 dB with well-designed tone controls. Return controls to center positions.

Change input to 100 Hz and to 10 kHz at same level. Note output, with the controls centered and at their extremes. The amount of variation should be compared to the manufacturer's specifications. Values from ±10 dB to ±20 dB are typical (they need not be symmetrical about the center response level). At maximum boost, be sure that the output waveform, as seen on the scope, is not clipped. Some low-powered amplifiers may distort at the suggested levels with full boost. If this occurs, reduce the input level as required.

Rumble and scratch filters can be checked the same way. From a 0-dB reference level at 1000 Hz, the drop in output at a low or a high frequency is measured when the filters are switched in. The choice of frequencies depends on the manufacturer's specifications, since there is no standardization of filter cut-off frequencies or slopes.

The IHF standard (IHF-A-201) procedure for hum and noise measurement is unnecessarily complex for our purposes. At *H-H Labs*, we have established standardized gain and power-level references for all amplifiers. The gain is set so that an output of 10 watts (8.94 volts across 8 ohms) is obtained when 1 volt at 1000 Hz is applied to a high-level input. In the case of a preamplifier, the reference output is 1 volt (unity voltage gain). For the phono input, the reference input is 10 millivolts.

With gains standardized, the signal is removed and the input is terminated with a resistor of about 2000 ohms. The output voltage is measured across the speaker load (or across an unloaded preamplifier output). The input termination is not critical; however, the open- and short-circuited conditions of the IHF procedure are unrealistic in terms of normal operating conditions. We feel that a finite resistance typical of a phono cartridge or emitter-follower output is more meaningful.

The hum and noise output is expressed in decibels below 10 watts (or below 1 volt, for a preamplifier). For example, 3 millivolts of hum and noise corresponds to about –70 dB, a completely inaudible level. Hum and noise levels of –60 dB or lower are usually satisfactory; on phono inputs –45 to –50 dB may be acceptable if the noise is largely sub-sonic "bounce" (which may be readily identified with the scope).

When testing a basic power amplifier, without controls, there is no standardized gain setting. Otherwise the procedure is the same, with the output noise referred to 10 watts. The use of a fixed reference power, independent of the amplifier rating, makes it possible to compare amplifiers of different power ratings, with respect to the audible hum they might contribute to a system. To correlate these noise figures with the manufacturer's rating, which is usually referred to his maximum power output, add $10 \log P_{rated}/10$ *decibels* to the figure that has been previously measured.

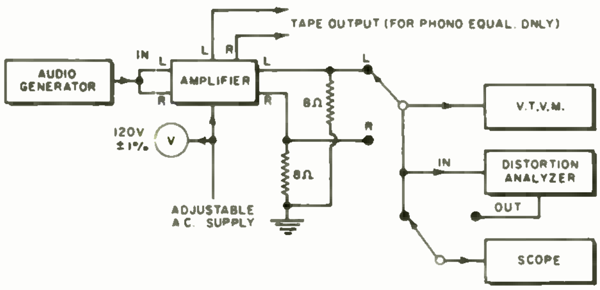


Fig. 2. Test set-up for making amplifier measurements.

Crosstalk between inputs of the amplifier is most easily detected and evaluated subjectively, by listening. It is most likely to be disturbing when the tuner output feeds through to the phono inputs while records are being played. With volume set somewhat higher than normal, and the pickup arm on its rest, switch to phono and listen for the tuner program in the background. In a receiver, the tuner is normally switched off in other modes and nothing will be heard, but with separate tuner and amplifier combinations crosstalk is not uncommon. If it exists, there is usually little that can be done by the service technician to correct a design fault. The same problem often occurs when the tape-monitor switch is set to listen to a pre-recorded tape while the tuner is operating. In either case, the cure is simple—turn off the tuner if it is a separate component, or switch the receiver to another input which is not energized.

Amplifier power and distortion measurements should be made with both channels driven, although it may be desirable to drive only one channel to verify a manufacturer's specification, which is often based on only one channel operating. Dynamic, or music-power, ratings cannot be checked without a rather complex test setup, and in our view are less indicative of an amplifier's performance than a continuous-power measurement.

Drive both channels through a high-level input at 1000 Hz. We prefer to use an external "Y" connector for this, leaving the amplifier in its stereo mode. Alternatively, one input may be driven, with the amplifier set to mono to internally parallel the two inputs. Sometimes this can affect the distortion characteristics of the amplifier, but in most cases there is little difference between the two connections. Adjust the balance control for equal output from both channels, with the volume control at maximum and tone controls centered. No amplifier control is to be disturbed during the tests.

While observing the output waveform of one channel on the scope, increase the drive level until the waveform clips. Sometimes the clipped portion contains hum components, and sometimes the clipping is clean. Both positive and negative peaks of the sine wave may or may not clip simultaneously. If the waveform distorts gradually rather than clips suddenly, or exhibits kinks at points other than at its peaks, the amplifier negative feedback is not very effective. This is typical of some low-priced "packaged" units, but is rare in hi-fi components of good quality.

Watch for bursts of oscillation, anywhere on the output waveform, as the level is increased to the clipping point and beyond. Repeat this with a capacitor of about 0.01 μF across the 8-ohm load. An amplifier should be stable with reasonable capacitive loads. Remove capacitor for other tests.

To check the maximum power output, monitor the line voltage and maintain it at 120 volts. Read the amplifier output voltage as the waveform just begins to clip. The power is $E^2/8$ watts per channel. This measurement should be repeated at the extremes of 20 Hz and 20 kHz where most amplifiers deliver less power than at 1000 Hz.

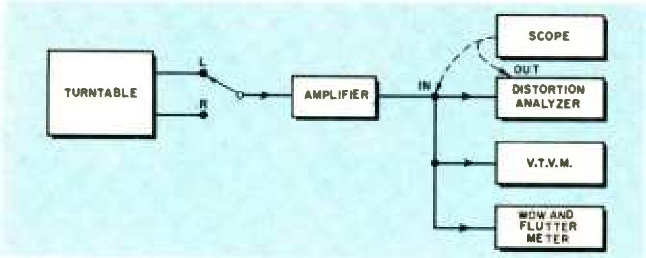


Fig. 3. Turntable and phono pickup measurement set-up.

Distortion should be measured at low power, medium power, and maximum rated power. All distortion analyzers operate satisfactorily at a 1-watt level (2.83 volts across 8 ohms), and this is suitable for low-power measurements. Distortion should also be measured at 10 watts (8.94 volts) and at the maximum rated power of the amplifier. When measuring distortion, connect the scope to the analyzer output to display the residual signal waveform. Often, at low outputs, the distortion is masked by hum or random noise.

If the tested channel appears to be normal, a full test need not be made on the other channel. A simple check of clipping power output at 1000 Hz should be sufficient.

Record Players

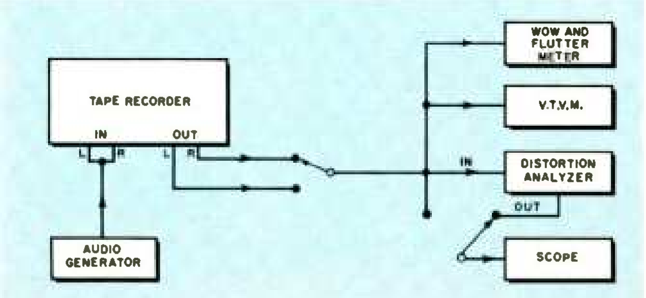
Turntable and pickup measurements are made with the test setup of Fig. 3.

For wow and flutter measurements, the 3-kHz test bands of the STEREO REVIEW SR-12 or *CBS Labs* STR150 records may be used. The amplifier can be any preamplifier or integrated amplifier, with its output going to the wow and flutter meter. An appreciable fluctuation in meter reading can be expected, especially when measuring wow, which requires operator judgment in determining the true reading. The meter manufacturer's instructions should be followed carefully. Wow and flutter may be measured independently by appropriate settings of the test instrument, or a single combined figure may be obtained. Either method is satisfactory. The combined wow and flutter of the better-grade turntables is under 0.1%, most good turntables fall between 0.1 and 0.2%, and low-priced units may go as high as 0.3%.

Rumble measurements, according to NAB standards, require playback equalization not found in standard hi-fi amplifiers. However, a reasonable approximation is possible with a good RIAA-equalized preamplifier. The response should be as accurate as possible at low frequencies, where errors can have a great effect on rumble measurements.

Rumble is referred to a reference level of 1.4 cm/s (stylus velocity) at 100 Hz. The *CBS Labs* BTR150 and STR100 test records have lateral bands recorded at 5 cm/s (1000 Hz). If either of these records is used to establish a reference level, add 2.1 dB to the measured rumble to obtain the correct figure. The STEREO REVIEW SR-12 record has four bands, recorded at 1000 Hz with different levels. If the highest level band is used (4.67 cm/s), add 2.8 dB to the measured rumble.

Fig. 4. Set-up that is used for tape-recorder measurements.



The procedure is simple. Play the reference-level bands and adjust the amplifier gain so that the v.t.v.m. reads 0 dB (or any other convenient level). Then play the silent groove bands of the BTR150 and SR-12 records and observe the meter reading. It will probably fluctuate considerably, requiring visual averaging over some period of time. The average reading is noted, as "X" dB below the reference level. Add the correction factor of 2.1 dB or 2.8 dB, and you have an approximate unweighted rumble figure.

It is approximate because of uncertainties in amplifier equalization and the meter-response characteristics, but is sufficiently accurate for our purposes. The rumble measured in this manner includes both vertical and lateral components. By paralleling the two channels of the cartridge, the vertical components are canceled, and the remaining rumble is essentially horizontal. There is usually a drop of 3 or 4 dB in the meter reading when this is done. The less the change in reading, the less vertical rumble is present (a desirable condition).

Typical rumble figures for low-priced turntables are –25 to –30 dB. Good component-quality automatic turntables usually have rumble between –30 and –35 dB (which is the NAB broadcast standard), while the best turntables measure from –35 to –40 dB or lower. These are unweighted figures, which cannot be compared to most manufacturers' specifications, but which are valid for appraising the quality of a turntable.

Phono Pickups

The same setup is used for pickup and arm testing as for turntables. It is usually advisable to install the cartridge with the manufacturer's recommended tracking force, using an accurate gauge. Do not try to operate at the minimum recommended force. Practically all cartridges give their best performance when operated in the middle or upper part of the range of recommended forces.

Anti-skating should be set initially as recommended by the arm manufacturer. As a check, play the special bands of the STEREO REVIEW SR-12 test record. Often a higher anti-skating force than recommended gives better results, and this record provides an accurate means of making the adjustment without instruments.

The most widely used frequency-response test record is the *CBS Labs* STR100. If an unequalized (flat) preamplifier input is available, it should be used when playing this record. Be sure to connect a 47k-ohm resistor across the cartridge if a regular phono input is not used (sometimes a high-gain microphone input is available). If you use a good-quality mono preamplifier for all your cartridge testing, you may be able to remove the RIAA de-emphasis in the preamplifier for this purpose.

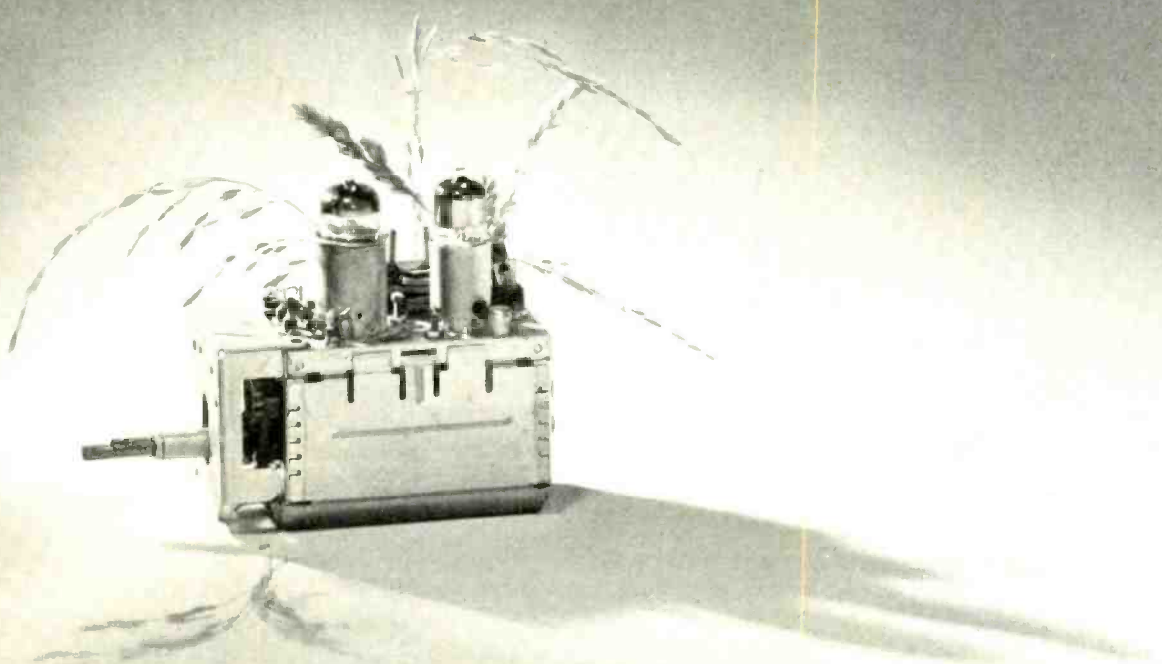
The test record has voice announcements of the spot frequency bands, from 20 kHz down to 20 Hz. An ideal pickup will have flat frequency response from 20 kHz to 500 Hz. The portion below 500 Hz can be ignored, since it is more likely to reflect the preamplifier equalization and record characteristics rather than the cartridge itself. If the preamplifier has RIAA equalization, the *CBS Labs* record is supplied with information for interpreting the response readings.

Record the output readings of the preamplifier from the v.t.v.m. for each test frequency, while playing the left-channel side of the record. Then turn the record over (right side) and repeat the test. This gives both the frequency response and crosstalk for the left channel. Repeat the process for the other channel. When the data is plotted, there will usually be some differences between the two channels. Moderate differences are normal and are due to a combination of record and cartridge characteristics.

Channel separation is usually 25 dB or better at mid-frequencies (500 Hz to several kHz), but may reduce to 10

(Continued on page 66)

TUNER GONE TO SEED?



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CIRCLE NO. 148 ON READER SERVICE PAGE

Changing Nature of Service

The more servicing problems seem to change, the more they seem to be like the problems we had with some of the early sets.

By **John Frye**

MAC'S Service Shop was wallowing in the December doldrums. Almost all the Christmas presents had been bought and wrapped; the customers, like everyone else, were flat broke; nobody was spending an extra nickel.

Actually Mac and Barney didn't mind. It was nice to be able to catch their breath after the hectic pre-Christmas rush. The lull gave them a chance to dig the solder blobs out of the corners of the bench, to restock parts, to put the service literature back in order, to replace worn line cords and test leads, and to clean and recalibrate their instruments. Finally, though, everything was ship-shape, and Barney saw Mac start loading his pipe—a promising sign he was ready to stop work and talk a while.

"It's kind of nice to be able to do all these little chores we don't have time for in the heat of battle," Barney observed.

"Yep," Mac agreed, lighting his pipe, "and I like your choice of words. While we've been working around here today, I've been thinking we're engaged in a constant battle against the enemy of electronic equipment, and that battle is all the tougher because of the protean nature of that enemy."

"Come again. The *what* kind of nature?"

"Oh, come on! You remember that old sea-demon, Proteus, in Greek mythology who knew all things, past, present, and future, but who was stingy with his knowledge? The only way you could make him talk was to catch him taking a siesta and tie him up. This took some doing because he tried to escape by assuming all sorts of shapes: that of a lion, a serpent, a leopard, a boar, a tree, fire, and water. But if you hung on to him, he finally returned to his original form and told you what you wanted to know."

"I still don't see what that has to do with electronics."

"Things that cause trouble with electronic equipment are just as tricky and shifty as Proteus was. About time we get a hammerlock on one thing that's fouling up the performance of electronic gear, trouble takes on an altogether new character and we have to shift our hold and start all over again. Let me give you some ferinstances:

"When I first started working on radios back in the early days of battery receivers, our troubles were mostly fragile tubes, costly battery consumption, insufficient sensitivity, and poor contacts. You don't know true horror unless you've accidently touched an 'A+' lead to the positive terminal of a B-battery and have seen four 201A's and a 112A light up with what seems a blinding light. And don't forget those tubes cost five dollars each—five hard, honest dollars; not the marshmallow imitations we call dollars today."

"Stick to your story; don't get off on inflation," Barney warned.

"Okay," Mac growled reluctantly. "Batteries, too, were expensive; and those early sets were hard on batteries. Filament rheostats were used to control the volume and keep current consumption as low as possible consistent with passable reception. There was no *good* reception, as we know it, in those days, no matter what reactionary old-timers with poor memories tell you. The chief problem was just to be able to hear signals from comparatively weak transmitters. To achieve sufficient sensitivity, tuned radio-frequency stages were cascaded until instability occurred. Since all sections of the ganged tuning capacitor carried the same frequency, if individual rotor section wipers did not make good contact, you had coupling and oscillation; therefore, cleaning these contacts was a ritual. Another source of contact trouble was the bayonet-type tube sockets used. Ends of the tube pins pushed down against the bronze contact springs. Sandpapering the ends of the pins and the bronze contacts and bending up the latter to create more contact pressure was standard operating procedure."

"Didn't you have capacitor or resistor troubles in the olden days?"

"Now don't get smart. Those sets used very few fixed capacitors or resistors. Plate voltages were supplied by a B-battery and bias voltages by a C-battery. Different voltages were secured by using taps on these batteries; consequently, no voltage-dividing or voltage-dropping resistors were necessary. About the only resistors used were the filament rheostats, the grid-leak resistor of the detector stage, and occasionally a fringe-howl suppressor across an audio transformer winding in a set using a regenerative detector. Since good batteries are low-impedance devices and since the stage gain of the receivers was low, bypassing of plate and grid returns was not necessary. Occasionally you found a capacitor used to remove the r.f. from the plate circuit of the detector. But any capacitors used were of a stable mica type that gave little trouble."

"I can't imagine a radio without gobs of capacitors and resistors," Barney admitted.

"They weren't long getting into the act. Alternating-current radios got away from the cost of batteries. Tube filaments were made heavier and less fragile. Tube sockets were changed from the bayonet type to the flat type with positive side-wiping contacts. The screen-grid tube was introduced to provide more stage gain, and we went to the superheterodyne circuit to get more sensitivity and selectivity. That meant the tuning capacitor usually had only two sections, each carrying a different frequency; so wiper contact resistance was much less critical."

"Sounds like you solved all your problems."

"Yes, and acquired a whole new batch! The a.c.-operated radios used power transformers, filter capacitors and chokes, resistance voltage dividers, and voltage-dropping resistors. Lots of bypass capacitors were necessary with the higher-gain stages requiring various voltages to keep the r.f. currents where we wanted them. Proteus changed to fire and water, because heat and moisture now became two of the chief enemies with which we had to contend. Lots of heat was generated by the power transformer, the rectifier, and the heavy-filament tubes. This heat melted the wax from the ends of the waxed-paper capacitors and dried out the electrolytics. With the wax seals gone from the bypass capacitors, moisture got into them and caused them to become leaky or to short out entirely. Moisture also produced electrolytic action in the windings of the power, i.f., oscillator, and audio transformers, causing the windings to short together or to open. Finally, the higher gain of the tubes made shielding necessary over the coils and the tubes; and this led to metal tubes."

"What did you do about all those other problems?"

"Capacitors were produced that did a better job of resisting heat and moisture. Intermediate-frequency transformers were made more heat- and moisture-resistant by using better materials and fabricating techniques. Oscillator coils were dipped in moisture-proof wax. Interstage audio transformers were replaced by resistance-capacity coupling. Eventually we got rid of the power transformer by going to a.c.-d.c. circuits that also permitted use of lower-current series strings."

"That should have solved your heat problem."

"It should have, but it didn't. Getting rid of the bulky and heavy power transformer, filter choke, and interstage coupling transformers, plus the development of miniature tubes, permitted the design of much smaller radios that could be fitted into smaller cabinets. Unfortunately, these cabinets afforded poorer escape of heat than had the big cabinets; so we still had a heat problem. And the initial surge of heavy current through the cold series filaments caused them to fail almost as often as had the old battery-type."

"We just can't win for losing, can we?" Barney observed.

"It seems that way. But then along came printed circuits and transistors. Transistor power requirements were so small that practically no heat was generated by the radio itself, but unfortunately, transistors were much more sensitive to ambient temperature than were tubes; so heat was still an enemy. And in tube receivers using PC boards, the heating and cooling of the board caused it to become brittle, warp, and crack right through the conductors. Improved boards largely took care of that."

"I can think of some other forms old Proteus has assumed," Barney offered. "Vibration became an enemy when radios were put in cars. That's when loktal tubes were developed to keep them from shaking out of their sockets. Vibration also caused breaks in PC boards and cracks in speaker cones. It breaks lead-foil connections of capacitors suspended by their leads."

"You're getting the idea. Let's not forget dirt and corrosion. It's the basis of poor contact resistance of any sort. It accounts for most noisy and erratic volume-control action, switch trouble, TV tuner troubles, etc. With communications transceivers, dirty relay contacts are a common cause of trouble.

"But I think we've pretty well made our point that the nature of trouble with electronic equipment is constantly changing. Many of the problems are cyclic in nature; I mean they fade out of the picture for a while and then come back strong in succeeding new equipment. For example, transistors brought back problems with batteries. Plug-in modules threw the spotlight again on contact resistance—the same problem we had with bayonet tube sockets in the beginning. Power transformers and their problems went out with the advent of a.c.-d.c. radios, but came right back with TV receivers, and the latter introduced some new high-voltage problems. AM radios had a.f.c. back in the 1930's; now we are back to a.f.c. on FM receivers and on TV sets. Design engineers are constantly going up into the electronic attic and bringing down something stored there, knocking off the dust, giving it a new coat of paint, and putting it into the latest equipment."

"I guess we eventually win most battles, but are we winning the war?"

"I think we are. You must remember electronic equipment is constantly changing, becoming more complex, and above all improving in performance. Since it does a better job, if it requires more service that would be understandable, possibly justifiable. But the truth is modern electronic equipment requires less service. The best proof of what I am saying is contained in the new solid-state modular color-TV receiver kit *Heath* is offering.

"I remember old-time service technicians who hung up their solder guns when printed circuits came out. They were too hard to service. More did the same thing when transistors became popular. Still more gave up when TV began pushing radios out of the limelight. And a whole flock of them threw in the sponge when color TV came in.

"I wonder what these quitters think when people with very little experience in electronics are paying out a sizable sum for a couple of bushel baskets of parts in full confidence they will be able to *assemble those parts into a color-TV receiver, adjust it, and service it with no other instruments than those furnished with the kit.* While I have not had an opportunity to see one of the sets, I have read the assembly, adjustment, and service manuals furnished with the kit, and I'm convinced the properly assembled receiver will perform as advertised. Please note the finished product is not just a TV receiver. It has all the most advanced and sophisticated features: completely transistorized with the exception of the picture tube and h.v. rectifier, modular plug-in construction, a.f.c., a.c.c., etc. If an amateur can build, adjust, and service an up-to-the-minute color-TV receiver, we must have done a pretty good job of wrestling the answers we want out of our electronic Proteus." ▲

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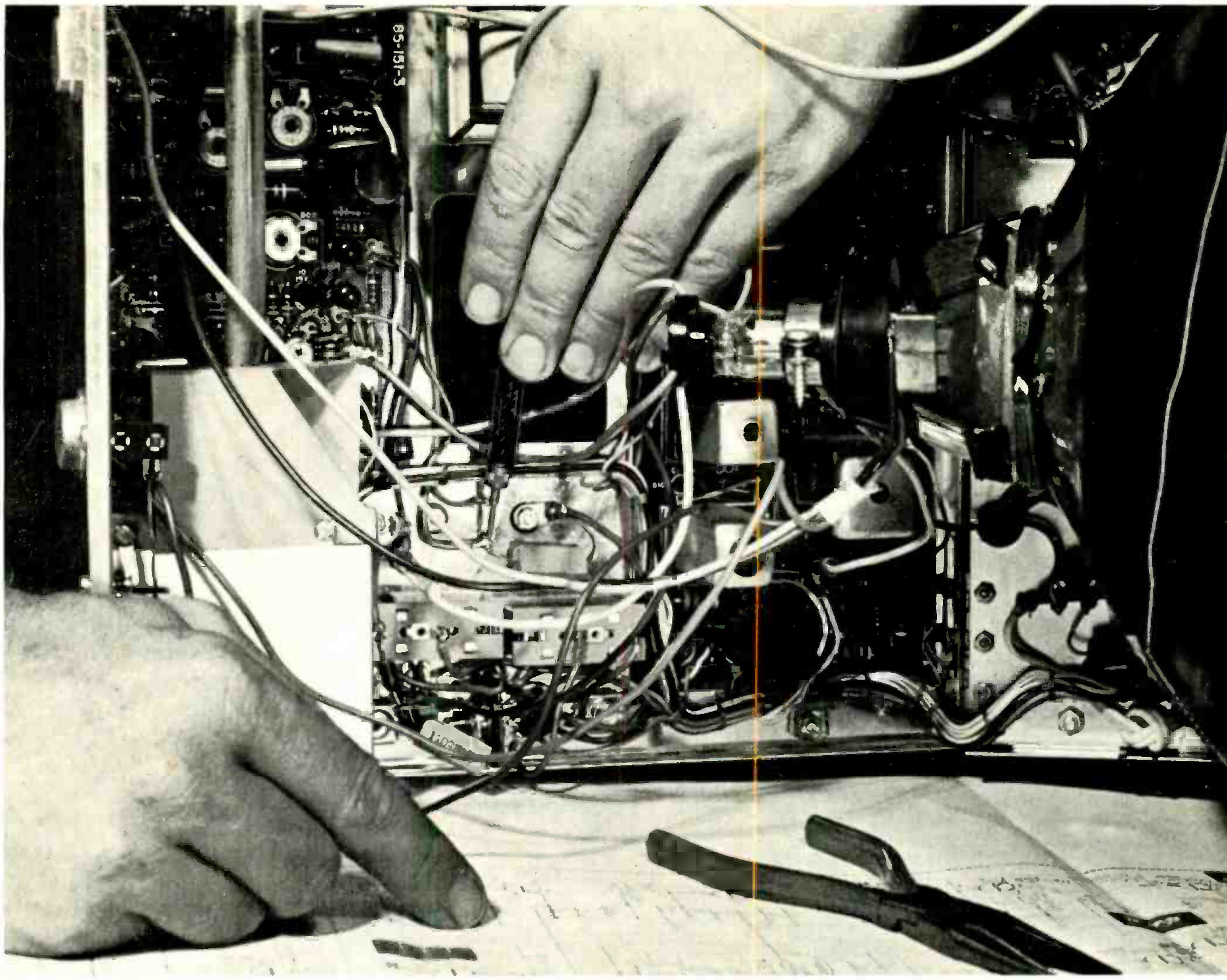

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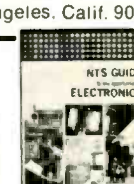

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1. Date of filing: October 1, 1970. 2. Title of publication: Electronics World. 3. Frequency of issue: monthly. 4. Location of known office of publication: One Park Avenue, New York, New York 10016. 5. Location of the headquarters or general business offices of the publishers (not printers): One Park Avenue, New York, New York 10016.

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7. Owner: William Ziff, Jr., One Park Avenue, New York, New York 10016; Barbara Ziff, Charles Housman and Jules I. Whitman Trustees, F/B/O Dirk Ziff et al, One Park Avenue, New York, New York 10016.

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10. Extent and nature of circulation:

	Average No. Copies Each Issue During Preceding 12 months	Actual No. of Copies of Single Issue Nearest to Filing Date
A. Total no. copies printed (net press run)	228,496	227,095
B. Paid circulation		
1. Sales through dealers and carriers, street and counter sales	33,090	32,400
2. Mail subscriptions	141,794	138,200
C. Total paid circulation	174,884	170,600
D. Free distribution (including samples) by mail, carrier or other means	2,037	2,030
E. Total distribution (sum of C and D)	176,921	172,630
F. Office use, left-over, unaccounted, spoiled after printing	51,575	54,465
G. Total (Sum of E & F—should equal net press run shown in A)	228,496	227,095

I certify that the statements made by me above are correct and complete.

WILLIAM L. PHILLIPS, Assistant Treasurer

Digital Instruments

(Continued from page 38)

output supplies power to the *RCA* display tubes, whose total current consumption ranges from around 300 mA to just over 1 A. The forward voltage drop of diode *D7* reduces the +4.5 V d.c. at the emitter of *Q1* to about +3.6 V d.c. at the "$+V_{cc}$" output. The +3.6 V d.c. at "$+V_{cc}$" is connected to pin 11 of every digital IC in the electronic counter (pin 4 of every digital IC is grounded). The +3.6 V d.c. distribution line should be bypassed to ground at frequent intervals with *Centralab* UK16-104 (or equivalent) 0.1-µF ceramic disc capacitors to suppress system noise transients. Lamp *PL1* and the SCR are intended to indicate the status of the counter gate. When a positive voltage is applied to the "Gate Monitor" input, this causes the SCR to conduct and the "Gate Open" light to illuminate.

Any attempt to substitute another transformer in place of the one specified for *T1* should be carefully considered—proper operation of the power supply depends on the ability of *T1* to maintain its peak-to-peak voltage under load.

Figs. 8 and 9 are system schematic diagrams for the complete three-mode electronic counter. The system consists of a power supply (Fig. 7); control logic (Fig. 4); a six-stage decade counter (Fig. 2); six of the decoder, display driver, and display modules shown in Fig. 3; a time base (Fig. 1); and input amplifier and shaper (Figs. 5 or 6); and miscellaneous controls and connectors. The front-panel controls (see lead photograph) consist of the "A.C. Input" jack (*J1*), "D.C. Input" jack (*J2*), "Sync Output" jack (*J3*), "Atten." control (*R1*), "Gate Open" lamp, "Time Base Period" selector (*S1*), and "Mode" selector (*S2*); the control logic functions "Open," "Close," "Reset," and "Display Time," and, if the input stage from Fig. 6 is used, "Trigger Level" and "Slope" controls (Fig. 8).

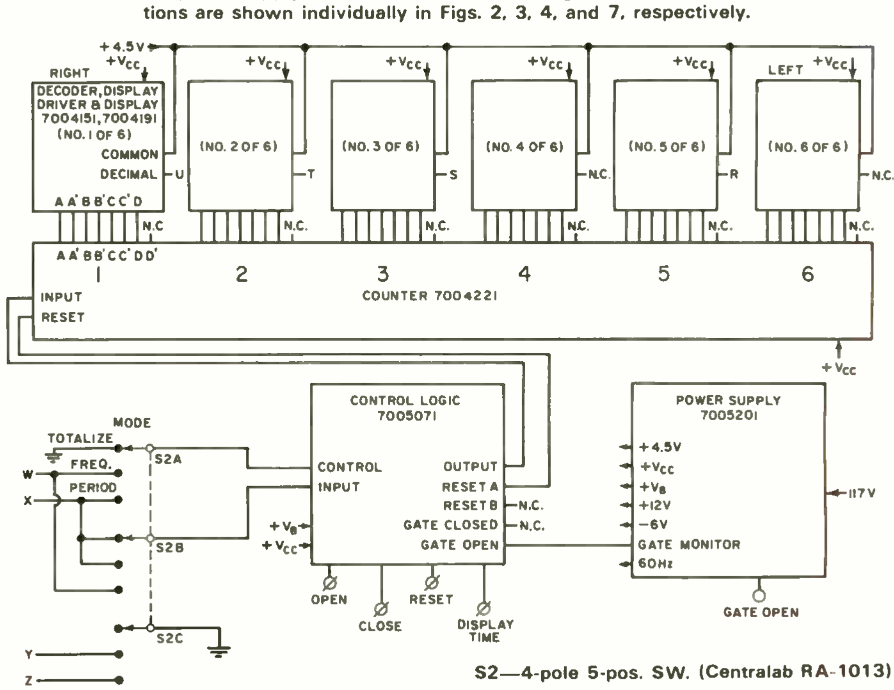
Switch sections *S2A* and *S2B* (Fig. 9) select the control logic "Control" and "Input" signals appropriate to the chosen mode of operation; *S2C* supplies power to the decimal-point selection sections of *S1* (Fig. 8). The desired time-base period and decimal-point position is selected by *S1*. Note that in the Period mode, the second and fourth positions of the "Time Base Period" selector are merely repeats of the first and third positions.

The signal available at the "Sync Output" jack is useful for synchronizing an oscilloscope (or other instrument or circuit) to the signal being counted, or for observing the appearance of the shaper output when counting errors are occurring, such as in the case of severe noise or distortion present on the input signal.

The 1-megohm "Atten." potentiometer may at first seem to unnecessarily reduce the input impedance of the electronic counter from the nearly 10-megohm input resistance of the FET input amplifier stage. In practice, however, the shunt capacitance (primarily due to the input jack and wiring capacitance) becomes significant at frequencies above a few kHz.

(Continued in March issue)

Fig. 9. Electronic counter system block diagram showing six-stage counter, decoder, display driver and display, control logic, and the power-supply sections. The schematic diagrams for these sections are shown individually in Figs. 2, 3, 4, and 7, respectively.



S2—4-pole 5-pos. SW. (Centralab RA-1013)

Myo-Cybernetics

(Continued from page 39)

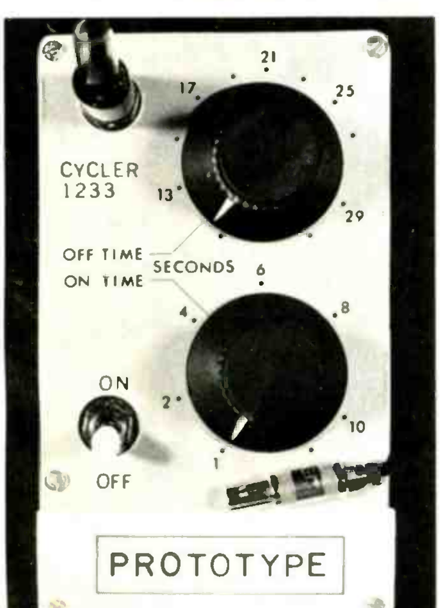
on patients who have one paralytic leg and one good one. Doctors hope this technology will one day help patients to walk.

Dr. Reswick told of one patient, a woman, who was paralyzed from the waist down. They implanted receivers in her buttocks and thighs. When triggered, the receivers sent out signals to cause the muscles to stiffen so that she could stand. Normally, she would have needed a full-length body brace to stiffen her enough to stand upright.

This is only the beginning. It may eventually be possible for some of these paralyzed patients to do a limited amount of walking. What is needed now, according to Dr. Nickel, is a better method of controlling these devices, *i.e.*, a steering wheel, clutch, brake, and accelerator are needed. He emphasized that engineers must now work harder than ever to develop these needed controls which will allow volitional, proportional, and sequential control of the device by the wearer. In other words, the device must respond, when the patient desires, with an output scaled to the patient's effort and with the timing or sequence of operations necessary to perform the desired physical activity.

Myo-cybernetic devices are expected to have a therapeutic effect for patients just as cardiac pacemakers help hearts to regain their natural rhythm. Some patients might use this device only for a short time to re-new their walking rhythm—while others may have to use it permanently. ▲

Front-panel view of prototype myo-cybernetic power pack, or cycler, that has both adjustable "on" and "off" times. Unit is not on market.



BOOKS

"LINEAR INTEGRATED CIRCUITS" compiled and published by *RCA Solid State Division*, Somerville, N.J. 413 pages. Price $2.50. Soft cover. (Technical Series IC-42)

This is an extensively revised and expanded version of an earlier volume and includes information on the latest innovations in IC technology as well as providing more detailed data on the fabrication, design, and applications of linear integrated circuits.

The body of the book consists of nine basic chapters dealing with fabrication, packaging, and mounting; the effects of monolithic fabrication on circuit design; basic circuit elements; differential-amplifier circuits; operational voltage amplifiers; operational transconductance amplifiers; multipurpose amplifiers; special-purpose circuits; and transistor, diode, and amplifier arrays.

It can be used as a helpful guide for circuit and system designers in determining optimum design specifications with respect to IC capabilities and system requirements or it can be used as a textbook for those wanting more information about LIC's.

The manual is rounded off with an application guide, a section containing technical data, and outlines of the IC packages. The well-illustrated and easy-to-understand text material makes this volume a welcome addition to the reference bookshelf.

* * *

"DC AMPLIFIERS IN INSTRUMENTATION" by Ralph Morrison. Published by *John Wiley & Sons, Inc.*, New York. 241 pages. Price $13.95.

From his years of experience in the instrumentation field, the author has sensed a need for a practical treatment of d.c. amplifiers by practicing engineers and senior technicians whose work involves many instruments of various types.

Divided into nine chapters, the text first covers linear components (resistors and capacitors) since they are used as feedback elements and their characteristics limit instrument performance. From there the discussion moves to magnetic components, parasitic effects, feedback, feedback amplifiers, modulation and demodulation, instrumentation amplifiers, specifications and evaluation, and finally active devices. Throughout the text the author places primary emphasis on practicality and provides a maximum amount of information in a straightforward and concise manner.

The text is well illustrated. The inclusion of problems at the end of each chapter suggests that this book could be used as a classroom text as well as a reference source.

* * *

"SINGLE SIDEBAND FOR THE RADIO AMATEUR" compiled by American Radio Relay League, Newington, Conn. 253 pages. Price $3.00. Soft cover.

This is the Fifth Edition of this popular ham handbook and, like the previous editions, consists of a compilation of SSB articles which have appeared in the pages of "QST."

Many authors have contributed to this volume, making for an interesting diversity of style and authoritative coverage as each writes about his "specialty."

The book is divided into nine chapters covering SSB principles, exciters, transceivers, linear amplifiers, amplifier construction, adjustment and testing, receivers, v.h.f. techniques, and accessories. The lavish use of photographs, schematics, partial schematics, tables, complete parts lists, and other illustrative material adds considerably to the discussions.

Most hams will want a copy of this comprehensive handbook on their bookshelves both for reference and new operating and equipment ideas.

* * *

"SERVICING MODERN HI-FI SYSTEMS" by Norman H. Crowhurst. Published by *TAB Books*, Blue Ridge Summit, Pa. 17214. 221 pages. Price $7.95.

The author's primary emphasis in this book is on circuit components, making measurements on these various parts, and working with test equipment. Actual hi-fi equipment servicing is covered in the final four chapters, including the last chapter which provides typical service data (and foldout schematics) on a number of packaged systems.

The text is well illustrated with schematics, line drawings, tables, photographs, and pictorials.

* * *

"BATTERIES AND ENERGY SYSTEMS" by Charles L. Mantell. Published by *McGraw-Hill Book Company*, New York. 213 pages. Price $14.00.

Although parts of this book are devoted to the chemistry of batteries and the pros and cons of various types of construction, there is much information that will be of value to the specifier of batteries to power equipment of all types.

The 21 chapters cover the history and the galvanic concept, the voltage concept, current-producing cells and batteries, dry cells, primary batteries, air-depolarized cells, fuel and mercury cells, silver batteries, water-activated systems, obsolete and historical systems, reversible systems, lead secondary and alkaline secondary cells, nickel-cadmium systems, battery charging, regenerative electrochemical systems, solar cells and related systems, specialized application cells, electric cars and batteries, and how to select a battery.

This well-written and well-illustrated text will serve as a complete source of information on all types of batteries no matter what the application requirement.

* * *

"BETTER SHORTWAVE RECEPTION" by William I. Orr & Stuart D. Cowan. Published by *Radio Publications, Inc.*, Box 149, Wilton, Conn. 06897. 155 pages. Price $3.95. Soft cover.

This is a book for SWL's, CB operators, hams, and students, written by two "old hands" at the game. It offers step-by-step instructions on buying (or building) a shortwave receiver, selecting the right antenna, how to tune for best reception, what to listen for, reporting your "finds," and just about anything else the beginner needs to know.

Since the authors are enthusiastic SWL's as well as active hams, they make excellent "salesmen" for the hobby. The book is lavishly illustrated with photos of various installations, equipment, cartoons, graphs, tables, line drawings, and schematics. The style is informal and conversational and even the construction of a shortwave receiver is made to seem simple the way the authors describe it.

* * *

"20 SOLID STATE HOME AND HOBBY PROJECTS" by R. M. Marston. Published by *Hayden Book Company, Inc.*, New York. 105 pages. Price $3.75. Soft cover.

Although written by an Englishman, the circuits and component parts required to build any and all of the 20 useful devices described are available in the U.S. as well as abroad and, where necessary, alternate component types are called out for 240- and 120-volt services.

The devices range from a light-operated switch to a self-contained metal detector. Each project is pictured, schematic and parts list provided, and in some instances PC board layouts and wiring diagrams included. ▲

Color Organs

(Continued from page 44)

over which an air-tight elastic material is stretched. Small, front-surface mirrors mounted on this material reflect the light beams onto a screen, wall, or stage. The action of the speaker cones forces trapped air to move the elastic material and cause the mirrors to reflect patterns that leap and lunge in perfect time with the music.

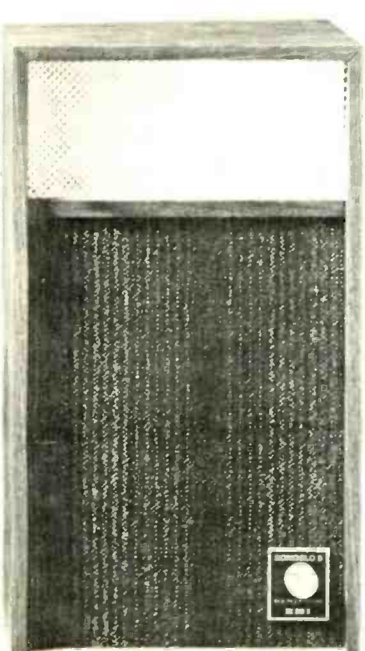
Why So Popular?

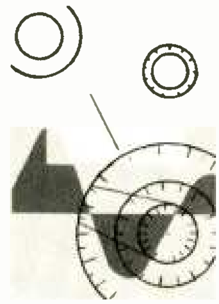
Why have these light displays become so popular? This question is best answered in the words of Leon Wortman:

"While it is true that there are emotional reactions when one sees and hears sound/color, the reactions are in reality an enhancement of the normal reaction to the sound. For example, if one dislikes music with a distinct beat, the addition of rhythmic light and color will irritate to the point where tempers get 'hot;' some will even leave the room in a huff. If one likes 'syrupy' sounds such as soaring strings produce, the viewer becomes almost hypnotized, mesmerized. If one becomes absorbed in the mood of a classical work, the absorption is intensified.

"The effect is more often like that of watching a crackling fire in a fireplace. The viewer sits entranced, unless it is 'beat' music and the aficionado then finds it almost impossible to remain seated but must get up and move with it." ▲

Here is a novel idea; this is a 2-way loudspeaker system with a built-in color-organ display. It is Benjamin/EMI's "Sonoglo 5."





TEST EQUIPMENT

Product Report

Hickok Model 3300 Digital V.O.M.

For copy of manufacturer's brochure, circle No. 3 on Reader Service Page.

THE new *Hickok* Model 3300 looks like a real workhorse of a portable v.o.m. except that, instead of the usual meter scale, a digital display is used. Measuring only 8-in high by 5⅞-in wide by 4-in deep and completely battery-operated if desired, the d.v.o.m. is easy to carry and convenient to use.

The meter has a 3½-digit display; that is, there are three complete 0–9 digit decades while the fourth digit is either a "0" or "1." There are 27 measurement ranges including 5 a.c. and d.c. voltage ranges, 4 a.c. and d.c. current ranges, and 7 resistance ranges. A high-voltage range (15 kV) is also available using a separate h.v. probe.

The meter may be operated from a 115- or 230-volt a.c. power line or from its internal rechargeable nickel-cadmium battery pack. The batteries permit a full 24-hour operation so that the meter can be used at field locations for extended periods of time. The meter may be operated from a.c. power while the battery pack is being recharged.

The bright fluorescent digital display consists of 7-segment numerical indicators, which provide a maximum display of 1999. Display features include an automatic polarity indicator, automatically positioned decimal point, and an out-of-range indication. Overrange is indicated by a blanked display which occurs when the reading exceeds 1999. The reading rate is one per second.

The test probes are permanently attached to the front panel and are fitted with a captive strap, which secures the probes to the combination carrying handle and tilt bail.

For operator protection on high-voltage measurements, the case is completely isolated from the input terminals and contains no metal on the outside. Only the probes selected by the switch settings are connected to internal circuitry and no damage to the instrument will result if the wrong probes are used or if the instrument has been incorrectly set up.

A high-impact-resistant plastic case, shock-mounted readout, and a wide temperature operating range make this a rugged instrument for field applications as well as for laboratory and production-line use. Price of the Model 3300 is $395, including battery pack and regular probes. ▲

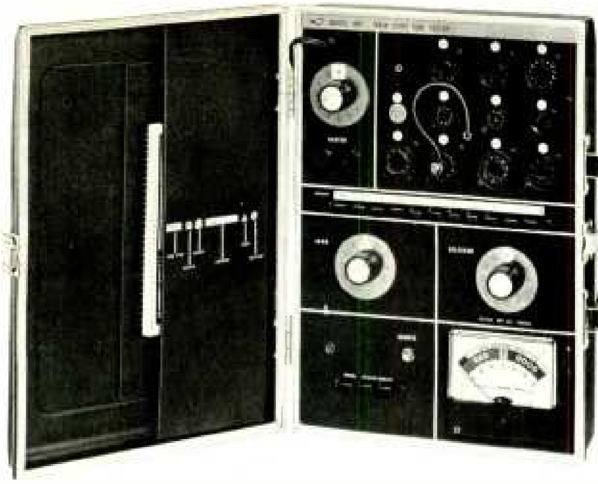
B&K Model 607 Tube Tester

For copy of manufacturer's brochure, circle No. 4 on Reader Service Page.

DESPITE all the transistorized TV sets and hi-fi receivers, there are still a good many pieces of equipment that employ vacuum tubes. Not only does this include some not-so-new TV sets, but there are quite a few hybrid sets coming out this year that use tubes along with transistors and IC's. In order to test these tubes, the technician needs a simple and quick-to-operate tester like the new *B&K* Model 607.

The tester has a couple of unique features that are worth noting. One of these is a novel short-circuit test that permits the user to lock out one tube element at a time from the grouping of elements that are tied together for the usual shorts test. In this way, the user can isolate where any internal short occurs and not overlook other internal shorts that may exist in the tube.

Another interesting feature is the se-



ries of shape-coded windows through which the setup readings are seen. By sliding the tube setup chart booklet up and down behind the flap in the cover of the tester, only one line of readings at a time can be seen. It is like a built-in roll chart but without the roll. By making the opening with different shapes (hexagon, triangle, square, rectangle, circle) and by matching these shapes with the control numbers, the setting up of a tube test is very fast and requires no searching and hardly any thought at all. It's just a matter of pushing in a button and reading the meter.

The tester checks just about all presently available tube types for cathode emission, grid leakage and emission, and shorts and leakage. Less than 1 microampere of grid current can be detected. The manufacturer refers to the tester as a solid-state unit; it does use an FET amplifier to drive the meter for grid checks and there are semiconductor diodes for power-supply rectification and regulation.

The tester is housed in an attractive, weatherproof, durable attaché-type carrying case. It sells for $114.95. Test data on new tubes is available every four months on a $5 per year subscription basis. ▲

General Radio Model 1542 Stroboscope

For copy of manufacturer's brochure, circle No. 5 on Reader Service Page.

AN electronic stroboscope, which produces bright flashes of light at a variable repetition rate, has a good many applications. It can be used in the industrial area to "freeze" machinery motion for inspection and design; it can be used in schools or labs to demonstrate the principles of physics; and it can be used in the home, in clubs, or even the concert hall as part of a psychedelic light display with color organs for recorded or live pop music.

The new *General Radio* Model 1542 provides bright white light flashes from a xenon lamp whose rep rate can be varied from 180 to 3750 flashes per minute. There is constant image illumination at any flash rate, while the flash duration can be as short as 5 microseconds. The stroboscope uses a reflector that confines the light to a beam angle of 40 degrees.

The unit operates from the a.c. power line from which it draws only 9 watts. The case is unbreakable molded plastic with a face plate to protect the flash lamp. A threaded hole in the case is for tripod mounting.

The 1542 is useful for observing the working of high-speed machinery. Setting the flash rate to coincide with the machine motion provides a "stopped" image while the equipment is working. A slight change in the strobe flash rate shows the machine moving in slow-motion so that its operation can be watched. Devices operating at speeds greater than the strobe flash rate can be stroboscopically observed by setting the flash rate to a submultiple of machine speed.

The company makes other more elaborate and more expensive stroboscopes. The Model 1592 is its latest and lowest-priced unit. It is available for $95. ▲

One of our students wrote this ad!

Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.


Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

In closing, I'd like to get in a compliment for Mr. Chet Martin, who has faithfully seen to it that my supervisor knows I'm studying. I think Mr. Martin's monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. Mr. Martin has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

I'm very, very satisfied with the whole CIE experience.

Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction.

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands"...learning by taking things apart and putting them back together...soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. As "theory men," they think with their heads, not their hands. For trained technicians like this, the future is bright. Thousands of men are urgently needed in virtually every field of Electronics, from two-way mobile radio to computer testing and troubleshooting. And with this demand, salaries have skyrocketed. Many technicians earn $8,000, $10,000, $12,000 or more a year.

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Many men who are advancing their Electronics career started by reading our famous book, "How To Succeed In Electronics." It tells of the many electronics careers open to men with the proper training. And it tells which courses of study best prepare you for the work you want.

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Testing Hi-Fi Equipment

(Continued from page 48)

dB or less at the highest frequencies. There are sometimes rather large irregularities in the crosstalk curve, compared to the frequency-response curve. This is not serious, unless the separation goes to less than 15 dB at mid-frequencies, which indicates a defective or improperly installed cartridge.

Caution: Do not play your test records with cartridges requiring more than 3 to 4 grams tracking force. The high-frequency bands can be seriously damaged by a single playing with a low-quality cartridge. In time, this will occur even when good cartridges are used. It is good practice to keep a fresh pressing of the record on hand as a check on the condition of your regular records.

The output level of a cartridge is measured by connecting one channel at a time to the v.t.v.m. (with a 47k-ohm terminating resistor) and playing the 5 cm/s band of the *CBS Labs* STR100 record. Most cartridges have an output between 3 and 10 millivolts, which can be read directly on inexpensive v.t.v.m.'s.

Tape Recorders

The tape recorder test setup is shown in Fig. 4. The recorder's playback equalization is first tested with a standard alignment tape. The high-frequency portion of this tape is also used for head-azimuth alignment, which is assumed to have been adjusted, together with any required bias and equalization adjustments, prior to testing.

The test frequencies on the tape are preceded by voice announcements. An amplifier and speaker (or headphones) may be used to monitor the tape during playback. If the recorder has its own playback amplifiers and speakers, these may also be used for this purpose. However, all measurements should be made at the line outputs. Record the v.t.v.m. reading for each frequency. By subtracting the meter reading for the reference level (usually at 1000 Hz or 500 Hz) from each reading, the net frequency response can be determined.

For the over-all record/playback response measurement, load the recorder with the manufacturer's recommended tape. Some machines are adjusted for the so-called "standard" tapes, such as *3M*#111, while others are optimized for low-noise tapes, such as *3M*#201 or #203. Supply a test signal at 1000 Hz, at a 0-dB level as indicated on the recorder's meters, and reduce the audio generator output by 20 dB. Record a series of test tones at this level, at frequencies from 20 Hz to 20 kHz. A reasonably complete test can be made with tones spaced in a 1, 2, 3, 5, . . . progression (*e.g.*, 20 Hz, 30 Hz, 50 Hz, 100 Hz, etc.). Make a record of the frequencies used or, preferably, identify each one with a voice announcement on the tape.

Rewind the tape and play it into the test instruments. Record the v.t.v.m. reading for each frequency. Repeat the playback for the other channel. The data, when plotted, is the record/playback characteristic of the recorder. If the recorder has several speeds, this test should be made at each speed.

For signal-to-noise ratio measurements, record a 1000-Hz signal at 0-dB level for about 30 seconds. Remove the signal and turn the recording gain to minimum, while continuing to record. When the tape is played back, note the v.t.v.m. reading from the 1000-Hz tone, and on the "quiet" portion of the tape which follows its removal. The change in meter reading is the unweighted signal-to-noise ratio of the machine. The scope will show whether the "noise" is random hiss or if it contains hum or sub-sonic "bounce."

Rewind to the beginning of the 1000-Hz tone and play it into the distortion analyzer. Measure the distortion level. If it is appreciably less than 3%, as it often is, make several additional recordings at higher levels, in steps of 1 or 2 dB and measure the distortion. This is necessary because most recorder manufacturers specify the S/N ratios of their machines relative to the recording level which produces 3% distortion on playback. This is usually somewhat higher than the maximum recommended recording level shown on their meters. As an example, if the S/N ratio is 45 dB relative to the 0-dB recording level, but a +8-dB level is needed to produce 3% distortion during playback, the S/N ratio of the machine is 53 dB.

To measure wow and flutter, use a standard flutter test tape with 3000 Hz recorded with very low flutter (usually less than 0.02%) and connect the flutter meter to the recorder output.

Most home tape recorders have an unweighted S/N ratio between 40 and 50 dB, with the best approaching 60 dB. Wow and flutter are similar in magnitude to that of good turntables, but in recorders the flutter is usually much greater than the wow, while the reverse is true of turntables.

If a standard flutter test cassette is not available, the wow and flutter of cassette machines can be measured by recording a 3000-Hz tone from the audio generator and playing it back into the flutter meter. This gives somewhat unreliable readings, usually higher than the true flutter of the recorder. The best cassette decks may measure as low as 0.15% flutter when tested in this manner, but 0.3% to 0.4% is more common. ▲

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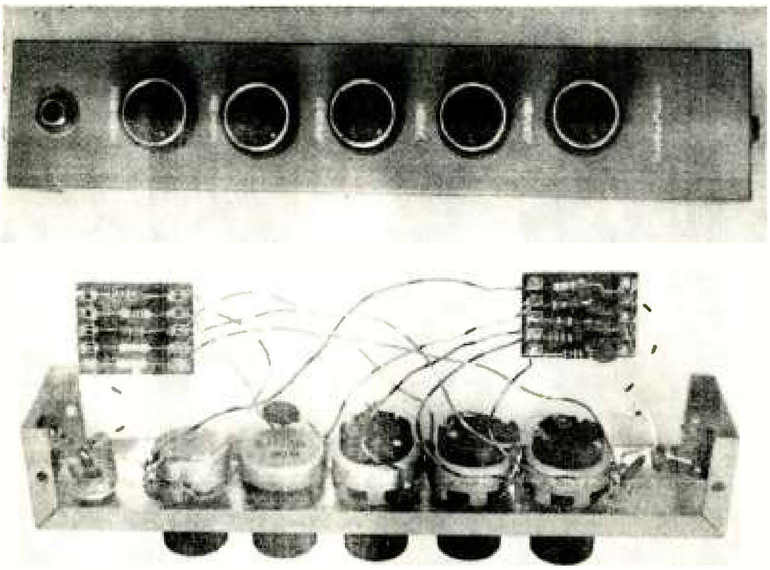


(Top) Author's 5-circuit tone-control unit along with preamp and battery were built into 12" x 2¼" x 2¼" chassis box. Box can also accommodate 7-circuit tone control diagrammed. (Bottom) Inside view with RC components on terminal boards.

"MULTI-TONE" Guitarist's Tone Control

By IAN E. ASHDOWN

Design details of a multiple tone control covering number of audio bands. Permits creation of unusual sounds that cannot be produced with bass and treble controls.

SOME days, no matter how he fiddles and adjusts, a guitarist can never get exactly the sound he wants from his amplifier. If he wants a warm, mellow jazz sound, it usually comes out with too much treble or bass. If he wants a piercing treble effect, there is always too much bass in the sound.

This problem could be alleviated if the guitarist had a more sophisticated set of tone controls. If he could control not just the bass and treble but a number of separate ranges of the audio spectrum, he would be able to create sounds impossible to obtain with bass and treble controls alone.

With such an objective in mind, "Multi-Tone" was designed and built. Essentially, this unit is a set of seven tone controls and a preamplifier built into a small case that can be attached to the amplifier or set on the floor. The unit can be built into almost any sort of case or chassis, although the author found the chassis box shown convenient and visually pleasing.

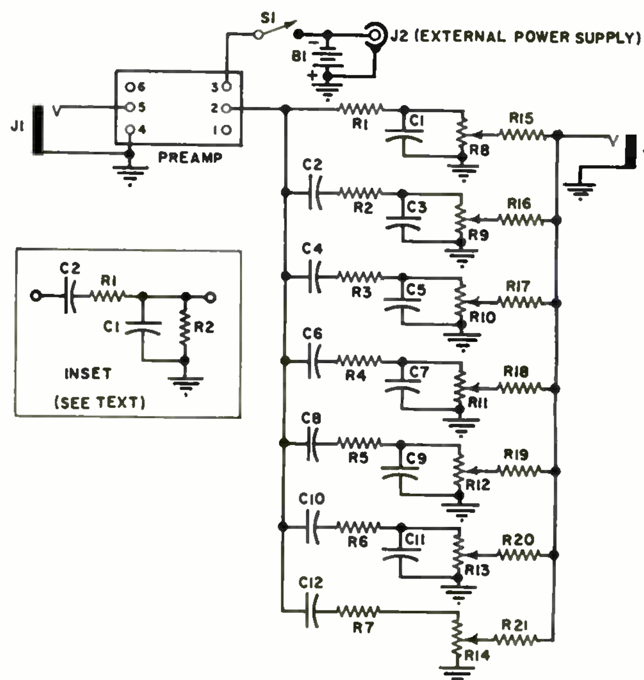
Because the tone controls attenuate the signal from the guitar pickups appreciably, a preamplifier is needed to boost the signal back to its original level. This preamp can be driven either by a battery or an external power supply. The control can be built for less than $15 if all parts are new.

The Circuit Design

The control unit consists of seven resistance-capacitance filters, each passing a different range of frequencies. The inset in Fig. 1 shows one of these filters.

*R*1 and *C*1 comprise a low-pass *RC* filter. The turnover frequency of this filter can be calculated by formula: $1/2\pi RC$. (This formula assumes that the filter is isolated from the circuit.) *R*2 and *C*2 comprise a high-pass *RC* filter whose turnover frequency may be calculated by the same formula. Thus, by using the same values for *R*2 and *C*2 as for *R*1 and *C*1, the two filters can be made to have the same turnover frequency. Combining these two filters as shown in the inset produces an *RC* band-pass filter with a center frequency equal to the turnover frequency.

Fig. 1. Schematic of the 7-circuit tone-control network inserted between guitar pickup and guitar-amplifier input.



R1, R7—820,000 ohm res.
R2, R3, R4, R5, R6, R15, R16, R17, R18, R19, R20, R21—470,000 ohm res.
R8, R9, R10, R11, R12, R13, R14—500,000 ohm pot
C1—0.0015 μF capacitor
C2, C3—0.001 μF capacitor
C4, C5—500 pF capacitor
C6, C7—250 pF capacitor
C8, C9—120 pF capacitor
C10, C11—68 pF capacitor
C12—25 pF capacitor
S1—S.p.s.t. switch
J1, J3—Phone jack
J2—Phono jack
B1—9-volt battery

As an example, assume that a band-pass filter with a center frequency of 600 Hz is desired. Using 500,000-ohm resistors for *R*1 and *R*2, *C*1 and *C*2 should be about 500 pF. By using different sets of values for *C*1 and *C*2, practically any center frequency can be obtained.

In the tone-control unit a potentiometer is used for *R*2. This allows the volume level of the signal passed by the filter to be controlled. Since the total resistance of the pot in the circuit is always 500,000 ohms, the turnover frequency of the high-pass filter isn't affected when the pot is used as a volume control.

The 470,000-ohm resistors following the pots are isolation resistors. Unless they are used in the circuit, varying the resistance of one pot will affect the signal levels of all seven filters. The isolation resistors buffer the action of the pots from each other, allowing the filters to act independently.

In choosing the center frequencies of the filters, a good design criterion is a separation of one octave between each frequency. Thus, if the first filter is chosen to have a center frequency of 150 Hz, the other filters should have center frequencies of 300, 600, 1200, 2400, 4800, and 9600 Hz.

In the event that some of the capacitors listed in the parts list are not readily available, capacitors of close value may be substituted. For instance, the parts list calls for 68 pF for *C*10 and *C*11. However, either 56-pF or 75-pF capacitors can be substituted without sacrificing performance.

The lowest note on the guitar is 80 Hz, while the highest harmonics extend beyond audibility. In order to control these frequencies, the 150-Hz filter should be a low-pass type and the 9600-Hz filter a high-pass type. These filters should have an attenuation characteristic similar to a band-pass filter on one side, and a constant attenuation on the other side of what for a band-pass filter would be the center frequency.

The inset schematic shows the high-pass and low-pass filter circuits as part of the "Multi-Tone." The high-pass filter consists of *C*12, *R*7, and *R*14. *R*7 and *R*14 function as a voltage divider to match the attenuation of the band-pass filters.

It was found that the attenuation curve of the high-pass filter best matched those of the band-pass filters when the turnover frequency was lowered an octave to 4800 Hz. The formula for the turnover frequency of this filter is: $f = 1/2\pi(R7 + R14)C12$ where it must be remembered that f is now 4800 (not 9600) Hz.

The low-pass filter is similarly designed, with *R*1 and *R*8 serving the same function as *R*7 and *R*14 in the high-pass filter. In this filter, however, the turnover frequency is raised an octave to 300 Hz. The formula used to calculate it is: $f = 1/2\pi[R1R8/(R1 + R8)]C1$, where f is now 300 (instead of 150) Hz.

All calculations (including the graph in Fig. 2) have been based on the assumption that the source impedance for each filter is zero (*i.e.*, input short-circuited) and that each filter is terminated with an infinite impedance. Actually, the source and load impedances are determined by such factors as the isolating resistor network, the output impedance of the preamplifier, the setting of the filter pots, and the input impedance of the guitar amplifier. The effects of these factors have been ignored.

Modifications

If the unit is to be used with a bass guitar, the builder may wish to change the circuitry to cover the extremely low bass frequencies. Since the 9600-Hz filter would be superfluous for a bass guitar, the only changes needed will be to double the values of all the capacitors. Center frequencies of the filters will then be 75, 150, 300, 600, 1200, 2400, and 4800 Hz.

The photos show the author's prototype "Multi-Tone." This model had only five filters—the 1200- and 4800-Hz filters were omitted. The unit performed superbly in the bass region, but performance in the treble region was inferior compared to the version described in this article.

One disadvantage of the circuit is the inherent signal loss.

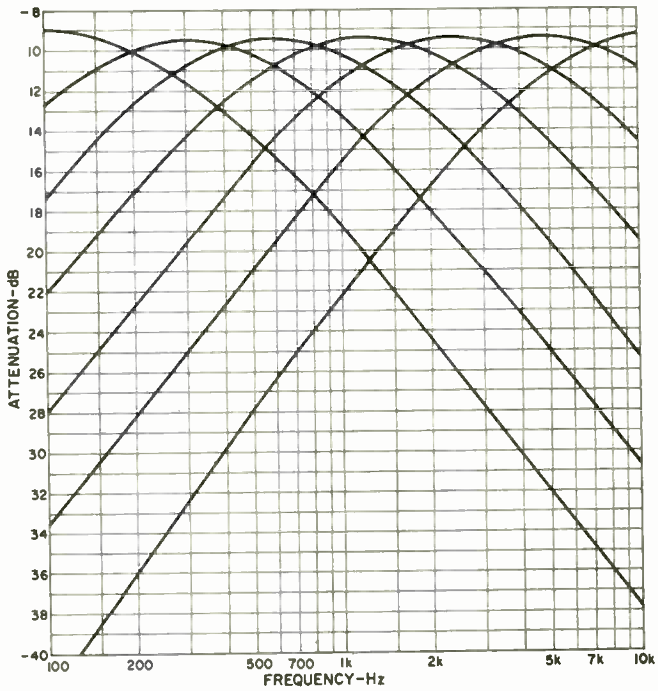


Fig. 2. Frequency-response curve of the "Multi-Tone."

At best the loss is over 25 dB—a 100-millivolt signal is reduced to less than 10 millivolts when it goes through the unit. Therefore, a preamplifier is a necessity, in order to maintain a reasonable signal level. The preamp should have a gain of 25 or 30 dB and a high input impedance.

Construction Details

Although it is possible to assemble all the components on the lugs of the potentiometers, the finished product is anything but neat. A better method is to mount the components on perforated (or terminal) boards and connect them to the jacks and pots with jumper wires.

The wiring isn't critical, but it's still a good idea to keep the jumper wires as short as possible in order to prevent hum pickup. Also, the pots should be connected to a single ground lug (preferably the input or output jack).

When mounting the boards, be sure to keep wiring from touching the case. An easy way of doing this is to mount the boards with machine screws, with a nut on each screw between the case and the board to act as a spacer. Another nut on the other side of the board will certainly hold the assembly fast.

Any preamplifier with a gain of 25 dB or more and an input impedance greater than 10,000 ohms is suitable for use with the unit. Most low-level magnetic phono-cartridge preamps with an output of a volt or so will also work. The author used the *Midland* phono-preamp module (about $2.50 from *Allied Radio*). The module has an input Z of 100,000 ohms, 28-dB gain, and can be driven by 9-V battery.

If the builder uses a phono-preamp module with a battery as its power supply, the entire unit may be built in a 12" × 2¼" × 2¼" chassis box. This chassis box is large enough to accommodate seven tone controls plus the preamp and battery, providing the pots are of the miniature variety (with a diameter of less than an inch). The "on-off" switch can be on one of the pots.

If an external power supply is used, the same case can be used, but with a phono jack for the power supply. Any 9-volt battery-eliminator power supply will work well.

No problems should be encountered in operating "Multi-Tone" unless the guitar or organ has a high output. If so, the preamp may be overdriven, resulting in distortion. The best solution is to adjust the volume of the guitar with the guitar volume controls until distortion ceases. ▲

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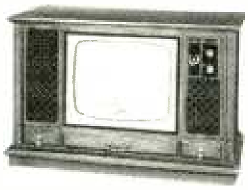

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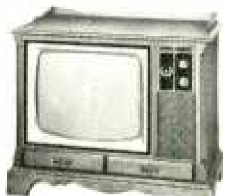

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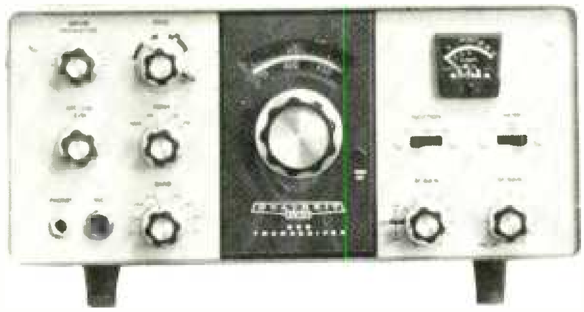

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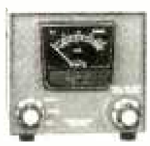

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By JIM ASHE

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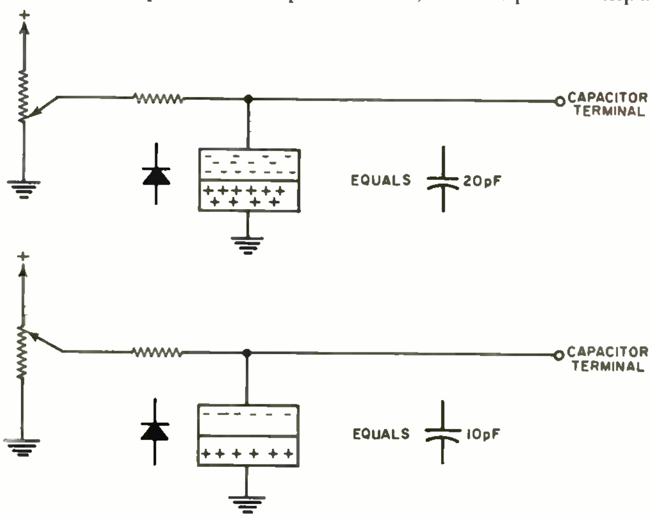
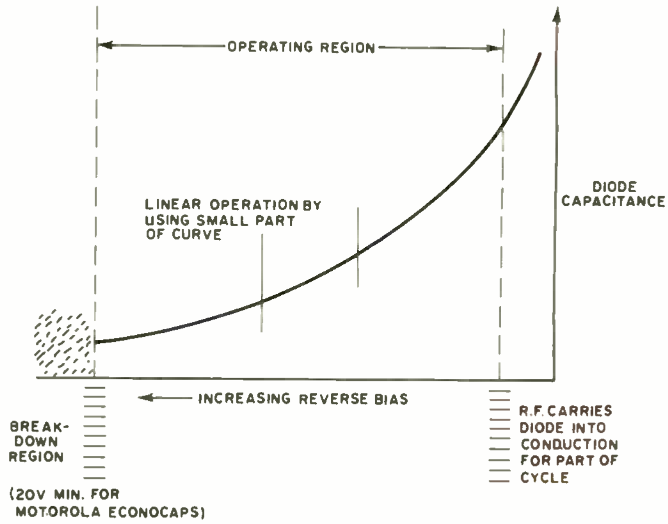


Fig. 1. Reverse-biasing a junction diode produces capacitance.

Fig. 2. Curved capacitance characteristic of diode capacitor. Manufacturers' charts will provide better data. Over a small part of curve, departure from a straight line is not very good.



and output devices. Commercial test gear combines the sweep drive and the swept oscillator, but for maximum versatility and convenience the sweep-drive circuitry can be kept separate.

A sawtooth signal is conventionally used for sweep testing in the laboratory. There is need for a linear sweep in certain specialized kinds of testing, but for work in which the same signal drives the tested circuit and an oscilloscope, the input-output relation will be linear anyway. Whatever kind of signal is available will work. Many TV and FM test sweepers use the 60-hertz a.c. signal for sweeping, and very successfully indeed.

However, this frequency cannot be used all the time because it is too fast. A 60-Hz signal will cause some filters to ring strongly, if they have sharp characteristics. And, for audio work, 60-Hz sweeping is not very useful to show response below a few hundred hertz. Hence, a frequency lower than 60 Hz is required.

Diode Capacitors

Some kind of electronic frequency control is required for generating sweep-tuned signals. There have been various arrangements used, including Miller-effect circuits, variable permeability inductors, and coils mounted on loudspeaker cones. One of the most convenient is the diode capacitor. Any junction diode or transistor base-collector or base-emitter junction is worth a try as a diode capacitor.

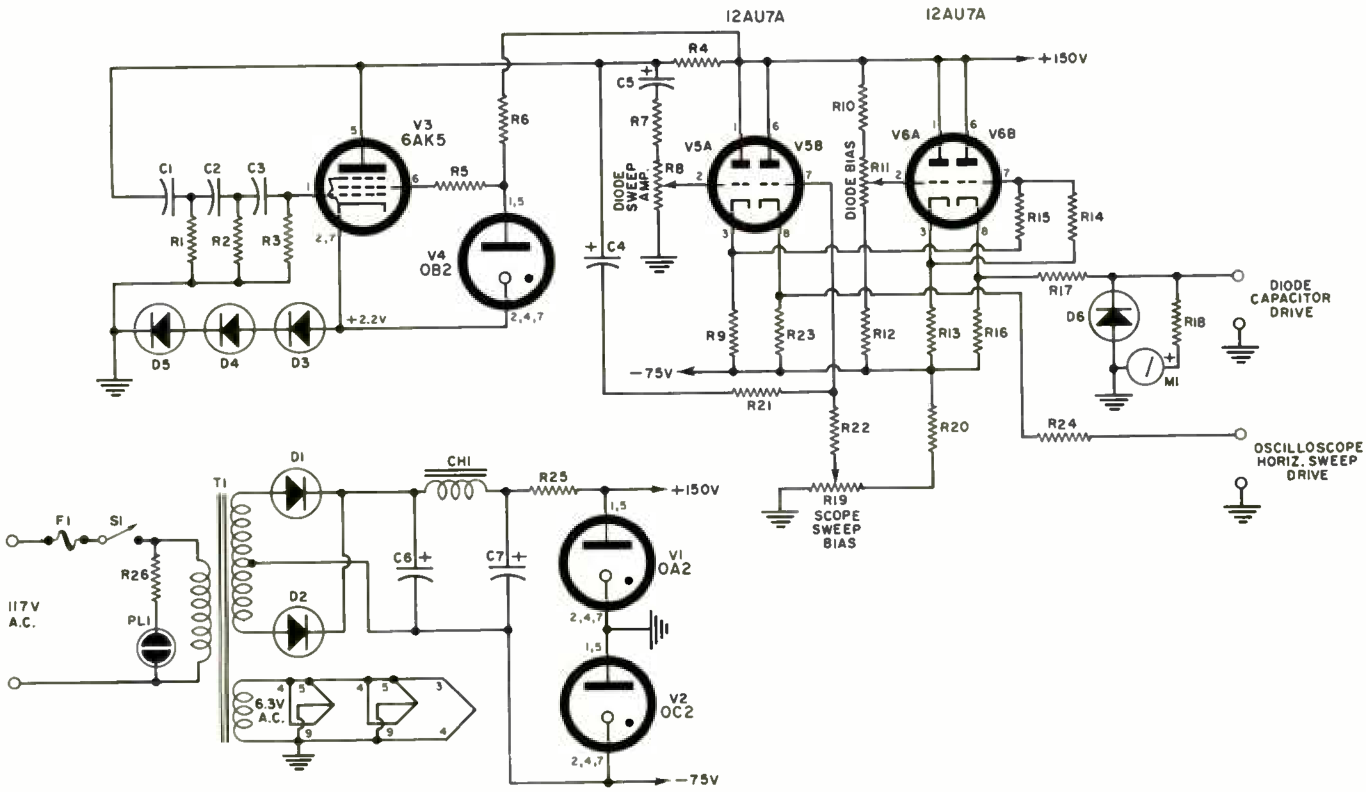
When the diode is forward-biased, charge carriers are rushing to the *p-n* boundary and joining. But when the diode is reverse-biased, the carriers are forced away from the *p-n* junction, and the semiconductor material that is without carriers acts like a dielectric. The diode becomes a surprisingly good capacitor, simply by being reverse-biased.

Fig. 1 (top) shows a diode with a slight reverse bias. The charge carriers have drawn back only slightly from the *p-n* junction, which is serving as a dielectric. But the diode regions containing the carriers act as conductors, so the diode seems to be a tiny capacitor whose plates are very close together. Typical capacitance values are a few tens of picofarads.

Now, if the reverse bias is increased, the charge carriers will all retreat further from the *p-n* junction. Again, imagine the regions still containing carriers as capacitor plates, then if they are farther apart the capacitance must be reduced. Typically, strongly reverse-biased capacitances are a few picofarads. And this voltage-varying capacitance is the key to r.f. sweep-signal generation without elaborate circuits. If a time-varying frequency is applied to a diode capacitor, the capacitor can electrically tune an oscillator or signal generator. But there are two problems that may come up when this technique is applied to real circuits.

The first problem is illustrated in Fig. 2. The tuning will not be linear because the diode capacitance characteristic is curved. A small voltage change at low reverse bias will pro-

Fig. 3. Complete schematic of sine-sweep generator. Most tubes serve as cathode-followers; the diode drive sine-wave amplitude is about one-quarter amplitude of the oscillator output.



R1, R2, R3—390,000 ohm, ½ W res (for 70-ms period, ≈ 14 Hz)
R1, R2, R3—1 2 megohm, ½ W res (for 200-ms period, ≈ 5Hz)
R1, R2, R3—3 3 megohm, ½ W res (for 600-ms period, ≈ 1 7 Hz)
R1, R2, R3—10 megohm, ½ W res (for 1800-ms period, ≈ 0 6 Hz)
Note: Use 3-pole rotary switch to select resistors
R4—56 000 ohm, ½ W res
R5, R6, R9, R13, R16, R23—33,000 ohm ½ W res
R7—470,000 ohm, ½ W res
R8—500,000 ohm linear-taper pot
R10—1 2 megohm, ½ W res.
R11—1 megohm linear-taper pot
R12—330,000 ohm, ½ W res
R14, R15, R20—68,000 ohm, ½ W res
R17,R24—1000 ohm, ½ W res
R18—Meter multiplier for 25 V full-scale reading
R19—10,000 ohm linear-taper pot
R21—20 000 ohm, ½ W res
R22—82 000 ohm, ½ W res
R25-Selected for 25 mA through V1 & V2 with all other tubes pulled
R26—120,000, ½ W res (if no res in neon lamp assembly)
C1, C2, C3—0.01 µF good-quality paper or ceramic capacitor
C4, C5—20 µF, 250 V capacitor (common positive)
C6, C7—50 µF, 350 V capacitor
T1—Power trans, 225-0-225 V at 50 mA, 6 3 V at 1 A
CH1—10 H, 50 mA choke
M1—50-200 µA meter (calibrate 0-25 V with R18)
PL1—NE-2 neon lamp
F1—½ A fuse
S1—On R19, or separate
D1 D2—600 p i v silicon power diode
D3 D4, D5—Silicon power diode (p i v not important)
D6—50 p i v germanium diode (or transistor base-collector diode)
V1—0A2 tube
V2—0C2 tube
V3—6AK5 tube V4—0B2 tube
V5 V6—12AU7A tube

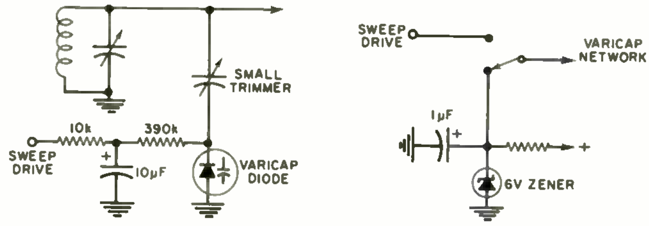


Fig. 4. (A) The basic diode capacitor circuit as installed in an oscillator. (B) Simple zener and switch circuit for reverse-biasing the diode capacitor when the r.f. oscillator is being used without the sine-sweep generator described.

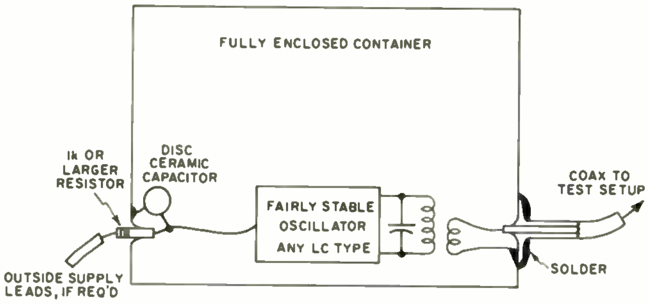


Fig. 5. Oscillator circuit should have bypassed power leads and be completely shielded for minimum of stray radiation.

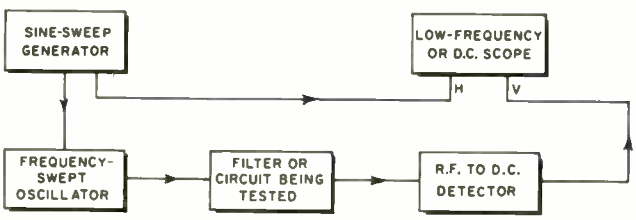


Fig. 6. Complete sweep-testing setup, appropriate for testing filters or receiver and transmitter bandpass circuits. All the leads are shielded and are grounded at both ends.

duce a much larger capacitance change than at a large reverse bias. This problem is minimized by sweeping the capacitance over only a small part of its range, so that the small part of the curve used is practically straight.

The second problem arises because the electrical characteristics of some reverse-biased diodes are not entirely stable. Diodes constructed for electrical tuning have good characteristics, but miscellaneous diodes picked off the bench or from a handy box of transistors may show an alarming and frustrating erratic drift. Placed in an oscillator, they tune at random up and down, so that a very good circuit sounds as though it has been pulled out of a junk box and should be promptly thrown back. This problem can be minimized by placing a tiny capacitor in series with the diode, reducing its influence over the circuit to that required for the job. Used in this way, a junk-box silicon power diode can give perfectly satisfactory performance.

Looking again at Fig. 2, we see that we cannot sweep the diode voltage to both sides of zero volts. It will be forward-biased one half of the time. Some steady biasing voltage must be added to the swept signal to displace the diode drive conditions into the always-reverse-biased region. This voltage-adding function, together with provision for the scope horizontal drive and generation of the actual sweep signal, are the three functions of the sine-sweep generator.

Motorola, and others, manufactures a sizable range of specially designed voltage-variable capacitors. They are available in DO-7 diode packages in capacitances from 6.8 pF to 100 pF at 4 volts reverse bias. They have a minimum breakdown voltage of 20 volts and have very good *Q*'s. Inexpensively priced, they are competitive with anything you find lying around that you may be tempted to "make do."

Solid-state components seem to be a logical choice for this application, but vacuum tubes have one advantage. Conveniently available tubes can generate and control the relatively large signal voltages which are preferred for this application, without complex circuitry or linearity problems. Fig. 3 is the complete schematic.

Circuit Description

There are two supply voltages because the output signals, both scope drive and diode drive, need to be referenced closely to ground. A side advantage is that circuit design is simplified at the cost of one extra voltage-regulator tube. Supply voltages of +150 and −75 volts are obtained by carrying the power-supply transformer secondary center-tap out as the −75-volt line, rather than connecting it to the chassis. Power-supply ground is between *V*1 and *V*2. Filtering and supply design are not critical, and anything goes if the supply circuit can deliver enough current through *R*25 to the regulator tubes. Choose *R*25 for 25-mA regulator-tube current with all other tubes pulled out.

A 6AK5 phase-shift oscillator generates the low-frequency sine-sweep signal, and its frequency is controlled by switching (not shown in schematic) the three resistors *R*1, *R*2, and *R*3 in its grid circuit. Constant grid bias is obtained by placing three silicon diodes in the 6AK5 cathode circuit. Their forward voltage is fairly constant, and some extra current is provided for them through the 0B2 screen regulator tube, *V*4. Because the screen terminal is not bypassed, 6AK5 gain is reduced but oscillation is controlled by a "soft" screen bottoming. This minimizes distortion of the bottom of the sine wave.

The rest of the circuit consists of cathode-followers. The oscillator signal is more than large enough, and part of its amplitude can be traded for really stable and straightforward circuitry. This results in an instrument that is entirely free from adventurous peculiarities.

Passing through *C*4, the oscillator signal is applied to cathode-follower *V*5*B* through a voltage divider that reduces its amplitude by a factor of about ten. A 1-megohm pot could be used here, but the oscilloscope horizontal gain control should be more than adequate. A simple adjusting circuit including *R*19 adds a small negative bias to the grid of *V*5*B* so that its cathode rests at ground potential rather than about 7 volts above ground. This is arranged in case some scope might not be able to ignore this small d.c. voltage. A series resistor, *R*24, prevents possible tube damage if the scope drive terminal should be shorted to ground.

Starting on its way to the diode capacitor, the oscillator output is applied through *C*5 to *V*5*A* and from *V*5*A* cathode it goes as a low-impedance-source signal to the voltage-adding network of *R*14 and *R*15. *V*6*A* supplies a potentiometer-variable d.c. signal to the same network and these two signals are algebraically added at the grid of *V*6*B*.

The adding process works in this way. Each signal comes from a voltage source (the cathode-follower) which appears, to the other signal, to be at signal ground. *R*14 and *R*15 appear as a 2-volt-in-per-volt-out divider as seen from either end, and the sum of the two inputs appears at *V*6*B*, another cathode-follower.

Newly converted again to low-impedance signals, the combined bias and sweep signals are delivered at the diode drive terminals. A series resistor, *R*17, serves to prevent tube damage in the event of a short to ground. Diode *D*6 clamps any voltage excursions in the negative direction (which would be forward-bias to the diode capacitor) and a meter provides a visual indication of output conditions.

Installed almost as an afterthought, the meter is necessary for effective use of the sine-sweep generator. The diode bias control, *R*11, also serves as a fine-tuning control, and the meter then becomes a calibration tool. Since, at the lowest frequency, the meter will follow the signal which is reproduced at the higher frequencies, you can observe drive to the diode capacitor.

A surplus meter used in this application had a mechanical resonance at one of the lower output frequencies. Its needle would swing wildly across its face. The inexpensive *Lafayette* 50-μA meters are better damped and a test shows that they will work very well in this application.

A 7-inch square by 2-inch deep chassis offers enough room for the sine-sweep generator circuitry. It would be difficult to assemble the instrument on a smaller chassis. The major power-supply components are placed at right rear, the voltage-regulator tubes at left rear. Remember that filter capacitors $C6$ and $C7$ have their cans at –75 volts with respect to the chassis. The 6AK5 oscillator tube goes left slightly in front of center, and the two 12AU7A's are placed to the front. The phase-shift capacitors $C1$, $C2$, and $C3$, go in the center of the chassis, where this arrangement leaves room for them, and the oscillator phase-shift resistors are placed on the rotary range switch. Assembly is not difficult since there is no parts-positioning problem at these low frequencies and less-than-one gain circuits.

The panel has a large job to do. There are a power switch, fuse, and pilot lamp to the left; a diode bias control, diode sweep amplitude control, and a sweep period switch in the center; and the meter and two output jacks placed to the right. The panel should be braced.

Power input is by way of a cheater-cord connector at right rear of the chassis. This is far more convenient than a permanently attached power cord. The two outputs are miniature phone jacks, and two pairs of banana jacks on ¾-inch centers might be preferable here.

R.F. Sweeping

One way to get an oscillator for r.f. testing is to breadboard it as required. Almost any simple design may be used, with the necessary adjustments in inductance or capacitance to bring tuning into the right range. Stability requirements aren't critical, but if the signal sounds drifty without being swept, it won't give good results in test work. Short leads are preferred, and the supply lines should be decoupled.

The circuit of Fig. 4A shows how to incorporate the frequency-sweeping feature. It is a reverse-biased diode in series with a small trimmer capacitor. The trimmer and the diode in series act as a voltage divider, so that the diode does not see the entire r.f. voltage appearing across the resonant circuit. The r.f., as well as d.c., can swing the diode voltage into the forward-bias region. A series resistor would be adequate to prevent r.f. loss along the sweep signal line, but an *RC* network is preferable because it also reduces unwanted signal pickup into the oscillator.

Any oscilloscope can be used for sweep testing, but a d.c. scope will work better because it does not have any low-frequency cutoff and it has better phase-shift characteristics. An a.c.-coupled scope will work at frequencies of a few Hz or tens of Hz, and its low-frequency response could be improved by shunting all series coupling capacitors with good grade capacitors ten times larger. A P7 screen CRT would be another worthwhile improvement, especially for the slower sweep speeds.

If your first experience with sweep testing is to be a good one, you must be careful to keep the r.f. where it belongs. Figs. 5 and 6 offer some suggestions. The oscillator circuit is carefully bypassed, and grounding is complete from the sine-sweep generator through the filter to the oscilloscope. All leads are mike cable, with coax for r.f. You have to be more careful at v.h.f. and one way to discover an incorrect setup is to sweep-test the instrument assembly without any work in it. The result should be a horizontal line somewhat above the zero axis. If you get wiggly curves, something in the setup is frequency-dependent, and this dependence will be added to the test results from the work.

A conventional signal generator can be modified for sweep work, but a zener or battery-biasing circuit will be needed to fix the diode capacitance for normal work not involving sweeping. See Fig. 4B. A s.p.d.t. switch connects the diode capacitor to the zener or to the outside sweep-signal terminal. When the diode circuit is installed, you can adjust its trimmer for sufficient frequency sweep at the high-capacitance end of the generator's tuning range, and then reset the manufacturer's trimmer capacitor, which is used for bringing instrument calibration into line with scale calibration.

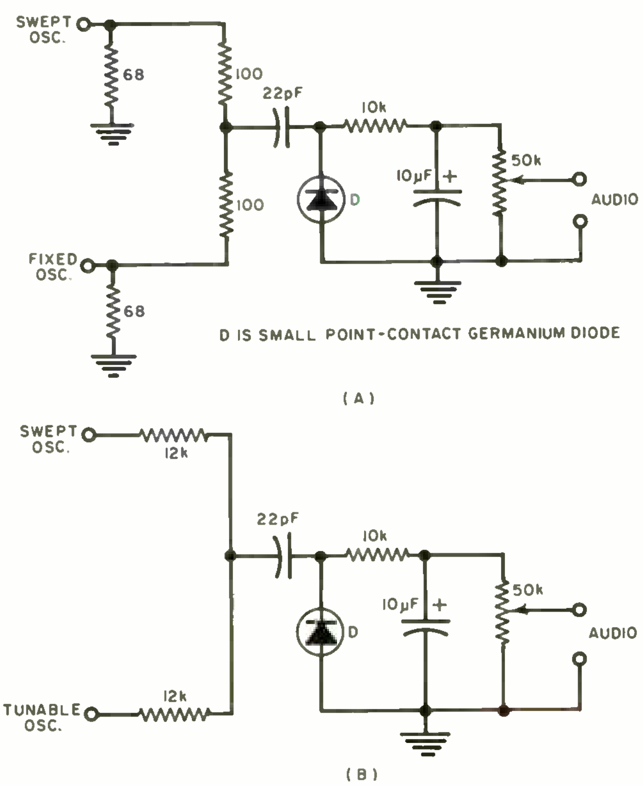
When sweeping active circuits, such as i.f. amplifiers, the test setup resembles that for sweep-testing filters, but you have to be more careful in setting up and using the gear. High-gain amplifiers will pick up a surprising amount of signal from the air, if there are a few loose leads around. The available signal can be minimized by making up a small transistor oscillator with a very low collector voltage, and then putting the oscillator in a can. With care, you can achieve signal leakages low enough to compare with good commercial laboratory signal generators, but without their convenient calibration and tuning features, of course.

Audio Sweep Testing

Because of the relatively small capacitance of voltage-variable capacitors, you should not try to build a swept audio oscillator. Sweep an r.f. signal, and then mix it with a fixed r.f. signal in a simple mixer. The sine-sweep generator's conveniently variable d.c. bias serves to tune the swept oscillator to just the right frequency for a near-zero-beat at one end of the screen, and juggling back and forth a few times between d.c. bias and amplitude controls will give the proper audio sweep width.

Fig. 7 shows low-impedance and high-impedance mixer circuits. There is nothing critical about these, or about the source impedances that feed them if they do not interfere with oscillator operation. Both are simple voltage-adding networks, which feed a diode that provides the nonlinear response necessary to bring out the audio. Volume-control outputs are recommended. ▲

Fig. 7. Two voltage-adding circuits for detecting an audio beat note from two oscillator circuits. Since audio may be stronger than expected, a gain control is good idea. (A) is for low-impedance and (B) for high-impedance circuits.



C.E.T. Test, Section # 12
Waveform Analysis

By DICK GLASS*

What is your electronics servicing I.Q.? You must get 75% on entire exam to pass.

This is the last in a series of 12 test sections that have appeared over the past year. You should now have a good idea of the kind of material covered in the National Electronic Associations' Certified Electronics Technician exam. If you have at least four years' electronics experience or schooling and would like to take the official exam, contact NEA at the address below. If you pass, you will receive a framed certificate, card identifying you as a CET, along with promotional material for your customers.

(Answers will appear next month.)

Answers to last month's quiz appear on page 82.

1. Match the following scope probes with the type of waveform with which they are used:

(A) direct probe	*1. i.f. waveform*
(B) demodulator probe	*2. video waveform*
(C) low capacitance probe	*3. audio waveform*
(D) capacitive divider probe	*4. flyback pulse*

2. The amplitude of the vertical sync pulse delivered by the integrator would normally be about:
(a) 150 V *(c) 15 V*
(b) 300 V *(d) 1.5 V*

3. With normal signal, the output of the TV video detector would be about:
(a) 1 V to 5 V *(c) 100 V to 150 V*
(b) 10 V to 50 V *(d) 0.1 V to 0.5 V*

4. With normal contrast, the output of the video output tube would be approximately:
(a) 5 V *(c) 50 V to 150 V*
(b) 10 V to 50 V *(d) 1 V to 5 V*

5. To view the 38-kHz multiplex frequency you need at least a:
(a) direct probe *(c) demodulator probe*
(b) low capacitance probe *(d) high resistance probe*

6. The video waveform at the picture tube should usually be:
(a) video information only
(b) video information and vertical sync pulses
(c) video information and horizontal and vertical sync pulses
(d) video information and 4.5-MHz FM sound frequency

7. To display four TV horizontal sync pulses on your scope, set the scope sweep rate at:
(a) about 57 kHz *(c) about 15,750 Hz*
(b) about 4 kHz *(d) about 31,500 Hz*

8. While viewing the composite video signal at the sync separator input, you notice the picture information portion of the waveform occupies less than 75% of the total. This indicates:
(a) loss of high frequencies *(c) you have sync compression*
(b) loss of low frequencies *(d) you don't have sync compression*

9. At the cathode of the silicon diode in a half-wave capacitive-input power supply, you notice the ripple voltage is sawtooth shaped. This indicates:
(a) normal waveform
(b) defective rectifier diode
(c) you are using a detector probe instead of direct probe
(d) improper filtering

10. The quickest way to check over-all frequency response of a video amplifier is:
(a) check high frequencies first, then lows
(b) check low frequencies first, then highs
(c) use a perfect sine wave
(d) use a square wave

*Executive V.P., NEA, 1309 W. Market St., Indianapolis, Ind. 46222 assisted by Lew Edwards, chairman of Test Make-up Subcomm.

Modular Color TV

(Continued from page 33)

All active devices in this module are contained in this single IC, which serves as a chroma bandpass-amplifier, burst amplifier, and reference oscillator, as well as performing the a.f.p.c., a.c.c., color-level, control, and burst-blanking.

The 3.58-MHz output from the first chroma module is then fed to the second chroma module, which contains the chroma demodulator and color difference amplifier functions. Again, a unique IC is utilized.

So far the chroma video system has borne at least some resemblance to circuits used in the past. The output of the chroma demodulator, however, consists of three color-difference signals, R-Y, B-Y, and G-Y, which are fed into three identical and corresponding picture-tube drive modules in which the matrixing of luminance and chrominance video is now accomplished ahead of the picture tube itself. The resultant output is used to drive the corresponding picture-tube cathodes. Note that we are using three medium-power devices in parallel as compared to one high-power video-output device and three separate picture-tube control-grid drivers.

The sound module is identical to one currently used in other *RCA* color receivers and requires no further comment.

This, then, represents the entire signal section and, with minor value changes in signal-board components, it can be used with any picture-tube combination.

The picture-tube drive modules represent the first application of thick-film technology to color receivers. This allows bulk production of discrete components by chemical means directly on a ceramic substrate. Due to good thermal characteristics, the transistors that are bonded directly to the substrate require no further heat sinking with a resultant package that is small, simple, and offers good long-term economic advantages.

Wide-Angle Picture Tube

The deflection and picture-tube assemblies represent another major advance. The CTC-49 is the first domestic receiver utilizing the new 110° wide-angle deflection picture tube as compared to a more common 90° deflection angle tube. This results in a substantially reduced depth in the over-all package. For the first time an 18-in color receiver is available on the market that has the slim appearance of comparable black-and-white television sets.

The horizontal-deflection circuitry itself bears close resemblance to the circuitry used in the company's CTC-40 chassis. Outside of parameter and component adjustments and modifications to provide for the substantially increased deflection power and increased raster pincushion distortion requirements, it does not differ greatly in operating principle. Noteworthy is the use of a high-voltage multiplier, which requires only one-fourth the voltage input to provide the picture-tube high-voltage requirements.

The vertical and convergence circuits represent substantial departures from previous practices. The usual vertical-output transformer has been eliminated through use of a complementary-symmetry output circuit, similar to that used in high-quality, high-power audio systems. The vertical-convergence waveforms are clamped at deflection center, resulting in substantial reduction in the interaction of the individual wave-shaping controls.

The CTC-49 represents a potential building block for future sets and provides means for substantial standardization of circuit modules. It indicates the expanded use of linear monolithic integrated circuits custom-tailored to unique color-TV needs. It also opens the door and gives us a glimpse of the future through use of ceramic circuits, wide-angle deflection CRT's and other circuit innovations. ▲

SPEED CONTROL for LARGE D.C. MOTORS

By LAWRENCE FLEMING

This circuit will instantly stop, reverse, and accurately control speed of any 1/3 hp (or less) d.c. shunt motor.

TRIAC and SCR half-wave controls for small 117-volt series motors have become common and inexpensive and are being built into portable power tools and small appliances. However, electronic speed controls for larger d.c. motors of 1/4 and 1/3 horsepower are necessarily more complex. These are still mainly an industrial item, priced in the $130 range. Motors in this horsepower range are, moreover, the staples of the motor business, running everything from attic fans to drill presses; although practically all are a.c. induction motors with only one speed or, at most, two switchable speeds.

While a 1/3-horsepower, 1750-r/min, 117-volt shunt-wound d.c. motor is not cheap, it can be worth the price—and there are some on the surplus market. With a suitable speed control, one of these d.c. motors is a delightful thing to have running such workshop items as a drill press or a lathe. You dial the speed. With dynamic braking, it stops at once; no waiting while it coasts.

The speed-control circuit of Fig. 1 works well on a 1/3-horsepower d.c. motor of this type. It is not particular about what kind of motor it is controlling, as long as it is rated at around 117 volts d.c., is shunt-wound, and draws no more than about 3 amperes at full load. The circuit is based on a component that some engineers consider a bit unsophisticated—the variable autotransformer. It has dynamic braking. It has no feedback loops; this insures that there can be no instability or "hunting" with varying types of motors or variations in mechanical load.

Operation

In the speed-control circuit of Fig. 1, half-wave rectifier *D1* supplies the shunt field of the 117-volt d.c. motor. Filter capacitor *C* maintains the required voltage level and eliminates any slight roughness in running that would be present with an unfiltered field supply.

Variable autotransformer *T* controls the armature voltage and hence the speed. Its output feeds a conventional full-wave rectifier bridge, *D2*. The rectifier output is fed to the motor armature through the normally open contacts of energized 117-volt a.c. relay *K*. When the motor is to be stopped by opening "Run" switch *S2*, the relay is de-energized and its normally closed contacts connect dynamic braking resistor *R* across the armature. While the motor is coasting, it acts as a d.c. generator. The power so generated is dissipated in resistor *R*, and the motor is loaded enough to come to an abrupt halt.

Since the motor field must be energized for this braking action to take place, a separate switch *S1* is provided for the field supply. Consequently, while the equipment is in use, *S1* is left on—the pilot light serving as a reminder. The field power required for a typical 1/3-horsepower shunt motor is only about 35 watts, since the field resistance generally runs around 400 ohms. Field current is around 350 mA.

The rated full-load current of a 1/3-hp motor is around 3 amperes d.c. or about half the line current drawn by an equivalent a.c. induction motor. The d.c. motor has a power factor of 100% and is also more efficient.

All the components run cool except braking resistor *R*. If the motor runs a load that has a large flywheel effect and is stopped frequently at high speeds, the resistor will have to convert a lot of kinetic energy into heat. On low-inertia loads like a drill press, it runs cool. The contacts on braking relay *K* should be rated at at least 10 amperes. Braking current is often high, although short-lived; starting surges are high because the d.c. resistance of the armature is typically only one or two ohms. The running current of the motor is, of course, limited by its back e.m.f.

The circuit shown in Fig. 1 can be built in a 6" × 6" × 6" metal utility box. Since the whole circuit is hot to ground at power-line voltage, *careful insulation and grounding are very important for safety.* The power cord should be of the 3-conductor grounding type. The green ground wire should be connected to the metal box and then carried through to the frame of the motor. *Do not omit the fuse.*

SCR's vs Autotransformers

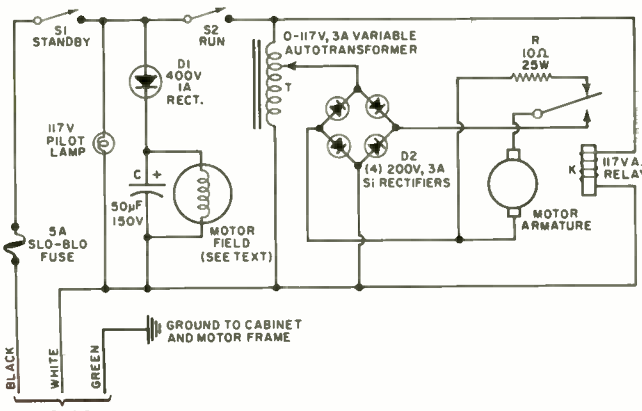
Variable autotransformers are extremely durable and efficient and are made by several manufacturers. The output of these units is low impedance and so the armature voltage has good regulation against changes in load current.

An SCR switching-mode circuit, at the smaller conduction angles, is inherently a relatively high-impedance source and so has poor regulation. Motor controls based on SCR's, accordingly, have feedback loops designed into them, making the phase of the firing pulses dependent on the back-e.m.f. of the motor as well as on the control-knob setting. A well-designed full-wave SCR control is very good indeed, but it is complicated. In the 1/3-horsepower range, the variable autotransformer circuit is simple, reliable, uncritical, and better suited to construction by the individual.

In cases where the mechanical load on the motor has low inertia, it is sometimes practical to omit "Run" switch, *S2*, and control everything from "Standby" switch *S1*. The dynamic braking will still work to some degree because of the residual magnetism in the motor field. Where this is feasible, it has the advantage that there is no "standby" function; everything is off until main switch *S1* is closed.

Where the motor is required to be reversible, simply wire a d.p.d.t. switch, connected criss-cross for reversing, between the armature supply and the armature. ▲

Fig. 1. Diagram of speed-control circuit that can be used with any type of d.c. shunt motor of 1/3 horsepower. Note that careful wiring, insulation, and grounding are required for safety.



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Created specifically for playback through stereo headphones, this unique record presents the listener with sound of unsurpassed realism. It recreates at each of the listener's ears the precise sound that each ear would have heard—independently—at the original scene.

Binaural recording re-creates the directions, distances, and even the elevations of sounds better than any other recording method. The super-realism of binaural recording is accomplished by recording the acoustical input for each ear separately, and then playing it back through stereo headphones. Thus the sound intended for the left ear cannot mix together with the sound for the right ear, and vice versa. This technique eliminates all acoustical problems in playback, such as the effects of "dead" rooms, over-reverberant rooms, variations in stereo perspective caused by changes in sitting position, and variations in frequency response due to changes in speaker positioning.

Binaural recording offers the listener the identical acoustical perspective and instrument spread of the original. The sound reaching *each ear* is exactly the same as would have been heard at the live scene. The Stereo Review Binaural Demonstration Record is the only record of its kind; there is nothing else like it. It provides a unique listening experience that you will want to share with your friends.

"MAX"—GENIE OF BINAURAL RECORDING. More than a year of intense effort was devoted to the preparation of this recording. "Max," a specially constructed dummy head, was modeled by a professional sculptor, then cast in silicone rubber. Super-precision capacitor microphones were installed in Max's ears so that each microphone would pick up exactly what each human ear would hear. The two separate sound channels were then fed into an ultra-low-noise electronics system and then recorded on an advanced-design tape recorder operating at 30 inches per second.

In making location recordings for the demonstration side of the record, a recording technician taped miniature capacitor microphones into his ears, so his head would serve its normal acoustical role as an absorber and reflector of sound. The result is a demonstration of phenomenal recorded sound.

STARTLING REALITY. The Binaural Demonstration Record offers 45 minutes of sound and music of startling reality. Side 1 introduces you to binaural recording via a narrated demonstration in nine sequences, taking you through a variety of situations that show off the remarkable depth and natural perspective of binaural recording.

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

MUSIC IN BINAURAL. With "Max" acting as your extension ears, the musical performances presented on the Binaural Demonstration Record transport you to the concert hall for a demonstration of a wide variety of music. Selections total 23 minutes, and include examples of jazz, rock, organ, and chamber music.

A highlight of the record is the first recording of *Space Virgin*, a new jazz work by noted composer Ronnie Roullier. Insiders have already called it one of the most exciting jazz recordings ever made. The organ recordings, with Frederick Swann at the keyboard of the majestic Riverside Church organ, have been hailed for reproducing the whole range of organ sonorities totally without distortion, and are among the most memorable listening experiences of a lifetime.

The Stereo Review Binaural Demonstration Record is the ultimate in sound reproduction. It has been made without compromise for the owner of stereo headphones. If you own stereo headphones, this record is a *must*.

Note: Although headphones are necessary to appreciate the near-total realism of binaural recording, the record can also be played and enjoyed on conventional stereo systems.

Order your Stereo Review Binaural Demonstration Record today. ONLY $5.98.

RECORDS, Ziff-Davis Service Division, 595 Broadway, N.Y., N.Y. 10012

Please send ________ Binaural Demonstration Records at $5.98 each, **postpaid.** My check (or money order) for $__________ is enclosed. (Outside U.S.A. please send $8.00 per record ordered.) N.Y. State residents please add local sales tax.

Print Name ____________________ EW1-71

Address ____________________

City ____________________

State ____________________ Zip ________

PAYMENT MUST BE ENCLOSED WITH ORDER

NEW PRODUCTS & LITERATURE

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

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

CASE FOR CASSETTES

A handy case for carrying and storing cassettes and 8-track cartridges is now on the market as the "Kari-A-Tape." The Models KA-27 and KAM-9 are designed to hold 27 cassettes

or 9 cassettes plus a portable machine and microphone, respectively. The Model 8T-27 holds 27 of the 8-track cartridges with labels up for easy selection.

Both cases have washable embossed leatherette covers and come with a black exterior with red interior or grey exterior with black interior. When closed, the cases resemble streamlined attaché cases with locks and comfortable carrying handles. Modern Album

Circle No. 6 on Reader Service Page

PHOTO RESIST KIT

Two new etched-circuit kits which use easy-to-make positive artwork, much of which is preprinted and in the kits, plus photo-sensitized copper-clad boards in various sizes, are now available as the 32X "sampler" assortment or the professional-sized version, Model 32XA.

With the materials supplied, which includes everything except water and a photoflood bulb, the user can make sharply defined etched circuits in single or multiple quantities without photography. Lead layouts for IC's, transistors, and connector patterns are all ready for transfer to the master-circuit Mylar sheet provided. This master sheet can be used to make duplicate boards if required. Vector Electronic

Circle No. 7 on Reader Service Page

VIDEOTAPE RECORDERS

A new generation of miniature videotape recorders and players featuring automatic cartridge loading and designed both for the CCTV and home recording and playback markets has been introduced as the "Instavision" system.

The Instavision recorder/player uses standard ½-inch-wide video tape enclosed in a small circular plastic cartridge 4.6 inches in diameter and 0.7 inch thick. It is compatible with all other conventional reel-type recorders using the

Type I standard recently adopted by most manufacturers of ½-inch recorders.

The basic recorder/player weighs less than 16 pounds complete with flashlight or rechargeable batteries. It measures 11" × 13" × 4.5" and permits slow-motion and stop-action recording and elementary editing. Two independent audio channels permit flexibility in audio recording, including stereo playback. Rewind or fast-forward controls advance the complete tape in one minute. A shoulder strap is included for portable operation. Ampex

Circle No. 8 on Reader Service Page

HOT KNIFE/SOLDERING IRON

The new dual-purpose hot knife/soldering iron has a removable adapter chuck which holds the knife blade. When the chuck is removed, the soldering tip, which is also supplied, may be screwed in.

When used as a hot knife, the 25-watt tool will cut most light plastics and epoxies, strip insulation from wires, carve foam plastics, and cut and seal ends of plastic rope and woven plastics.

More information on the Model SP23HK will be supplied on request. Weller

Circle No. 9 on Reader Service Page

MODULAR POWER SUPPLIES

A new line of high-efficiency, high-power modular supplies designed to power transistor circuitry, lights, relays, motors, and solenoids is now available.

The new LW Series performs at high efficiency (greater than 50%) at current ratings to 200 amperes and voltage ranges up to 48 volts d.c.

Forty-two models are offered in four package sizes. Packages D, E, and EE are sub-rack modular components while package G is a full-rack unit.

Self-restoring current limiting and a self-resetting thermostat provide full protection. A fixed, automatic electronic current-limiting circuit limits the output current on external overloads—including short circuits—providing protection for the load as well as the power supply.

Complete specifications on the LW Series will be supplied on request. Lambda

Circle No. 10 on Reader Service Page

LED DISPLAY-PANEL METER

A light-emitting-diode display digital panel meter which is half the size of a calling card and readable in sunlight has been introduced as the Model 3330.

The brillant, ruby-red gallium-arsenide diodes give the 3½-digit display a lightness and reliability unobtainable in tube-type digital meters, according to the company.

The new panel meter is designed for such rigorous, high-density applications as aircraft cockpit displays or anywhere space, weight, or severe environmental conditions are problems.

To obtain complete specifications on this new type of panel meter, address your letterhead request to Digilin, Incorporated, 1007 Air Way, Glendale, California 91201.

MODULATION INDICATOR

A solid-state modulation indicator, designed for CB use in monitoring microphone output signals, is presently on the market as the "Mod 1."

The new unit allows a CB operator to instantly know and correct, if necessary, output modu-

lation. With the indicator, an operator no longer has to depend on incoming reports to determine what kind of signal he is transmitting.

The unit operates on a standard 9-volt battery and is compatible with all CB sets. It measures 7½" long × 3 $^{15}/_{16}$" high × 4" deep and is finished in brushed aluminum and black Lucite. Turner

Circle No. 11 on Reader Service Page

ALKALINE BATTERY

A new heavy-duty rechargeable alkaline battery is now available as the "Duracell" 6K70.

This 6-volt dry battery can be used to power portable television sets, roadside barricade lights, portable lighting, and other applications where high energy and better charge retention is required.

The battery comes fully charged and ready for use. Since it is a dry cell and does not require the addition of acid or water, there is no danger of electrolyte spill. Recharging restores the battery's power overnight, using ordinary house current and an approved charger. Mallory Battery

Circle No. 12 on Reader Service Page

TRANSISTOR CURVE TRACER

The Model A curve tracer performs the function of dynamically testing transistors both in-circuit and out-of-circuit. This new type of instrument allows a technician to use the curve tracer to troubleshoot any type of transistorized circuit irrespective of impedance or type of circuit being tested. The curve tracer is used with a monitor scope to display the patterns which are developed when a circuit under test is checked

with the special probe supplied with the instrument.

The tracer produces two signals, a 120-Hz pulsating d.c. voltage, variable from 0 to 80 volts, which appears across the collector to emitter of the transistor under test and a synchronous staircase generator which applies six steps of current to the base of the transistor. This current is variable from 10 μA/step to 1 mA/step in a 1-2-5 sequence.

Complete specifications and further details are available on request. Jud Williams

Circle No. 13 on Reader Service Page

IC EXPERIMENTER KITS

A series of seven integrated-circuit kits that require only a soldering iron and simple hand tools to build have been introduced for the experimenter wishing to obtain experience working with IC's.

The kits contain both active and passive components, predrilled printed-circuit boards, and complete instructions. Included in the present line of kits are a mike preamplifier, two-channel mixer, audio oscillator, 9-volt regulated power supply, intrusion alarm, fire alarm, and an oscillator-amplifier—plus a kit enclosure and hardware pack. All circuits are battery operated and require a minimum of tools to build. RCA Commercial Engineering

Circle No. 14 on Reader Service Page

STEREO RECEIVER

The new KR-5150 stereo receiver incorporates several deluxe features such as terminals for three sets of stereo speakers with a front-panel speaker-selector switch to control each separately, or A and B or A and C together; center-channel output; inputs for two phonographs; two auxiliary lines; and terminals for a tape deck.

Frequency response is 20-40,000 Hz ± 1.5 dB, power bandwidth is 17-30,000 Hz, and distortion is 0.5% at rated output. The tuner section

features a two-FET four-gang tuning capacitor front-end and two IC and mechanical filter i.f. stages. An AM-FM signal-strength meter and an FM zero-center tuning meter with indicator light aid in tuning accuracy.

Complete information and specifications on the KR-5150 will be forwarded on request. Kenwood

Circle No. 15 on Reader Service Page

ALPHA-NUMERIC READOUT

A new alpha-numeric readout has just been introduced by Opennheimer, Inc., Wyandotte Road, Willow Grove, Pa. 19090.

The new unit features miniature size (character measures 0.40" × 0.40"), readability in sunlight, front relamping, and a choice of colors and filters. The mating solid-state circuitry is optional.

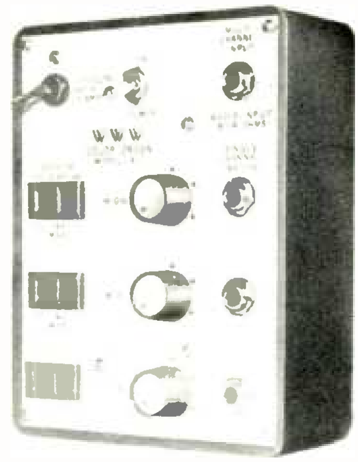
The company can supply the readouts as individual units that can be stacked or can furnish custom integrated blocks with digits, symbols, and decimal points.

Data Sheet TDS-514 giving complete information on these new units will be forwarded upon letterhead request.

COLOR ORGAN

The Model 412 three-channel color organ delivers 500 watts per channel and features individual channel inputs for use with instrument amplifiers or a single-channel input for use with hi-fi systems.

The bass, mid-range, and high-frequency sen-



sitivity is adjustable for each channel. The filter bandpass is from 20-200 Hz for the low frequency, 140-2000 Hz for the mid-range, and 1400-20,000 Hz for the high channel. Audio input is 8 ohms and each channel or multi-channel sensitivity is 0.5 volt. The unit is powered by 120-V, 60-Hz a.c. and draws 6 amps. The light display is not included. WWW Electronics

Circle No. 16 on Reader Service Page

PANEL DISPLAYS

The Electronic Components Division of Burroughs Corporation has recently introduced two new panel displays—the "Panaplex" numeric panel display, a unitized 8 to 18 digit display; and the miniature "Self-Scan" alpha-numeric panel display.

The "Panaplex" uses a 9-segment character format and common-cathode construction, providing a "centered" 1, in-plane readout, and consistent digit alignment. With the "Self-Scan" display the dot size is 0.018" with the dots on 0.030" centers. The character shape is in the standard 5 × 7 dot matrix format.

Technical data sheets on both of these new displays are available on letterhead request to the Division, P.O. Box 1226, Plainfield, N.J. 07061.

BURGLAR ALARM

An automotive burglar alarm that can be installed in minutes and features a unique triggering system has been introduced as Catalogue No. 30-3180.

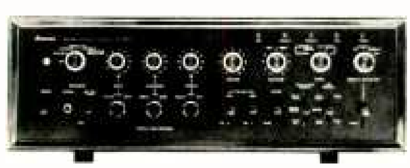
The alarm is triggered by a sudden drop—even a few millivolts—in battery voltage. Such a drop occurs when a door is opened, turning on the dome light, or when lighted glove compartment, trunk, or engine compartment is opened. It is also activated when the starter is used, the headlights turned on, or even when the radio is turned on. Such a sudden voltage drop fires an SCR which activates the alarm—a loud emergency bell. GC Electronics

Circle No. 17 on Reader Service Page

CONTROL CENTER/AMP

The Model AU999 control amplifier is capable of handling two recorders or decks in a tape-copying operation while independently handling other program material. It also features electrical separability of the preamp-control section from the power amp for handling different programs or for introducing electronic crossover networks.

The basic power amplifier, direct-coupled throughout, has a frequency response of 5 to 100,000 Hz ± 1 dB at normal listening levels, music power output of 180 watts (4 ohms IHF).



and distortion less than 0.4% at rated power output. The preamplifier response is 20-70,000 Hz +0.5 dB, −1.5 dB, with IHF hum and noise figures better than 80 dB for the phono and mike inputs. Sansui

Circle No. 18 on Reader Service Page

REVERSING CASSETTE RECORDER

An automatic-reverse cassette deck has recently been introduced as the Model 150D. Frequency response is 30-14,000 Hz±3 dB while the outer-rotor synchronous motor used with the deck provides constant speed and freedom from distortion, according to the company.

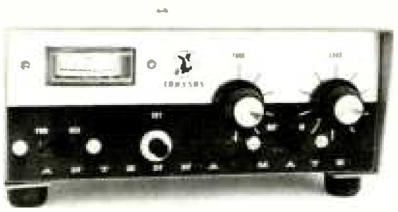
Other features incorporated in the deck include automatic shut-off and stop, which turns the amplifier off at the end of both sides of the cassette in play and record; two vu meters for accurate control of level on each channel; pause control; slide-pot controls for selection of left- and right-channel volume; push-button control for all modes of operation; tape-position index counter; and a full complement of inputs and outputs. Cassette features include slot loading, cassette viewing window, and instant cassette eject. Roberts

Circle No. 19 on Reader Service Page

TUNER/S.W.R. METER

A new combination antenna tuner and s.w.r. meter, which contains everything needed to measure and correct antenna line mismatch has been introduced as the "Antenna Mate."

It can correct antenna line s.w.r.'s of up to 5:1



to less than 1.1:1. A built-in meter reads the standing-wave ratio from 1:1 to 10:1 and also indicates the relative power output. The unit is merely inserted in the coaxial line between the transceiver and antenna, using standard coax connectors. E.F. Johnson

Circle No. 20 on Reader Service Page

FLUTTER METER

The new Model F-1 flutter meter is simple enough in its operation and fast enough to be used for production testing and service work. It

can be used with all types of tape recorders and is useful in checking turntables.

In operation, a signal is recorded (in the range 2-4 kHz) on the recorder under test and then the playback signal is connected to the Model F-1 and the flutter read. Calibration is accomplished by adjusting two screwdriver controls through access holes in the bottom of the case. A $7\frac{1}{2}$ in/s calibration tape is supplied for this purpose.

The Model F-1A with a built-in 3-kHz oscillator is also available. Details on either or both of these models will be supplied on request. BHK Electronics

Circle No. 21 on Reader Service Page

ALL-CHANNEL SPLITTER

A 300-ohm TV color-rated v.h.f./u.h.f./FM signal splitter is now available as the Model FS-1314-FM.

This unit, connected to the lead from any all-channel antenna, produces signals for an all-channel TV receiver in color or in black-and-white and for mono or stereo FM. The splitter separates the incoming signals according to frequency range and the signals are available at three different sets of 300-ohm outlets: v.h.f. from 54 to 216 MHz, u.h.f. from 470 to 890 MHz, and FM from 88 to 108 MHz.

No stripping of the lead is needed for this easily installed unit. Jerrold

Circle No. 22 on Reader Service Page

23-CHANNEL CB UNIT

The "Tiger 23" CB radio features 23-channel operation with all crystals included, a 3-position delta-tune switch which corrects for off-channel transmissions at the other end, a large illuminated combination r.f./"S" meter, an automatic noise limiter with manual override switch, and automatic modulation control.

Weighing only 4.5 pounds and measuring $6\frac{3}{4}$" wide × $2\frac{3}{8}$" high × $8\frac{1}{8}$" deep, the unit also features a p.a. system, modulation light, illuminated dials, and a plug-in dynamic mike. The circuitry is solid-state and the unit includes a ceramic filter. Pearce-Simpson

Circle No. 23 on Reader Service Page

2-METER MOBILE

A compact mobile FM transceiver for operation in the 144-148 MHz band is now available as the Model HR-2.

The solid-state unit features a 10-watt power output with operation on any of six transmit and receive channels in the band. Simple operator modification, however, will enable the radio to transmit and receive on any of twelve different duplex combinations.

The receiver section is a double-conversion superhet with a selective ceramic filter for operation on both wide- and narrow-band signals. Sensitivity is rated at 0.35 μV, 20-dB quieting, and audio output at 5 watts. The transmitter features phase modulation for carrier stability.

The $2\frac{1}{4}$" × $5\frac{1}{2}$" × $7\frac{1}{4}$" package comes complete with plug-in ceramic microphone, a 3-4 ohm 4" built-in speaker, and mobile mounting bracket. Regency

Circle No. 24 on Reader Service Page

STATIC-CHARGE METER

An electrostatic locator with all-solid-state circuitry, for use in detecting static charges and indicating their polarity and magnitude, is now on the market. The small, lightweight, battery-powered unit is operated by merely pointing it toward the object or material on which charges

are to be measured. The meter is direct-reading, eliminating the need to refer to calibration charts. It operates continuously without periodic readjustments. Optional accessories include an extension probe for reaching into normally inacessible areas and an adapter for measuring charge on a single thread. Simco

Circle No. 25 on Reader Service Page

Answers to C.E.T. Test, Section #11

Published in Last Month's Issue

1. **(c)**
2. **(b)**
3. **(d)**
4. **(c)**
5. **(a)** On weak signals, with possibly only a portion of a volt a.g.c. supplied to the tuner, the small plus bucking voltage is a significant percentage of it to reduce or "delay" the tuner a.g.c. As the a.g.c. increases, on medium- or high-level signals, the percentage is reduced and tuner a.g.c. is greater in effect.
6. **(b)** Neutralization or stabilization is needed to reduce "Miller effect," leading to oscillation.
7. **(c)** Once the sound frequency is tapped off and channeled to the sound i.f., a trap is needed in the video output section to eliminate 4.5-MHz interference in the video.
8. **(a)** Passing the horizontal pulse through a short time-constant RC network sharpens the pulse to a spike, or narrow pulse width, and eliminates any low frequencies reaching the horizontal section.
9. **(d)**
10. **(d)** Many receivers have provisions for changing the focus connection to several different voltage sources; selection is based on best over-all focus, determined visually.

MANUFACTURERS' LITERATURE

TOOLS FOR TECHNICIANS

A 72-page, handbook-size catalogue entitled "Tools for Electronic Assembly and Precision Mechanics" is now available for distribution as No. 470.

Of particular interest to electronic technicians, engineers, scientists, and instrument mechanics working on fine assemblies, the publication describes over 1700 individual items. Section headings include screwdrivers, wrenches, pliers, tweezers, files, shears, knives, microtools, relay tools, tool kits, power tools, metalworking tools, wire strippers, soldering equipment, lighting and optical equipment, work holders, and miscellaneous apparatus. Jensen Tools

Circle No. 26 on Reader Service Page

ELECTROLYTIC CAPACITORS

A 4-page folder that features axial-lead (TAD series) and upright radial lead (PCD series) low-voltage, 85C miniature aluminum electrolytics is now ready for distribution. Complete capacitance, voltage, and size specifications on both series are clearly shown for easy reference.

A section on performance characteristics defines all the elements associated with capacitor use, such as capacitance, voltage, environment, d.c. leakage current, dissipation factor, and equivalent series resistance. Related tests are also described. International Electronics

Circle No. 27 on Reader Service Page

LOUDSPEAKER LINE

The completely new, redesigned line of "Concert Series" loudspeakers is covered in a two-color, 8-page catalogue (No. 1090-E) which has just come off the press.

Speaker sizes span the range from 3" to 15" in the round type and 2" × 6" to 6" × 9" in the oval configuration. The catalogue provides information on model numbers, impedance, magnet weights, voice-coil diameters, power, physical size, baffle openings, shipping weights, and list prices. Photographs of the various speakers are also included. Jensen Manufacturing

Circle No. 28 on Reader Service Page

FILM CAPACITORS

A 28-page illustrated catalogue which describes 23 types of precision film capacitors is now available. The publication includes specifications and photos of miniature capacitors of polystyrene and hermetically sealed Mylar and mica capacitors. The catalogue contains capacitor nomenclature and selector guides as well as information on the firm's facilities and production techniques. PFC Division of Arco

Circle No. 29 on Reader Service Page

POWER-SUPPLY CATALOGUE

A 32-page catalogue covering modular d.c. power supplies and precision voltage references is now available on request.

In addition to providing complete technical details on a standard line of high-regulation power supplies, the catalogue includes information on the CEA2 series of d.c.-to-d.c. converters, the CEA3 series of high-efficiency power supplies, and a line of highly shielded line isolators.

All of the power supplies include as standard such features as series starting, no turn-on or turn-off overshoot, all silicon semiconductors, and shielded transformers. A unique ordering system allows selection of an almost unlimited cross combination of any desired center voltage from 3.5 to 500 volts with voltage adjustment ranges from ± 10% to ± 40%, classes of regulation from 10% to 0.0005%, and output from 50 mA to 60 A. CEA Division

Circle No. 30 on Reader Service Page

MOBILE ANTENNA DATA

A 12-page brochure covering CB mobile antennas and mounting options is now off the press and ready for distribution.

The brochure describes three new CB whips plus nine new interchangeable mounting accessories which are packaged and marketed separately to provide the CB-er with the equivalent of 78 mobile antenna systems from which to choose. The units are pictured and described in detail and the mounting options outlined to facilitate selection. Mosley

Circle No. 31 on Reader Service Page

CAPACITOR REPLACEMENT GUIDE

A 24-page electrolytic capacitor replacement guide which lists the firm's "Arcolytic" capacitor replacement products by original manufacturer's part number for color and black-and-white receivers, as well as replacements for certain Aerovox, Sprague, and Mallory electrolytics, is now ready for distribution. Loral Corp.

Circle No. 32 on Reader Service Page

SEMICONDUCTOR ALMANAC

General Electric's Tube Department has just issued a new 52-page Entertainment Semiconductor Almanac (ETRM-4311F) containing approximately 20,000 cross references from JEDEC or OEM part number to GE part number for universal replacement semiconductors, selenium rectifiers for color TV, dual diodes, and quartz crystals.

Also included is application and technical data on universal transistors, as well as specifications, prices, and terminal and base drawings for the company's entertainment transistors, quartz crystals, zener and crystal diodes, maintenance industrial replacement semiconductors, and selenium, silicon, and germanium rectifiers.

Write the Tube Department, Distributor Sales Operation at 316 E. Ninth St., Owensboro, Ky. 42301 on your business letterhead for a copy.

FIXED RESISTOR BULLETIN

The Electronic Components Division, Stackpole Carbon Company, Kane, Pa. 16735 has released copies of its new fixed composition resistor bulletin, No. 80-100.

The 8-page booklet covers comprehensive technical data with illustrated charts, component features, application guidelines, and packaging specifications.

To obtain a copy, address your letterhead request to the attention of James S. Sennett, Product Sales Manager of the division. ▲

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60	Hickok Instrumentation
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Marine Communications

(Continued from page 27)

tions have v.h.f./FM before they could license and install SSB (after January 1, 1972). They also, quite naturally, supported the requirement for both coast and ship station monitoring of channel 16 (156.8 MHz) in the v.h.f./FM marine band. Since v.h.f. is, more or less, line-of-sight, a blanket listening watch on the National Distress frequency of channel 16 is even more vital than on 2182 kHz. With this in mind, the Coast Guard has "embarked on a multi-million dollar program of equipment procurement which eventually will provide continuous guard of 156.8 MHz in all areas of heavy boating traffic and to at least 20 miles offshore along our coast line." In addition, Coast Guard v.h.f. installations on the West Coast, heretofore a weak point, have been bolstered by high-altitude installations. Finally, direction finding (DF) capability on v.h.f. will, according to Captain Gordon F. Hempton, the Coast Guard's Chief of Communications, be implemented on all Coast Guard search aircraft. This lack of DF capability has often been cited as a drawback.

Some minor changes made are: no new double-sideband transmitters will be type-accepted after January 1, 1971; tightening of frequency tolerances in the 2-3 MHz band (see Tables 2 and 3); availability of more frequencies in the 2-3 MHz band (see Table 4); and SSB transmitters type-accepted under the 3.5-kHz bandwidth framework (prior to December 31, 1969) may continue in use *as long as they are installed before January 1, 1972*. If the installation is to be after January 1, 1972 the manufacturer must submit an amendment showing that these transmitters will be able to maintain a 3-kHz bandwidth.

Commercial fishing vessels presently have one v.h.f./FM channel (#88; 157.425 MHz) which is limited to their use alone. It is a ship-to-ship and ship-to-associated aircraft frequency and became available on March 1, 1969. Under the transition to single-sideband, commercial fishing vessels acquire a 2-3 MHz frequency—2093 kHz—limited to their use alone on a ship-to-ship basis (see Table 4 for conditions of use).

Whom it Affects

This finalization of marine communications will affect every user both commercial and recreational and, in the end, every technician and service and maintenance organization in the country. These effects will range from a change in sales policies, need for improved instrumentation, increased knowledge on the part of technicians all the way to what crystals to carry in stock (Table 5).

Different organizations will be affected in varying degrees. Those shops which have specialized in land-mobile v.h.f. as well as marine work will have no difficulty in transferring the know-how acquired in that work to the repair and maintenance of v.h.f. marine equipment. Those who have been handling a great deal of ham radio work will have no mysteries presented to them in servicing marine SSB phones.

With no known exceptions, the major old-line sales and service houses are well-provided with instrumentation and technicians for both SSB and v.h.f./FM and their hardest job will be to wait for the great influx of business. Not really concerned even with waiting are those firms which have been doing a large amount of commercial radio maintenance. There remain only those shops which haven't been doing much except servicing 2-3 MHz double-sideband marine radiotelephones. If they haven't yet realized that there's going to be more to the radio business than finding the right size screwdriver to fasten those little clips on the tank coil, they will be faced with a dwindling supply of customers. ▲

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

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

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

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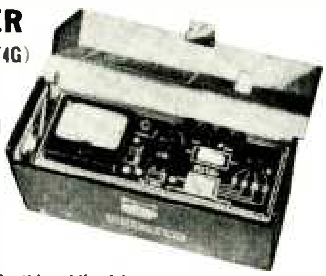

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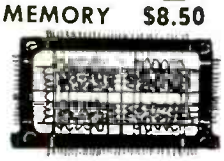

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