Electronics World

DECEMBER, 1970
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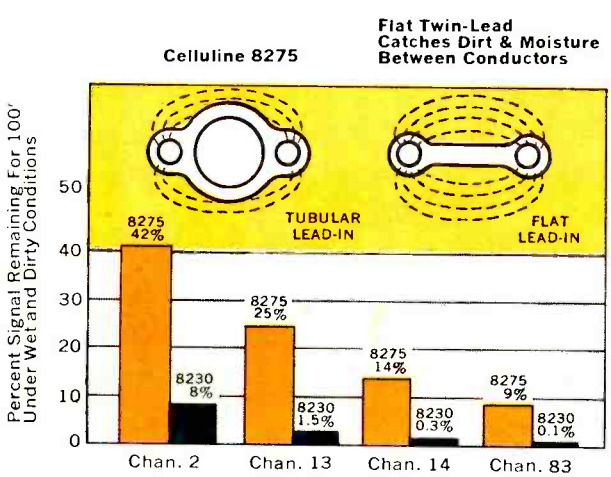

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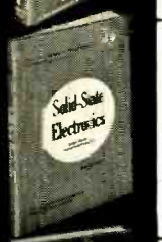

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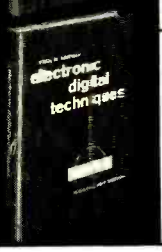

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Electronics World

DECEMBER 1970 VOL. 84, NO. 6

Contents

THIS MONTH'S COVER illustrates our lead story on the new stereo receivers which we have lab-tested. The four receivers shown are representative of the entire group. Receiver at the upper right is the KLH Model 27. Below it is the Marantz Model 22. At bottom right, with its cover removed, is the Altec-Lansing Model 714A. Standing on end at left, also with cover removed, is Panasonic Model SA-70. For complete details on these and other receivers, see our lead story on page 27.
Photograph: Dirone-Denner.

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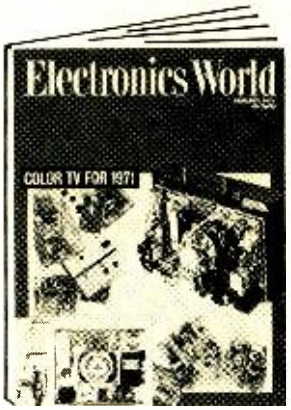
Special Feature Articles



Color Television for 1971

Next month's issue will feature three timely and important articles on the 1971 color-TV receivers available on the market. A comprehensive listing of makes and chassis will include the most important specifications—both electrical and mechanical—on the sets you will encounter this next model year. One interesting and popular design trend seems to be toward modularizing TV sets for greater reliability and ease of servicing. Details on two color receivers, one from RCA and the other from Heath, will be discussed in two informative articles covering design philosophies and special features of these two representative sets.

Light Displays That Enhance Music

Color organs and strobe lights can add to the emotional impact of music and, for that reason, are gaining in popularity at a phenomenal rate. How do they work, what can they do—or not do—and what sort of units are available? This article provides the answers.

Testing Hi-Fi Equipment

In this second article of a two-part series, Julian Hirsch covers the test procedures for servicing quality hi-fi components, provides useful hints on avoiding some common testing errors, and outlines simplified techniques which require a minimum of specialized test equipment. Whether audiophile or professional technician, you can't afford to miss this article if you want your equipment to operate at its peak potential.

Marine Communications Up-to-Date

A summary of the latest and proposed FCC Rules and Regulations that will lead to extensive changes in marine radio operations. While SSB will still be used in the 2-3 MHz band, there will be a decided expansion of the v.h.f./FM marine band. For the pleasure boater, commercial ship operator, or marine-radio technician, this article is a "must."

*All these and many more interesting and informative articles will be yours in the **January** issue of ELECTRONICS WORLD . . . . . on sale **December 17th.***

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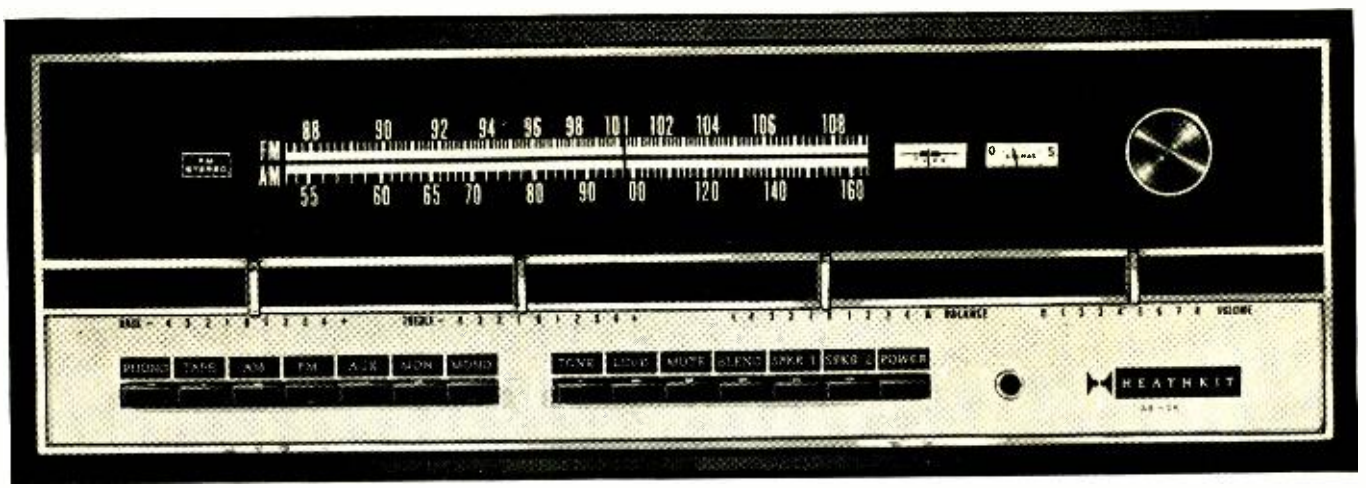
"How well does the Heathkit AR-29 perform? Very well indeed!"..."No other receiver in its price class can compare with it!"

Julian Hirsch, Stereo Review magazine



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And this is what he writes about Distortion: "Harmonic distortion was under 0.1 per cent from 0.15 to 50 watts, and under 0.03 per cent over most of that range. IM distortion was about 0.1 per cent at any level up to 50 watts. At its rated output of 35 watts per channel, or at any lower power, the distortion of the AR-29 did not exceed 0.15 per cent between 20 and 20,000 Hz. The distortion was typically 0.05 per cent over most of the audio range, at any power level."

About Input Characteristics: "... the AR-29 can handle any modern cartridge without risk of overload, and provide low distortion and an excellent signal-to-noise ratio."

About Hum & Noise: "Hum and noise were extremely low: -90 dB at the high-level auxiliary input and -71 dB on phono, both referenced to a 10-watt output level."

About Assembly: "... the AR-29 construction made a positive impression." "... assembly has been markedly simplified."

Says Mr. Hirsch about overall performance: "The test data speaks for itself." "... no other receiver in its price class can compare with it."

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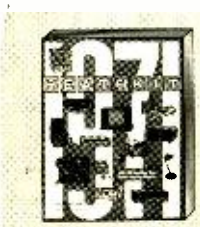

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CIRCLE NO. 137 ON READER SERVICE CARD

For the Record

More on 4-Channel Sound

WM. A. STOCKLIN, EDITOR

WE have just returned from a three-day session at the Island Inn Motel (Westbury, Long Island, N.Y.) where this year's IHF Hi-Fi Show was held. It was an outstanding success, beyond the expectations of some of us in the industry, with over 12,000 in attendance. Despite the small rooms, narrow halls, and inadequate air conditioning (with temperatures in the 80's), very few seemed to object. Attendance was also good at the technical symposia which we have handled at all the Hi-Fi Shows for the past seven years. We attracted even greater numbers of enthusiasts than at previous shows, and many of these sessions were "standing-room only" affairs.

Four-channel stereo was the main attraction and we were not too surprised to find that very few individuals, including many in the industry, really had even a basic concept of how one of the most important 4-channel techniques to date, the Scheiber system, works. Unfortunately, not much has been published on it. One of the best analyses, as far as we know, was that published in our September issue. Still, even today, Scheiber's company (patent now owned by *Advent Corp.*) has not released all pertinent details or any schematic diagrams. Even though there is this lack of information on the subject, we think it appropriate to review some of the basics of 3- and 4-channel phantom stereo, along with further thoughts on the Scheiber system.

Picture a conventional 2-channel stereo system with speakers 12-feet apart. If you were to add a bass-only center speaker, it would have no effect on stereo response except to fill the hole in the middle. If, however, you were to add a wide-range speaker in the center, it would tend to pull the speakers together. With a simple matrixing system, the speaker could be connected between the output terminals of the left and right channels. If connected in-phase, as it should be, signals on left and right channels would be additive; that is, they would appear on the center channel. A soloist would then dominate the center, as he should. In a ping-pong set-up (left speaker "on" and right one "off"), the sum would be 1 + 0 and the center speaker would have the same signal as on the left. Conversely, with the right speaker "on" and the left one "off," the center channel would reproduce the same material as the right side. In essence, the center speaker is "on" in both situations.

With the same program on the left and center speakers simultaneously, the source would appear to be at a point midway between the two. The tendency would be to reduce the apparent sound spread between the speakers from 12 feet to 6 feet. Under normal operation, the power output of the center speaker would be reduced (down 6 dB) and, in a case like this, the pulling-in effect would not be as great.

In the early days of stereo there were many 2-channel discs and tapes which were not properly phased; some were 180 degrees out-of-phase. An interesting phenomenon occurred, and it is not beyond the realm of possibility that even today, in playback with a center speaker, the soloist would not be heard dead center but through the two outer speakers.

Dave Hafler of *Dynaco, Inc.* is not averse to the front-center speaker but he suggests that another be added in back of the listener, connected 180 degrees out-of-phase. (See "Adding Extra Channel for Improved Hi-Fi Ambience" in our October issue.) This effect is somewhat similar to that of the front-center speaker in that a ping-pong effect would be similarly produced from the rear speaker. The only difference is in the soloist's performance. In an out-of-phase connection, the rear speaker would have zero output. But picture what would happen if the 2-channel program source were originally out-of-phase as suggested above. Then the soloist would be heard in the rear speaker and be divided across the two outer speakers in the front. This, of course, is unnatural and should be avoided.

Let's replace the rear-center speaker with two in the back—one on the left and one on the right—connected out-of-phase with the front units. Through matrixing, it is possible to direct a negative-going, out-of-phase signal to one side and a positive-going, out-of-phase signal to the other, thus creating a phantom 4- or 5-channel system. Bear in mind that the entire response is thus obtained from a conventional 2-channel disc or tape program source. This phenomenon (although not a true 4-channel system) is excellent and adds immeasurably to listening pleasure.

Now let's substitute four microphones for the four speakers—with a combo in the center—and obtain a tape recording on a four-track system. Normally, the front-left and rear-left programs are added together in-phase to produce one channel of a 2-channel stereo system. The other side similarly produces the right channel.

Peter Scheiber, on the other hand, came up with the idea of adding a fixed combination of in- and out-of-phase signals from each of the 4 tracks onto each of the four channels, and then developed an encoder to combine the 4 channels down to conventional 2 tracks. A decoder enables the listener to separate them into independent sources. In essence, he has developed a 4-channel stereo system. It is compatible with present 2-channel and mono systems. It can be reproduced on 2-channel discs or tape and can be broadcast over FM stations without further FCC approval.

The final result of his system is of particular interest. Without his gain-riding control, channel separation was quite poor. Starting with equal signals on all 4 tracks, final channel separation was 3 dB between any of the two side speakers with zero output from the diagonal speaker. So he developed the gain-riding circuit that cuts off and/or reduces output from the two diagonally opposed speakers while boosting the output of the other two. The final result, even with the gain-riding circuits active, is that channel separation varies from a minimum of 3 dB to a relatively high value, depending on the relationship of signal levels. Actually, the company claims that, under average conditions, the channel separation between any two speakers is

around 15 dB. (See page 43 for a more detailed explanation.)

Other 4-channel stereo systems have been announced. For example, Len Feldman, President of *S.C.A. Services Co., Inc.*, has designed a unit which supposedly gives good performance. But, since nothing has been released on this as yet, we're unable to comment on its potential. Other designs will be cropping up shortly, too, including some from overseas. For example, the *Victor Co. of Japan* has developed a 4-channel disc using a subcarrier technique.

Four-channel tape with four distinct tracks is here today. Many manufacturers have announced 4-channel, reel-to-reel machines and there are already a few 4-channel tapes available. Looking ahead, we hope the industry will follow along these lines. At the moment, it's the only true form of 4-channel stereo available.

RCA has already announced that it plans to go with 4-channel on 8-track cartridge machines, while *North American Philips* has also been promoting the idea of four channels, on both 4- and 8-track cassette cartridges. In our opinion, an 8-track cassette is ludicrous. In trying to divide an eighth-of-an-inch tape into 8 distinct tracks, you'd fall below the minimum requirements for signal-to-noise ratio, frequency response, and channel separation. Since the cassette is earmarked as an economy machine, it seems more sensible to keep it as it is and use a 2-track, 4-channel system source, similar to the Scheiber system, as the actual program medium. We also feel that this approach would be more suitable for the 8-track cartridge machine although, as mentioned above, *RCA* has already announced a 4-channel system.

No doubt Peter Scheiber's system, and possibly two or three others, will co-exist, much like the 33⅓, 45, and 78 r/min discs have—at least in the beginning. But, the system that provides the best technical performance will undoubtedly survive. If all systems perform equally well, then marketing know-how may be the key to success. We also picture that this approach will be used in FM broadcasting until a true 4-channel multiplexed system is developed. There are at least ten such systems before the FCC now but, judging from past experience, it will probably be 5 to 10 years before field tests are made and final approval given to any one specific design.

Four-channel stereo is here and it's not just a sales gimmick to promote the sale of hi-fi equipment. It's a truly more enjoyable medium for hi-fi sound reproduction. It adds still another dimension and comes much closer to providing true concert-hall reproduction in the home. ▲

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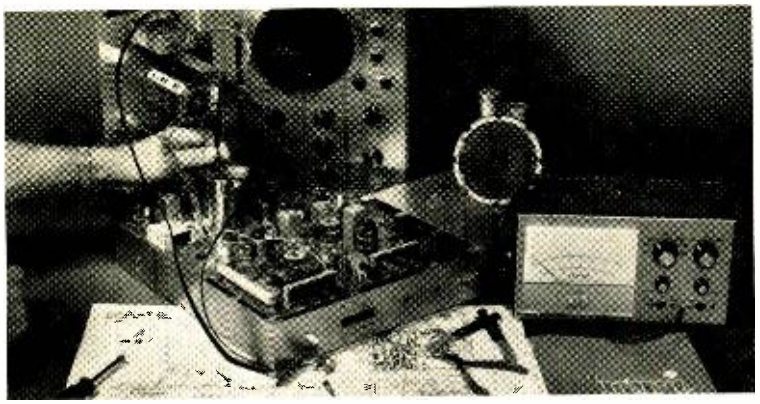

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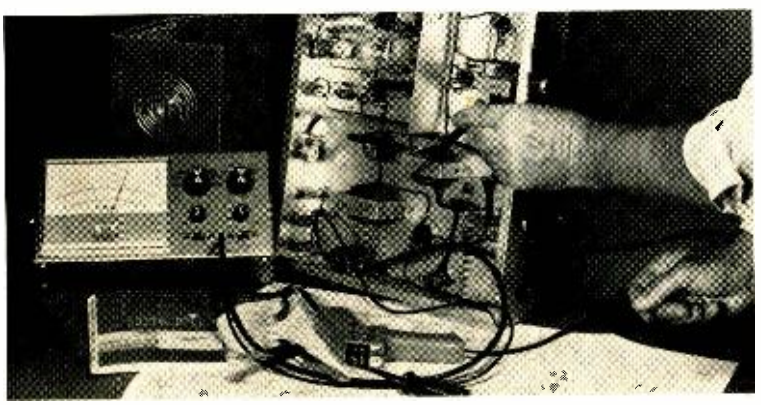

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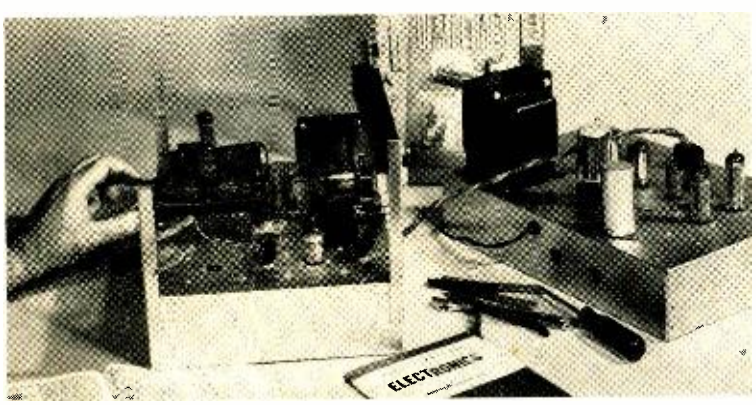

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LETTERS

ELECTRONICS BY HOME STUDY

To the Editors:

I have just finished reading the article by Louis E. Frenzel, Jr. in your September, 1970 issue ("Can You Learn Electronics by Home Study?"). Speaking for both the *Cleveland Institute of Electronics* and as a past president of the *National Home Study Council*, I want to compliment the author and ELECTRONICS WORLD for the fine presentation of the question and the answer. It is the best coverage of the subject I have ever seen in a national publication.

There is one point that needs additional comment. Our school enrolls students both by mail and by salesmen and has done so for over 15 years. In that period approximately 50% enrolled by mail and 50% by salesmen. The costs of enrollment are likewise about equal. Therefore, while we have no "axe to grind" by favoring one registration procedure over the other, it is manifestly inaccurate to categorically state that the tuition cost is higher for a particular course if a salesman is employed. If Mr. Frenzel would care to explore this matter in detail, I'm confident he will see that tuition costs are based on educational value to the student.

Finally, there is an implied fallacy in Mr. Frenzel's use of the term "equivalent course." Courses offered by the different schools may have equivalent objectives, but that by no means is the same as equivalent courses. Education is not bought and sold by the pound. Unless all aspects of a course are carefully evaluated, it cannot be considered equivalent to another course of a similar name.

G. O. ALLEN, President
Cleveland Institute of Electronics
Cleveland, Ohio

* * *

ELECTRONICS & METEORITES

To the Editors:

I was very much interested in the article by L. George Lawrence, "Electronics & Meteorites," in the July, 1970 issue. The study of meteorites has been a fascinating hobby of mine for many years and I have been engaged in exploration geophysics since 1935. Since most of my experience has been in seismic exploration for oil, I was a little disappointed that Mr. Lawrence did not mention the seismic method. However, I doubt that this technique has been applied to any great extent to the search for meteorites, so I do not consider the omission too serious.

I was fascinated by the theory of the ricocheting meteorite that produced the Barringer Crater. It would be a great advance for this theory if meteoritic material were to be located in the Gulf of Mexico somewhere near the trajectory shown in Fig. 3 of the article. I believe I can indicate a good place in the Gulf to begin the search. I should like to call to Mr. Lawrence's attention a paper published in "Geophysics" Vol. 21, pages 755-764, by L.G. Ellis and A.C. Winterhalter, "Unusual Reflection Events in Off-shore Seismic Work," which describes a number of unusual reflection patterns observed in a seismic survey in the Gulf of Mexico, off the mouth of the Rio Grande River, in South Texas, not far from where the theoretical trajectory is shown entering the Gulf. Due to the unusual nature of these events, which seemed to come from eight definite sources, it was decided to investigate them in some detail.

I was associated with this investigation and suggested that the sources of these unusual reflections might be meteorites embedded in the Gulf floor. We did not have a magnetometer or a gravitometer available for this work so it was not possible to obtain data to either support or refute the meteorite theory.

The locations of some of the sources were investigated with a depth sounder. This study indicated that a shallow depression in the Gulf floor was associated with each of these sources. The largest one investigated was about 13½ miles east/southeast of Brazos Santiago Lighthouse, which is located at latitude 26° 04′ and longitude 97° 24′. The other seven sources lay northwest and some were a little west of north from the largest one. The most distant was about 16 miles northwest. The large depression was about 1000 feet long and about 250 feet wide, with the major axis oriented northwest/southeast. The other depressions were not large enough to determine orientation with any degree of accuracy. There is too much more data to discuss in a brief letter, but I shall be

glad to go into additional detail for serious scientists in the field of meteoritics.

JOHN W. MILLINGTON
5555 Hooks Ave.
Beaumont, Texas 77706

* * *

ARMY's SCR-268 RADAR

To the Editors:

On looking at the June, 1970 issue of ELECTRONICS WORLD, I was pleasantly surprised to see Dr. Harold Zahl's article on the SCR-268. I enjoyed it more than any other I've seen in a good many years as it brought back memories of days (and nights) spent on Sandy Hook, Twin Lights, and the lab at Fort Monmouth.

I am living on the San Francisco peninsula only a few miles from the San Bruno *Eimac* plant (since torn down) where they made some of the VT-127's for the SCR-268. Enclosed is a sketch of another facet of the Sandy Hook story.

BEN CHOW
Foster City, Cal.

Thanks to Reader Chow for sending along a cartoon drawn in 1941 at Sandy Hook, N.J. showing Dr. Zahl chasing some of his associates around the old Army radar after one of them dropped one of his experimental tubes.—Editors

* * *

IMPORTED REPLACEMENT PARTS

To the Editors:

The first item in the "Radio & Television News" column (June issue) on the difficulty of getting replacement parts may be correct in some instances, but mostly these difficulties originate in the American service shops which just won't work on foreign products.

I had the following experience with my *Uher* tape recorder: A small plastic part holding the tape reel to the uptake drive broke. I tried to buy this minor part in several service stores and finally wrote to the U.S. distributor for the L.A. area, also with no result. I not only did not get the part but was not even found worthy to have my letter answered. I therefore wrote to the *Uher* factory, Germany, and received this part by air mail, free of charge, in 12 days. This ultra-fast service puts the blame squarely in the laps of the American distributors and service shops.

LEOPOLD F. SCHATZL
Ontario, Cal.

As was pointed out in our column, obtaining replacement parts is a major problem not only from foreign but also from domestic manufacturers. Reader Schatzl puts the blame in still another quarter. All of which points up the difficulty of keeping up with the ever-increasing supply of all types of electronic and non-electronic appliances.—Editors ▲

Radio & Television news

By MURRAY SUNTAG/Associate Editor

Inspecting Color TV

In an attempt to intensify and speed up inspection of potentially hazardous color-TV sets, *RCA* has retained the services of *A.C. Nielsen Company*, a national research organization. *Nielsen* will contact dealers and service agencies to explain and help implement color-TV safety program started in January, 1970. Absorbing full cost of program, *RCA* is supplying its dealers as well as approximately 12,500 independent TV service agencies with technical information kits that will further assist them in locating, inspecting, and, if necessary, modifying the *RCA* sets involved.

Investigations have shown that instances of fire or smoke reported in *RCA* sets have occurred principally in older models and had involved components which, although having met or exceeded applicable safety standards at time of manufacture, had worn out after long periods of usage. Actually the number of the company's sets involved was less than 37 out of every million *RCA* sets in use annually over the 1965-69 period covered by the National Commission on Product Safety study.

Herbert T. Brunn, Vice-President of Consumer Affairs (see News Highlights of June, 1970), expressed *RCA's* sense of commitment when he said, "The number of sets that still could be characterized as a potential problem, while small in relation to the total in use, remains unacceptable to *RCA* and therefore we are continuing our program of corrective action." He further added, "We hope other TV-set manufacturers will join in the type of corrective action we have undertaken."

Hazardous Weather Warning

The Weather Bureau's v.h.f.-FM weather radio stations, part of nation-wide Natural Disaster Warning System, have added a device which will alert listeners to special warnings of hazardous weather. Device, called "tone-alert," transmits signal which will automatically de-mute (turn up volume on) special receivers within 40- to 50-mile radius of station. Receivers without de-muting capability will produce distinctive three- to five-second tone when adjusted for normal listening. Weather Bureau then proceeds with emergency message.

Weather Bureau stations operate 24 hours a day and transmit continuous weather forecasts and observations. When hazardous weather threatens, routine transmissions are interrupted and messages are devoted exclusively to emergency weather bulletins. Now, thanks to tone-alert, schools, hospitals, civil disaster agencies, newspapers, radio and TV stations, and any individuals who have radio receivers with a "weather band" at 162.550 or 163.275 MHz can be assured of positive notice of impending storms.

Stations equipped with tone-alert are located at Boston, Mass.; New London, Conn.; Atlantic City, N.J.; Washington, D.C.; Norfolk, Va.; Charleston, S.C.; Jacksonville, Miami, and Tampa, Florida; New Orleans and Lake Charles, La.; Galveston and Corpus Christi, Tex.; Cleveland, Canton, and Akron, Ohio; Los Angeles and San Francisco, Calif.; and Honolulu, Hawaii. The radio station at New York City will install the tone-alert in the near future and new stations equipped with the tone-alert will soon be transmitting from Brownsville, Tex.; Seattle, Wash.; and Portland, Ore.

De-muting tone-alert receivers are currently priced at from $150 and up to those without de-muting feature, that can pick up Weather Bureau's v.h.f. transmissions, from below $20 and up.

TV Repairwoman

Changing nation's image of a TV service*man* and bolstering the declarations espoused by the Women's Liberation Leagues, Diana Ildefonso, America's youngest (17 years old) TV "repairwoman," has proven that a woman's place is definitely not only in the home. In fact, according to Diana, women are even more qualified than men for TV repair because "Women care more about detail." A Job Corps graduate in electronics, Diana is receiving on-the-job training at *Regal Magnavox Home Entertainment Center* in Linden, New Jersey. In addition, she is also taking the *Magnavox* correspondence course in color-TV repair and plans to complete her training by attending classes in TV repair at Union County College in Fall.

Consumer Backlash

The coming year, 1971, could very well be the year that industries catering to consumer appetites will

receive their comeuppance—perhaps long overdue? Storm flags are flying, warning of the disenchantment of the consumer with the products rolling (perhaps literally so) off the assembly lines today. Looking back, it seems that not so long ago we used to laughingly point to the large volume of defective consumer items being produced in Russia. We attributed it to the apathy that existed there as a result of the lack of competition in a communistic-oriented economy. So, what's our excuse?

There are many bills pending before Congress which are regulatory by nature and it may be this year's new crop of Congressmen, who campaigned on the consumerism issue to garner votes, may just be obliged to make good on their promises to their constituents. No one is pointing a guilty finger but, where charges can be made to stick, certain industries will have to tighten up their inspection programs or face the penalty. Let's hope that our system of *laissez faire* can weather the onslaught—because the last thing we need is a government-controlled economy.

Zenith's "Phonevision"

In August of this year, *Zenith Radio Corporation's* "Phonevision" system for over-the-air subscription TV (STV) became the first to be granted technical approval by the Federal Communications Commission. Three other firms, *Vue Metrics, Inc.* of Philadelphia and two others—one in Detroit and the other in Boston—have filed with the FCC to conduct pay-TV operations. (At press time, authorization had not as yet been received.) Pay-TV technical systems cannot be used commercially unless advanced approval has been granted by the FCC. Requirements state that the system must deliver a signal to the customer's antenna that complies with all the Commission's technical standards for TV pictures and sound, and must not require any internal modifications to subscriber's receiver.

The *Zenith* system transmits a scrambled television signal (picture and sound) that is unscrambled by a compact Phonevision STV solid-state decoding device installed in the subscriber's home. The subscriber can see first-run movies, blacked-out sports events, Broadway shows, and other features not available on free TV simply by placing a subscriber's "ticket" in the decoder and then dialing a simple code. *Teco, Inc.* has been licensed by *Zenith* to promote and commercially develop Phonevision in North America and to establish franchising organizations. *Teco* will supply franchise holders with encoding equipment for STV transmissions and provide expert technical assistance in the marketing, engineering, and program services areas. *Zenith* will supply franchisees with decoding units for installation in subscriber's homes.

All in all, 1971 promises to be a banner year for all TV-philes with this vintage crop of TV innovations (STV, CATV, VTR) coming to fruition. Competition will be keen. Undoubtedly, the state of the economy and which system offers the "mostest for the leastest" will have a profound influence as to which system or systems will survive. We'll keep you informed on all the interesting highlights as they occur.

1971 NEW Show Florida-Bound

James L. Nichols, a *Mallory Distributor Products Co.* executive and newly elected president of the Electronic Industry Show Corp., has announced that the 1971 NEW Show will be held on June 3, 4, and 5 (Thursday through Saturday) at the Americana Hotel in Bal Harbour, Florida. The Show will feature displays, product presentations, distributor/supplier conferences, national marketing seminars, the introduction of new products, new policies, and new packaging, as well as providing an ideal setting for sales meetings. Because of the profitable operation of the 1970 NEW Show in Chicago, all those who exhibited will receive a *pro rata* rebate of $24.72 from an operating surplus of $6750. For further information about the 1971 NEW Show, contact Executive Vice-President Kenneth C. Prince at the Electronic Industry Show Corporation, 100 South Wacker Drive, Chicago, Illinois 60606; telephone (312) 263-4523.

Business Sidelights

Anticipating increased European demand for American-made high-fidelity equipment, *Superscope, Inc.* recently opened a new division, *Marantz International, S.A. Inc.* in Brussels, Belgium. All sales and warehousing of *Marantz* stereo and hi-fi components for the European, Mideast, and African markets will be handled by this division.

Reflecting what may become a nation-wide trend among some of the giant corporations of this country, due to defense cutback and economic slowdown, *RCA* has consolidated its defense and commercial electronics groups. In an attempt to streamline operations and enhance company's competitive position in government and commercial systems markets, the *RCA* Commercial Electronic Systems groups and Defense Electronic Products have been merged into the Government and Commercial Systems Group. Irving K. Kessler, *RCA* Executive Vice-President of new organization, feels that this reorganization will benefit business programs and customers of both of the firm's government and electronics operations by facilitating the interchange of capabilities and technologies between the two areas. ▲

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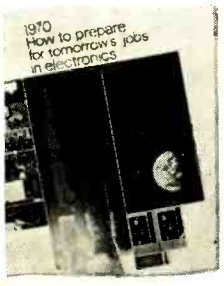

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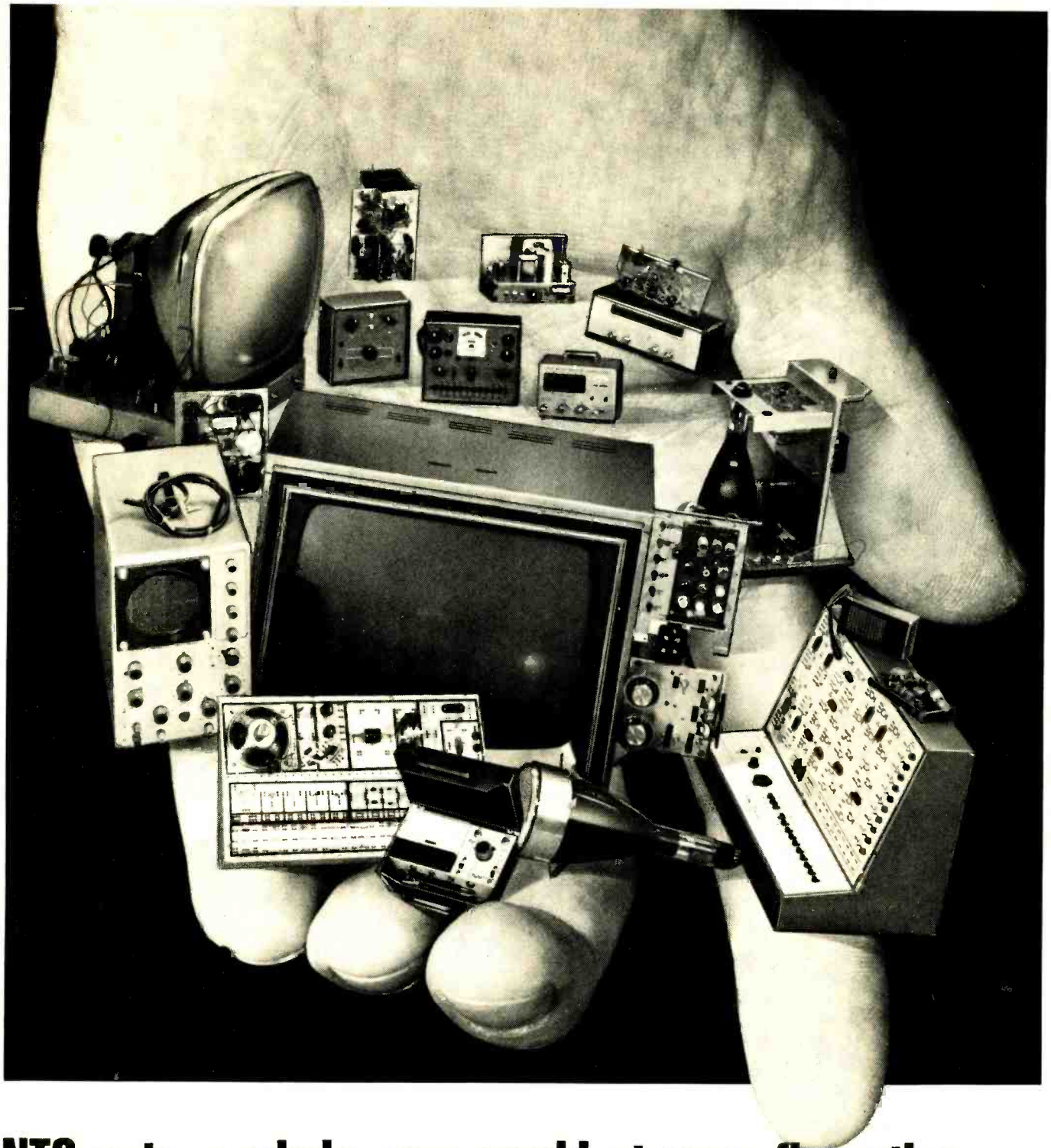

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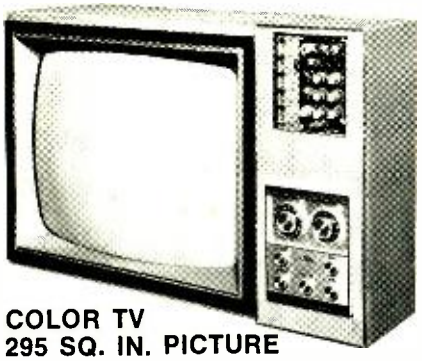

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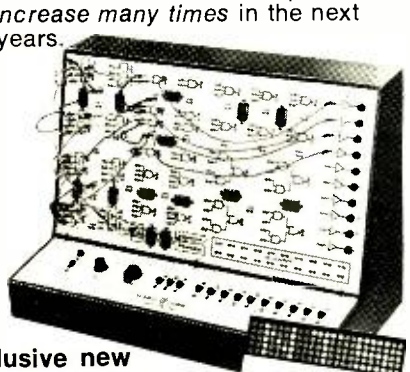

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HI-FI PRODUCT REPORT

EW LAB TESTED

by Hirsch-Houck Labs

Dynaco SCA-80 Integrated Stereo Amplifier
Wollensak 6250 Tape Recorder

Dynaco SCA-80 Integrated Stereo Amplifier

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

DYNACO has combined its highly regarded PAT-4 preamplifier and Stereo 80 power amplifier (with minor modifications) into a single unit, the SCA-80. Hardly larger than the preamplifier alone, the SCA-80 delivers a conservative 40 watts per channel, with the very low distortion and noise level that has characterized the company's amplifiers in the past.

Some of the exceptional control flexibility of the PAT-4 has been omitted from the SCA-80, but it is not likely to compromise the usefulness of the SCA-80 in any way. Instead of concentric tone controls, the SCA-80 has ganged controls operating on both channels simultaneously. The steep cut-off high-cut filter of the PAT-4, with its three cut-off frequencies, has been replaced with a single cut-off at about 6 kHz, having a 6 dB/octave slope. The filters (including the 150-Hz high-pass rumble filter) are controlled by a single three-position rocker switch. The low-cut filter can be used alone, or both can be operated simultaneously, or both switched off. The tone-control circuits and characteristics have not been changed.

The SCA-80 has three high-level inputs, plus a set of connectors for a tape recorder which allows its playback to be selected by the Tape Monitor switch. The two low-level inputs are Phono and Special. The latter is normally used as a second phono input with RIAA equalization. Alternatively, it can be wired with NAB tape-head equalization, or without equalization as a microphone input.

Separate volume and balance controls are provided, with switchable loudness compensation. The three-position Mode rocker switch has the usual Stereo and Mono positions, and in the middle it is a Blend control, giving 6-dB separation. This is designed to be used with a center-fill speaker (full information can be obtained from *Dynaco*) or to reduce the separation for headphone listening. The company has introduced a system for four-channel stereo reproduction which uses the blending capabilities of its SCA-80 (and PAT-4) plus two additional speakers, and does not require any additional amplifiers. The headphone jack of the SCA-80 will drive 8-ohm stereo phones.

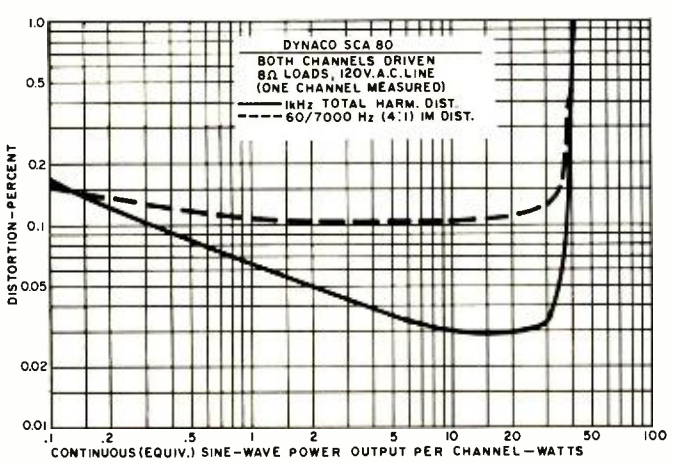
The two sets of speaker outputs can be selected, one at a time, from the front panel. In the rear of the amplifier, in addition to the inputs and outputs, are two a.c. convenience outlets, one of which is switched. The speaker terminals use plastic-insulated screws, which are very easy to turn and do not require a screwdriver.

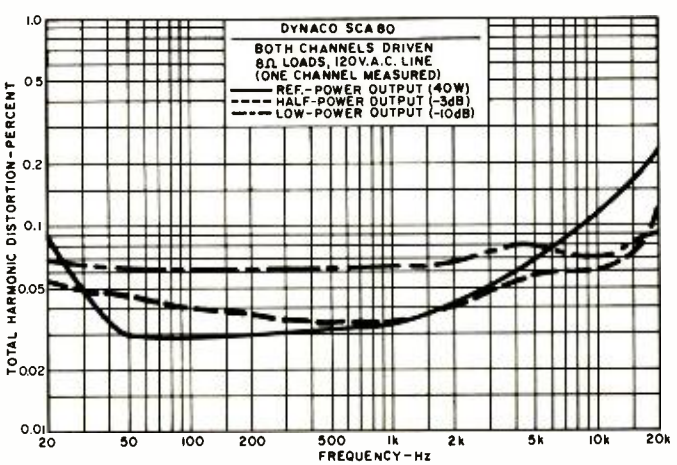
In our lab tests, the SCA-80 proved to be very much like the PAT-4 and Stereo 80 in its performance. The tone-control characteristics are rather unusual, with most of their very large range of control taking place near the ends of the knob rotation, for the treble control, and near the center of the knob settings for the bass control. With both controls centered, the response was ±0.5 dB from 20 Hz to 20 kHz.

The RIAA equalization was within ±1 dB from 30 Hz to 15 kHz. The filters have very gradual slopes, which limit their ability to remove noise or rumble without affecting the program material.

With both channels operating at 1000 Hz, the *Dynaco* SCA-80 had less than 0.1% harmonic distortion from 0.35 watt to 37 watts per channel. It clipped at 46.5 watts (into 8-ohm loads). IM distortion was 0.15% or less up to 33 watts. Into 16 ohms, the output was down about 37%. The power amplifier has a protective circuit that limits its output current so that we could not make full power measurements into 4 ohms. However, the circuit tripped at 41 watts, so it can easily deliver its rated power to 4-ohm loads.

At the rated 40-watts output, harmonic distortion was under 0.1% from 20 Hz to 9 kHz, rising to only 0.25% at 20 kHz. At half power or less, the distortion was under 0.1% over almost the full 20-Hz to 20-kHz range, and typically measured about 0.05%. Hum and noise were 76 dB below





10 watts on the high-level inputs, and 72 dB below 10 watts on phono inputs. The phono gain was high enough so that only 1.35 millivolts were needed to drive it to 10-watt output, yet the preamplifier did not overload until 70 millivolts were applied.

Clearly, the outstanding performance of the PAT-4 and Stereo 80 have been retained in this integrated amplifier, which is available both in kit form and factory-wired. It is simple to construct, with a clearly written instruction manual. We tested both a factory-wired unit as well as one that was assembled from a kit, with essentially similar results.

The *Dynaco* SCA-80 sells for $169.95 in kit form, or $249.95, in the factory-wired version. ▲

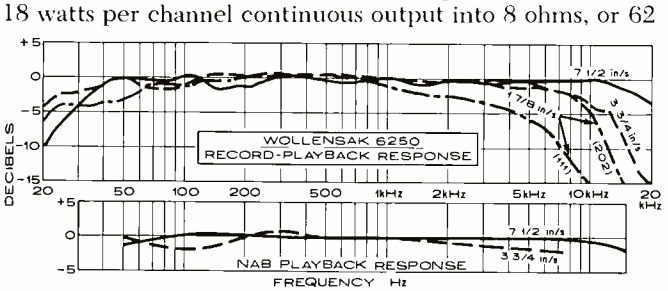
Wollensak 6250 Tape Recorder.

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

THE *Wollensak* 6250 tape recorder, designed for home use, offers a level of performance that only a few years ago was unobtainable except in truly professional machines. The recorder is housed in a slim portable case and weighs only 25 pounds, making it truly portable. It can be operated horizontally or vertically. The three-speed transport has two motors—one for driving the capstan and the other for the two reels. Its mechanically operated controls are the ultimate in simplicity, with no sacrifice in flexibility. An automatic shut-off turns off the transport when the tape runs out or breaks in any operating mode.

The 6250 is a three-head machine, with separate recording and playback amplifiers. Either the original signal or the taped signal can be channeled to the output jacks. Tape threading is as simple as we have seen on any machine; the tape path is a direct wrap across the heads, without any tensioning arms or rollers in the way.

The speakers supplied are meant for monitoring only and cannot approach the quality required for full appreciation of the recorder's capabilities. The built-in amplifiers are better than most we have seen in home tape recorders, and are good enough to serve as a moderately good home music system using external speakers. The amplifiers are rated at 18 watts per channel continuous output into 8 ohms, or 62 watts total IHF dynamic-power output. External program sources can be readily plugged into the amplifier and all the normal high-fidelity component-amplifier features are included.



In addition to the standard inputs, there are two mixing inputs that can be used for re-recording material coming from the unit's own playback amplifiers, or for adding other external program sources. As many as four mono sources can be mixed in this manner. Two sets of preamplifier outputs are provided for connection to an external amplifier. One set is fully controlled by the 6250's own controls; the other is unaffected by any control settings. A slide switch sets the 95-kHz bias level for optimum performance with standard tapes (such as *3M* 111) or low-noise tapes.

We made record-playback frequency-response measurements at all three speeds, using both *3M* Type 111 and Type 202 tapes. At 7½ and 3¾ in/s, we found no essential difference in the frequency response of the two tapes when the bias-level switch was set appropriately. At 1⅞, however, the 202 tape had markedly superior highs, so that it yielded approximately the same response as at 3¾ in/s. Typical record-playback response measurements were 30 to 20,000 Hz ±2 dB at 7½ in/s, 25 to 10,000 Hz ±2 dB at 3¾ in/s, and 20 to 10,000 Hz ±3 dB at 1⅞ in/s. Using *Ampex* test tapes, the playback frequency response conformed to the NAB standard within ±1.5 dB at 7½ in/s, and within ±2 dB at 3¾ in/s.

The 6250 requires only 33 millivolts at the high-level inputs, or 0.37 millivolt at the magnetic phono inputs, to achieve 0-dB recording level. The output from a fully recorded tape was 220 millivolts from the "uncontrolled" outputs, and up to 1.1 volts from the controlled preamplifier outputs. Distortion was a low 1 percent at 0 dB, and only 1.9 percent at the maximum meter reading of +3 dB. Signal-to-noise ratio, referred to a recording distortion level of 1.9 percent, was 47 dB, and the noise was principally 60-Hz ripple. If the 0 dB had been set by the manufacturer at the 3-percent level (a common practice), the signal-to-noise ratio would have measured even better. In any case, hiss levels were extremely low, and no noise was audible in normal use.

Wow and flutter were low: 0.04 and 0.09 percent respectively at 7½, and 0.08 percent and 0.12 percent at 3¾ in/s. Tape-playing speeds were slightly fast, by about 12 seconds in 30 minutes. In the fast-forward and rewind modes, 1200 feet of tape were handled in about 67 seconds.

We also checked the built-in amplifiers of the recorder. The 1000-Hz harmonic distortion was under 0.3 percent from 1.5 to 14 watts, rising to 1 percent at slightly over 20 watts and below 0.15 watt. The IM distortion was under 0.6 percent up to 8-watt output, reaching 1.2 percent at the rated 18 watts. At the full 18-watt output (per channel), distortion was under 1 percent from 90 to 20,000 Hz. It rose rapidly at lower frequencies. However, at half power or under, it was well below 1 percent from a frequency of 20 to 20,000 Hz.

We found the recorder very easy to operate. Its controls are extremely simple and tape loading was much less of a chore than usual. Recording stereo-FM broadcasts, we could hear no difference whatever between the original and recorded signals at 7½ in/s, and only a slight loss of highs at 3¾ in/s. At 1⅞ in/s the quality was very pleasant and certainly more than adequate for background music as well as the usual speech-recording applications of this particular speed.

When one considers the fine performance of the *Wollensak* 6250 as a tape recorder and deck, as well as an audio amplifier and control center, its suggested list price of $380 makes it quite a bargain. This price includes a pair of low-impedance dynamic microphones of surprisingly good quality. ▲

NEWS HIGHLIGHTS

Engineering Dilemma

Approximately 9400 immigrant engineers enter the U.S. each year. This fact, plus shrinking job market for engineers, prompted John R. Kiely, acting president of the Engineers Joint Council, to recommend to Secretary of Labor James D. Hodgson that prospective immigrant engineers be required to have a job offer before entering the U.S. According to report put out by the Council's Manpower Commission, about 45,000 new engineers were needed this year and only 40,000 will be required in 1971, in contrast to previous Labor Department estimates of approximately 65,000 per year. Since same number of engineering graduates will become available, barring further changes in draft or major declines in engineering college enrollments, and due to large number of engineers being laid off in aerospace and defense industries, continued unrestricted immigration can only serve to aggravate the unemployment situation. A copy of the report, "The Future Supply of Engineers 1970-1978," published as Engineering Manpower Bulletin Number 17 can be obtained from EJC, Dept. P, 345 East 47th Street, New York, N.Y. 10017, at a handling charge of $1.00.

Japanese Computer Industry

According to a recent issue of Japan's Fuji Bank Bulletin, the Japanese, although starting their own research and development programs ten years later than their foreign competitors, are now serious contenders in race to become world leaders in computer manufacturing. This was only made possible through the help of American technology and the imposing of import and tariff restrictions by the Japanese government. Another interesting sidelight brought out by this bulletin was that all Japanese computer manufacturers, with exception of *Fujitsu*, have tie-ups with American firms: *Hitachi, Ltd.* with *RCA, Mitsubishi Electric* with *TRW, Nippon Electric* with *Honeywell, Oki Electric* with *Sperry Rand (Univac)*, and *Toshiba* with *General Electric* (computer division recently combined with *Honeywell*). And, despite restrictions on direct investment, a number of foreign-owned enterprises, *IBM Japan* and *National Cash Register Co. (Japan)*, are already in existence.

Deaf "Hear" via Teleprinter

Thanks to *ITT World Communications*, subsidiary of *International Telephone and Telegraph Corp.*, and "Tele-typewriters for the Deaf," a non-profit organization, deaf people can now communicate with each other by telephone. By supplying deaf people with teleprinters, one deaf person can contact another simply by picking up phone and dialing. Instead of phone ringing a light comes on and the two then "talk" to each other over their teleprinters. An acoustical coupler is used to convert teleprinter signals into high- and low-pitched sounds which can be carried by an ordinary telephone line. These sounds activate similar equipment at the other end of the line. *ITT* has been supplying old teleprinter models gratis to "Tele-typewriters for the Deaf" where volunteer mechanics strip, clean, and re-wire them. Renovated models are then delivered to people on waiting list.

Off-Track Betting

Computer Sciences Corp. (CSC) of Los Angeles, California has been selected by the *New York City Off-Track Betting Corp.* to receive a five-year contract for design, development, and implementation of nation's first totally automated wagering system. The *CSC* system will provide New Yorkers access to off-track wagering through some 100 to 200 branch offices and a telephone deposit betting exchange. Ironically, or perhaps not so ironically since gambling *is* a big business in this country, this will represent one of the largest and most unique data processing systems in nation.

Open Sesame

Like tale out of Arabian Nights, computerized security system, called comSAFE (computerized Safeguard Against False Entry), refuses person admittance to vaults and other strategic areas unless properly encoded badge is inserted into badge reader. If punched code on badge is not recognized by system computer (or has been reported missing), badge reader will hold fraudulent card and alert security officer. No two badges are alike, as 12 digits can be punched into badge, offering millions of combinations. With rash of illegal office entries occurring every day in congested urban areas, a system of this type could be used to keep out unauthorized personnel. Badge reader, which is key to system, was developed by *Sealectro Corp.* of Mamaroneck, N.Y. and comSAFE by *World Computer Systems Engineering Corp.* of Dallas, Texas.

Optoelectronics

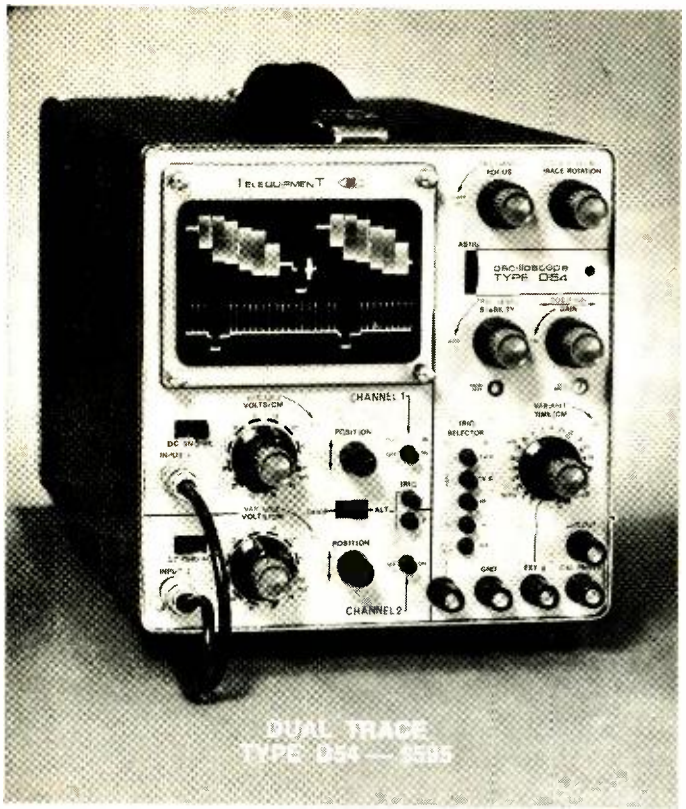
Realizing potential market that will exist for optoelectronics by late 1970's (expected to exceed $1 billion annually), *RCA* has created the Solid-State Optoelectronics Products Department. New department, to be headed by Edward O. Johnson, was created by consolidating the liquid crystal, infrared emitting diode, infrared injection laser, photocell, and tunnel diode activities. Applications for optoelectronics are constantly being found in consumer, industrial, aerospace, and military equipment. For example, liquid crystals are being applied to numeric and animated graphic displays; infrared emitting diodes and injection laser diodes and diode arrays in intrusion systems, communications systems, collision warning systems, traffic control equipment, and aircraft altimeters; and photocells provide convenient means to control street lights, automatically monitor oil burner flames, automatically adjust the iris on a camera, and perform many other light-sensitive functions. By placing all these activities under one roof, *RCA* hopes to gain broad technological capability in optoelectronic product design.

Aquaplaning Risk Indicator

Inertial Switch Ltd. of 123 London Rd., Camberly, Surrey, England claims to have developed system that will measure exact depth of water on an airfield runway and provide pilots with precise knowledge about risk of aquaplaning. Tests have shown that only 0.05" of water can cause aquaplaning on most untreated runways and 0.2" on grooved or porous runways. The system, called Aquaplaning Risk Indicator for Landing (APRIL), is made up of a series of sensing heads and their control boxes, an air traffic controller's monitoring panel with an electronics console, a power unit, and a chart recorder that provides permanent print-out of water depth. APRIL can measure depth of water from 0.006" to 0.6" to an accuracy within $\pm$0.001". Data is transmitted by cable from runway directly to control tower. Within a year manufacturer hopes to replace cables with a radio telemetry link.

Apollo Safety Features

As a direct result of near tragedy on Apollo 13 mission last April, a 400-amp/hour battery will be added to service module as an alternate power source in case spacecraft's main power supply fails. An additional 20 pounds of water and a third oxygen tank have also been installed. These modifications will permit a powered-down mode of emergency flight from lunar orbit to landing back on Earth. ▲



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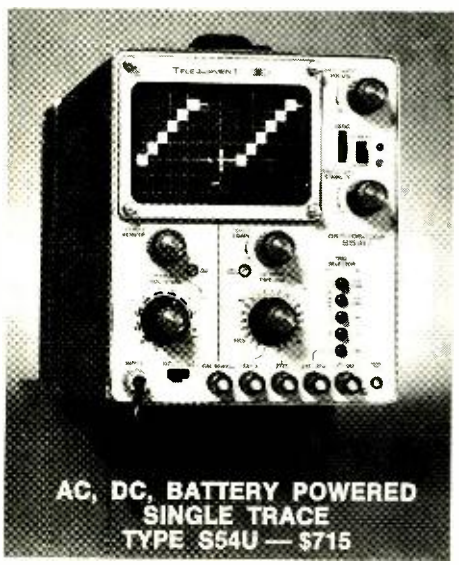

The 54 Series represents a new standard of performance for low priced oscilloscopes. The use of field effect transistors in the input stages means that the trace is stable . . . even at a deflection factor of 10 mV/cm. The ability to trigger at TV field or line rate, coupled with magnified sweep speeds to 40 nanoseconds per centimeter, permits high resolution analysis of video signals. Want to look at the 3.58 MHz color subcarrier? You can do it with any of the 54 Series.

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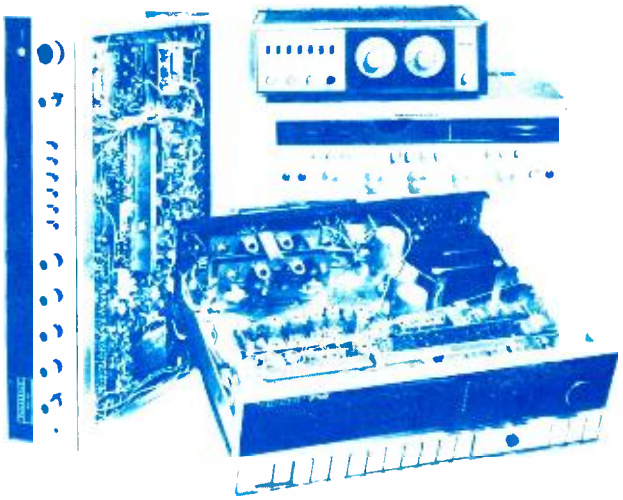
EW Lab Tests New STEREO RECEIVERS



By JULIAN D. HIRSCH /Hirsch-Houck Laboratories

Results of our laboratory measurements on seventeen of the newest hi-fi models. Recent design trends are covered, along with descriptions of other available receivers.

THE latest stereo receivers reflect, for the most part, their designers' utilization of recent developments in semiconductor devices and assembly techniques. As always, styling is an important consideration for a component occupying such a visible position in the user's home, and here each manufacturer has gone his own way. As might be expected, certain design trends (push-button switches, slider-type controls, etc.) appear quite generally throughout the field.

For this survey, we have tested seventeen stereo receivers from as many manufacturers. Most manufacturers offer a line of receivers, similar in general configuration, but with substantial differences in power output, sensitivity, and price. In such cases, we will describe the other models briefly, indicating their principal differences from the unit tested.

The receiver tests were generally similar to those we perform for our regular equipment reports, but were slightly abbreviated to simplify a tabular presentation of the data. Unlike some equipment "surveys" which present only the manufacturers' specifications, all the performance data in this report was obtained from actual measurements made in our laboratory. Due to normal variations from unit to unit and to differences in test conditions, our numerical data may not always match the published ratings, but since it was obtained under identical conditions for all the receivers, it forms the basis for a valid comparison.

Recent Design Trends

Certain features are common to most of the receivers, and need only be mentioned where a particular model differs from the others. For example, AM reception is provided by all the units except the *AR*, which is an FM-only receiver. Although some of the AM tuners contain interesting design features, and there are significant differences in performance among them, we did not test them except for a brief listening evaluation. In our judgment, all of the units in this survey offered satisfactory AM performance, although none could qualify as a "high-fidelity" AM receiver.

The *KLH* 27 was the only receiver lacking a front-panel stereo-headphone jack, capable of driving low-impedance phones. All the receivers had tape-recorder inputs and outputs, with switches for monitoring from a three-head recorder while recording. A few, as noted in the table, had additional tape-input and output jacks on the front panel for connecting a recorder without access to the rear of the receiver, or for dubbing from one recorder to another.

As far as we could determine, all the receivers tested had FET r.f. amplifiers, and many also used FET's in the mixer stage. In a few cases (*Harman-Kardon*, *Panasonic*, and *Sherwood*), schematic diagrams were lacking, but we assume from their performance and the current state of the art that they also used FET's. The FET is relatively immune to overload and cross-modulation effects from strong signals.

With their freedom from self-heating, solid-state receivers are virtually drift-free, and automatic frequency

(Continued on page 30)

MFGR. & MODEL	Cont. Pwr. per Ch. at 2% THD (8 ohms)			Harm. Dist. at 1 kHz			Audio Sens. for 10 W Out.		Hum & Noise re 10 W		RIAA Phono Resp. 50-15 kHz re 1 kHz (dB)	Phono Overload (dB) (5)	Max. Power (8 ohm pwr =100%)		IHF FM Usable Sens. (μV)	FM Dist. at 75 kHz Deviation (1%)	FM Sens. (Dist. 3 dB over Min. value) (μV)	FM Freq. Resp. 30-15,000 Hz (re 1 kHz) (dB)
	30 Hz (W)	1 kHz (W)	20 kHz (W)	1 W (%)	10 W (%)	Max. Pwr.(4) (%)	Aux. (mV)	Phono (mV)	Aux. (dB)	Phono (dB)			4 ohms (%)	16 ohms (%)				
Acoustic Research Model AR	>50(1)	65	>50 (1)	.068	.031	.060	84	0.72/2.1	−70	−62	+0, −1	34.5	122	60	1.8	0.46	3.7	+0, −2
Altec 714A	45.3	55.5	48.5	.125	.059	.081	106	0.75	−77.5	−74	+1.3, −0.7	33.0	114	64.5	1.7	0.73	2.6	+1.8, −0
Bogen BR-360	15	27	>15 (1)	.47	.40	.30	170	1.1	−77	−72	±1.5	30.8	103	67.5	2.8	0.59	5.5	+0, −3.7
Electro-Voice EVR-3	39.2	55.3	54.5	.08	.048	.035	90	0.95	−73	−70	±1.0	29.5	128.5	61	1.5	0.71	2.0	+0, −3.7
Fisher 450-T	55 (1)	60	55 (1)	.08	.075	.08	95	0.8/3.0	−73	−66/ −53	+0.8, −0.3	36.0	125	60	1.85	0.55	3.0	+0.5, −3.2
Harman-Kardon 330	11	18.3	17.5	.15	.14	.22	135	2.5	−72	−70	+0.3, −0.8	26.0	127	67	2.1	0.87	8.0	+0.7, −0.9
Heath AR-29	>35(1)	55	>35 (1)	.03	.023	.028	81	1.0 (3)	−90	−71	±0.5	27.0(3)	152	57	1.75	0.70	2.5	+1.0, −0
Kenwood KR-4140	17.1	21.5	24.0	.08	.04	.06	88	1.25	−71	−68	+0.5, −1	38.8	127	63.5	1.6	0.70	2.4	+0.8, −0.6
KLH 27	19.8	32.5	27.0	.40	.37	.44	69	0.7	−71	−63	+2.5, −0.8	33.3	118	68	2.6	1.0	4.5	+1.9, −1.3
Lafayette LR-1500TA	41	45.5	>40 (2)	.071	.045	.057	96	0.75 1.65 4.6	−77	−75	+1, −0	32.7	140	62	1.7	0.70	8.0	+3.1, −0.2
Marantz 22	49.5	55	52.5	.028	.013	.017	82	0.76	−81	−77	+3.5, −0.5	38.3	83.0	57.4	2.3	0.47	3.2	+0.3, −0.6
Panasonic SA-70	23.5	31	30	.15	.13	.16	96	1.0 3.0	−73	−68/ −56	+2, −0	36.5	121	71	3.5	0.85	7.5	+1.4, −6.8
Pioneer SX-1500TD	>35(1)	47	>35 (1)	.17	.155	.17	91	1.0	−75	−73	+1.5, −0	36.8	136	60	1.9	0.90	4.5	+0, −2.8
Sansui 2000A	30.4	37.5	36.8	.16	.083	.14	80	1.4	−77	−70	+0.8, −0.5	35.5	129	60	1.6	0.95	2.25	+0, −3.8
Scott 387	61	68	64.5	.24	.085	.15	200	1.4 2.8	−68	−63	+1, −0.2	26.5	166	61	2.9	0.74	3.7	+0.6, −0.5
Sherwood S-7100	17.1	25.6	22.4	.22	.10	.21	140	1.05	−73	−68	+1.5, −1	36.0	109	67	1.5	0.69	2.5	+0.3, −5.6
Sony STR-6055	41.5	46	46	.017	.007	.028	63	0.76	−78	−75	+0, −3.5	40.5	122	64	2.5	0.52	4.0	+0, −3.2

NOTES: (1) Exact figures not available—Not measured under stated conditions; (2) Protective circuits operated, prevented measurement. (3) Continuously adjustable phono sensitivity. Overload not possible when set up correctly; (4) 1dB

OTHER STEREO RECEIVERS

BECAUSE of time and space limitations, we were able to test only one receiver from each of the manufacturers listed in the table above. In addition to the models tested, most of these companies have other receivers in their lines. More expensive models usually have higher output power, an improved tuner section, and more features. Also, some manufacturers make the tuner or amplifier sections of their receivers available as separate components. In all cases, prices have been rounded off to the nearest whole-dollar amount and these prices are all "audiophile net," which is the price the final buyer pays for the receiver. All prices are subject to change.

Acoustic Research also has available the Model AR stereo control amplifier with specs similar to the amplifier section of its receiver. The amplifier, rated at 50 W/ch (watts per channel) continuous power output into 8 ohms, is priced at $250, with metal cover.

Altec-Lansing also offers the Model 725A, an AM/stereo-FM receiver rated at 60 W/ch continuous power output into 8 ohms. The tuner section has slightly better sensitivity and capture ratio than the Model 714A. Price is $699 without cabinet.

Bogen, in addition to the Model BR360 tested, has a number of other AM/stereo-FM receivers with various output powers. The Model BR320 is rated at 15 W/ch cont. power output into 4 ohms and is priced at $200. The Model BR340 is similar except that its power output is 30 W/ch cont. into 4 ohms and is priced at $250. The Model BR350 has a built-in expander-compressor, and is rated at 30 W/ch cont. into 4 ohms; its price is $280. Finally, there is the Model BR-380, which is the same as the BR350 but with a power rating of 45 W/ch cont. into 4 ohms and a price of $350. Cabinets are optional at additional cost.

Electro-Voice also has a Model E-V 1181 stereo-FM receiver rated at 21½ W/ch cont. power into 8 ohms and priced at $189. The Model E-V 1182 is similar but with an AM tuner added; its price is $210. Then there is the Model E-V 1281 stereo-FM receiver rated at 26 W/ch cont. power into 8 ohms and priced at $230. The Model E-V 1282 has AM added at a price of $249. The Model E-V 1382 is an AM/stereo-FM receiver with 40 W/ch cont. power into 8 ohms which is priced at $300. Separate walnut cases are available for all models. In addition to these receivers, the company also has Model EVR-1, an AM/stereo-FM receiver rated at 18 W/ch cont. power into 8 ohms and priced at $230 with wood cabinet. Also available is Model EVR-2, an AM/stereo-FM receiver rated at 27 W/ch cont. power into 8 ohms and priced at $300 with wood cabinet.

Fisher has a number of additional AM/stereo-FM receivers. The Model 201 is rated at 26 W/ch cont. power into 8 ohms and is priced at $200. The Model 202 is rated at 32 W/ch cont. power into 8 ohms and is priced at $250. The Model 210-T is rated at 36 W/ch cont. power into 8 ohms and is priced at $300. The Model 250-TX has a power rating of 38 W/ch cont. power into 8 ohms, features push-button tuning, and is priced at $350. The Model 500-TX is rated at 52 W/ch cont. power into 8 ohms, it has push-button and signal-searching tuning, and is priced at $500. The company also has a Model 701 four-channel receiver with an output power of 32 W/ch cont. into 8 ohms at a price of $700. Cabinets are separately available in all cases.

Harman-Kardon also has available the following AM/stereo-FM receivers. The Model 130 is rated at 10 W/ch dynamic power into 4 ohms at a price of $130 with walnut cabinet. The Model 230 is rated at 17½ W/ch dynamic power into 4 ohms at a price of $160, with cabinet separate. The stereo-FM Model 820 has a power rating of 55 W/ch dynamic power into 4 ohms at $270, with cabinet separate.

Heath also has a Model AR-14 stereo-FM receiver with a power rating of 10 W/ch cont. power into 8 ohms at a kit price of $120 less cabinet. The Model AR-15 is an AM/stereo-FM receiver rated at 50 W/ch cont. power into 8 ohms at a kit price of $350 and a wired price of $540, less cabinet. The Model AR-17 stereo-FM receiver is rated at 5 W/ch cont. power into 8 ohms at a kit price of $73, less cabinet. The Model AR-19 is an AM/stereo-FM receiver rated at 20 W/ch cont. power into 8 ohms at a kit price of $225, less cabinet.

Kenwood has the following additional AM/stereo-FM receivers. Model KR-2120 is rated at 11 W/ch cont. power into 8 ohms at a price of $160, less cabinet. The Model KR-3130 is rated at 19 W/ch cont. power into 8 ohms at a price of $200, less cabinet. The Model KR-5150 is rated at 40 W/ch cont. power into 8 ohms at a price of $320, less cabinet. The Model KR-6160 is rated at 70 W/ch cont. power into 8 ohms at a price of $380, less cabinet. The Model KR-7070 is rated at 80 W/ch into 8 ohms, has automatic tuning, and is priced at $550. There is also the Model KR-4130

FM Stereo Separation			Tuning Indicator (7)	FM Muting	MPX Noise Filter	Lo Filter	Hi Filter	Center-Channel Output	Over-all Dimensions (inc. knobs & AM ant.)			Weight (lbs)	Price ($)	Special Features, Access., Comments
50 Hz (dB)	400 Hz (dB)	10 kHz (dB)							W (in)	H (in)	D (in)			
25.4	35.6	18.3	ZC meter	Yes	No	No	No	Lo level	16 5/8 (6)	5 11/16 (6)	11 1/8 (6)	24.5	420	IC's & crystal filters in i.f., wood cab. $20, linear dial calibration, no AM, no loudness comp., single set of spkr. outputs
21.2	33.3	22.3	2 meters (ZC, SS)	Yes	No	No	Yes	Lo level	16 1/2	5 3/8	14	26.8	399	IC's & crystal filters in i.f., two audio-level ranges for improved loudness compensation ,preamp & power amp can be separated
28.9	38.1	20.3	ZC meter	Yes	No	Yes	Yes	No	16 1/8	4 5/8	15	19.5	300	IC's & ceramic filters in i.f.; adjustable compressor/expander
23.0	32.5	19.5	2 meters (ZC, SS)	Yes	No	Yes	Yes	No	17 7/8	5 1/2	12 1/2	21.5	350	IC's & ceramic filters in i.f.;wooden cab. included, IC in multiplex circuit; tape in/out on front panel
27.0	34.5	19.3	SS meter	Yes	No	No	No	No	15 1/2 (6)	4 5/8 (6)	14 1/4 (6)	25 (6)	400	IC's & crystal filters in i.f., electronic "Auto Scan" tuning, a.f.c., wooden cab. available
20.5	23.4	10.1	SS meter	No	No	No	No	No	15 7/8	4 5/8	13 1/4	16.6	200	
24.4	30.8	22.3	2 meters (ZC, SS)	Yes	Yes	No	No	Hi level	16 3/4 (6)	5 1/8 (6)	14 1/2 (6)	26.5 (6)	285 (kit)	Fixed LC filter & IC's in i.f., wood cab. $20, IC in multiplex circuit
28.5	34.0	20.5	SS meter	Yes	No	Yes	Yes	Lo level	16 5/8	5 1/2	14	21.5	260	IC's & crystal fiter in i.f., preamp & power amp can be separated, front-panel mic. input, 2 phono inputs, step tone controls
19.8	26.0	20.0	ZC meter	No	Yes	No	Yes	No	13 1/4 (6)	4 1/8 (6)	15 (6)	21	320	Separate AM/FM planetary tuning dials, no phone jack
26.7	35.2	20.5	SS meter "Acritune" light	Yes	Yes	Yes	Yes	No	16 3/4	5	14 3/4	35	300	IC's in i.f., "Acritune" tuning indicator, wood cab. $20, tape out on front panel
20.8	23.4	17.1	2 meters (ZC, SS)	Yes	Yes	Yes	Yes	No	17 (6)	5 9/16 (6)	15 (6)	37 (6)	449	Ceramic filters & IC's in i.f., ant. tuning indicator for min. multi-path dist., IC in multiplex circuit, wood cab. avail.
23.2	28.6	17.2	SS meter	Yes	No	Yes	Yes	Hi level	19 5/8 (6)	5 1/8 (6)	14 (6)	28.5 (6)	350	Wood cab. included
20.9	33.3	23.3	2 meters (ZC, SS)	Yes	No	Yes	Yes	Lo level	18 1/16 (6)	5 11/16 (6)	14 1/2 (6)	25 (6)	400	IC's in i.f. and multiplex, microphone & separate gain control inc., wood cab. included, preamp/power amp can be separated
23.2	36.6	20.3	SS meter	Yes	Yes	Yes	Yes	No	17 3/8	5 1/2	14 3/8	27.3	300	IC's in i.f., linear dial scale, wood cab. available, two phono inputs
25.9	33.8	22.7	SS meter "Perfectune" light	Yes	No	No	Yes	No	17 1/2	6	15	27	450	IC's & crystal filter in i.f., plug-in circuit boards, "Perfectune" light, multiplex IC, tape in/out on front panel
26.2	35	21.5	SS meter	Yes	No	No	No	No	17 1/2	5 5/8	13 1/2	22	200	Tape out on front panel, wood cab. included
24.8	33.4	14.1	ZC meter	Yes	No	No	Yes	No	17 3/8	6	14 3/8	26.5	300	Linear dial scale, front panel Aux. 2 input jack

(20%) under 1kHz, 2% distortion power level; (5) Ratio of phono overload level to phono input required for 10 watts;
(6) Manufacturer's figure—(may not include knobs and AM antenna); (7) ZC = zero-center SS = signal-strength meter.

stereo-FM receiver rated at 24 W/ch cont. power into 8 ohms at a price of $220, without cabinet.

KLH has a Model 18 stereo-FM tuner with many of the same specs as the tuner section of the Model 27 receiver tested. The Model 18 is priced at $130, including cabinet.

Lafayette has a number of other AM/stereo-FM receivers in its line, all priced to include metal cases. The Model LR-75 is rated at 10 W/ch dynamic power into 4 ohms and is priced at $110. The Model LR-100 is rated at 20 W/ch dynamic power into 4 ohms and priced at $140. The Model LR-775 is rated at 40 W/ch dynamic power into 4 ohms and is priced at $200. The Model LR-1000TA is rated at 60 W/ch dynamic power into 4 ohms and priced at $240.

Marantz also has available the Model 26 AM/stereo-FM receiver, which is rated at a power output of 10 W/ch cont. into 8 ohms at a price of $219, with metal cabinet. There is the Model 27, an AM/stereo-FM receiver rated at 30 W/ch cont. power into 8 ohms at a price of $319, with metal cabinet. There is also the Model 19 stereo-FM receiver rated at 50 W/ch cont. power into 8 ohms at a price of $1000, less wooden cabinet. The Model 23 is a separate tuner with the same tuner section used in the Model 22 tested; price is $259, less wooden cabinet. The Model 24 is a separate tuner/preamp with the same tuner/preamp section used in the Model 22; its price is $339, less wooden cabinet.

Panasonic also has a Model SA-40 AM/stereo-FM receiver rated at 12 W/ch cont. power into 8 ohms and priced at $220. Model SA-60 is an AM/stereo-FM receiver rated at 22½ W/ch cont. power into 8 ohms and priced at $280. The Model SA-50 is the same as the SA-60 except without AM; its price is $250. There is also the Model SA-6500 AM/stereo-FM receiver rated at 50 W/ch cont. power into 8 ohms and priced at $400. The Model SA-4000 is a stereo-FM receiver with push-button and automatic tuning; power rating is 60 W/ch cont. power into 8 ohms; the price is $990.

Pioneer has a number of additional AM/stereo-FM receivers in its line. The Model SX-440 has 12 W/ch cont. power output into 8 ohms and is priced at $200, with cabinet. The Model SX-770 has 15 W/ch cont. power output into 8 ohms and is priced at $250, with cabinet. The Model SX-990 has a power output of 28 W/ch cont. into 8 ohms at a price of $300. The Model SX-9000 is rated at 50 W/ch cont. power output into 8 ohms and is priced at $500. The Model SX-2500 is rated at 84 W/ch cont. power into 8 ohms and is priced at $550. This model also features automatic signal-seeking tuning in the tuner section.

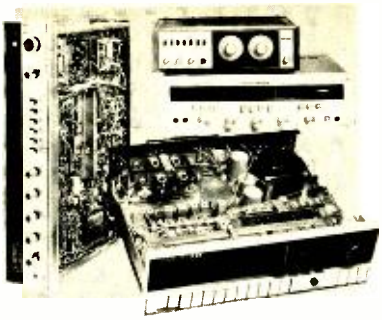
Sansui also has a rather extensive line of AM/stereo-FM receivers. Model 350 is rated at 18 W/ch cont. power output into 8 ohms at a price of $200. The Model 1000X has 34 W/ch cont. power output into 8 ohms at a price of $270, with wood cabinet. The Model 4000 has 45 W/ch cont. power output into 8 ohms at $350, less wood cabinet. The Model 5000A has an output of 55 W/ch cont. into 8 ohms and is priced at $400, less wood cabinet.

Scott also has a Model 631 AM/stereo-FM receiver which is rated at 18 W/ch cont. power into 8 ohms and priced at $200. The Model 342C is a stereo-FM receiver rated at 25 W/ch cont. power into 8 ohms and priced at $270. The Model 382C is the same, but with AM, at a price of $300. The Model 386 AM/stereo-FM receiver is rated at 35 W/ch cont. power into 8 ohms and is priced at $390.

Sherwood also has, in addition to the receiver tested, a Model S-7500 AM/stereo-FM receiver with a rated output power of 40 W/ch cont. into 8 ohms, priced at $340 with a metal cabinet. The Model S-8500 is the same except without AM; it is priced at $300. There is also a Model S-7900 rated at 48 W/ch cont. into 8 ohms and priced at $440 with metal cabinet. The Model S-8900 is the same except without AM; price is $400. There is also the Model SEL-200 stereo-FM receiver rated at 42½ W/ch cont. into 8 ohms priced at $599 with metal cabinet. Walnut cabinets are available at extra cost.

Sony also has a number of other AM/stereo-FM receivers available. The Model STR-222 is rated at 8 W/ch cont. power into 8 ohms and is priced at $150. There is the Model STR-6040 which is rated at 15 W/ch cont. power into 8 ohms and priced at $200. The Model STR-6065 is rated at 70 W/ch cont. power into 8 ohms and is priced at $400. Cabinets are available for all receivers at additional cost.

In addition to the models covered above, most of the manufacturers have a selection of other amplifiers, control amplifiers, and tuners to meet just about any user requirement.—Milton S. Snitzer/Tech. Editor ▲



control (a.f.c.) is rarely used nowadays. The only receiver in this group to use a.f.c. was the *Fisher* 450-T, not to correct any drift problem, but because its signal-seeking "Autoscan" tuning requires a.f.c. to lock on to a signal once it is acquired.

A few years ago, the *Heath* AR-15 initiated a trend toward permanently tuned i.f. filters. (This feature was also found in the *Marantz* 10B FM tuner.) These filters can be designed to have a flat-topped, steep-skirted pass-band response, much closer to the ideal shape than is readily obtainable with conventional double-tuned i.f. transformers. Their controlled phase-shift characteristic is also highly desirable for uniform stereo-channel separation across the audio frequency range. The elimination of periodic realignment is an obvious benefit to the consumer.

The *Heath* AR-15 uses a relatively costly quartz-crystal filter. Since its introduction, many other receiver designs have incorporated fixed i.f. filters of various types. Some use quartz crystals but there is a trend toward the much less expensive ceramic filters. From a practical standpoint, a well-designed ceramic filter seems to perform as effectively as a crystal filter. Still another approach is found in the new *Heath* AR-29, which uses a hermetically sealed, multi-pole *LC* filter. The top model of the *Sherwood* line (the SEL-200, not tested for this report) also uses an *LC* filter in its i.f. section.

Integrated-circuit (IC) i.f. amplifiers are used in most of today's receivers. Their high gain and excellent limiting properties contribute to their popularity among receiver designers. As far as we could determine, only the *KLH* 27, which has been on the market for several years, still depends entirely on discrete components and transistors in its i.f. amplifier.

Integrated circuits have made slower inroads into other portions of stereo receivers, but there are clear signs of a change in this situation. The *Motorola* multiplex IC, which replaces most of the usual multiplex demodulator components and does a generally superior job in addition, is now used by *Electro-Voice*, *Heath*, *Marantz*, *Pioneer*, and *Scott*. *Scott* also uses an IC in its audio preamplifier stage. It seems probable that there will be greater utilization of IC technology in future receiver designs (such as the recently announced IC's which combine i.f. amplification, limiting, FM detection, and audio amplification on a single silicon chip).

Several types of tuning aids are found among these receivers. Some use a single meter indicating relative signal strength, and are tuned for a maximum meter reading. When used carefully, this can be an adequate tuning indicator. A more accurate method is the zero-center meter used by other manufacturers. Some receivers provide both types of metering with the relative signal-strength indicator being most useful for aiming a rotatable directional antenna. An interesting variation on the zero-center tuning meter is the voltage comparator used in the *Scott* and *Lafayette* receivers. This is a circuit which monitors the d.c. output from the discriminator and extinguishes a lamp on the front of the receiver when the voltage departs from zero (the condition for correct tuning). The circuit is inhibited from functioning unless a signal is actually being received. When the lamp is lit, it illuminates a suitable word on the dial ("Perfectune" and "Acritune" for the *Scott* and *Lafayette* models, respectively). This indicator can be made extremely sensitive to mistuning and eliminates all user judgment in tuning the receiver. *Scott* uses an IC voltage comparator; *Lafayette* uses discrete circuits with several transistors.

The *Fisher* "Autoscan," which we mentioned earlier, causes the receiver tuning to sweep electronically across the FM band until a signal is received and the a.f.c. locks it in. The scan can be initiated by a push-button on the panel or with a remote-control accessory.

One trend which we are pleased to note is the use of linear dial calibration. Instead of a one-megahertz band segment occupying a quarter-inch at one end of the dial and an inch at the other end, a linear-tuning receiver maintains a uniform tuning rate throughout. If a sufficient number of intermediate calibration points are provided, it is possible to interpolate dial readings and set the receiver accurately to a desired frequency, or to identify a station unambiguously from its position on the dial. Linear dial scales are found on the *AR*, *Sansui*, and *Sony* receivers.

Almost all receivers have outputs for two pairs of speakers with switches to energize either or both sets. Exceptions are *AR*, which has only a single set of outputs, and *Pioneer*, which has three sets.

A few of these receivers have unconventional features which are deserving of mention. *Bogen* incorporates a "Crescendo" compressor/expander circuit. This can be set to expand the dynamic range of music which was previously compressed (this applies to all recorded music) or to restrict the dynamic range when the program is used for background purposes and occasional high-level passages might be annoying. The circuit works well, without objectionable distortion or other side effects. *Marantz* has a unique antenna-tuning feature which connects one of its tuning meters to display the amplitude fluctuations caused by multipath distortion. (This is done by a much more expensive cathode-ray tube on a higher-priced *Marantz* model.) In use, the antenna is rotated for minimum meter fluctuation which corresponds to minimum multipath distortion. *Pioneer* has a front-panel gain control and internal mixing circuits for a microphone which is supplied with the receiver. This allows the receiver to be used for public-address and similar applications.

On some receivers, the preamplifier outputs and power amplifier inputs are brought to jacks in the rear, with a switch or external jumper cables to join them for normal operation. By separating the two sections of the amplifier, an electronic crossover network, active equalizer, reverberation unit, or similar accessory can be used in the system without disturbing the tape-monitoring function which is sometimes appropriated for this purpose. This feature was offered on the *Altec*, *Kenwood*, *Pioneer*, and *Sansui* receivers in the group tested.

Test Procedures

With both channels driven simultaneously into 8-ohm loads, the power output per channel was measured at the point where the harmonic distortion reached 2%. This was done at 30 Hz, 1 kHz, and 20 kHz. At 1 kHz, the total harmonic distortion was measured at 1 watt, 10 watts, and "Max Power," which was actually 1 dB or about 20% less than the 2% distortion power output. These measurements give a concise picture of the audio performance of the receiver over a wide range of frequencies and power outputs. As a guide to users having 4-ohm or 16-ohm speakers, the maximum output into these impedances was measured and expressed as a percentage of the available output into 8 ohms.

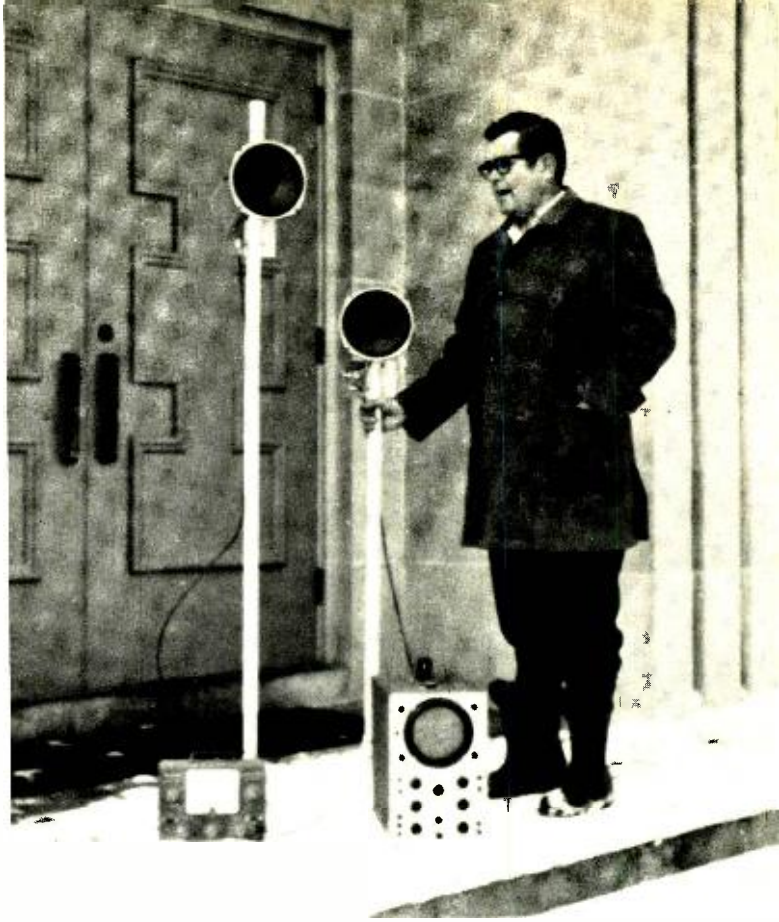
The audio sensitivity was measured at maximum volume-control settings, through both Aux and Phono inputs, at 1 kHz. It was considered to be the number of millivolts input needed to develop a 10-watt output. In addition, the phono overload point was measured by reducing the receiver volume-control setting and increasing the input signal level until the output waveform began to distort (at low-power levels). This was expressed in decibels relative to the phono sensitivity for 10-watt output. The phono dynamic range reserve of the tested receivers ranged from 26 dB to over 40 dB with the average being about 32 dB. Receivers fall-

(Continued on page 59)

Phasing P.A. Speakers

By HARDIN STRATMAN

Simple technique using audio generator, scope and pair of speakers can be employed to properly phase the loudspeakers in public-address system.



Author is shown here in front of the church whose speakers he has just phased. Behind the signal generator at the left is a tall pole with the transmitting speaker and the transmitter directly below it. The pole at the right, behind the scope mounts the receiving speaker and receiver above hand.

PUBLIC-ADDRESS systems are used in large auditoriums, halls, or churches to insure that the performer's words carry to every part of the room. Besides the normal routine of providing enough speakers, adequate amplifier power, and acoustical treatment, there is one additional thing that can be done to improve listening—at no additional cost. This involves phasing all speakers to each other as well as to the performer. The end result is maximum sound power at minimum amplifier power, improved clarity, less garbling, and a sound that has a one-point source rather than seeming to come from all directions.

Many home hi-fi or stereo entertainment systems have a phase switch labeled "normal" and "reverse." This switch merely reverses the connection to one speaker so that mono sound seems to originate from a single source. Bass frequencies are usually reinforced. This same principle may be applied to auditoriums to give large audiences improved audibility. By using the test equipment to be described, one person can accomplish the desired result scientifically without having to rely upon the personal preferences of several people with varied viewpoints (and hearing).

Relative Speaker Phasing

Two kinds of speaker phasing are possible. One is *absolute*, the other *relative*. Absolute systems are used in elegant auditorium installations where money is no object. This involves taking into account the difference in propagation time between sound in air and electrical impulses in wires and associated electronic gear. Some sort of mechanism is used at each speaker to delay the electrical impulses applied to that particular speaker so that the sounds agree absolutely in time, amplitude, and phase with sounds coming direct from the performer or the other speakers.

A delay system of this sort may take the form of a tape recorder with the recording and playback heads arranged on a single loop of rotating tape so that sound from the performer or other speakers coincides exactly with sounds emitted from the speaker in question.

Since no simple and low-cost delay system is presently available, we will consider only a relative phasing system which involves proper placement of speakers and their correct connection. Results, using the relative system, can be quite satisfying to one who has struggled with a public-address system in attempting to gain maximum clarity at low cost.

As a rough rule-of-thumb, sound travels at a speed of 1100 feet per second at normal room temperature. If a performer sings at one end of a hall 100-feet long, it takes 90 milliseconds for the sound of his voice to reach the other end. If an amplifier and associated speaker are placed midway down the hall to assist the performer, sound from the speaker will reach a listener at the rear of the auditorium before sound from the performer unless something is done to delay sound from the speaker.

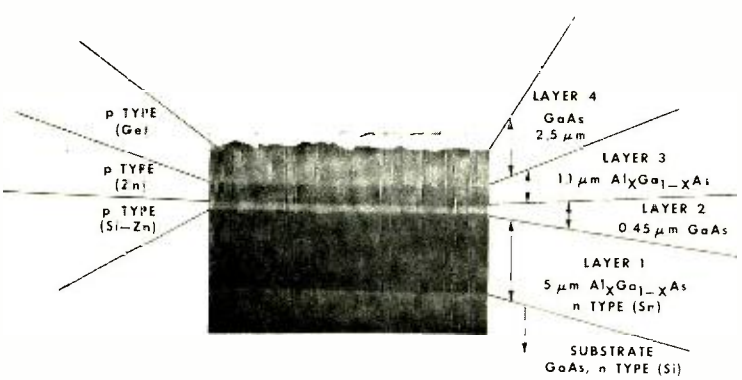
It stands to reason that maximum clarity is realized if rarefactions and condensations coming from the speaker system coincide with the rarefactions and condensations from the performer's lips. In addition, vibrations from all of the speakers should coincide with each other as far as possible as the sound reaches the listener's ears.

If a performer sings a note of 200 Hz, there will be 18 repeats of condensations and rarefactions down a 100-foot long hall before the sound first reaches a listener at the other end. Also, the distance from condensation to condensation or rarefaction to rarefaction is 5.5 feet. At this frequency a speaker need only be moved one-half wavelength or 2.75 feet to place it at a point of maximum or minimum reinforcement of the sound wave. Approximately the same results can be obtained by merely reversing the leads to the speaker. It is probably just as well to go ahead and place all speakers where most convenient and phase them in a relative manner later.

When one considers all the possible audio frequencies, all possible angles that the sound waves may make with various walls, and the many other variables, it is obvious that the relative-phasing method is not 100% foolproof. However, a speaker system will work best for a large band of frequencies when connected properly. This applies particularly to the lower audio frequencies from male voices.

(Continued on page 56)

Recent Developments in Electronics



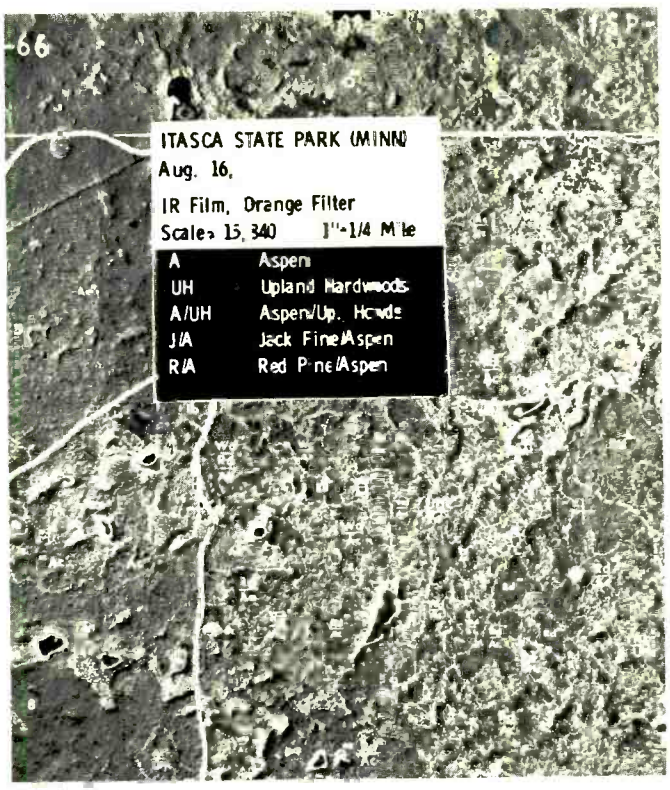
"Prescription TV"—CCTV for Hospitals. (Top left) When CBS Labs unveiled its EVR (electronic video recording) system some time ago for playing back a reel of special picture and sound film through TV receivers, it was Motorola who announced that it would be producing the playback units for the system. This unit, called a "Teleplayer," handles the 7-in diameter film reel which provides a 25-min color or a 50-min black-and-white picture and sound program. The output of the player is connected to the antenna terminals of one or a large number of TV receivers which then display the program. Now, Motorola Systems Inc. has introduced a closed-circuit TV system for hospitals using the EVR player, which they have dubbed "Prescription TV." The system is supplied with an initial package of ten training and hospital-orientation films produced for patient education, staff training, and continuing professional education. In addition, there will be a number of programs for patient entertainment. These programs, mainly comedy shows and sporting events, have been slanted for the male patient who may not go for the usual afternoon-TV fare of soap operas and game shows.

Optical Scanner for Computing Cash Register. (Center) A hand-held wand, the size of a ballpoint pen, is being used here to read a merchandise price tag. The wand, which can also read credit cards and sales-person identification badges, is part of a new computer cash-register system introduced recently by National Cash Register Co. Data collected at the point of sale is subsequently processed by computer for customer billing, inventory control, and various management reports. Special color-bar-coded tags and labels are scanned by the wand, which operates at the end of a flexible cord of fiber-optic bundles. The scanner optically senses the variations in the color of the light reflected from the price-tag coding and these color transitions are electronically translated and entered into the register in a single operation. Up to 56 characters of information may be encoded on a tag in the form of a series of black, green, and white color bars. The salesperson can start at either end of the strip of bars and can move the wand at any speed. If the strip is read fully and correctly, an audible signal is emitted. Data is recorded on magnetic tape, which can then be transported to a central computer at the close of business for processing. The system is being field-tested at Montgomery Ward's retail store in Lima, Ohio.

Battery-Powered Semiconductor Laser Works at Room Temperature. (Below left) "This is the laser we've been waiting for" is how one Bell Labs scientist described a new semiconductor laser developed by the Labs. As shown in the photomicrograph of the cross-section of the tiny speck of material, the laser is made up of four layers of gallium aluminum arsenide alternating with gallium arsenide. These layers are doped with tin, silicon, zinc, and germanium. With this new type of structure, the laser can be operated continuously at room temperature. Heretofore, semiconductor lasers had to be pulsed or had to be refrigerated to keep them from burning up. The threshold current (at which lasing action starts) of the new experimental device is far lower than previous semiconductor lasers. This not only keeps their temperature down but also permits low-power sources to be used to operate them. In the demonstration we saw, ordinary dry-cell batteries were used to power one of the units. The laser emits a beam of near-visible infrared light (about 8500 Å) with an output power of about 20 mW and a power efficiency of nearly 2 percent. Such lasers may one day speed the transmission of voice, data, and other information signals in high-capacity optical communications systems.

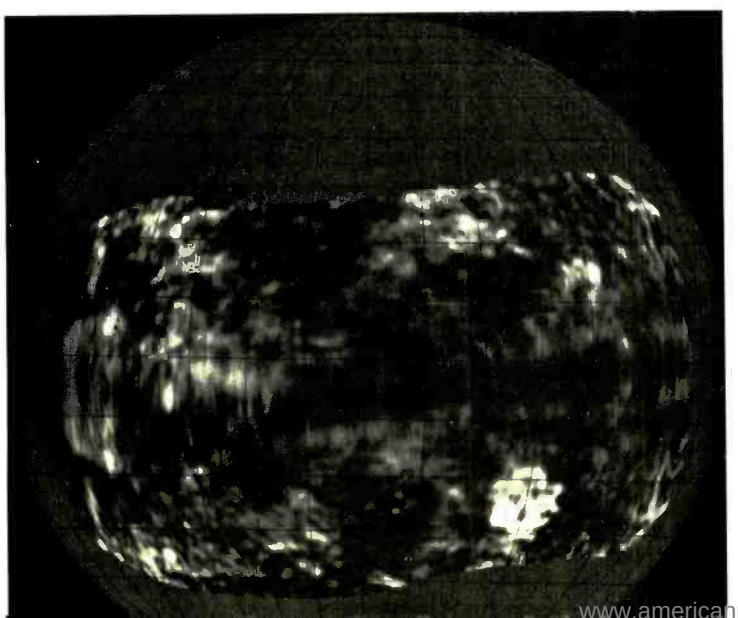
Four-Channel Phono Disc. (Top right) A new four-channel phono record and matching decoder have been produced by Victor Co. of Japan. The system used is entirely compatible with two-channel phono-playback equipment. A matrix circuit is used to encode the four separate channels into the two sidewalls of the record groove. One sidewall carries the sum of channels one and two along with the difference between these channels, modulated onto a 30-kHz carrier and at a –20-dB level. The other sidewall carries channels three and four combined in the same manner. The phono pickup used employs an elliptical stylus and has a frequency response of up to 45,000 Hz. The cutter used to make the disc must also have this response. Negotiations to license record companies to produce discs under the new system are now in progress. In the U.S. this is being handled by JVC America, Inc.

Trees Identified by Computer. (Center) The aerial photo shows four square miles of Itasca State Park (Minn.) with the types and areas of tree stand indicated by a computerized photo interpreter. The electronic system, developed by Honeywell, uses electronic sensors and scanners to interpret aerial photos of forests in a fraction of the time that it would take a human "reader." A skilled photo interpreter must first study the photos and assign symbols to identify typical features, such as texture, density, and shape. He then programs the computer to extract automatically those features of interest, while ignoring all the other material.



Venus Mapped by Radar Astronomers. (Below left) The largest map yet projected of Earth's sister planet has been plotted by two radar astronomers at Caltech's Jet Propulsion Laboratory. The map covers some 30 million square miles or about one-sixth of Venus' surface. The bright spot in the southern hemisphere is Alpha, which could be a mountain range. The map was made using radar beams from the Goldstone (Calif.) tracking station, which JPL operates for NASA. The station uses a huge 210-ft parabolic dish antenna to pick up echoes from the planet. The amount of Doppler shift as well as the change in polarization of the signals are used to determine the nature of the planet's terrain.

"Instavision" TV Tape Recorder. (Below right) A new generation of compact video-tape recorders and players featuring automatic cartridge loading and designed for CCTV as well as the home market has been introduced by Ampex. The "Instavision" recorder/player uses standard half-inch-wide video tape enclosed in a circular plastic cartridge $4\frac{1}{2}$-in in diameter and $\frac{3}{4}$-in thick. It is compatible with other recorders using the Type 1 standard recently adopted. Prices will be about $800 for a black-and-white player, $900 for a black-and-white recorder/player or color player, and $1000 for a color recorder/player. The blank tape cartridge will sell for less than $13 for 30 minutes of recording time at the Type 1 standard.



Designing a Small CCTV System

By KENNETH B. KNECHT
Chief Engineer, TV
State University College, New Paltz, N.Y.

How to select components and interconnect them to form effective closed-circuit television system.

Different types of video tape recorders (VTR's) can be used in CCTV systems. Shown here is an IVC Model 800 video tape recorder in operation.

WHEN considering a small CCTV system, the first thing you will have to decide is exactly what you want the system to do and how well you want it to do it. Once that decision has been made, you will then have to make up your mind as to what type of components will be needed to accomplish this. This article provides detailed information to help you in making some of these decisions.

Production Switcher

The production switcher is a good place to start, as it is the heart of any production system (Fig.1). The basic purpose of the switcher is to route the camera or other input selected to either monitors or a video tape recorder (VTR). A fader can be incorporated to allow dissolves (fades) to another input. A fader also permits "supering" (superimposing) one input over another; usually one of the input scenes is a title card which can be supered over a background provided by another camera.

A special effects unit that allows you to split the screen horizontally or vertically or make inserts into one of the screen's corners can be built into the switcher or be added as a separate unit later. The position of the insert or dividing line can be varied at will. If the switcher contains a fader or special effects, the inputs to the switcher should be driven from a common source of synchronizing pulses.

The switcher can switch either mechanically or electronically. There are two types of electronic switching: fast lap, which is an automatic fast dissolve from one input to the other (about 20 ms in duration), and vertical interval. Vertical interval switching is usually found in broadcast-quality equipment and automatically performs a very fast switch (microseconds) during the vertical interval where any re-

sulting switching transients will not be visible in the picture. The fast lap can occur anywhere in the field.

If a mechanical switch is used, it should employ make-before-break type switches to avoid loss of sync during switching. Electronic switching gives a cleaner cut. Larger switchers also have what is called a "preview bank" which, among other things, allows you to set up a super or split screen before switching it to the output line. A monitor should be provided adjacent to the switcher so the picture can be viewed on the output line. If a preview bank is included, a monitor should be available to view its output too.

The switcher should also have a switch to allow either the program or preview banks to be fed to the output line during a production without picture breakup. If separate monitors are not available for each input, then the preview bank and monitor can be used for this purpose.

Camera Selection

Before selecting a camera, ambient light conditions should be taken into account as they will determine the type of camera tube (vidicon or Plumbicon) required. The resolution (definition of detail) varies from camera to camera; 600 lines in the picture center would be a good choice. The simpler, less expensive cameras have few adjustment and automatic target controls, while cameras with more adjustments, although more flexible, require an experienced operator.

Cameras are supplied either with or without viewfinders (or with provision for adding one). Cameras without viewfinders (fixed cameras) are preset to cover the area of interest, while those with viewfinders allow the operator to see the picture and thereby assure himself of proper focus and composition.

The camera can be equipped with a tally light that indicates when it is switched up on the line (switcher should be equipped with suitable contacts to use this feature) and with an intercom which allows communications with the director. Cameras are usually cradle-mounted on top of wheeled tripods so that they can be easily moved, panned, and tilted. Cameras also come equipped with a single lens, a rotary-type turret with three or four lenses, or a zoom lens. The zoom lens can be focused and its focal length changed from the rear of the camera or these adjustments can be performed manually at the lens.

A remote-control version of the camera (Fig.2) is also available which permits remote control of the pan and tilt head and the zoom lens as well. This type of camera offers great flexibility but is more difficult to operate smoothly on the studio floor during production than the ordinary camera.

VTR Selection

There are a number of choices when it comes to VTR's (see lead photograph). Concerning ourselves only with simpler, less expensive machines, the first consideration is whether to get a ½" or 1" machine. The 1" VTR is generally used in studio applications and the ½" as a portable recorder. Of course, either one can be used either way, but the small size and light weight of the ½" makes it easier to move about. The controls on the ½" machine are frequently designed with the inexperienced operator in mind; for example, the machine has automatic audio and video gain controls, easy threading, etc.

Editing, a second audio track, slow motion, and other features are available in VTR's. Don't pay for something you don't need, but keep in mind that these features usually cannot be added later. Another thing to look for is tape interchangeability among all of a given manufacturer's machines using the same format. For example, this means you can make a tape on any *Ampex* 1" VTR (using low band standard, not all will play high band) and know you can play it back on any other 1" *Ampex* machine. However, the tapes won't play on a 1" *Sony, IVC,* etc. In fact, almost all of the ½" and 1" helical tape machines make tapes that can't be played on another manufacturer's machine. Therefore, you must consider whether you will want to swap recorded tapes with someone else. If so, interchangeability will be an important consideration. Of course, you can dub to another format, but the less dubbing you do the better off you are in terms of picture quality.

Lighting Equipment

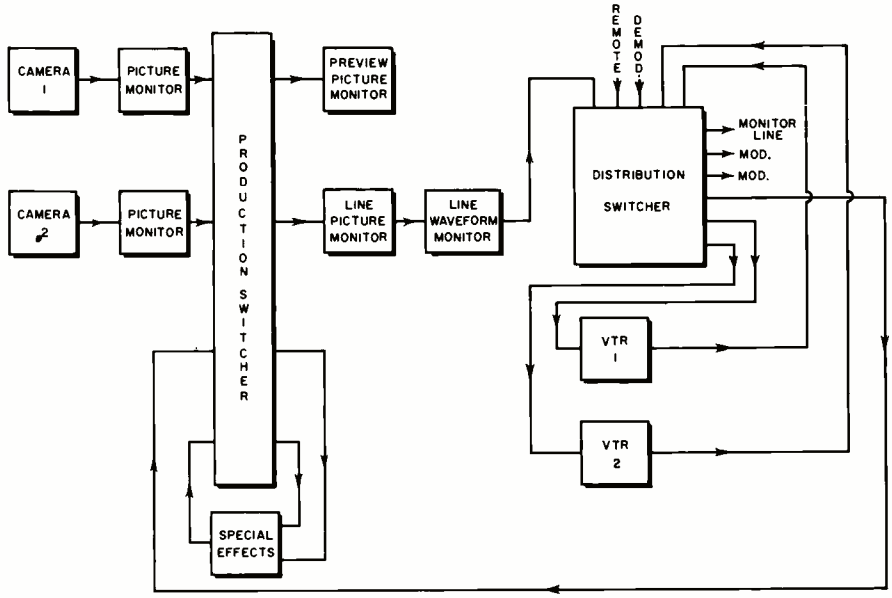
The lighting equipment you will need depends on how big an area has to be illuminated at one time. For example, to get a nice crisp picture with good depth of field, about 2000 watts of front light and 1000 watts of back light are required to light one person as opposed to about 3000 watts of front light and 1500 watts of back light for two persons sitting at a table. Pictures can be made with the camera at much lower light levels but this will result in lag (smear) when the subject or camera moves and a flatter, noisier picture. If the target is run too high, it will result in the vidicon burning. This means that if the camera is held on one spot for more than a few minutes and then the spot is changed, a faint (or sometimes not so faint) negative image of the previous shot will remain on the vidicon target. This will go away after a while, but it could spoil your program. Vidicons specially designed for low light level operation are available.

Audio System

It is useful to have an intercom system between the director and his camera operators and floor manager so that he can give them directions during the production. It is also a good idea to have a p.a. speaker in the studio so that the director can talk to the people in the studio. He can hear their replies through their mikes.

At the very least, the audio system should provide control over two or three low-impedance microphones (Fig.3). The mixer should have a vu (volume-unit) meter in order to keep a constant level feeding the VTR or the output line.

Fig.1. Simplified block diagram of typical, small video production system.



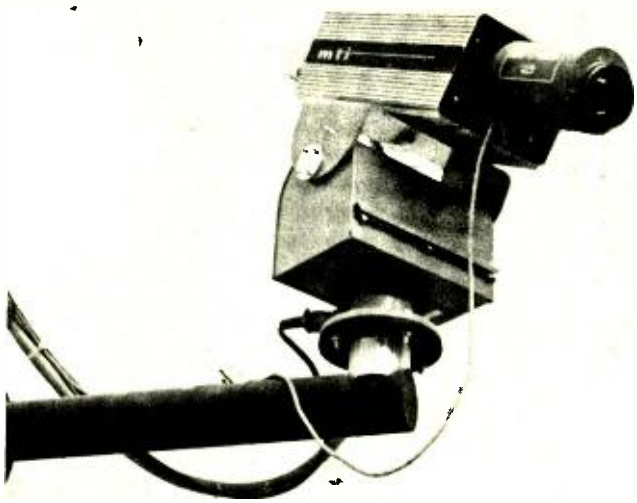


Fig.2. Remote-control camera used in a CCTV system.

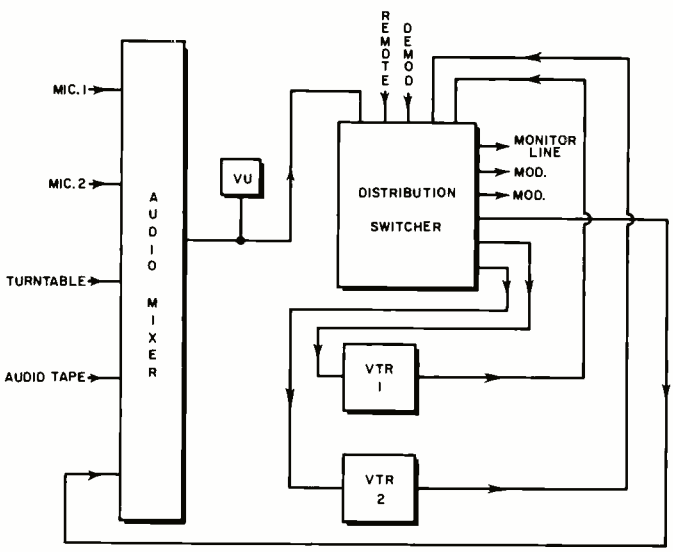
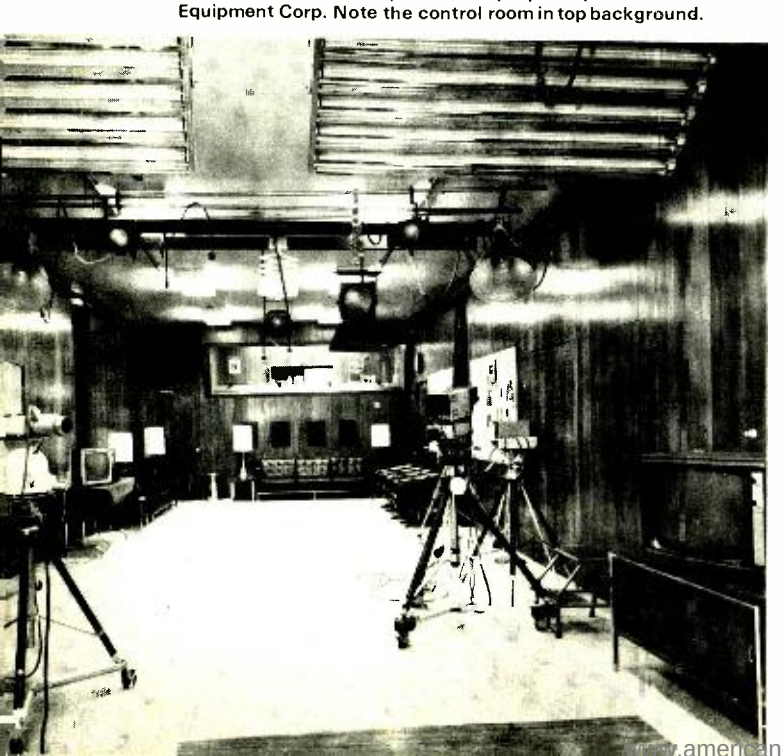


Fig.3. Simplified diagram of an audio distribution system.

Fig.4. A CCTV studio system set up by Philips Broadcast Equipment Corp. Note the control room in top background.



The mixer output should also be amplified so that the program audio can be heard in the control room. If required, a mixer with more inputs can be used, allowing a turntable or audio tape to be mixed into the program. If only one microphone is being used, it can be connected directly into the VTR. However, if monitors are being fed from the studio, the microphone will have to be amplified. If the plan is to feed a mike directly into a VTR be sure the mike input impedance of the VTR matches that of the microphone. This also applies to the microphone inputs on the mixer.

Sync Generator

If special effects or dissolves are planned, then a sync generator will be needed. The sync generator supplies pulses, or a sine wave in some cases, at the horizontal and vertical scanning rates. These pulses are fed to the special effects and the cameras and keeps them scanning in unison. This allows them to be mixed in any manner, without the picture tearing or breaking up. However, most helical-scan VTR's cannot be locked to external sync, so if a VTR playback is included in a production, you will have to "take" them, you cannot dissolve or wipe into them. Even with a direct take, there will probably be some picture disturbance, while the monitor re-establishes timing.

Sometimes the sync generator is built into one of the pieces of equipment, such as the special effects. If a sync generator is used, be sure the cameras purchased can be driven from an external sync source. The best is one that can either be driven or can be switched to an internal sync source for independent operation. If the camera has its own sync generator, one thing to look out for is industrial sync (exaggerated blanking). This will cause the top of the picture on the monitor to "flag wave;" that is, the top 30 or 40 lines will swing back and forth as the monitor's horizontal oscillator locks in. The reason for this is that regular vertical sync has horizontal rate pulses interlaced with it, therefore the monitor horizontal oscillator stays locked in during the vertical interval. Industrial vertical sync is just one pulse about 9 or 10 lines long. The horizontal oscillator in the monitor has to free-run during this period, then lock to the horizontal sync again when it reappears. The a.f.c. circuit in the horizontal sync circuit in the monitor will determine how much of the top of the picture will be unstable. This type of sync is generally used in surveillance cameras, where the instability is not so objectionable.

The Studio

The studio (Fig.4) should be large enough for the largest production contemplated and the ceilings should be high enough so that a light hanging directly over someone for backlighting will not show in a wide shot. The studio should be air conditioned because the lights put out a lot of heat. The control room, where the switcher, monitors, VTR, and any other equipment used for a production is housed, should be adjacent to the studio, preferably in a room containing a window to allow the director to see into the studio. The window glass should keep control room noise from being picked up by the microphones in the studio and mixed into the program audio. The studio ceiling should be equipped with a grid made of pipe spaced every three or four feet to mount the lights and should contain a sufficient number of power pigtails to power all of the required lights.

Program Distribution

As for program distribution, there are two choices—as video or r.f. Programs can be originated from a point remote from the studio. In most cases, with a small system, it is simpler to take a recorder, camera, and other required paraphernalia to the remote site and record there. Of course, if the plan is to originate frequently from that same point, then some sort of separate line between that point

and the TV center should be considered. For short runs, regular 75-ohm coaxial cable with equalized amplifiers with some sort of hum rejection (such as a differential input or clamping) could be used. Thought should also be given to the possibility of using a balanced line to eliminate hum or other interference.

No matter how the program is distributed, a switcher should be used to select which input should go to which output line or modulator. A modulator is a piece of equipment that converts audio and video to a TV v.h.f. channel. For example, if there are two VTR's, an off-the-air tuner and modulator, a studio, one line feeding monitors, a line feeding the production switcher, two modulators, and one remote origination point which is used regularly, then a five-input, six-output switcher would be needed. The type of distribution switcher to be described can switch any of the inputs (both video and audio) to any number of the outputs.

As with the production switcher, either electronic or mechanical switching is available. To just route signals, the mechanical type is probably best, while an electronic switcher would be a better choice if video tape is to be edited during a recording. The audio portion of the switcher will probably use relays, followed by a high-impedance-input, unity-gain amplifier, to do the switching. This will permit the input to be switched up on more than one output bus without loading the input and changing the level.

If several lines have to be fed from one output of the switcher, single-input, multiple-output, unity-gain amplifiers (distribution amplifiers) which allow the signal to be split up as required can be used. Audio can be treated the same way. If necessary, video and audio line amplifiers can be added to make up for line losses on a long run. These should contain equalization to make up for high-frequency losses. Audio should be distributed as a low impedance, usually 600 ohms.

To distribute signals as r.f., a modulator that can convert a video and audio signal to any v.h.f. channel is available. If only a few channels are used, it is best to employ only every other low-frequency channel to eliminate a lot of potential problems. The low frequencies are affected less by line losses and, by avoiding adjacent channels, troubles with adjacent-channel interference will be eliminated. Of course, if necessary, all twelve channels and more can be used if the system is well designed.

The modulator should be followed by a band-pass amplifier for that channel to reduce the possibility of the signal spilling over into an adjacent channel and causing problems. If you want to put an off-the-air channel on the distribution cable, a converter which costs about the same as a modulator, can be installed to allow the signal to be received and converted to one of the vacant channels.

Monitors and Cables

The monitor selected should have both r.f. and video inputs so that it can be used anywhere in the system. Of course, if *only* video (or r.f.) is distributed, then a suitable type of monitor should be selected. One monitor on the market that, among others, will accept video or r.f. at the flip of a switch also has an audio jack on the back that acts as an audio output for an external amplifier or audio tape recorder when the set is acting as a TV receiver. This same jack becomes an audio input to the built-in audio amplifier when the set is used as a video monitor. Roll-around stands for the sets can be purchased or sets can be fastened to the wall, hung from the ceiling, set on shelves, or mounted in other ways. Another possibility is a TV projector that projects a television picture onto a rear or front screen and can accept video and/or r.f. If the production is in a large auditorium which will require a great number of monitors and present mounting problems, it might be worth looking into TV projectors—if a screen can be easily added.

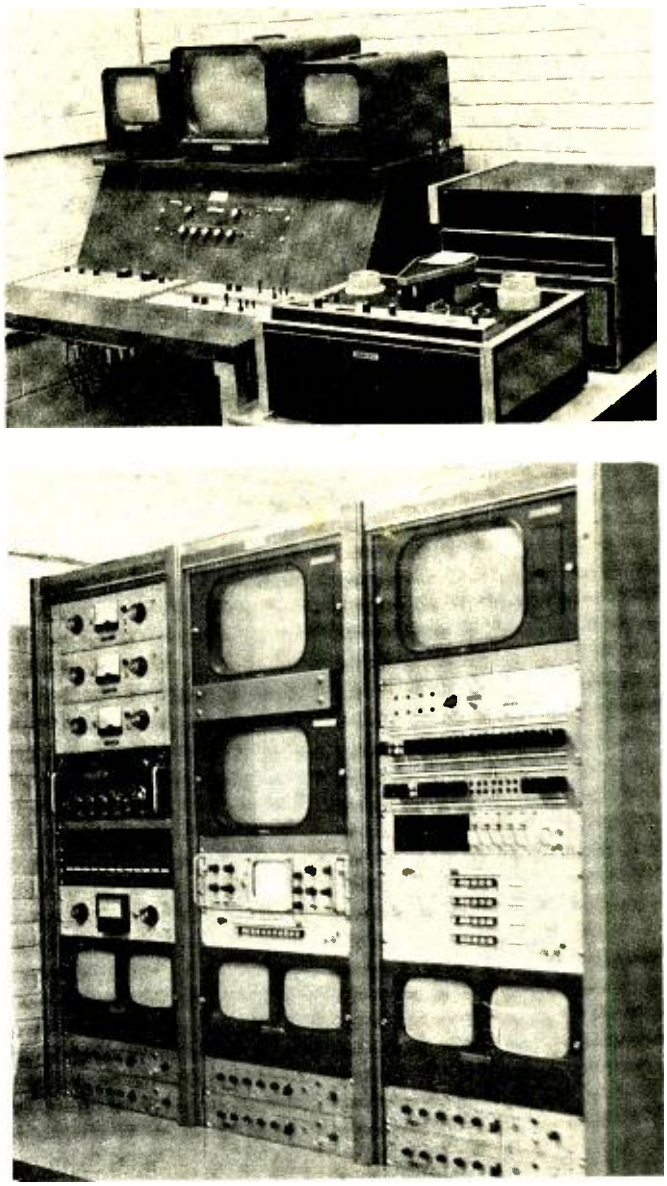


Fig. 5. Types of equipment that can be found in a well-equipped control room. (Top) Control console with two camera monitors, one line monitor, an audio mixer, switcher and special effects, remote camera controls, plus two Ampex VR5100 VTR's; (bottom) camera controls, distribution switcher, test switcher, patch panels, sync generator, and various monitors.

The 75-ohm cable used to route signals comes in two versions: a small-diameter RG-59/U which is used for short runs of video and r.f. and a larger version with a lower signal loss, the RG-11/U, which can be used for longer runs or where low loss is imperative. Both these cable sizes are also available with a foam dielectric which cuts the line losses considerably. The author prefers the foam for r.f. and long runs of video. For long runs of r.f., an aluminum-sheath-jacketed cable that comes in either 0.412", 0.500", or 0.750" diameters should be used. This cable is quite stiff and should be handled carefully as it will not bend sharply without kinking. If the proper connectors are used, this cable will be weather-resistant and have very low loss. For long runs of video, 124-ohm balanced shielded cable is preferred. However, to change from 75 to 124 ohms and *vice versa*, amplifiers will be needed at each end of the line and an equalizer will also be required to make up for the high-frequency loss (of course, irrespective of type, a long run of cable has to be equalized).

Audio should be run balanced, if possible, in shielded, jacketed cable. Stranded conductors are better if the cable

(Continued on page 75)

Computers That Talk

By FRED W. HOLDER

These computers employ voice response to reply to user's request for information.

IBM's 360/65 mass-storage computer maintains up-to-the-minute watch over materiel movement for Rohr operations.

WE'RE all familiar with talking computers. They've been around for years, on our TV and movie screens. Now, they're for real. "Mabel," or is it "Clara," speaks clearly and distinctly with her 79-word vocabulary. She's definitely a woman—always getting in the last word.

Mabel isn't as versatile as the "Star Trek" computer, but like it she has a big job of monitoring and controlling a large operation. *Rohr Corporation* employees in Chula Vista, California find her very helpful. They can reach Mabel from any of the plant's data-phone stations. On command, she will tell them where to find parts and tools, or will move parts and tools to a new location, giving verbal feedback for every transaction.

The 79 words in Mabel's vocabulary are separated on a magnetic disc file, Fig. 1, in random order—each having a specific location or address. They were recorded at *IBM's* programming department in Poughkeepsie, N.Y. by one of the girls working there. As needed, the computer selects words from the file and puts them together in the proper sequence for transmission over telephone lines to answer queries for information. Strangely enough, when speaking, Mabel pauses just like a human. This capability was provided electronically so that information could be written down.

Mabel can act faster and perform unerringly because her "brain" is an *IBM* 360/65 mass-storage computer (see lead photograph). In response to a request for a part's location, Mabel's voice is even, confident, enunciating clearly:

"Part location . . . three, six, zero, zero . . . date . . . seven, two, seven . . . time . . . zero, nine, five, seven . . . quantity . . . two, one . . . priority . . . five . . ."

This talking computer was originally developed as an important component in the *Rohr* Automated Data Acquisition and Retrieval (RADAR) system. This new system—developed jointly by *Rohr*, *IBM*, and *Pacific Telephone*—was initially implemented in June, 1967. *Rohr's* total program (known as "Automove") is being developed and implemented as described in the three basic steps that follow.

The first step was to turn the job of following parts progress, from work center to warehouse to work center, over to the central (*IBM* 360) computer. Personnel use the voice-response terminals to report every step to the computer. The second step, implemented in mid-1969, features a direct link between the central computer and the warehouse computer (PDP-9), which controls the 15 stacker cranes and conveyors servicing the storage locations. In this stage, the warehouse computer became a full satellite of the central computer.

The central computer keeps track of parts and tools, remembers the empty pigeonholes and where parts and tools are stored in any of 16,684 possible locations. It remembers short-term production schedules, and work-center priorities for all job orders stored in the warehouse.

When a dispatcher in the shop requests more work, the computer evaluates the schedules and decides which job orders to release from the warehouse. It will continue selecting job orders, based on priority, until the request for work is filled. The warehouse computer then directs the cranes to remove parts and tools from their pigeonholes and stages them on outgoing conveyors.

The third step is planned for completion in 1972. When complete, the system will feature an enlarged warehouse for parts and tools and automated delivery between the warehouse and production line. At this point, the warehouse will consist of 135,000 pigeonholes and 26 stacker cranes, a significant increase over the current capability. The warehouse computer will automatically control the cranes, conveyors, and tractors. It will dispatch automatically guided tractors between the conveyor stations in the warehouse and production areas. The loading and unloading of trailers will be automated.

Operation

How does the system work? Briefly, a transaction with

Mabel goes something like this: An employee lifts the Touch-Tone receiver and presses an order code (see Fig. 2). For example, to request a present location for parts or material, he would press digits 3 and 5 and the symbol #.

"Register Number," Mabel's voice responds.

The employee responds by punching in eight digits (the order number) "9998902#" and transmits a series of electronic, coded impulses to the computer.

The computer quickly searches its disc files for that order number and instructs Mabel's voice drum to respond, "nine, nine, nine, eight, nine, zero, two . . . location . . . three, zero, seven, six . . . date . . . two, one, two . . . time . . . one, four, five, eight . . . quantity . . . one . . . complete date . . . seven, zero, zero . . . part number . . . three, four, seven, one, one, one, dash, four, six . . ."

If the order were in transit, Mabel would reply, "From Location . . . Date . . . and Time . . . To Location . . . Date . . . Time . . ." She might also give the priority rating of the order.

This was only a simple example of what Automove is doing to help *Rohr* save $400,000 a year. When fully implemented, the savings will be much greater. Automove opens avenues to smooth, uninterrupted manufacturing flow, resulting in increased efficiency, reduced costs, and ultimately higher profits.

Mabel is almost fool-proof, too, so that employees can use the terminals with a minimum of errors. The computer audits certain sensitive inputs. For example, the computer asks for the eight-digit register (order) number that is affected. This number contains a "check digit" that enables the computer to detect transposed numbers, or other errors. If the computer detects a mistake, Mabel asks the employee to resubmit the number. If the mistake occurs a second time, Mabel tells him to get help.

How can Mabel do all of these things? Perhaps, it's the size of her "brain." It has a work area that can store 250,000 characters of information. This is backed up with tape-storage and disc-storage files (Fig. 3). The tape-storage file has a capacity for 20 million characters of information per tape and several tapes can be connected to the computer simultaneously. The disc storage file can accommodate 25 million characters per disc. The computer can perform 750,000 additions or subtractions per second, record and organize input data, perform checks to ensure accuracy, and much, much more. It can print information on paper at the rate of 1100 complete lines per minute and can punch information on *IBM* cards at the rate of 300 cards per minute.

Strangely enough, only a small part of the total capability of *Rohr's IBM* 360 computer will be involved with the automatic warehouse operations. Its *IBM* 360 computer complex is operated in a multi-processing mode which allows numerous programs to be run simultaneously thus leaving time to perform functions for other departments such as engineering, finance, production control, planning, personnel, and others. In fact, the extra capability of this huge computer has given birth to "Clara."

Clara and Mabel have the same brain, but Clara serves a different clientele—the "everyday" housewife. Clara is the computer choice of *TeleMart Enterprises, Inc.* in San Diego, California. *TeleMart*, implemented on September 7, 1970, offers supermarket shopping by telephone for over 3000 items and as in the "good old days" delivers the groceries to the customer's home.

The shop-by-phone concept is not new. A "telemart" by a different name is alive and well in Sweden. It operates on 100-percent telephone orders and 100-percent home delivery. The difference is in the medium. The Swedish phonemart is not computerized like *TeleMart*. It has been in business for 10 years, however, and did a strapping 10-million-dollar gross in 1969.

(Continued on page 69)

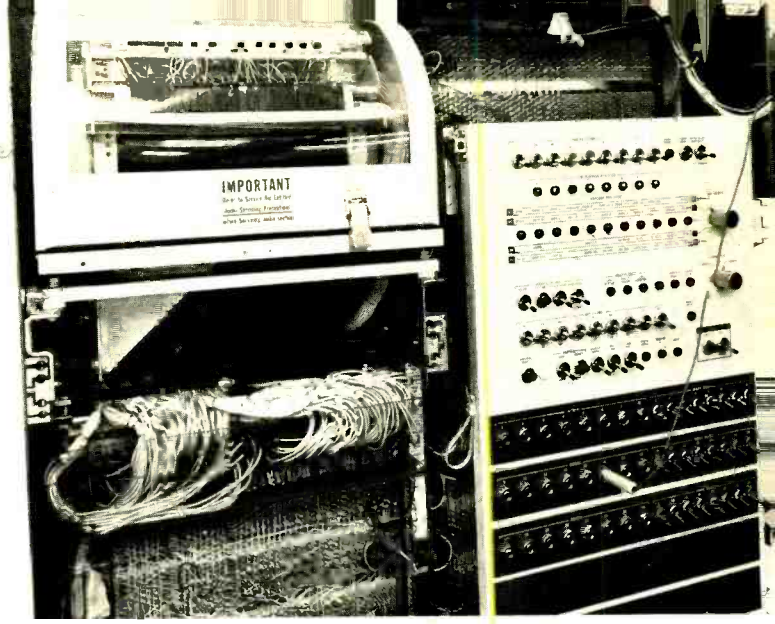


Fig. 1. The voice for the talking computer is recorded on a voice drum that can be seen in sealed container, upper left.

Fig. 2. An employee of the Rohr Corporation shown using Touch-Tone pad to enter data into the IBM 360 computer.

Fig. 3. The disc storage file shown here provides storage for 25 million characters of information.

Chip Capacitors for IC's

By DAVID L. HEISERMAN

Microminiature ceramic and tantalum chip capacitors, no bigger than match heads, are available for use on hybrid IC's. Design parameters and comparative characteristics are covered.

A group of ceramic chip capacitors, showing their small size.

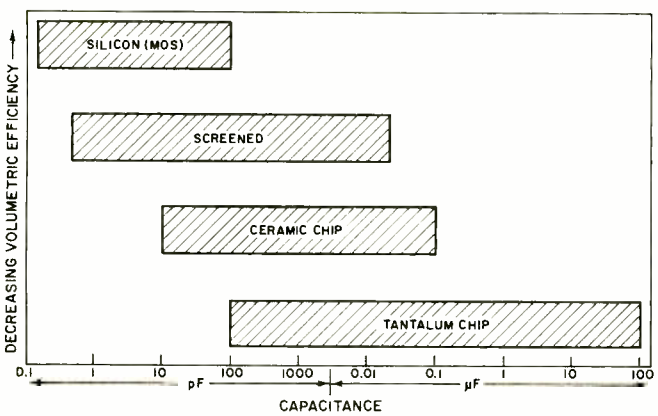
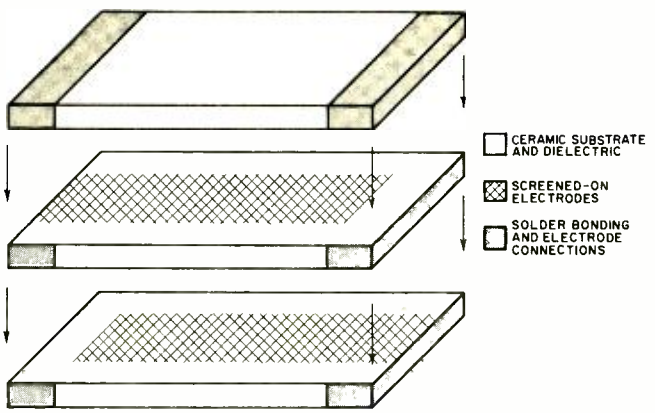


Fig. 1. Volumetric efficiency (capacitance per unit volume) of chip capacitors. Ceramic and tantalum types are highest.

Fig. 2. Basic elements of a typical ceramic chip capacitor.



INTEGRATED circuits are tributes to modern research and production ingenuity. Today it is not only technically possible, but economically feasible to put a hundred or more transistor structures onto a single silicon chip no larger than a match head. Even with this remarkable talent for producing microscopic and complicated active structures growing every day, no one has yet figured out a way to integrate a common passive capacitor larger than 100 pF onto a transistor-ladened chip.

Whenever circuit designers want to add a capacitor to an IC, they have to solder it in externally. Until recently, a single external capacitor took up more space on a printed-circuit board than a hundred integrated transistors and resistors. Capacitor manufacturers have joined the rush to microminiaturization, though, and it is now possible to buy reliable monolithic (single-chip) capacitors in the 100-pF to 1-μF range that are no larger than a match head. These chips are still add-on devices, but many are so small that several can fit into a package with an active IC chip.

Standard chip capacitors have package configurations that make it easier to solder or weld them into hybrid micro-circuit packages. Some have dabs of solder on each end instead of the traditional wire leads. A hybrid circuit manufacturer, then, can solder the capacitor terminals to a bonding pad by means of a solder reflow technique. Other kinds of chip capacitors have a dab of solder on one end and a short lead on the other. At a customer's request, chip capacitor manufacturers can also place long leads on both ends, dip the assembly into epoxy, and sell the chip as a standard microminiature discrete capacitor for PC-board mounting.

Volumetric Efficiency

The most important chip capacitor design parameter is that of volumetric efficiency (capacitance per unit volume).

Fig. 1 shows the volumetric efficiency of four chip capacitor compositions as a function of capacitance.

Silicon chips have the least volumetric efficiency and the lowest capacitance values. Since they can be integrated directly onto an MOS integrated circuit chip, there isn't much call for single-chip versions, anyway. A typical MOS chip capacitor has a tolerance that runs anywhere between 100 and 200 percent. This limits their use to simple bypass applications where tolerance isn't a critical factor.

Modern thick-film technology makes it possible to produce capacitors by screening alternate layers of conductive and dielectric inks onto a substrate material. These so-called "screened" chip capacitors can compete with ceramic and tantalum chips up to about 10 pF. This competition, however, is only by default. Present-day dielectric inks have relatively low dielectric constants, so screened chips are bound to have lower volumetric efficiencies. It is only the fact that 10 pF is the smallest ceramic chip on the market that makes screened chip capacitors competitive in lower ranges.

Ceramic and tantalum chip capacitors are, by far, the most popular chip capacitors on the market today. Looking through the mass of literature on chip capacitors, one might even get the impression there are no other kinds available.

Just like screened capacitors, ceramic chip capacitors have a thin layer of screened-on conductive ink for electrodes (Fig. 2). Instead of a dielectric ink, however, ceramic chips have a thin layer of ceramic material between the electrodes. Ceramic materials can have a dielectric constant (K) two or three orders of magnitude greater than the best dielectric inks. This accounts for the higher volumetric efficiency of ceramic chips.

Tantalum chip capacitors have the highest volumetric efficiency of all, and the highest and widest range of capacitance values. A 68-μF *Union Carbide* (Kemet) tantalum chip rated at 4 w. V d.c. measures only about a quarter-inch square and an eighth of an inch thick. The secret of tantalum chips' volumetric efficiency is the fact that they are actually microminiature electrolytic capacitors.

Traditional circuit designs make capacitors in the 100-pF to 10-μF range the most popular values. Available ceramic and tantalum chip capacitors have values that overlap in this popular range, so there is a great deal of competition for the market. Some manufacturers have thrown their lot with one kind of chip capacitor or the other exclusively. *Aerovox, Centralab, Republic Electronics, San Fernando,* and *Vitramon,* for instance, produce only ceramic chip capacitors. *Mallory,* on the other hand, is one company that produces tantalum chips exclusively. Other companies, such as *Union Carbide* and *Sprague,* supply both markets with lines of ceramic and tantalum chip capacitors.

Although volumetric efficiency is a prime chip-capacitor design parameter, it is not always the first thing circuit designers consider when selecting chip capacitors for a particular application. Tantalum and ceramic chips both have their own advantages and shortcomings. An understanding of how they are made points up their merits and drawbacks.

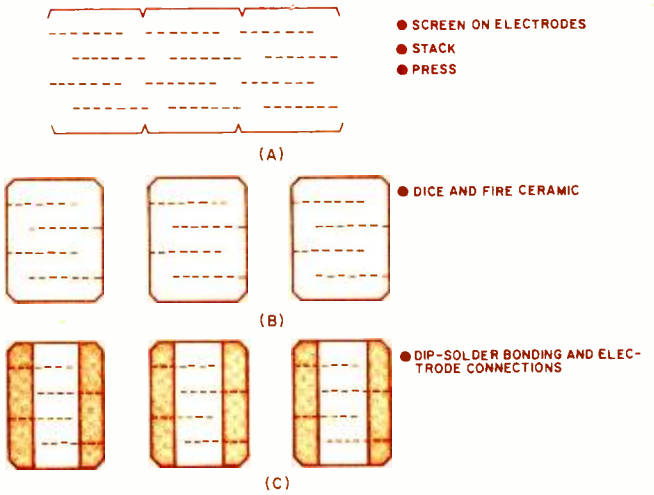


Fig. 3. Production steps in the fabrication of ceramic chip capacitors. End view of the capacitors are shown in figure.

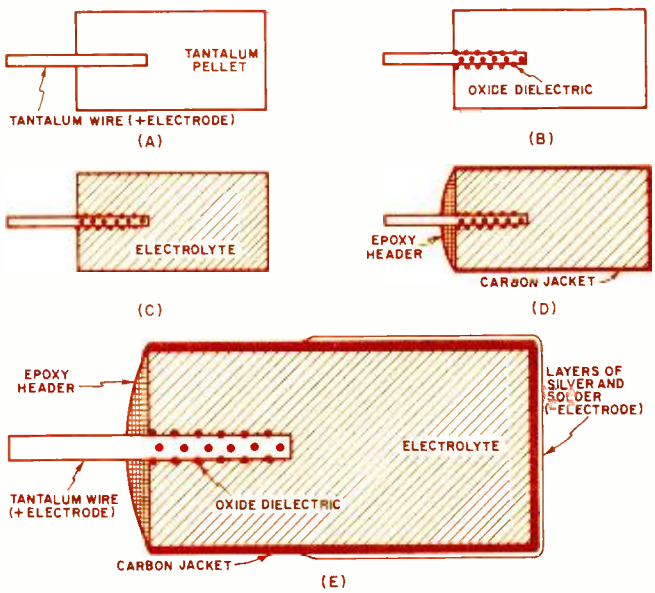


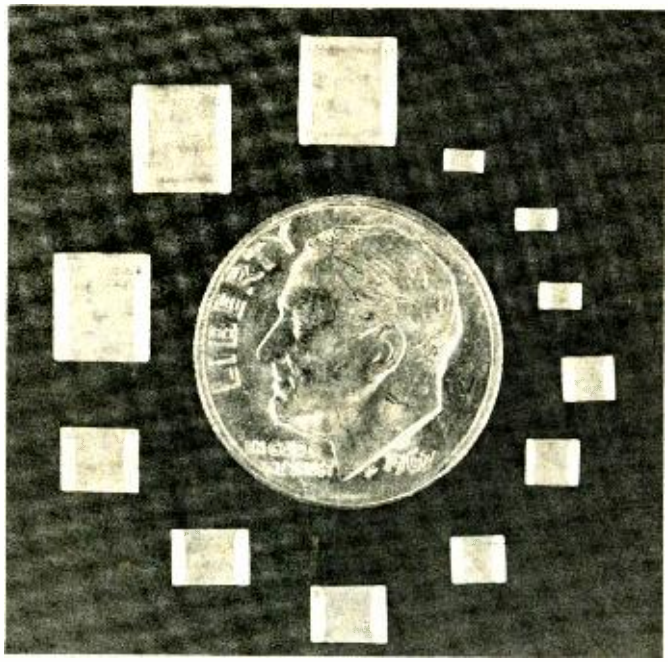
Fig. 4. Production steps in making tantalum chip capacitors. Completed capacitor is shown enlarged in part (E) of figure.

Manufacturing Chip Capacitors

The ceramic chip capacitor production process begins with several large, thin slabs of unfired ceramic (Fig. 3). A thin coating of conductive ink is screened onto the slabs, then they are aligned and stacked to form alternate layers

Table 1. Comparison of some of the essential characteristics of ceramic and tantalum chip capacitors.

	Capacitance Range	Tolerance Range	Working Volts (d.c.)	Temp. Range(°C)	Cap. Change with Temp.	Dielectric Constant	Dielectric Strength	Insulation Resistance	Dielectric Thickness
CERAMIC CHIPS	10 pF to 0.5 μF	±1% to ±20%	up to 200 V	−55 to +125	±12% worst case	1200	350 V per mil	1000 meg	0.5 mil
TANTALUM CHIPS	100 pF to 100 μF	±5% to ±20%	up to 50 V	−55 to +125	±12% worst case	26	17 kV per mil	1500 meg	0.01 mil



Ceramic chip capacitors come in larger sizes too. The light patches on ends of the chips are solder terminals.

of ceramic and electrode material.

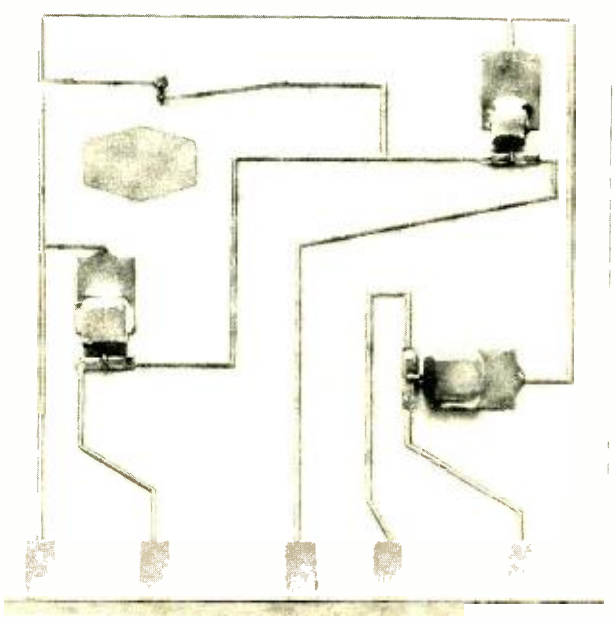
A precision pressing operation squeezes the stacks together to form the desired dielectric thickness. Ceramic technology has advanced to the point where it is possible to squeeze the stacks to get dielectric thicknesses of less than 0.5 mil.

After they're pressed, the ceramic slabs can be diced into individual chip capacitors and fired in an oven at about 2600°F. The only step that remains, then, is silvering and dip-soldering each end of the capacitors.

This dip-solder process electrically connects alternate electrode layers together to form the equivalent of several capacitors connected in parallel. The metal coatings also serve as bonding terminals.

The manufacturing process for tantalum chip capacitors is much more involved. The first step consists of compressing a bit of high-grade tantalum powder into a pellet of the desired size and shape (Fig. 4). A typical pellet for a 1-μF tantalum chip measures about 0.15 inch square and 0.05 inch thick. A piece of AWG #24 tantalum wire is pressed into the pellet during the compression operation. This wire later serves as the positive terminal.

There are four tantalum chip capacitors soldered to PC board.



An anodic process forms the dielectric layer around the tantalum wire. This layer of dielectric material, tantalum pentoxide, is often as thin as 0.003 mil. The dielectrics in some tantalum chips manufactured by *Mallory* are so thin they can be measured in angstroms—a unit generally reserved for measuring wavelengths of light.

Since tantalum chip capacitors are actually miniature electrolytics, the pellet has to be impregnated with an electrolyte, such as manganese dioxide. This electrolyte is the true negative terminal of the capacitor.

Once the electrolyte has formed, the pellet is coated with a protective jacket of conductive carbon. The carbon jacket itself gets a thin coating of silver and ordinary 60/40 solder. Since all three of these materials are good electrical conductors, they form a negative terminal surface that can either be welded or soldered directly to the microcircuit bonding pad.

A blob of epoxy around the tantalum wire—the positive terminal of the capacitor—strengthens the connection and insulates it from the conductive materials that make up the negative terminal.

Ceramic versus Tantalum

Table 1 compares some of the essential characteristics of ceramic and tantalum chip capacitors. These figures mainly reflect the quality of the dielectric material.

The volumetric efficiency of ceramic chip capacitors depends upon the extraordinarily high dielectric constant of modern ceramic materials, especially those containing barium titanate. The K value for most ceramic materials lies between 1000 and 6000, but a few high-performance chips use ceramics having K values as high as 13,000. By comparison, conventional capacitor dielectrics, such as mica and aluminum oxide, have K values of less than 15.

The dielectric constant of tantalum compounds is only about 26. This means that tantalum chip capacitors cannot rely upon the dielectric constant for their superior volumetric efficiency. The value of any given capacitor, however, is both a function of the dielectric constant *and* the thickness of the dielectric material itself. Increasing the volumetric efficiency of any capacitor, then, is a matter of increasing the K value of the dielectric material or decreasing the dielectric thickness. Tantalum chip capacitors depend on the latter technique for their very high volumetric efficiency.

For example, Table 1 shows that a typical ceramic dielectric has a K value about 50 times greater than the tantalum versions. To more than make up the difference, tantalum chip capacitors of the same value and voltage rating have a dielectric material that is 50 times thinner. These ratios change considerably with different capacitance values and voltage ratings, but the ratios always favor the tantalum chips.

Tantalum chip capacitors suffer the same disadvantages inherent in most electrolytics—polarized terminals and relatively low working voltages. Accidental voltage reversal on a tantalum chip can change the value of the capacitor, reduce its breakdown voltage, or increase its insulation leakage. At worst, a reverse voltage can destroy the dielectric altogether, so hybrid microcircuit engineers must abandon tantalum chips and use ceramics wherever there is a possibility of voltage reversals.

An inherently low capacitor working voltage is not the serious disadvantage it used to be. Except for high-voltage power circuits, there is virtually no need for capacitors with voltage ratings in excess of 50 volts. Hybrid microcircuits,

(Continued on page 74)

More on the SCHEIBER SYSTEM

By MILTON S. SNITZER/Technical Editor

Answers to questions being asked about the operation of this fully compatible, four-channel stereo system.

SINCE the appearance of our September article "The Scheiber 4-Channel Stereo System," a number of questions have come up on the operation and performance of the system. Our article showed the equations used in the matrixing sections of the encoder and decoder (see Fig. 1). Some readers have found that these equations raised more questions about the system than they answered.

For example, if you substitute the numerical values of the four separate channels that are matrixed into Scheiber's two (A and B) channels in the playback decoder, here is what you find. When there are equal signals on all four input channels, the signal fed to the front left (FL) speaker after matrixing consists of 100% of the FL signal plus 70% of front right (FR) signal plus 70% of rear left (RL) signal plus none of the rear right (RR) signal. Under these same conditions, the signal fed to the front right (FR) speaker consists of 100% of the FR signal plus 70% of FL signal plus 70% of RR signal plus none of the RL signal. A similar analysis holds for signals applied to the other two speakers.

According to these figures, the *channel separation* would be only 3 dB; that is, signals from adjacent channels are down only 3 dB or 70% of the desired signal. However, bear in mind that when the signals are similar in all four channels and all four speakers are reproducing the same information, there is little or no need for channel separation.

Next, consider what happens when there is signal in *only one channel.* Assume our original program consists of information in the front left (FL) channel only. Again, using the matrix equations and noting that all terms except FL drop out, here's what happens after matrixing in the decoder. There will be a 100% FL signal and nothing else in the FL speaker. At the same time the FR and RL speakers will carry 70% of the FL signal, and the RR speaker will carry none (0%) of the FL signal. Notice how the matrix arrangement groups the four speakers into two sets of diagonally opposite pairs.

Now here is where the gain-sensing circuits, employing the IC differential amplifier, come into the picture. When these circuits sense the difference between the 100% and the 0% FL signals in this example, they increase the gain of this pair of diagonal channels (FL and RR) and, at the same time, they turn off the opposite diagonal pair of amplifiers (FR and RL) which had been carrying the 70% FL signals. As a result, separation, or more exactly "isolation," goes way up. The only limitation now is the inherent crosstalk between the channels, which can be made very small. The same type of analysis holds true for the four channels when any one of the other three contains information.

If the difference between the two signals in the opposite-corner amplifiers is less than the 100% to 0% ratio, then the relative gains of the four channels are adjusted between the above limits. In practice, then, the amount of separation varies with signal content. The more similar the signals are in all four channels, the less will be the separation. Average values of 15 dB or better are readily obtained with most program material. Hence, in return for being able to combine four channels into two, the Scheiber system trades off channel separation.

There are still some unanswered questions about the system, since full details have yet to be released. For example, do the gain-sensing circuits work only on amplitude differences or can they adequately take into account the differing frequency and phase content of the signals being compared? What if you had a violin in one channel, a piano in the second, a clarinet in the third, and a flute in the fourth—all at exactly the same amplitude? Would the system be able to compare them and retain a high degree of separation between the channels? Circuits can be designed to make this type of comparison but they are not simple. In any case, the Scheiber system is an important "first" and is well worth watching. ▲

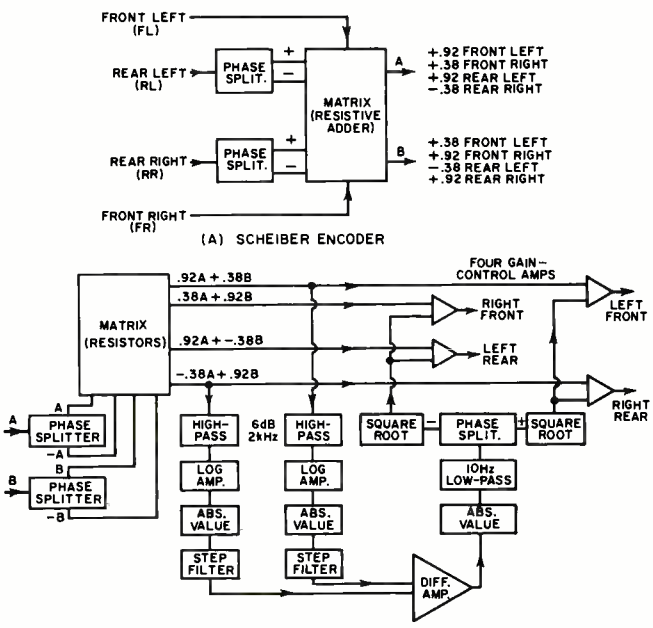
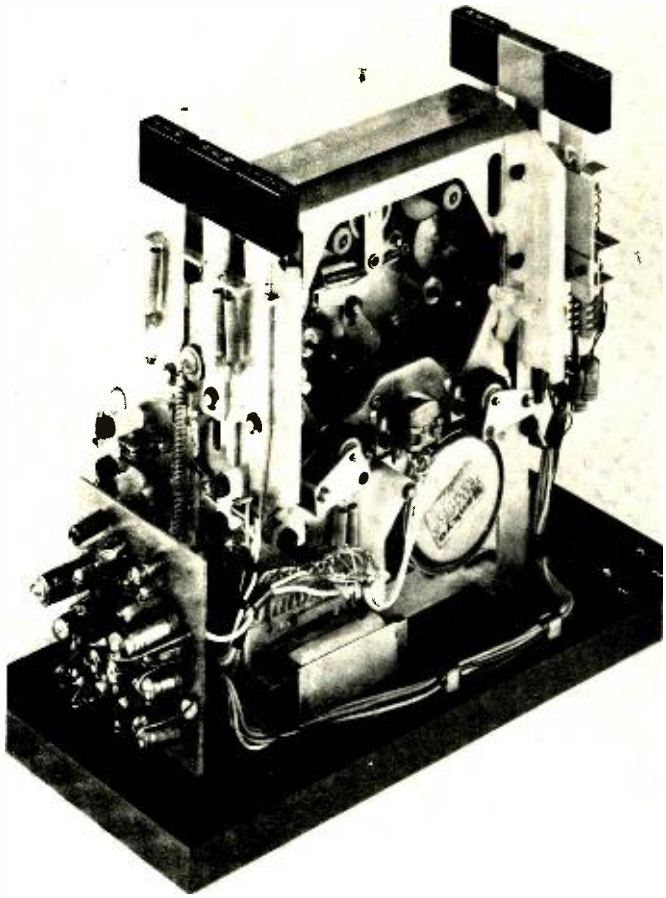


Fig. 1. Block diagram of encoder and decoder repeated from September issue. Encoder is installed into phono or tape mastering system or in broadcast transmitter. The decoder is inserted in the playback system where it is located between the output of a two-channel preamp and a four-channel power amp and speakers.



A Slot-Loading Cassette Transport

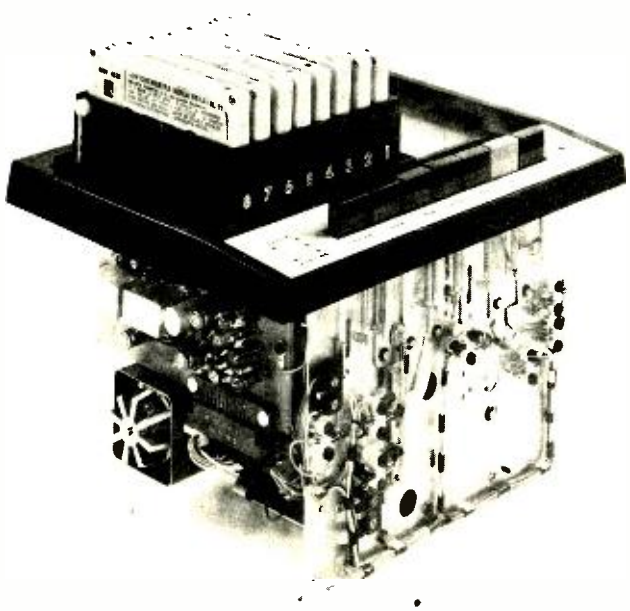
By ALFRED ZUCKERMAN/Vice President, Engineering
Benjamin Electronic Sound Corp.

Description of Staar mechanism, which permits slot loading and automatic changing of cassettes. System has been licensed to 25 manufacturers throughout the world.

Basic slot-loading Staar transport mechanism for cassettes.

THE *Staar* System is a slot-loading transport mechanism for cassettes. It permits cassettes to be simply pushed into a slot in the transport much like the endless-loop cartridges are inserted into their players. The mechanism was developed by *Staar S.A.*, a Belgium-based company specializing in equipment for the audio field. The firm has pioneered in record changer, tape-transport, and dictating-machine design for over 30 years, and holds many basic patents in these areas.

An 8-cassette automatic changer mechanism using same system.



The basic *Philips* compact cassette configuration, a refinement of the *RCA Victor* 1959 twin-hub cartridge, was introduced to the U.S. market by *Norelco* in 1965. This system required insertion of the cassette along the axes of the reel hubs and capstan. This was accomplished by broadside-loading, which was acceptable for home and portable use but was unsuited for auto use where the space requirements and distraction were considered excessive.

Theo Staar, President of *Staar S.A.*, recognized this problem initially and in 1965 he filed a patent application which covered a mechanism that permitted slot-loading. As the cassette is pushed into the slot, it bears against pins attached to a plate on which is mounted the motor-flywheel-capstan system and the two hubs (Fig.1). The plate is hinged at four points by parallel-action linkages attached to the main chassis. As the cassette is inserted the hubs and the capstan swing up into the appropriate openings, engaging the reels fully and pinching the tape between the capstan and pinch roller in the final position when contact is made between the tape and the head.

When the hinged plate is fully engaged, it is latched into position. Release of the plate and ejection of the cassette can be effected by several means:

1. A simple eject button which mechanically unlatches the plate.
2. A solenoid which duplicates the action of the eject but-

ton. This solenoid is connected to a sensing circuit which automatically ejects the cassette at the end of the tape.

3. This solenoid and sensing circuit provide a means of automatically ejecting the cartridge in the event the power is turned off while the cassette is engaged. This protects the capstan follower and tape.

Many systems have been devised to sense the end-of-tape condition. Those which sense program material are subject to unwanted false triggering by a long silence on the tape. Those which sense a conductive tab on the face of the tape are limited only to those cassettes that are so equipped. Space limitations preclude the insertion of tension-sensing switches in the cassette.

Staar devised an ingenious system based on the motion of the supply reel which avoided all of the limitations just outlined. By coupling a s.p.d.t. switch ($S1$) to a cam on the supply hub, shaft information is fed into the eject-solenoid circuit (Fig. 2).

The circuit consists of two direct-coupled transistors driving a solenoid. Ordinarily $R1$ and $R2$ bias $Q1$ to a cut-off condition which results in $Q2$ operating in saturation and activating the solenoid. When power is applied, however, the charging current of $C1$ drives $Q1$ to saturation for the brief period before the motor comes up to speed and the tape starts moving. When this occurs, the contacts of $S1$ alternately short $C2$ (through low-value resistor $R5$) and connect it across $C1$. The average recharging current of $C2$ is sufficient to bias $Q1$ to saturation, cutting off $Q2$ and keeping the solenoid unactivated. When the tape motion stops, $C2$ is either shorted out of the circuit or charged up fully. Soon $Q1$ is no longer forward-biased; it stops conducting and $Q2$ is driven to saturation, energizing the solenoid. Time constants are such that after 1.5 s. the solenoid is activated, cassette is ejected, and system is turned off.

Another interesting feature covered by *Staar* patents is the "Sensitune" device. In the basic unit, Fast-Forward and Rewind functions are initiated by the lateral motion of the Eject lever which is spring-loaded and returns to the normal play mode when released. In the Sensitune model, this lever locks into either fast mode. An auxiliary tape head senses the program material on the tape and, in conjunction with associated circuitry, automatically senses the (minimum) 4 seconds of silence between selections. The circuit then automatically actuates a solenoid which unlocks the fast-mode lever, returning to the playback mode. This permits the user to skip a tune or replay a tune by simply activating the fast-mode lever in the desired direction.

A more recent development is a transport mechanism which automatically senses the end of the tape on the cassette and reverses tape direction to play the other tracks. The Fast-Forward and Rewind push-buttons automatically reverse function when the tape reverses so that the Fast-Forward button functions as Fast-Forward irrespective of the direction of tape motion.

A further development for home entertainment use is a cassette changer which incorporates the control features of the bi-directional unit just described. In this unit, a small tray which accepts up to eight cassettes is loaded onto the top of the machine. The first cassette drops into a slot, plays, reverses, plays the return tracks, and then rises to the tray. The tray advances to permit the next cassette to play. This process continues until the last cassette is played at which time the cassette returns to the tray and the mechanism shuts itself off. There is also a 24-cassette version of the changer which uses a rotating tray.

Licenses for the slot-loading cassette mechanism, primarily for use in automobiles, have been issued to 25 manufacturers throughout the world. Licenses to manufacture the changers, however, have been issued to only four manufacturers. These are *Ampex* in the U.S., *Plessey* in England, *Matsushita* in Japan, and *Lenco-Italiana* in Italy (distributed in U.S. by *Benjamin Electronic Sound Corp).* ▲

Benjamin/Lenco 24-cassette automatic changer using Staar system.

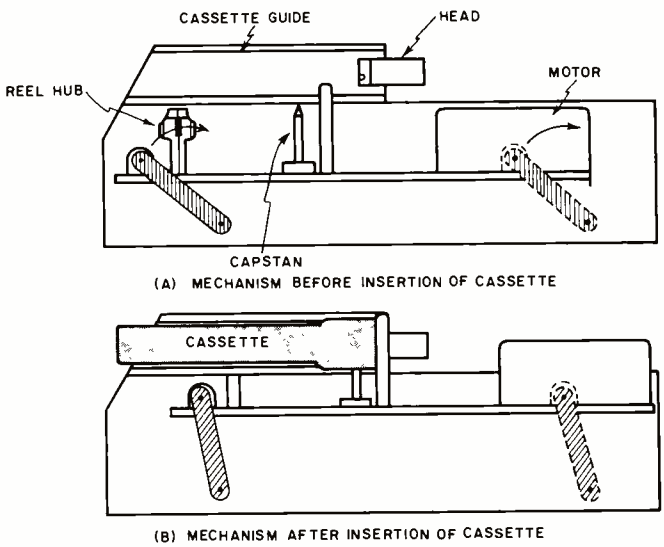
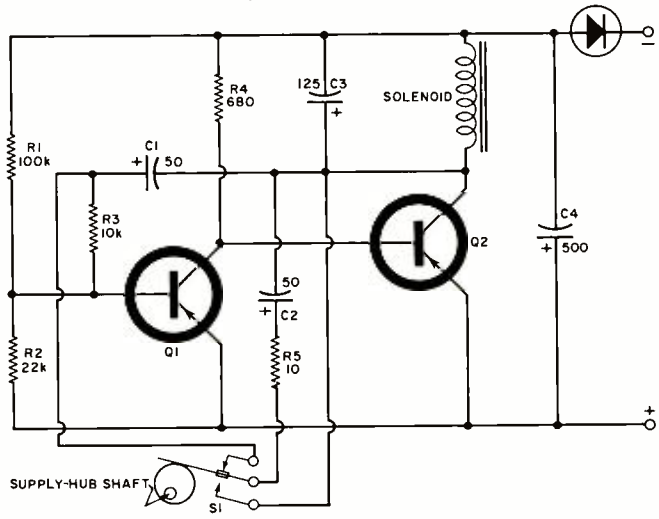


Fig.1. Simplified view showing how cassette slides or drops into slot. Two reel hubs and capstan, mounted on plate, move up into the cassette to drive the tape.

Fig. 2. Cassette-eject circuit. When supply reel stops turning at the end of the tape, the solenoid is energized. This unlatches the plate and pushes cassette out of slot.



Nomogram Aids Voltage-Drop Calculations

By JAMES E. McALISTER

Straightedge is used to determine IR drop in conductors where high currents are to be carried over long runs.

IN many high-current applications, the voltage drop in current-carrying wires themselves can be quite significant. Even in lower current applications, especially when long wires are used, voltage drops can be an important factor.

The equation used to calculate the voltage drop can be expressed as:

$$E = R \times I \times L$$

where: E = voltage drop in millivolts

R = wire resistance, in ohms per 1000 feet

I = current in amperes

L = length in feet

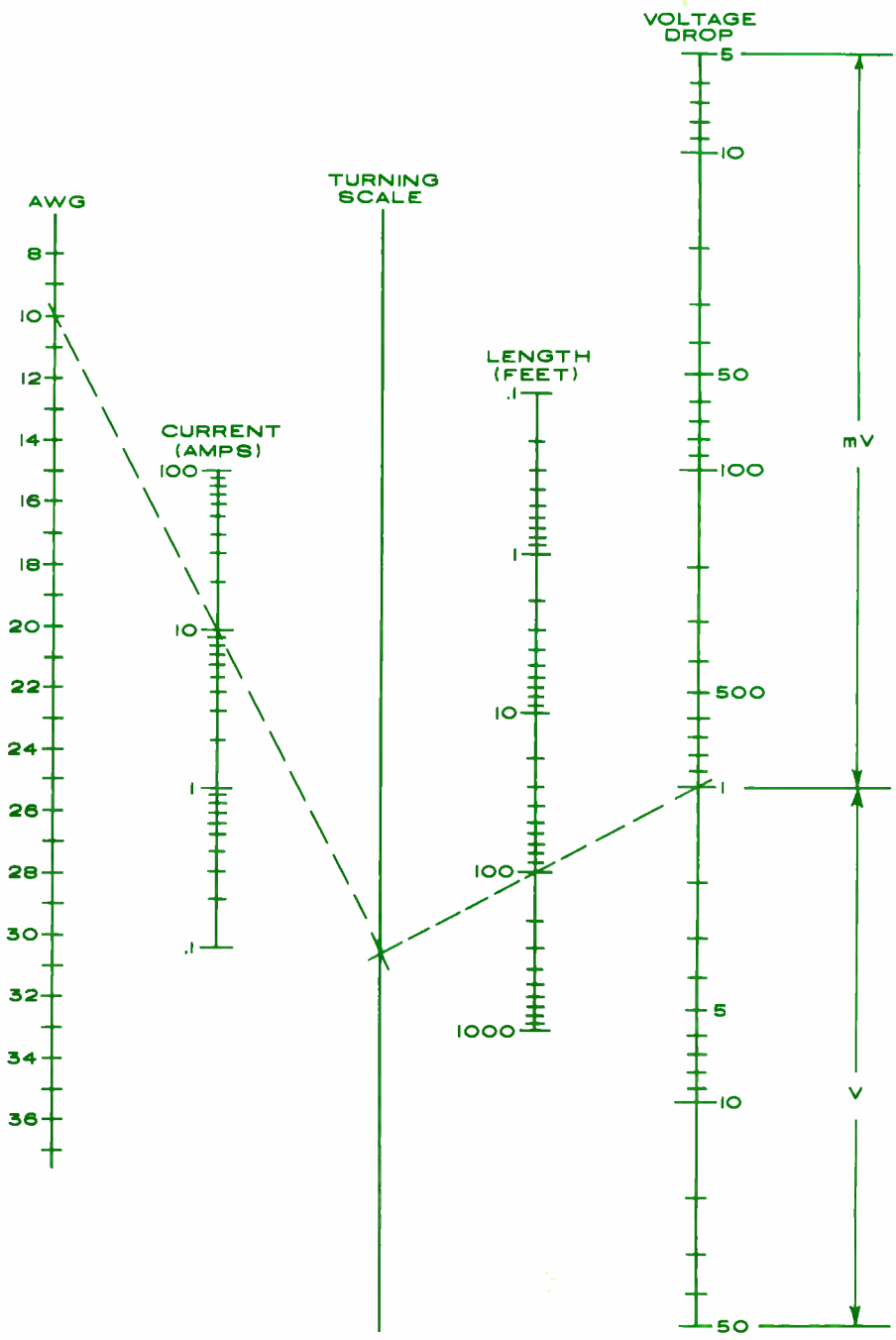
Even though the wire resistance per 1000 feet can be found in most electrical handbooks, looking up the resistance when several wire sizes are involved can become a nuisance. The nomogram shown here allows the voltage drop in wires to be calculated with a minimum of effort.

Example of Use

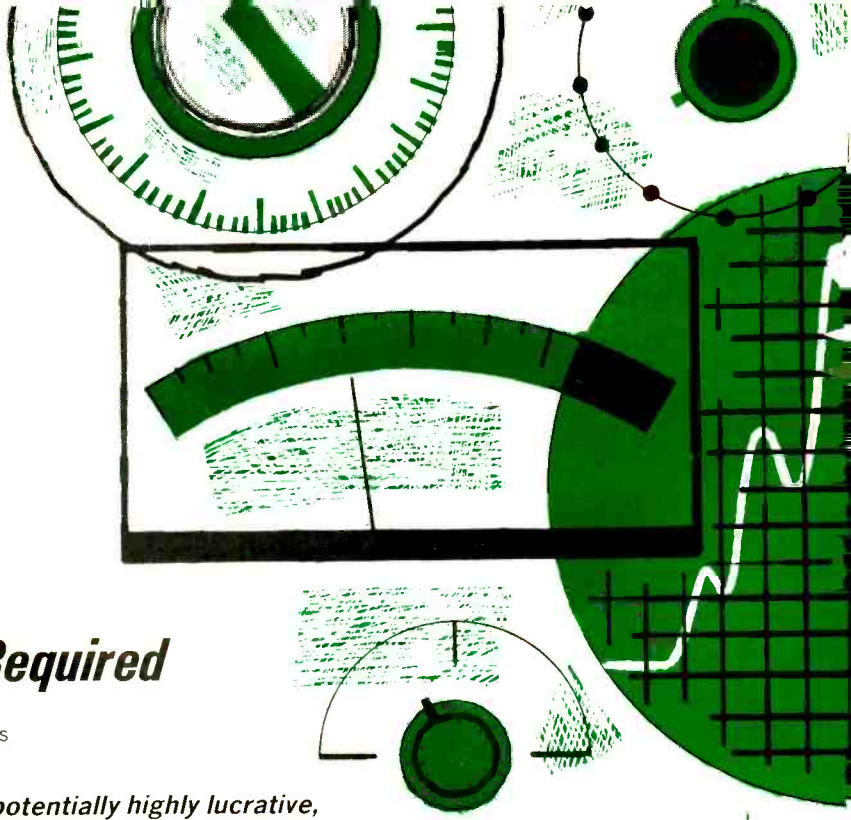
Calculate the voltage drop in 100 feet of #10 wire carrying 10 amperes.

First, draw a line from the desired wire gauge (#10 on the AWG scale) through the current the wire is carrying (10 on the Current scale). This line should be extended until it crosses the turning scale. From this point a line should be drawn through the wire length (100'). The intersection of this line with the Voltage-Drop scale gives the voltage drop in the wire (1 volt).

If two wires of the same gauge are paralleled to carry current, a single equivalent gauge can be found for computational purposes by subtracting 3 from the original wire-gauge number. If two #16 wires are paralleled, for example, a #13 should be used in the calculations of the voltage drop. Similarly, 6 should be subtracted for four wires in parallel, and 9 should be subtracted for eight wires in parallel. This useful characteristic is a consequence of the arrangement of wire tables. ▲



Testing Hi-Fi Equipment



Part I-Test Equipment Required

BY JULIAN D. HIRSCH/Hirsch-Houck Laboratories

Smaller than the TV servicing market, but potentially highly lucrative, hi-fi servicing requires some special equipment and attention to quality of equipment performance. Here's the kind of test equipment needed and its cost, in order to make hi-fi components not merely work, but work well.

AT one time, a radio service technician needed a minimum of test equipment and technical background to do his job. The old time "screwdriver mechanic," operating with a mixture of experience, intuition, and luck, was able to do an adequate job of servicing AM radios and phonographs.

The advent of TV changed that situation somewhat. Anyone who expected to earn his living in TV servicing had to become familiar with the use of basic test instruments, such as the oscilloscope, v.t.v.m., and sweep generator. Color TV added a new dimension of sophistication to the service technician's work. Many have not been able to make the transition to color-TV service, but those who have are reaping the rewards of that expanding market.

Concurrently with the growth of TV, there has been a smaller but potentially as lucrative market which, for some reason, has hardly been tapped by the service industry. Component high fidelity, beginning as an enthusiast's hobby more than 20 years ago, has since developed into a multi-million dollar industry.

Many people, when troubles develop in their hi-fi systems, have experienced great difficulty in getting competent service. The local radio and TV shop is generally reluctant to take on the job, and frequently fails to satisfy the customer when it does. A number of shops specializing in hi-fi service have appeared on the scene and partially filled this void, but it is evident that they are too few and far between. Often the customer has no recourse but to ship his ailing component back to the factory or to an authorized service center. This is, at best, inconvenient and often unsatisfactory (did you ever try to describe, in writing, a subtle but irritating distortion?).

When you consider that even a minimal hi-fi system costs as much as a TV set and that many systems represent an investment of $1000 to $2000 or more, it should be evident that there is money to be made in hi-fi servicing. Why, then, have so few service technicians gone into this field? For one thing, most owners of hi-fi components are highly critical. They are not satisfied if their equipment merely "works." They bought it because it offered performance unobtainable in mass-produced packaged radio/phonographs and they want to keep it working as well as it did when it left the factory.

Although hi-fi components are not unduly complex (not at all comparable to a color-TV set, for example), their performance in terms of frequency response, distortion, and sensitivity frequently approaches the state-of-the-art. No one can expect to check out modern hi-fi equipment "by ear" or with a few crude measurements. A number of specialized test instruments and procedures are required to do a thorough job. Many of these are quite expensive and will not be found in the average service shop. It is possible, with a little "know-how," to handle a large percentage of hi-fi service jobs with a minimum investment in test equipment. Whether a service technician elects to operate on a minimum basis or equip himself for hi-fi servicing depends on his own circumstances. Either way, there is a crying need for more widespread competence in this field.

The basic servicing and troubleshooting procedures for hi-fi components are much the same as for ordinary radios and TV sets and we will not concern ourselves with them at this time. The real problem, for the average service technician, is that of testing, or verifying the performance of a repaired unit, or of adjusting and aligning it to meet its original specifications. Nearly every service shop is already equipped with an oscilloscope, which is used in most audio test procedures, but it is unlikely that many of the other instruments needed will be on hand.

FM Tuner

We will consider each type of hi-fi component in turn and describe the minimum equipment required for adequate measurement of its performance. In a subsequent article, the specific test procedures will be discussed.

A grouping of stereo-FM signal generators for adjusting FM tuners and receivers.

To verify the performance of an FM tuner, it is necessary to measure its sensitivity, distortion, image and i.f. rejection, and dial calibration. In addition, stereo tuners should be checked for channel separation and proper operation of automatic stereo/mono switching circuits. Frequency response may also be checked, although it is unlikely to be affected by normal use or any servicing procedures.

The most important instrument for FM-tuner measurements is a good FM signal generator. Ordinary service instruments are unsuited to this purpose, although TV/FM sweep generators may be used for i.f. and discriminator alignment. The FM signal generator must have calibrated deviation (usually indicated on a meter) up to at least 75 kHz with low distortion, and a calibrated output attenuator capable of setting accurate output levels from 1 microvolt to 100,000 microvolts into a matched 50-ohm load. If it is to be used for stereo measurements, the generator should have a modulation bandwidth of at least 75 kHz. However, it is possible to use specialized stereo test instruments containing their own r.f. generators, in which case the FM signal generator modulation will be in the audio range.

A good FM signal generator is the most expensive piece of test equipment required for hi-fi servicing. One of the least expensive models with suitable characteristics is the *Measurements Corp.* Model 188 ($700). Other FM generators, such as those made by *Hewlett-Packard* and *Marconi*, are designed for laboratory use and have many features not required for hi-fi servicing. Their high price ($1200 to $2000 or more) is not usually justified for service work, but sometimes they can be found on the surplus market for less than $500. Some older laboratory-grade FM generators do not have the modulation bandwidth needed for accurate channel-separation measurements, but are otherwise quite adequate for servicing tuners and receivers.

Stereo-FM measurements require a multiplex generator to develop a standard composite modulating signal from left and right channel input signals. The multiplex signal, including the 19-kHz pilot carrier, modulates the FM signal generator. Several manufacturers produce multiplex generators with built-in r.f. generators (uncalibrated), usually operating around 100 MHz. This eliminates the need for an expensive FM signal generator for ordinary stereo servicing applications, although it is still required for measuring tuner sensitivity and distortion. These instruments are relatively inexpensive and are quite satisfactory for servicing and aligning stereo-FM tuners.

Typical multiplex generators with built-in r.f. sources include the *Heath* IG-37 ($80, kit), the *Eico* 342 ($175), and the *RCA* WR-52A ($248). When used with a modern FM signal generator such as the *Measurements Corp.* Model 188, the *H.H. Scott* Type 830 multiplex generator ($600) provides a stereo-FM signal which fully meets broadcast quality standards.

The IHF Usable Sensitivity measurement requires the use of a distortion analyzer on the audio output of the tuner. The distortion analyzer has a tunable notch filter, which nulls out the fundamental frequency, leaving the r.m.s. sum of the harmonics (plus hum and noise, if present) to be read on a meter as a percentage of the total signal amplitude.

Laboratory-grade distortion analyzers, such as the *Hewlett-Packard* Model 331A ($650) are not really needed for tuner measurements, where distortion rarely goes below 0.5%, although they are exceptionally convenient and rapid to use. The inexpensive *Heath* IM-58 ($65, kit) is capable of making any distortion measurements necessary in hi-fi servicing, in amplifiers as well as tuners. Additional flexibility is offered in the *Eico* Model 902 ($250), which also includes an intermodulation analyzer and a sensitive a.c. v.t.v.m., and in other respects is similar to the *Heath* IM-58.

Although an inexpensive audio oscillator might be used as a modulating source for some tuner measurements, it is necessary to maintain a constant audio level (within ± 1 dB or better) and to have accurate frequency calibration when making frequency-response measurements on any audio component. A good investment is a low-distortion audio generator, such as the *Heath* IG-72 ($47, kit or $70, wired) or the *Eico* Model 378 ($60, kit or $80, wired). These instruments cover a range from 10 Hz to 100 kHz, with accurately re-settable switch-selected frequencies, uniform metered output level, and distortion less than 0.1%. Some continuously tuned laboratory-grade oscillators, including the *Hewlett-Packard* Model 204-C ($250) and the *General Radio* Type 1310-B ($295) are also well-suited for high-quality audio measurements.

Testing any hi-fi component requires that audio voltages be measured over a wide range of amplitudes, from perhaps 1 millivolt to 20 or 30 volts. Ordinary service multimeters are lacking in sensitivity and frequency response. Inex-

pensive a.c. v.t.v.m.'s, such as the *Heath* IM-38 ($42, kit or $58, wired), *Eico* Model 250 ($60, kit or $90 wired), or *RCA* WV-76A ($90), are satisfactory for this purpose. Greater accuracy, typically 1% as compared to 3% for the lower-priced meters, plus wider frequency bandwidth are offered in laboratory-grade meters, such as *Singer (Ballantine)* Model 303-01 ($335), the *Hewlett-Packard* Model 400E ($335), and *General Radio* Type 1808 ($295).

AM Tuner

Every service technician is already equipped to work on AM tuners, which are included in many stereo receivers, and sometimes in separate component AM-FM tuners. No special instruments are required and, with the present trend toward using ceramic i.f. filters, it should not be long before an AM tuner alignment will consist only of a front-end tracking adjustment.

When an FM or AM tuner is part of a complete receiver, it is preferable to make all measurements of its audio output at the tape-recording jacks, which are provided on practically all receivers. This eliminates the effect of tone-control response, or audio distortion, on the measurement of tuner performance.

Amplifier

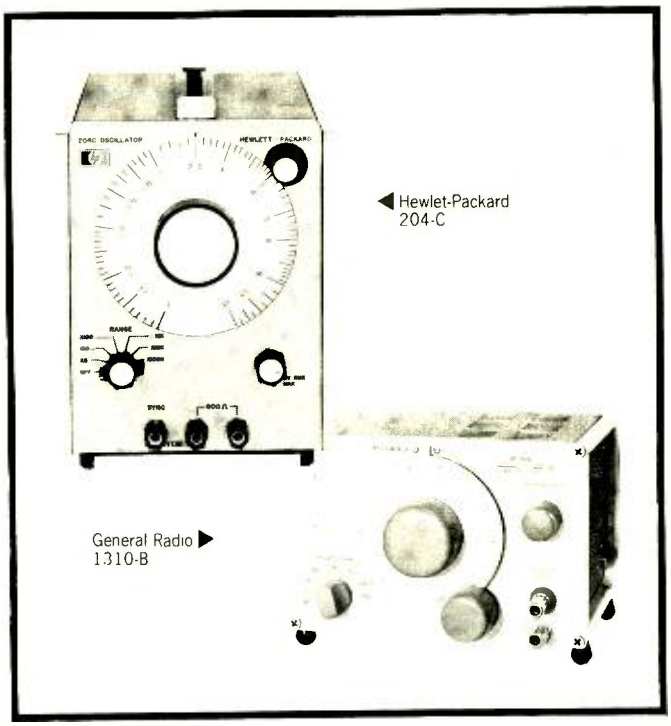
Functionally, amplifiers can be broken down into two distinct sections, on which different measurements must be made. The *preamplifier* includes the input switching, phono equalization, tone controls and filters, and volume-control functions. The *power-amplifier* section usually has no controls or external adjustments (except for speaker switching) and amplifies the low-level output of the preamplifier to drive the speakers. Sometimes the preamplifier and power amplifier are physically separate, but more often they are combined in a single unit, frequently with tuners included to form a complete receiver.

Preamplifier measurements include frequency response, tone-control characteristics, phono and tape-head equalization accuracy, distortion, hum and noise, and crosstalk between inputs. Stereo crosstalk (between channels of the same program source) is rarely great enough to be audibly significant.

The basic instruments for audio measurements include an audio signal generator, with metered output and attenuators capable of controlling the output level between 1 millivolt and several volts; an a.c. v.t.v.m. with a similar range; an oscilloscope; and a distortion analyzer. The instruments suggested for testing tuners are also suitable for amplifier measurements.

Power-amplifier tests differ somewhat from the basic frequency-response measurements made on tuners and preamplifiers. The frequency response of a power amplifier—even an inexpensive one—is usually quite flat across the audio range from 20 to 20,000 Hz and there is little point in measuring it. We are more concerned with determining how much power can be delivered at different frequencies and at how much distortion. Hum and noise are important factors, since they will not be affected by volume controls or filters in the preceding preamplifier section. Instability under various conditions of load or drive is a common fault, which can occur because of a component failure. Oscillations outside the audio range may not be heard as such but can affect the sound and in an extreme case even damage a speaker. A stability check is an important part of the check-out procedure.

A low-distortion audio generator, such as those previously described, is ideal for driving a power amplifier. It will be necessary to provide suitable resistor loads for the two outputs, replacing the speakers while making measurements. Although series and parallel combinations of standard wire-wound power resistors can be used to make 8-ohm loads, this tends to be clumsy. While most amplifiers deliver less



A pair of audio oscillators that can be used to supply audio test signals.

than 30 watts continuous output per channel, there are some capable of 50 to 60 watts or more.

We have found an excellent solution to the problem of dissipating this much power safely in the use of a compact, high-wattage precision resistor manufactured by *Dale*. The Type RH-50, listed in the *Allied Radio* and other mail-order catalogues, is available in an 8-ohm value, with a 1% tolerance, for about $2.50. When it is mounted to a metal chassis by its integral "ear," it can dissipate 50 watts without damage or undue change of value. At least two resistors will be needed, for the two stereo channels. We have found it convenient to use two 8-ohm resistors with a switching arrangement to connect them in series or parallel when 16-ohm or 4-ohm loads are required. If they are to be used continuously at high power levels, they may be suspended in mineral or transformer oil, and will safely dissipate sever-

Laboratory-grade high-sensitivity a.c. voltmeters for signal-level measurements.

al hundred watts for sufficient time to make any necessary measurements.

The *Heath* IM-48 audio analyzer ($69, kit) combines an IM analyzer (not really needed if a harmonic-distortion analyzer is available) with an a.c. v.t.v.m. and built-in load resistors so that it can serve as a direct-reading wattmeter. Although it is convenient to use, another load must be provided for the second channel and its built-in load is only rated at 25 watts continuous dissipation. All in all, we feel it is more convenient to build a two-channel load with adequate dissipation capability and measure the voltage across the load with a v.t.v.m. to determine power output.

The rated power of an amplifier can be obtained only when the proper a.c. line voltage is available. A drop of a couple of volts in the supply voltage can have a disproportionate effect on the maximum undistorted output power. It is important to continuously monitor the line voltage with an accurate meter. The *RCA* Model WV-120A ($18.50) is an inexpensive line monitor with sufficient accuracy. When driving a powerful amplifier to its maximum, it is not uncommon for the line voltage to drop several volts. Not only must it be monitored, but there must be some means of maintaining the proper voltage (normally 120 volts). A variable autotransformer, such as the *General Radio* Type W-5M Variac ($31) or the *Superior* Type N21 ($39) is the simplest way to control the line voltage. Automatic regulators of the saturable-reactor type should not be used unless they are designed to deliver a sinusoidal output waveform.

Pair of distortion meters, an FM signal generator, and a wow and flutter meter.

Record Players

Aside from correct operation of the record-dropping and indexing mechanisms, record players are required to operate at the correct speed, without excessive wow, flutter, or rumble. If adjustable anti-skating compensation is provided this should be set up properly for the stylus force in use.

Speed is readily checked with an inexpensive stroboscope disc, viewed under fluorescent or neon light. For wow or flutter measurements, special test records and a wow and flutter meter are required. Wow and flutter are normally measured with a 3000-Hz test tone, since the human ear is most sensitive to speed fluctuations in that frequency range. Test records providing this signal, recorded with very low wow and flutter, include the STEREO REVIEW SR12 ($4.98) and the *CBS Labs* BTR-150 ($10). The SR12 record also has a music flutter test with four passages of piano music recorded with successively greater amounts of flutter. This is useful for subjective evaluation of turntable flutter, without using a wow and flutter meter.

There are several makes of wow and flutter meters available. The *Woelke* ME-104 ($365) is imported by *Gotham Audio Corp.* The *W.H.M.* Model 3 ($190) is imported by *ReVox Corp.* Several more refined (and expensive) meters are made in this country by *Data Measurements Corp.* (formerly known as *Micom*).

Rumble may be judged subjectively by listening to the silent groove bands of the *CBS Labs* BTR-150 record or to the special rumble test band of the STEREO REVIEW SR12 record. Unless the listening is done in the normal environment of the system, or at the very least with speakers having the same or better low-frequency response, this may be of limited value. Speaker and room characteristics have a strong affect on audible rumble.

Standard NAB rumble measurements are referred to a level corresponding to a recorded velocity of 1.4 cm/s at 100 Hz, or 7 cm/s at 500 Hz, with RIAA low-frequency playback equalization (slightly modified at low and high frequencies to eliminate the effects of other noise sources). Unfortunately, the records named do not have a recorded reference level tone, but it can be determined with sufficient accuracy from some of the recorded tones of the *CBS Labs* BTR-150 or STR-100 records.

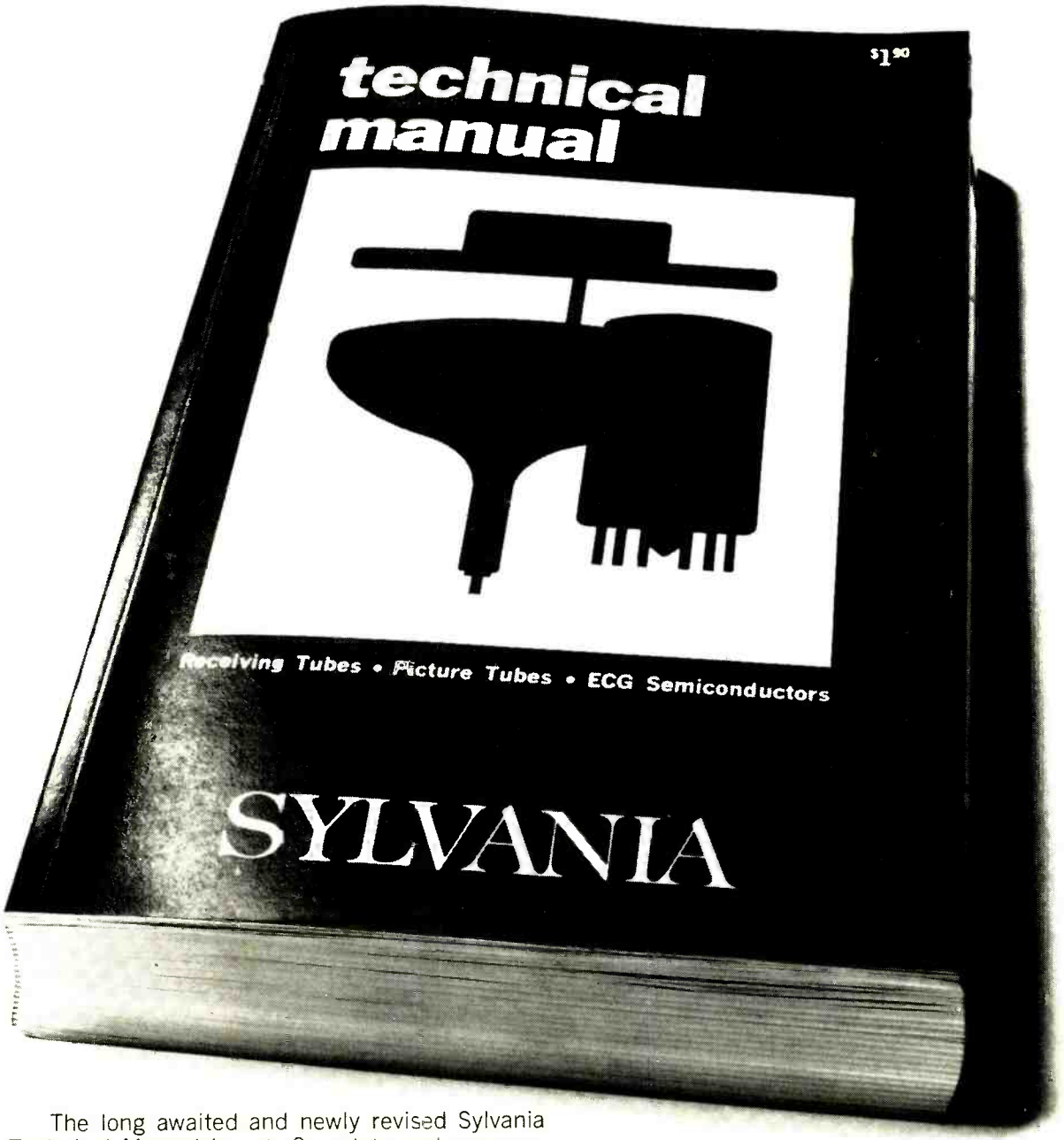
A playback preamplifier, with RIAA low-frequency equalization, is needed when making rumble measurements. There are many standard preamplifiers that are suitable for this purpose. Used monophonic preamplifiers of excellent quality can often be purchased for a fraction of their original cost if a stereo preamplifier is not readily available. Since this measurement may be made on only one channel, a monophonic preamplifier is perfectly satisfactory.

Under the best of conditions, turntable-rumble measurements are difficult to make with accuracy and repeatability. However, when checking out a turntable after servicing, it is only necessary to know the approximate rumble, which is easily determined with sufficient accuracy using simple equipment—or even with no equipment other than a silent groove test record.

Phono Pickups

The tonearm (with the cartridge installed) should be checked for correct stylus overhang, tracking force, and anti-skating compensation, if this feature is provided. Many arms, particularly those in lower priced record changers, have no provision for cartridge positioning (overhang) or

(*Continued on page* 66)



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Phasing Speakers

(Continued from page 31)

Test equipment to provide a good solution to the problem involves a transmitter and a receiver. The transmitter duplicates the performance and consists of an audio signal generator, audio amplifier, and a loudspeaker. The speaker should be mounted on a pole or tripod at about the height of a performer's lips. The receiver duplicates a listener's ears and consists of a microphone or loudspeaker, an audio amplifier, and an oscilloscope or meter to indicate levels. An oscilloscope is preferable because it is more sensitive and more easily observed than a meter. The microphone or receiving loudspeaker should be mounted on a pole or tripod at about the level of a listener's ears.

The phasing method used by the author and recommended for any installation is as follows:

1. Disconnect all but one "key" speaker and terminate all the disconnected wires with resistors equal to the impedance of each speaker. This will allow the public-address system amplifier to be turned on without damaging any internal components. The "key" speaker should be the one closest to the microphones.

2. Place the transmitter in front of one of the microphones, turn the transmitter on, and adjust the output to an audible level that may be heard at least 20 to 30 feet away. Set the frequency to 200 Hz.

3. Place the receiver in a listening area 20 to 30 feet away and turn the receiver on. Adjust gain of amplifier or scope for a visible sine-wave pattern.

4. Turn public-address system on and observe amplitude change on the scope. Reverse connections to the "key" speaker. Move receiver around in an arc of 5 to 10 feet. Leave connections to "key" speaker in the position which provides the greatest amplitude, as observed on the scope.

5. Move transmitter to any other microphone location but leave receiver in the same position. Reverse connections to the "key" speaker and observe amplitude change. If maximum amplitude does not agree with the phase of first microphone, reverse leads to the second microphone if possible. Do the same with any other microphones that are used.

6. Place transmitter in front of the most often used microphone with generator still set at 200 Hz and the "key" speaker properly phased.

7. Move receiver toward the end of the hall so as to be in front of other speakers being used. Remove terminations from wires one by one and connect each speaker in a way that will increase the scope amplitude a maximum amount. Move the receiving loudspeaker about somewhat to be certain of the best system loudspeaker connections.

8. Continue on down the hall and reconnect all speakers one by one for the best general amplitude increase as observed on the receiving scope.

After phasing has been completed, listen for results with a live performer under actual audience conditions. Expect that normal listening level will occur with gain controls of the public-address system down somewhat from where they were before executing the phasing operation. Better clarity and improved listening should result. ▲

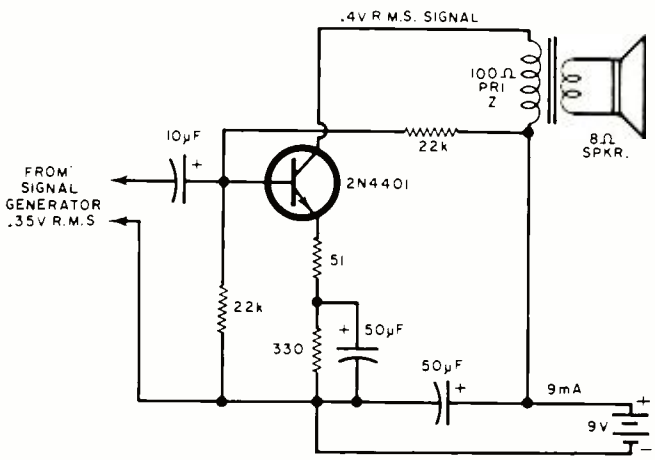


Fig. 1. Circuit diagram of transmitter hooked up to the generator. Unit was constructed by author and used an 8-in loudspeaker.

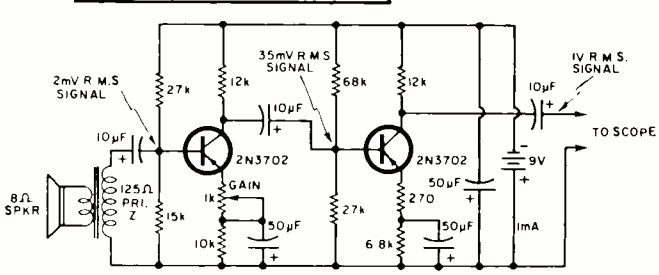


Fig. 2. Circuit of the receiver whose output feeds the scope.

Instrument Rental Considerations

Rentals can solve many problems in manufacturing and even in service work, but must be used with discretion.

By **John Frye**

THE pre-Christmas rush of children's record players, transistor radios, stereos, and TV sets had already begun; and Mac and Barney had been slaving away since early morning. If their customers didn't hear the sounds of Christmas, it wouldn't be the fault of Mac's Service Shop!

But now they had paused for a breather and the cup of coffee Matilda had brewed for them. Before she could pour it, however, a truck stopped at the back door and the expressman brought in a bulky package and collected the transportation charges from Mac.

"Hey, you been buying something new?" Barney demanded as the truck drove away.

"No, I'm renting an oscilloscope to use while ours goes back to the factory for a complete overhaul and recalibration," Mac replied, stirring his steaming coffee.

"I wondered how we were going to get through the Christmas rush with our scope on the blink," Barney said. "It has been going downhill for several weeks, but the intermittent in the vertical amplifier that showed up just recently makes it almost useless for trace-voltage measurements."

"Uh-huh, I know. The bad part is that we do not have proper equipment to do a decent job of recalibrating it even if we did change all the tubes and locate the cause of the fluctuating gain. We need an accurately calibrated fast-rise-time pulse generator to do that. I'd have to shell out five-hundred dollars up for such a generator, and we'd probably not use it more than two or three times a year. For most of our needs, our square-wave generator, even with its comparatively slow rise and fall time, is good enough.

"On the other hand, we simply cannot get along without a good calibrated scope. We've been using one too long for that. But I fully expect the instrument to be away for a month, considering the holidays get involved in the act. I have a friend who is just starting a small electronics manufacturing business and he suggested I rent a scope for a month while ours is away."

"Where did you get it?"

"From *Rental Electronics Incorporated*, a *Pepsico* service leasing company, whose main offices are in Gaithersburg, Maryland. Actually the instrument came from Rosemont, Illinois, the nearest of six local inventory centers spread across the United States."

"How does this renting thing work?"

"Quite simply. They send you an Instrument Rental Catalogue in which are listed twenty-one categories of electronics equipment, such as signal generators, recorders, analyzers, scope cameras, amplifiers, etc. Under each category you are given a wide choice of manufacturer, sophistication, and rental price. Each listing contains a short description of basic specifications together with a price-per-month charge for periods of one, three, and six months. Cost-per-month declines as renting time increases. If you live within 30 miles of an inventory center, delivery and pickup of the instrument is free; otherwise you pay the cost of transportation to you *via* means you specify, and *REI* pays the return transportation *via* means they specify. Eighty percent of the transportation of these rental items is by Air Express or Air Freight. The customer usually wants the instrument in a hurry and the company has another place for it when he is through with it."

"What kind of scope is in that box?"

"A *Tektronix* 515A d.c.-coupled general-purpose scope. It was the nearest in specifications to the one we've been accustomed to using, having a bandwidth of d.c. to 15 MHz, a rise time of 23 ns, deflection factor of 50 mV/cm, and a time base of 0.5 μs/cm to 0.5 s/cm. A 5X magnifier extends the time base to 40 ns/cm."

"How much did it set you back for a month?"

"$94.50. If I wanted it for three months, this would drop to $84 a month and for six months, it would be $73.50 a month."

Barney emitted a low whistle. "That's pretty salty," he said. "I can see where you're going to be cracking the whip over me all this month so you get your money's worth out of that instrument."

"You better believe it!" Mac nodded. "The rent is going to be ticking away all this month whether we're using that scope or not; so let's really keep it in use."

"Aye, aye, sir! I'll even use it to check the line voltage."

"Now let's not get carried away! Actually the charge is not as bad as it seems at first blush, nor is it arbitrarily set. On instruments costing more than $500, the one-month rate is 9% of the list price; the three-month rate is 8%; and the six-month rate is 7%. When I'm writing out my check for the rent on the instrument, I'll console myself with these thoughts: (1) by paying my monthly bill within fifteen days of the billing date—it is billed when sent—I'll get a discount of 2%; (2) while I am paying rent equal to 9% of the cost price, the other 91% will still be in my bank drawing interest; (3) if the instrument fails during normal usage, *REI* will send another *muy pronto* and fix this one at their expense, thus sparing us both maintenance cost and down time; (4) we'll not be paying taxes on the scope; and (5) we don't need to be fretting about its becoming obsolete—as happens to all electronics instruments these days.

"Spoken like a true Scotsman! But could you have rented it for less than a full month if you had wanted to?"

"Yes, I can rent an instrument for as short a period as a week. The cost for periods less than a month is one-third the monthly cost per week or fraction thereof. In this case it would have cost me $31.50 for seven days or $63.00 for ten days."

"Does the rental period start when the instrument is delivered and end when you turn it over to the carrier for return to the company?"

"Not exactly. The rent period actually begins when the instrument is shipped and ends when the instrument is received back at the *REI* inventory center. However, on 'out of the area' shipments, two days' travel time each way is subtracted from this time span to arrive at the charge period. You can see this favors use of a fast means of transportation."

"I assume that if you damage the instrument while it is in your possession, that's a horse on you."

"You assume right. Repairs, replacements, and/or recalibration necessitated by equipment operator misuse (such as improper application, overload, burnout, burnt CRT faces, broken components, etc.) are chargeable to the lessee. Every instrument is checked carefully to be sure it meets manufacturer's specifications prior to shipment. You have three days after receipt in which to report any defect or malfunction. If none is reported, it is assumed the instrument arrived in good condition. The equipment is insured for $1000 or actual cash value, whichever is less, while in transit. If loss or extensive damage occurs while in the lessee's possession, he is obligated to replace the instrument or remit the full fair market price to the company; and rental fees continue until this is done. Incidentally, *REI* assumes the equipment will be used by the lessee under 'normal conditions and times,' and they define 'normal time' as not more than 40 operational hours per week or 180 hours per month."

Is it Really Practical?

"Do you think instrument rental is really practical for the average service shop?"

"Not on a long-term basis, but I do think it is financially defensible in a couple of situations. One is an emergency situation such as our present one. Having the use of the scope during this rush season will result in income that will more than offset the rental. Let's take another situation: suppose the shop owner is wondering if buying a new higher-quality scope will speed up and improve his servicing enough to warrant the cost. Renting such an instrument for a week will give him the answer at a reasonable cost.

"But rental, for the service technician, is not ordinarily a substitute for purchase. Service instruments tend to stay in use much longer than lab instruments. This is because they are usually not so specialized and do not have to maintain such rigid performance standards. Their cost can therefore be spread over several years. And the relationship between the service technician and his instruments is a much closer one, based on longer association than is the case in the laboratory. Watching a fine technician troubleshooting a TV set with his scope is like watching an intimate dialogue. The technician propounds a question; his hands almost automatically manipulate the instrument controls; and the scope gives him the answer and possibly a hint as to the next question he should ask. This man/instrument rapport takes time to establish, and it cannot be transferred immediately from one instrument to another.

"Instrument rental companies, therefore, would starve to death if they had to depend on service technicians. Their major customers are manufacturers who maintain electronic testing laboratories, R&D labs, defense contractors, etc. *REI* has put out an Instrument Rental Handbook that is designed to establish basic guidelines to help engineers, engineering supervisors, and procurement and corporate management to make sound rent-or-buy decisions regarding electronic instrumentation.

To Rent or Purchase

"This book defines *rental* as covering a period up to a maximum of a year; anything beyond a year is considered a lease. How long an instrument will be needed largely determines whether it will be less expensive to rent or purchase. *Almost invariably* it can be shown rental is less expensive when the need is for four months; it is *usually* less expensive when the need is for four to eight months; it is *sometimes* less expensive when the need is for eight months to a year.

"Many situations call for renting," Mac said, ticking them off on his fingers: "Covering short peak-load requirements; temporary replacement of equipment that has failed; determining if a specific instrument will accomplish the desired task; when in-house or external calibration/repair costs get out of hand or when down time of the instruments is extensive; when there is an urgent need for new instruments that cannot be obtained immediately from the manufacturer; when a temporary conservation of capital is indicated by budget limitations or for other reasons; when the contract makes it easier to recover rental costs than outright purchase costs; or when demonstration or field location needs cannot be met without crippling the laboratory operation."

"Is *REI* the only company renting instruments?"

"Oh no. My friend reeled off several other renting companies including *Beckman Instruments*, *General Electric*, *Simpson Electric*, *Electro Rents*, *Rentronix*, *Continental Rental*, and *Leasametric*. He said he thought their operations were basically similar to those of *REI*."

"Well, this is all new to me," Barney admitted, as he started opening the carton resting on the floor. "I intend to tuck away in a corner of my mind the fact that if the need is great enough, a person can have access to almost any kind of electronic equipment for a limited time by laying out only a small fraction of the list price." ▲

New Stereo Receivers

(Continued from page 30)

ing near the low end of this range should be used with fairly low-output phono cartridges to avoid the possibility of overload and distortion on loud passages. Those measuring about 35 dB or more are not likely to be overloaded by any current phono cartridge or record.

The unweighted audio signal-to-noise ratio was measured with the gain set to standardized values (1 volt input on Aux, or 10 millivolts on Phono, for 10-watt output at 1 kHz). It is expressed in decibels relative to 10 watts. The accuracy of the RIAA phono equalization was measured and expressed in ±dB relative to the 1-kHz response between 50 Hz and 15 kHz. We also measured the tone-control curves, loudness-compensation curves, and filter responses, but these do not lend themselves to a tabular format. All the receivers except the *AR* had switchable loudness compensation, and all had satisfactory tone controls. The *AR* tone controls had characteristics which made them suitable for very effective loudness compensation.

The IHF usable sensitivity was measured for each FM tuner section at 100 MHz. The FM distortion, with a 75-kHz deviation, was measured at 1000-microvolt input level. We also reduced the signal input until distortion was 3 dB greater than the latter value. This was considered to be the weakest signal which could be received in mono with entertainment quality. The ratio of this figure to the IHF sensitivity is an indication of the steepness of the tuner's limiting curve; the lower the numerical ratio, the better the limiting action.

The FM tuner frequency response was measured between 30 Hz and 15 kHz and expressed in ±dB relative to the 400-Hz level. Stereo channel separation was measured at 50 Hz, 400 Hz, and 10 kHz.

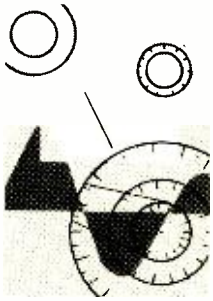
Other receiver features are indicated in the tabular listing. Note that a Lo Level center-channel output is typically about 1 volt, to drive a separate power amplifier and speaker directly. Unless otherwise specified, dimensions and weights are our own measurements, from the rearmost protrusion (usually the AM ferrite-rod antenna) to the maximum front-panel knob extension, and including the supporting feet in the height measurement.

It will be evident from a study of the table that all of the receivers in this group are of excellent quality and some of them are truly outstanding.

Their wide price range, from $200 to $450, is reflected in their audio power outputs and distortion, FM sensitivity, and in the general flexibility and convenience offered. All of the receivers come, at the least, with a complete metal enclosure. Some have wood-grain finished metal cabinets, and a few include a wooden cabinet as standard equipment. Accessory wooden cabinets are available for virtually all models.

Obviously, one's choice should be influenced by the other system components. Low-efficiency speakers require considerable amplifier power; some of the lower-powered units, otherwise excellent, might not be suitable for use with them. In most urban and suburban locations, any of the receivers has more than sufficient FM sensitivity. In fringe areas, the more sensitive models would be indicated. Other factors such as possible use of one or more tape recorders or more than one record player will influence one's choice.

A major consideration, in many cases, is the styling of the receiver. This, of course, is a totally subjective matter. The units reviewed for this survey vary from starkly functional to verging on gaudiness—take your choice! In any event, all of them performed very well indeed, and we would be happy with any of them from the standpoint of performance and listening quality. ▲



TEST EQUIPMENT

Product Report

Sencore Model FE-20 FET V.O.M.

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

THE latest addition to *Sencore*'s line of solid-state meters is the Model FE-20 FET v.o.m. Several special features add to the usefulness of this instrument. First, the meter has both high- and low-power resistance ranges. In the low-power function, the resistance-measuring circuits are powered by less than a tenth of a volt. This is below the voltage that would cause most semiconductor diodes and transistors to conduct. Hence resistance of these devices can be measured in-circuit without turning the semiconductors "on" and causing incorrect readings. In the high-power function, the usual 1.5-volt battery is used to power the resistance-measuring circuits.

A second feature is the inclusion of a low-voltage range with a full-scale reading of only 0.1 volt. This makes it possible to measure very low transistor bias voltages.

Still another feature is the high-voltage probe that is included with the instrument. The probe is used on three d.c. ranges of the meter: 3 kV, 10 kV, and 30 kV. Now the technician can use his instrument to measure the high voltage at the h.v. electrode of color picture tubes without having to buy a separate probe or other meter.

The meter is battery-operated using standard "C" cells. Because of the very low current drain on these batteries, which are larger than many used in other solid-state v.o.m.'s, the batteries should last a long time. To further conserve battery power, they are disconnected completely when the meter's case is closed.

There are 9 d.c. voltage ranges, 3 high-voltage ranges, 9 a.c. voltage ranges, 7 resistance ranges, and 9 d.c. current ranges up to 1 A. Input resistance is 15 megohms on d.c. and 10 megohms on a.c. for minimum circuit loading. Accuracy is within 1.5% on d.c. and 3% on a.c.

Price of the Model FE-20 is $130. ▲

Eico Model 379 Sine/Square-Wave Audio Generator

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

A good audio generator is indispensable for testing hi-fi and audio amplifiers and transducers. The generator should have low distortion and, if it produces square waves as well as sine waves, it's even more useful. The *Eico* Model 379 is just such an instrument. It produces stable sine waves from 20 Hz all the way up to 2 MHz. Hence, the generator is useful at ultrasonic and low radio frequencies as well as audio. Accurately shaped square waves are available up to 200 kHz. By using square waves and observing on a scope how much your amplifier alters the squareness, you can do a quick check of frequency response.

The Model 379 is one of the manufacturer's new line of all solid-state test instruments that boasts a 5-year warranty for the factory-wired version. There is no charge for repair parts and labor that may be required for the first 90 days, and there is only an $8 service fee thereafter up to 5 years. No additional charges are made for repair parts, labor, or handling.

The generator that we checked out had good calibration accuracy and flatness of output. Over the first 4 ranges (20 Hz to 200 kHz), the calibration accuracy averaged +0, –2.7 percent over-all, while on the highest range (200 kHz to 2 MHz) it ranged from +2 to –4 percent. These figures are well within the manufacturer's specs. We also found the amplitude response extremely uniform up to about 1 MHz, above which frequency output rises gradually. Sine-wave output voltage was measured at from zero up to 7.5 volts maximum into a high-impedance load. The square-wave output varied from zero to 13 volts (p-p).

The circuitry consists of 8 transistors and 11 diodes. Sine waves are produced by an *RC* oscillator using a bridge-"T" network between output and input. A FET is included in the positive-feedback loop and a lamp, used as a thermistor, is in the negative-feedback loop for good stability.

The separate square-wave circuitry takes the sine-wave signal and feeds it into a 2-transistor Schmitt trigger. The square waves from the Schmitt trigger are then applied to an emitter-follower output stage for good load isolation. The instrument's power supply includes a power transformer and uses a three-wire power cord for maximum safety.

The Model 379 measures 8½-in wide by 7½-in high by 8½-in deep. Price is $70 in kit form or $95 factory-wired. ▲

Audio Equipment Co. "Rayguard" TV H.V. Monitor

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

ALTHOUGH color-TV set manufacturers are working hard to minimize x-radiation, many consumers are still a little wary. The fact remains that some of the early receivers as well as a few of the more recent ones could be made to emit x-radiation that exceeded the safe limits as set forth in government standards. During tests on such receivers it was found that if a set's high voltage were boosted above the value recommended by the maker, x-radiation would go way up.

To make sure that this doesn't happen with sets in use, the *Audio Equipment Co.* (a division of *Walter Kidde*) has introduced what they call "Rayguard"—a TV warning device. This is a high-voltage monitor that the technician installs on his customer's receiver and which is left permanently attached to the receiver in the home. When the consumer sees the pointer on the monitor's meter in the safe area, he knows that his set's high voltage is at or below its normal value. If the pointer rises to the danger area (with its radiation symbol on the meter face, rather than actual voltage readings), it's time for him to call the technician to check his set.

The device itself is actually a high-voltage multiplier resistor voltage divider and meter-protective circuit in a special high-voltage housing that is placed inside the receiver. A ground lead is then connected to the set's chassis and a clip leading from the divider is placed under the h.v. electrode of the picture tube by the installing technician. The readout meter, with its calibrating pot, is connected to the divider and hung on the back of the receiver. The calibration is originally set at 25 kV, above which a dangerous condition is indicated. However, the technician can readjust the meter for different normal high voltages as recommended by the set's manufacturer.

"Rayguard" has a single-unit list price of around $40 but its price goes down in higher quantities. The manufacturer feels that some technicians will install the monitor at a nominal fee with the hope that they will be called upon to service the set when it becomes defective. ▲

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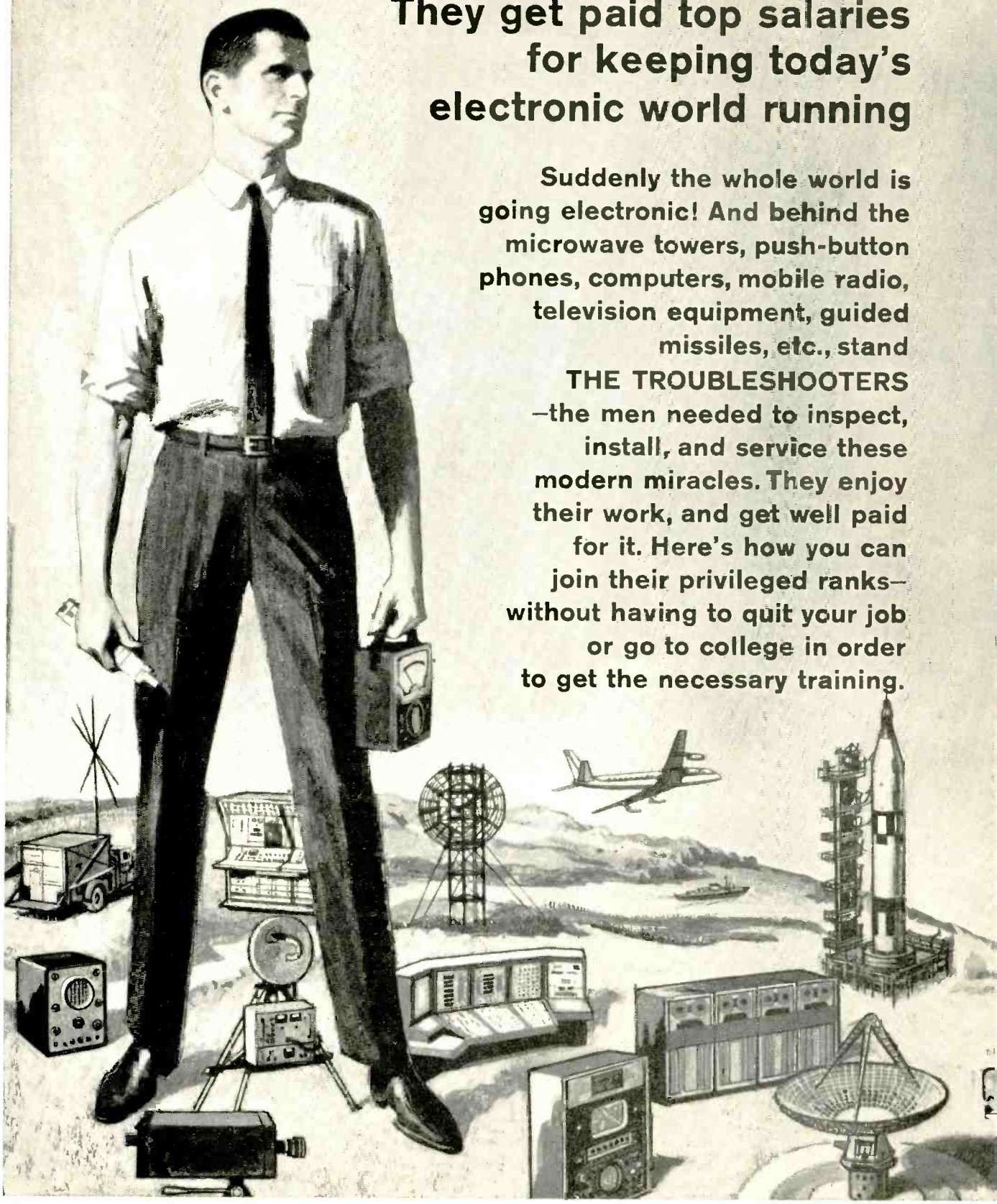

JUST THINK how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

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Think With Your Head, Not Your Hands

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on—you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom...and without giving up your job!

For over 30 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® lessons build your knowledge as easily and solidly as you'd build a brick wall—one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day received, while everything is fresh in your mind.

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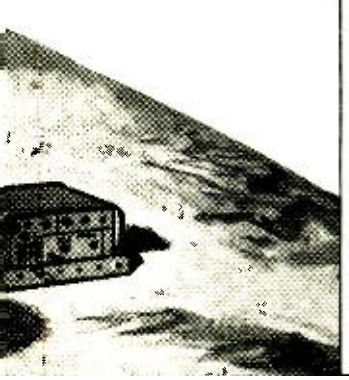


NEW COLLEGE-LEVEL COURSE IN

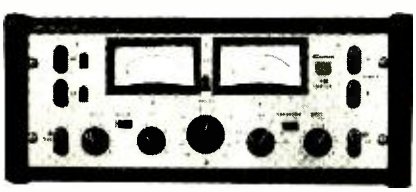
ELECTRONICS ENGINEERING

for men with prior experience in Electronics. Covers steady-state and transient network theory, solid state physics and circuitry pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

NEW IM ANALYZER ADVANCES STATE OF THE ART

Extended measuring range and high-speed readings are the outstanding features of a unique new Intermodulation Distortion Analyzer introduced by Crown International recently. The American firm is known for its line of Crown precision professional tape recorders.

This analyzer was developed to meet the production line requirements of the Crown DC300 lab standard amplifier. The first need was for accurate measuring capability through 0.01%. This analyzer guarantees a residual IM level of less than 0.005%, with seven full-scale ranges from 100% to 0.1%.



The second requirement was for an instrument simple enough to be operated by production-line personnel and rapid enough to make sequential readings across the entire power band. The Crown analyzer meets the challenge by reducing measuring time from minutes per reading to just seconds. This is accomplished by a "tracking" function, using two meters and a ganged input/output gain control. The input level is set using the calibrate meter, and distortion is immediately read on the percentage distortion meter. Successive readings at 5db increments take under five seconds each. The entire operation is completed in less than one minute.

Solid state construction, utilizing FETs, makes the Crown analyzer highly stable and uniquely compact, measuring 7x19x7 inches. Rack mount list price is $595. Write for spec sheet to CROWN, Dept. EW-12 , Box 1000, Elkhart, Indiana, 46514.

CIRCLE NO. 146 ON READER SERVICE CARD

Testing Hi-Fi Equipment

(*Continued from page* 50)

anti-skating. Usually, when the cartridge overhang is adjustable, the record-player manufacturer provides a jig or reference point to establish the correct mounting position for minimum tracking error. The mounting instructions for separate tonearms, if followed carefully, accomplish the same end.

If no other means of checking anti-skating compensation is available, the arm manufacturer's recommendations should be followed. Frequently, a more effective adjustment can be made with the aid of the special test bands of the STEREO REVIEW SR12 test record.

With a pickup tracking at several grams, almost any of the numerous stylus-force gauges on the market can be used to set the force. However, most good hi-fi pickups track at forces in the 1- to 3-gram region and an accurate balance-type gauge should be used. The British-made *Transcriptors* gauge (about $18) is very accurate, within 0.05 gram up to 6 grams, but is relatively cumbersome to use. The *AR* gauge ($1) is excellent for forces up to 3¾ grams, in ¼ gram steps. Other suitable balance gauges are made by *Robins* and *Almega*.

Before checking a cartridge that has been previously used, examine its stylus under a microscope for damage. Failure to do this could damage an expensive test record. The *Robins* PM-1 stylus microscope ($1.90) is satisfactory for this purpose.

The *CBS Labs* STR-100 test record ($8.50) has frequency-response test bands, with voice announcements identifying spot frequencies from 20 to 20,000 Hz. The a.c. v.t.v.m. used for other frequency-response measurements, and the preamplifier used in rumble measurements, can be used when checking cartridge response and crosstalk. If possible, the high-frequency phono equalization should be disabled, since the *CBS* record is cut with constant velocity and the high-frequency amplitude will be greatly reduced if the preamplifier has equalization. Even if this is not practical, conversion data supplied with the record permits its use with an RIAA-equalized system. This technique will have to be used in compact systems where the cartridge output cannot be measured separately from the amplifier. In this case, the tape outputs of the amplifier are used as measurement points, with due allowance for phono equalization.

Tape Recorders

Tape-recorder testing requires an audio generator, a.c. v.t.v.m., oscilloscope, and a wow and flutter meter. All of these can be the same types used for testing other components previously discussed.

In addition, a few specialized accessories are needed. Tape-speed measurement requires a special stroboscope wheel, held against the moving tape and viewed in the same manner as for a disc stroboscope. The *Robins* TW-1 ($7.00) is one such tape strobe. A tape-head demagnetizer should be used on the heads before playing any of your expensive test tapes on a machine whose operating history is unknown. There are many types of demagnetizers and other tape accessories, such as splicers, which may be purchased according to your specific requirements.

Special test tapes are required to align heads and check the performance of a tape recorder. The most widely accepted standards in this country are the *Ampex* professional alignment tapes. You will need the *Ampex* 31331-01 (3¾ in/s) and the 31321-04 (7½ in/s) alignment tapes ($22 each). If you have a wow and flutter meter and wish to check a tape recorder, you will also need the *Ampex* 31336-01 (3¾ in/s) and 31326-01 (7½ in/s) flutter tapes ($22 each). It is possible to check flutter by recording a 3000-Hz tone on a blank tape and playing it back into a flutter meter, but this does not give accurate results obtainable with a special tape, since the recorder introduces flutter both in the recording and playback processes, which cannot be separated from each other in the measurement process.

At present there are few test tapes available for cassette recorders. Their over-all record/playback response can be measured in the same manner as with reel-to-reel recorders. Alignment cassettes have been made by *Philips* and *BASF*, but have had limited distribution in this country and are quite expensive.

Although this array of specialized test equipment and accessories for hi-fi testing may seem formidable, it is difficult to adequately check out the performance of modern hi-fi components (as distinguished from mass-produced packaged units) without them.

The actual test procedures required will be described next month, together with hints on avoiding some common errors leading to incorrect results. Do not be concerned with the apparent complexity of the tests. In most cases, a few spot checks will establish the condition of the unit being tested, without the need for a full series of measurements. Simplified procedures, involving a minimum of instruments, will also be described, for the benefit of the service technician whose volume of hi-fi business does not warrant a major investment in test equipment. ▲

(*Concluded Next Month*)

C.E.T. Test, Section #11

TV Circuits

By DICK GLASS*

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

This is the eleventh in a series of 12 test sections to be published monthly. While these test exam sections are not part of the actual NEA C.E.T. examinations presently being administered, they are similar in nature. Should you find you are able to correctly answer 75% or better, you might be a candidate to become a registered CET. You can take exam in your area but you must show 4 years of experience to qualify.

(Answers will appear next month.)
Answers to last month's quiz appear on page 80.

1. Solid-state u.h.f. tuners generally have:
(a) r.f. amplifier, mixer, and oscillator *(c) oscillator and mixer*
(b) r.f. amplifier and oscillator *(d) oscillator only*

2. Noise-cancellation circuits primarily affect which circuit?
(a) video *(c) audio*
(b) sync *(d) audio i.f.*

3. Early model TV receivers used a 21-MHz sound i.f. amplifier. Today the standard TV audio i.f. frequency is:
(a) 10.7 MHz *(c) 45.5 MHz*
(b) 455 kHz *(d) 4.5 MHz*

4. The greatest amount of picture signal gain in a TV receiver is obtained in:
(a) the r.f. amplifier section *(c) the i.f. amplifier section*
(b) the mixer section *(d) the video-amplifier section*

5. Delayed a.g.c. to the tuner r.f. amplifier causes the r.f. a.g.c. to have less effect on:
(a) weak signals *(c) strong signals*
(b) intermediate signals *(d) same effect on all levels*

6. TV r.f. amplifiers need special degeneration, or negative feedback, circuitry to prevent:
(a) loss of high frequencies *(c) Hall effect*
(b) oscillation *(d) image rejection*

7. A 4.5-MHz trap might be found in the:
(a) tuner section *(c) video-amplifier section*
(b) r.f. section *(d) sync section*

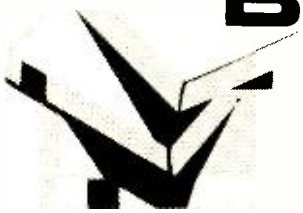
8. The horizontal sync pulse is usually:
(a) differentiated *(c) integrated*
(b) neutralized *(d) lower in amplitude than vertical sync pulse*

9. Keyed a.g.c. stages are "turned on" during horizontal retrace time by a high-level pulse from the horizontal section, so that:
(a) conduction will not occur during the vertical interval
(b) variations of audio frequencies will not affect the a.g.c. level
(c) the a.g.c. stage won't absorb power from the horizontal-output section
(d) a.g.c. will be unaffected by varying video levels

10. The CRT focus voltage found on recent-model monochrome TV receivers is typically:
(a) zero volts *(c) near the "B+ boost" level*
(b) near the "B+" level *(d) any of these.*

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

BOOKS



"HANDBOOK OF THIN FILM TECHNOLOGY" edited by Leon I. Maissel & Reinhard Glang. Published by *McGraw-Hill Book Co.*, New York. Price $29.50.

In compiling this comprehensive text, the two editors/authors have called upon the services of their colleagues at *IBM, 3M, Pyrofilm, Plessey, Micro-Bit, Bell Labs, General Electric, Cogar Corp., Fairchild, Lincoln Laboratories*, and *David Sarnoff Research Center* as well as experts from Israel Institute of Technology, NASA Research Center, and the Universities of Toronto and Minnesota. The result is an authoritative and in-depth treatment of a technique which is sweeping the electronics industry.

The text material has been arranged in four parts, covering the preparation of thin films, the nature of thin films, properties of thin films, and applications of thin films.

The authors have supplied the necessary tables of units, symbols, and conversion factors; comprehensive reference listings; and other pertinent data to enable the engineer to work from this single volume. The reader is expected to be thoroughly familiar with calculus and a good grounding in solid-state physics would not come amiss.

Those working in the field or planning a career in the field of thin-film technology will find this volume invaluable as a day-to-day reference as well as an in-depth text.

* * *

"50 IC PROJECTS YOU CAN BUILD" by Ronald M. Benrey. Published by *Hayden Book Company, Inc.*, New York. 121 pages. Price $3.75. Soft cover.

This book is designed for the electronics experimenter who wants a chance to gain familiarity with IC's. All of the devices described in this book are practical, easy-to-build, and instructive.

The first chapter provides the necessary background material on the nature of IC's, the second deals with handling IC's, while the third chapter gives information on constructing power supplies for IC's and testing IC's. The balance of the book is given over to the construction data.

The projects themselves range from code-practice oscillators through photoelectric relays, games of various types, to audio accessories, ham gear, test equipment, and automotive testers. Most of the circuits have been designed around easily obtainable *Motorola, RCA*, and *General Electric* IC's and the author provides information on suitable substitutions should individual devices be unobtainable in a specific area.

As a useful and largely painless way to gain experience working with integrated circuits, this handy volume would be hard to beat.

* * *

"THE VERSATILE OP AMP" by Michael Kahn. Published by *Holt, Rinehart and Winston, Inc.*, New York. 223 pages. Price $10.00

This volume has been prepared as a classroom text for courses at the junior college or technical institute level. Pre-requisite are familiarity with intermediate algebra and trig and a working knowledge of d.c. and a.c. circuit analysis. Persons with that background could use this book as a self-instructional text or in self-improvement projects.

It is the author's contention that the days of the discrete component are numbered and that sooner or later the circuit designer will be a physicist who develops single packages to be interconnected to form complete systems.

Since the modern op amp is a good example of this technology, the author has chosen to cover this package in depth. In nine chapters he deals with the amplifier, the black box, a practical op amp, non-inverting and inverting amplifiers, d.c. offset and drift, frequency response, oscillation and phase compensation, and applications.

The text is well illustrated, carries a number of problems for assignment or self-checking, and provides suitable references and a listing of terms used in the text.

* * *

"ELECTRONIC COMMUNICATIONS SYSTEMS" by Ben Zeines. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N. J. 476 pages. Price $13.95.

The author, an instructor at *RCA Institutes*, has developed his subject on the basis of his experience in teaching students the fundamentals of transmitters and receivers. If the would-be student has the math to handle d.c. and a.c. circuit theory and a working knowledge of basic vacuum-tube and semiconductor physics, there is no reason why he should have any trouble grasping this material.

The book is divided into ten chapters covering communications systems as a whole, rectifiers and filters, transistorized voltage amplifiers, FET voltage amplifiers, regulators, untuned power amps, tuned power amps, feedback amplifiers and oscillators, modulation, and demodulation. In line with the present trend of using FET's and semiconductors in modern communications equipment, principal emphasis is placed on these components although vacuum tubes, which are still to be found in hundreds of transmitters in active service, are covered as well.

This well-written, well-illustrated text makes a useful addition to the literature of communications technology.

* * *

"BIOMEDICAL ENGINEERING SYSTEMS" edited by Manfred Clynes & J.H. Milsum. Published by *McGraw-Hill Book Co.*, New York. 653 pages. Price $27.50.

The application of electronics to medicine has grown so rapidly in such a relatively short span of time that the information gap grows wider each passing day.

In an attempt to disseminate pertinent information to as wide an audience of engineers and doctors involved in the application of electronics to the detection and treatment of disease, the editors have brought together an important collection of papers, each by a recognized authority in his particular field.

The material is divided into four main sections dealing with instrumentation, analysis, control of information and energy, and artificial devices or prostheses. Contributors have been drawn from among acknowledged experts and those seeking authoritative, up-to-date information on the state-of-the-art will find this volume invaluable.

* * *

"DIGITAL COMPUTERS MADE SIMPLE" by Saul Heller. Published by *Ameco Publishing Corp.*, Williston Park, N.Y. 121 Pages. Price $1.75. Soft cover.

Since computers take such an important role in everyone's life, even the layman requires some knowledge about how they work and their possible effect on his way of life.

In this non-technical discussion of digital computers, the author has provided an introduction to computers, computer number systems and arithmetic, the language of computers, the computer system, input and output devices, the computer memory, and computer programming. The final chapter covers some of the basic circuits used in computers for those with a technical flare and a curiosity as to why and how computers work.

There are no pre-requisites for using this book and its simple language, extensive illustrative material, and easy-to-read format should prove useful and instructive. ▲

Computers That Talk

(Continued from page 39)

TeleMart is computerized with a computer that talks to the customers like Mabel. "Clara Computer," as *TeleMart* calls her, can talk by phone to as many as 48 customers simultaneously—what a woman!

TeleMart will service more than 40,000 San Diego customers, each a member of this exclusive shop-by-phone club. An initial membership fee of $2.00 pays the expenses of setting up a new member's account and provides him with a subscription to *TeleMart's* Shopper's Guide. The Shopper's Guide lists some 3000 supermarket items. It does not give prices, however, because these are adjusted daily by Clara to maintain a competitive position in the supermarket environment. Clara will give up to three prices for an item: for one, for a few, or for a case.

Each shopper at *TeleMart* has an account number. When the shopper calls in, she gives her account number. Immediately Clara verifies the number and accepts or rejects it. The shopper then reads the code numbers of the items she has selected over the phone to the Tele-Shopper (*TeleMart* telephone operator) who punches the number into the computer with a 12-key, Touch-Tone telephone pad. Clara gives the prices for the item, can provide a running total as each item is ordered, for budget-minded shoppers.

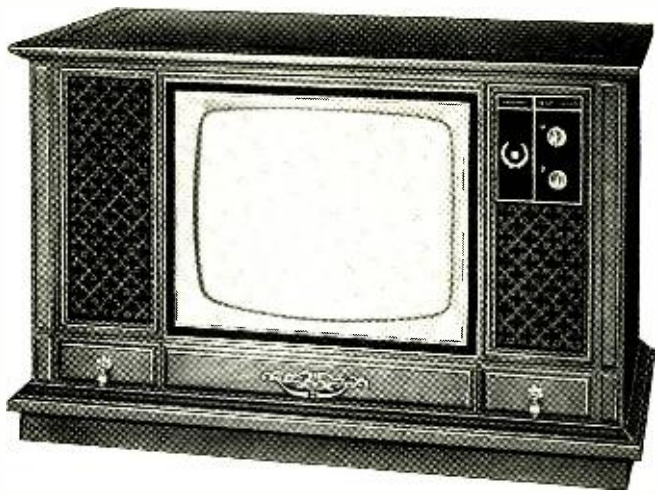
When the shopper hangs up, Clara keeps on working. Almost immediately, the computer prints out the order sheet which is used by the warehouse crew to gather the items to fill the order. In addition, Clara updates the inventory records with each order that is filled to ensure that there will always be an adequate supply. What supermarket manager wouldn't give a great deal to have instant inventory records available at his store? Clara then determines which of *TeleMart's* 75 delivery trucks should deliver the order. *TeleMart* charges a delivery fee of $1.00 for all orders under a certain size; the size hasn't been fixed at this writing. However, *TeleMart's* Chairman, A.G. "Bill" Bailey, indicates that most customers will probably receive free delivery.

TeleMart's warehouse isn't computer-controlled like *Rohr's*, but is highly mechanized. The warehouse was designed by *Rapistan Corporation* of Grand Rapids, Michigan and features exclusive distribution conveyance systems and special collateral mechanisms. ▲

(Editor's Note: As we go to press, Tele-Mart Enterprises, Inc. *has filed for bankruptcy but hopes to be able to continue operations under Chapter XI of the Federal Bankruptcy Act.)*

New from Heath...in time

New Heathkit® solid-state modular color TV

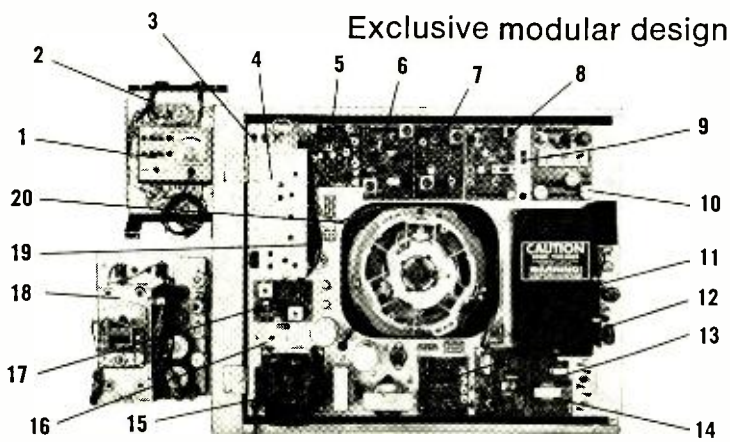


The result of over five years in research and development, these sets represent one of today's greatest color TV values. Here's why: a total of 45 transistors, 55 diodes, 2 silicon controlled rectifiers, 4 IC's containing another 46 transistors and 21 diodes plus 2 tubes (picture and high voltage rectifier) combine to deliver performance and reliability unequalled by any conventional tube set. Other features include: MOSFET VHF tuner; high-gain 3-stage solid-state IF; emitter-follower output; automatic fine tuning; VHF power tuning; built-in degaussing plus manual degaussing coil; automatic chroma control; adjustable noise limiting and gated AGC; "instant-on"... sound instantly, picture in seconds; bonded-face, etched glass picture tubes; adjustable tone control; exclusive hi-fi outputs; and 48-hour factory service facility for modules. The sets are designed to be owner-serviced ... the only sets on the market with this exclusive feature. A built-in dot generator, volt-ohm meter, and modular snap-out epoxy circuit boards make routine adjustments and service a snap ... virtually eliminating service calls and offering significant savings over the life of the set. It all adds up to the color TV buy of a lifetime in the GR-270 and GR-370 ... ready now for Christmas giving!

- Modular plug-in circuit board construction
- MOSFET VHF tuner and 3-stage IF
- Pushbutton channel advance
- Hi-fi sound outputs — for amplifier
- Designed for owner-servicing

Kit **GR-270,** 227" 20V tube, 114 lbs. **$489.95***
Kit **GR-370,** 295" 23V tube, 127 lbs. **$559.95***
Kit **GR-370MX, GR-370** with RCA matrix tube, 127 lbs. **$569.95***

Exclusive modular design

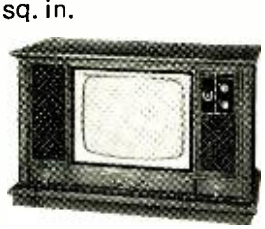


1 Exclusive check-out meter
2 Tilt-out convergence/secondary control panel
3 Gun shorting switches
4 3-stage IF assembly
5 Plug-in AGC/Sync circuit board
6 Plug-in 3.58 MHz oscillator circuit board
7 Plug-in Chroma circuit board
8 Plug-in Luminance circuit board
9 Service and Dots switches
10 Plug-in Video Output circuit board
11 High voltage power supply
12 Plug-in Vertical Oscillator circuit board
13 Plug-in Horizontal Oscillator circuit board
14 Plug-in Pincushion circuit board
15 Conservatively-rated power supply components
16 Circuit breaker protection
17 Plug-in Sound circuit board
18 Master control panel
19 Hi-fi sound output
20 Plug-in wiring harnesses and connectors for faster assembly

Choice of factory-assembled cabinets

3 models in 295 sq. in.

Luxurious Mediterranean Cabinet...factory assembled of fine furniture grade hardwoods and finished in a flawless Mediterranean pecan. Statuary bronze trim handle. 30-½" H x 47" W x 17¾" D.
Assembled GRA-304-23, 78 lbs. **$129.95***



Deluxe Early American Cabinet...factory assembled of hardwoods & veneers and finished in classic Salem Maple. 29²½" H x 37¼" W x 19¾" D.
Assembled GRA-303-23, 73 lbs. **$114.95***

Contemporary Walnut Cabinet...factory assembled of fine veneers & solids with an oil-rubbed walnut finish. 29¹⁷⁄₃₂" H x 35¹³⁄₁₆" W x 19⅞" D.
Assembled GRA-301-23, 60 lbs. **$74.95***

3 models in 227 sq. in.

Exciting Mediterranean Cabinet...assembled using fine furniture techniques and finished in stylish Mediterranean pecan. Accented with statuary bronze handle. 27³½" H x 41⅞" W x 19⁹⁄₁₆" D.
Assembled GRA-202-20, 85 lbs. **$114.95***

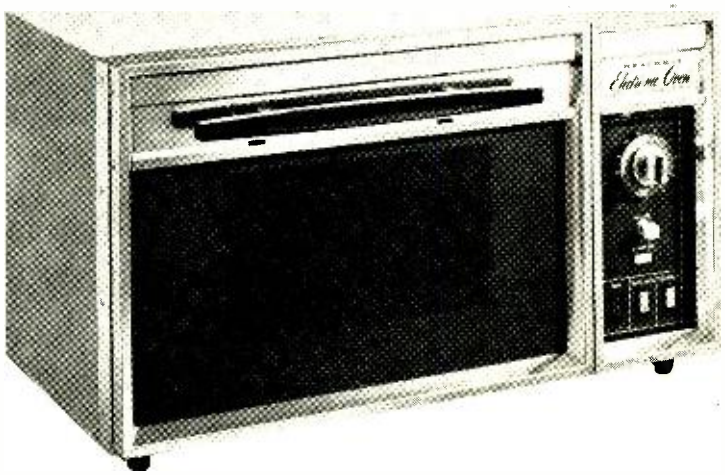
Contemporary Walnut Cabinet and Base Combination. Handsome walnut finished cabinet sits on a matching walnut base. Cabinet dimensions 20³¹⁄₃₂" H x 31⁷⁄₁₆" W x 18⅝" D. Base dimensions 7¾" H x 27¾" W x 18⅝" D.
Assembled GRA-203-20 Cabinet, 46 lbs. **$49.95***
GRS-203-6 above cab. w/matching base, 59 lbs. **$59.95***

Handy Roll-Around Cart and Cabinet Combination. Features the GRA-203-20 walnut cabinet plus a walnut-trimmed wheeled cart with storage shelf.
Assembled GRA-203-20 Cabinet, 46 lbs. **$49.95***
GRA-204-20 Roll-Around Cart, 19 lbs. .. **$19.95***
GRS-203-5 Cart & Cabinet Combo, 65 lbs. **$59.95***

for Christmas giving

New Heathkit Electronic Oven

...only $399.95*



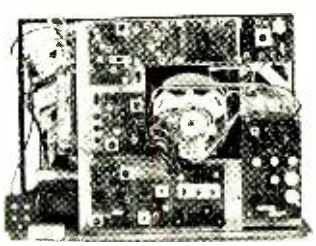
Now, through the miracle of microwave energy, a cooking revolution that frees you from conventional kitchen drudgery forever!

Imagine a baked potato in 4 minutes; baked beans in a little over 6 minutes; a five-pound roast in 45 minutes. This is the miracle of microwave cooking. And now Heath brings you this modern miracle for the first time in money-saving, easy-to-assemble kit form. For busy families on the go, meal preparation is a matter of minutes. You can cook on china, glass, or even paper dishes since only the food becomes hot. Your cooking dish can be your serving dish. Frozen foods can be defrosted in minutes for quick spur-of-the-moment frozen meals cooked right in their own containers. And there is not the slightest cause for concern about the safety of your Heathkit electronic oven. Exclusive door design prevents microwave leakage from the oven cavity. And with a SAFETY INTERLOCK SYSTEM UNIQUE IN THE INDUSTRY, not only does the oven stop cooking if the door is opened, but the door can't be opened unless the interlock is operating properly. A second independent door interlock is also provided for maximum protection. And all interlock mechanisms are tamperproof. Assembled in accordance with the manual, the GD-29 meets all the new federal standards for safety and radio interference. No special precautions are required when operating. The Heathkit electronic oven is as safe as your conventional oven! Quality components are used throughout: magnetron tube by Litton, the uncontested leader in the field; avalanche diode circuitry for longer tube life; simplified wiring harness with push-on quick-connectors for reliability and ease of assembly. GD-29 prototypes endured grueling "life-tests" equivalent to over 60 years of continuous service...further assurance of uncompromised reliability. Another feature is portability: the Heathkit electronic oven operates on regular household current. Plug it in anywhere...on a countertop, a wheeled cart, in the kitchen, on the patio, at the cottage...anyplace a grounded 120V AC power outlet is available. Make this a Christmas to remember by putting a Heathkit electronic oven under the tree. It's a gift your wife will thrill to...and a present the whole family will enjoy...meal after meal after meal.

Kit **GD-29,** 80 lbs. **$399.95***

New Heathkit portable solid-state color TV

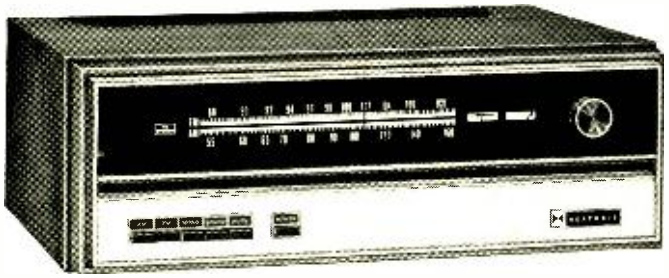
- Big set performance, portable convenience
- MOSFET VHF tuner & 3-stage IF
- Modular, self-service design
- 102", 14 V picture tube



What do you do for an encore after you've created the solid-state GR-270 and GR-370 big-screen sets? Simple. Make them portable. That's virtually what's been done in the new Heathkit GR-169 solid-state portable color TV. Heath engineers took the same cool-running solid-state circuitry from the large screen chassis and packaged it in an easy-to-assemble compact chassis...with the same nine plug-in glass epoxy circuit board modules used in the big sets. In fact the only difference is the smaller preassembled horizontal deflection and high voltage power supply. The same MOSFET tuner and high gain 3-stage IF found in the big sets offer superlative color performance. And, as in the larger sets, complete owner-service features are provided by inclusion of built-in dot generator and degaussing along with an exclusive volt-ohm check-out meter. 48-hour factory service facilities for modules are also provided with the GR-169. Other features include: built-in antennas and connections for external antennas; instant picture and sound; complete secondary controls available behind the hinged door on the front panel; high resolution circuitry for sharp, crisp pictures; adjustable noise limiting to keep external interference to a minimum. If you're looking for big set color fidelity and performance with portable convenience...put the new Heathkit GR-169 on your Christmas shopping list now!

Kit **GR-169,** 48 lbs. **$349.95***

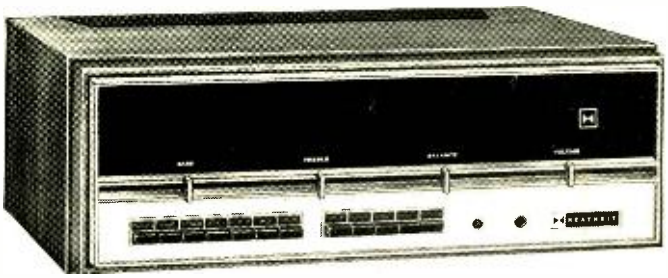
New Heath-gift ideas... for



New Heathkit® AJ-29 AM-FM-FM stereo tuner

This is the feature-packed tuner section of the famous Heathkit AR-29 stereo receiver . . . now available as a stereo "separate." The pre-assembled, factory-aligned FM tuner boasts 1.8 uV sensitivity for whopping station pulling power using FET design for superior overload characteristics. Three IC's in the IF section offer superior AM rejection, hard limiting, temperature stability, and outstanding reliability. Other features include a computer-designed 9-pole L-C filter for greater than 70 dB selectivity; new "blend" and "mute" functions; and a built-in AM rod antenna that swivels for best reception.

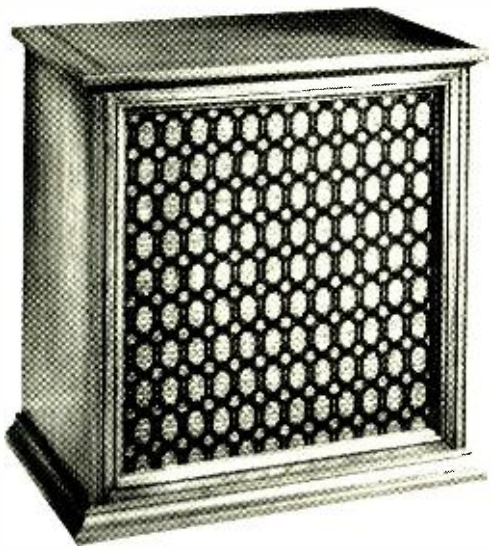
Kit **AJ-29,** 19 lbs., less cabinet **$169.95***
Assembled **AE-19,** oiled pecan cab., 9 lbs. **$19.95***



New Heathkit® AA-29 100-watt stereo amplifier

Power-packed amplifier section of the Heathkit AR-29, the AA-29 stereo "separate" marks another milestone in superior Heathkit amplifier design. Its 70-watts of continuous power is more than enough to drive even the most inefficient speaker systems. A massive, fully-regulated and filtered power supply, 4 conservatively heat sinked output transistors and the best IM and harmonic distortion specifications in the industry add up to sound fidelity you never expected to hear outside the theater. Modular plug-in circuit boards make assembly easier . . . snap out in seconds for future servicing.

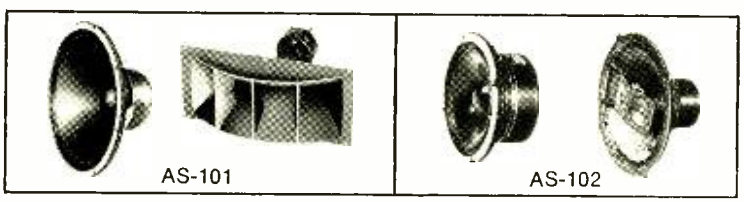
Kit **AA-29,** 27 lbs., less cabinet **$149.95***
Assembled **AE-19,** oiled pecan cab., 9 lbs. **$19.95***



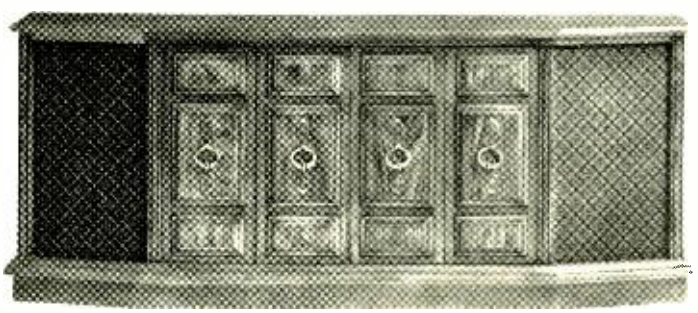
New Heathkit® floor model speaker systems

In the new Heathkit AS-101 and AS-102 speaker systems, Heath engineers have combined the best of both worlds of sound and beauty. The AS-101 Heath/Altec-Lansing 2-way system features a 15" woofer and sectoral horn delivering from 35 to 22,000 Hz with uncompromising accuracy. The AS-102 Heath/Bozak 3-way system uses a 12" woofer, 6" mid-range, and two 2½" tweeters in an infinite baffle design to produce clean natural reproduction from 40 to 20,000 Hz. Both systems are housed in assembled Mediterranean pecan cabinets, 29⅝" H x 27¾" W x 19⅞" D.

Kit **AS-101,** 53 lbs. **$259.95***
Kit **AS-102,** 39 lbs. **$259.95***



New Heath stereo equipment credenza



Romantic Mediterranean styling in wife-pleasing one-piece console design . . . yet with plenty of room for your favorite separate stereo components. Six-and-a-half feet of solid craftsmanship executed in North American Hickory veneers and solid oak trim, finished in oiled pecan. Completely assembled and finished, ready for installation of Heath or other components. Speaker enclosures are ducted port reflex design, pre-cut for 12" speakers. An adjustable shelf has room for stereo receiver, cartridge or cassette tape player or separate tuner and amplifier. Below the shelf is room for your turntable and record storage. Accessory matching drawers on ball bearing slides are available for turntable and tape player.

Model **AE-101,** 90 lbs. **$189.95***

home, shop and ham shack

New Heathkit® IC 15 MHz frequency counter...199.95*

A highly accurate, low cost frequency meter for anyone requiring accurate frequency measurements. Compare these features to counters selling for over twice this low price: accurate counting, 1 Hz to over 15 MHz; integrated circuitry; automatic trigger level for wide range input without adjustment; five digit readout with Hz/kHz ranges and overrange indicators for eight digit capability; high input impedance; storage circuitry for non-blinking, no-count-up readout; computer-type circuitry, no divider chain adjustment; temperature-compensated crystal time base oscillator; BNC input with cable; double-sided, plated-thru circuit board with sockets; three-wire, removable line cord; heavy-duty aluminum case handle/tilt stand and die cast zinc front panel; no special instruments required for accurate calibration.

Kit **IB-101,** 7 lbs. **$199.95***

IB-101 SPECIFICATIONS: Frequency Range: 1 Hz to greater than 15 MHz. **Accuracy:** ±1 count ± time base stability. **Gate Times:** 1 millisecond or 1 second with automatic reset. **Input Characteristics: Sensitivity:** 1 Hz to 1 MHz, less than 100 mV rms. 1 MHz to 15 MHz, less than 250 mV rms. After 30 minutes warmup. **Trigger Level:** Automatic. **Impedance:** 1 Meg ohm shunted by less than 20 pf. **Maximum Input:** 200 V rms, DC–1 kHz. Derate at 48 V per frequency decade. **TIME BASE: Frequency:** 1 MHz, crystal controlled. **Aging Rate:** Less than 1 PPM/month after 30 days. **Temperature:** Less than ±2 parts in 10^7/degree C. 20 to 35 degrees C after 30 minutes warmup. ±.002% from 0 to 50 degrees C. **GENERAL: Readout:** 5 digits plus overrange. **Temperature Range:** Storage; −55 to 80 degrees C. Operating; 0 to 50 degrees C. **Power Requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 8 watts. **Cabinet Dimensions:** 8¼" W x 3⅛" H x 9" D not including handle. **Net Weight:** 4½ lbs.

See these and 300 other Heath-gift suggestions at one of the following Heathkit Electronic Centers:

Anaheim, Calif. 92805
330 E. Ball Road

Boston Area
Wellesley, Mass. 02181
165 Worcester St.

Chicago, Illinois 60645
3462-66 W. Devon Ave.

Chicago Area
Downers Grove, Ill. 60515
224 Ogden Avenue

Cleveland, Ohio 44129
5444 Pearl Road

Dallas, Texas 75201
2715 Ross Avenue

Denver, Colorado 80212
5940 W. 38th Ave.

Detroit, Michigan 48219
18645 W. 8 Mile Road

Fair Lawn, N. J. 07410
35-07 Broadway (Rt. 4)

Houston, Texas 77027
3705 Westheimer

Los Angeles, Calif. 90007
2309 S. Flower St.

Milwaukee, Wisc. 53216
5215 W. Fond du Lac

Minneapolis Area
Hopkins, Minn. 55343
101 Shady Oak Road

New York, N.Y. 10036
35 W. 45th Street

Philadelphia, Pa. 19149
6318 Roosevelt Blvd.

Pittsburgh, Pa. 15235
3482 William Penn Highway

St. Louis, Mo. 63123
9296 Gravois Ave.

San Diego Area
LaMesa, Calif. 92041
8363 Center Drive

San Francisco Area
Redwood City, Calif. 94063
2001 Middlefield Road

Seattle, Wash. 98121
2221 Third Avenue

Washington, D. C. Area
Rockville, Md. 20852
5542 Nicholson Lane

All Heathkit Electronic Centers are units of Schlumberger Products Corporation. Heathkit Electronic Center Prices Slightly Higher.

During 1971, consult Heathkit Catalog Supplements and local newspapers for announcements of new Heathkit Electronic Centers opening in these places:

Long Island Area
Westbury, New York

Miami, Florida

San Francisco Area
El Cerrito, California

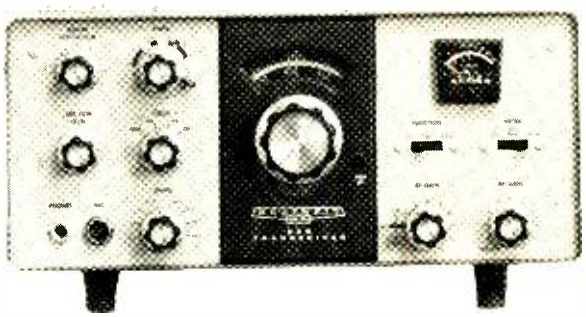
Cincinnati, Ohio

Los Angeles Area
Woodland Hills, California

Atlanta, Georgia

Prices listed are factory mail order. Retail prices are slightly higher.

. . . or send for your FREE factory mail order catalog



New Heathkit® HW-101 SSB transceiver

The Hams at Heath have done it again . . . with an uprated version of the Heathkit HW-100, one of the most popular pieces of ham gear on the market! The HW-101 features improved receiver circuitry resulting in better than 0.35 uV sensitivity for 10 dB S+N/N. Image and IF rejection are better than 50 dB. Other improvements are a new 36-to-1 ball-bearing dial drive; new selectable SSB or CW filters and attractive new front-panel styling.

Kit **HW-101,** 23 lbs. **$249.95***

New Heathkit wattmeter/SWR bridge

Two switch-selected ranges allow measurement of RF output from 10-200 W and 100-2000 W. Built-in calibrator permits 10% accuracy throughout the 80-10 M ham bands.

Kit **HM-102,** 3 lbs. **$29.95***

HEATHKIT
a Schlumberger Company

HEATH COMPANY, Dept. 15-12
Benton Harbor, Michigan 49022

☐ Enclosed is $_____, plus shipping.

Please send model (s) _____

☐ Please send FREE Heathkit Catalog. ☐ Please send Credit Application.

Name _____

Address _____

City _____ State _____ Zip _____

*Mail order prices; F.O.B. factory.
Prices & specifications subject to change without notice. CL-394

(Continued from page 42)

the home of most chip capacitors, operate in the 6-, 12-, or 24-volt range, anyway.

Ceramic chip capacitors, as simple as they are, are susceptible to hazards even more difficult to track down than accidental reverse voltages. Barium titanate additives contribute many of the problems of ceramic chips. For one thing, the electrical characteristics of barium titanate change after being subjected to temperatures in excess of 125°C. Although ceramic chips are not supposed to be polarity sensitive, it is possible to accidentally polarize them if they happen to hold a small charge when bonded into a circuit with a high-temperature soldering process. Later on, such capacitors appear to have one value when charged with one polarity and quite a different value when charged with the opposite polarity.

Barium titanate is also a piezoelectric material that causes the value of a chip capacitor to change with mechanical distortion or pressure. Manufacturers, then, have to trade off high-K barium titanate additives for better temperature and stress specifications.

In spite of these problems with ceramic chips, it is possible to construct NPO (zero temperature coefficient) ceramic chip capacitors. Such capacitors have K values less than 20, but ceramic chips can afford this further loss of volumetric efficiency because tantalum chips cannot have an NPO characteristic at this stage of development. Until recently, NPO capacitors with values above 500 pF were unheard of. *Aerovox*, though, is one company now producing NPO ceramic chip capacitors above 1 μF.

In general, tantalum chip capacitors are less expensive than the ceramics. A tantalum chip capacitor that costs 75 cents may have a ceramic counterpart that costs over a dollar. The manufacturing process for ceramic chips is much simpler than the tantalum process, so the higher cost of ceramics is not due to manufacturing techniques. The higher cost of ceramic chips can be attributed to the cost of metal alloys used as electrodes between the dielectric layers. These alloys have to be of noble metals such as palladium and platinum. Less expensive metals corrode or break down after the high-temperature ceramic firing process.

Ceramic chip capacitor manufacturers are attempting to develop "cold" ceramic firing processes that will eliminate the need for expensive noble metal alloys. Until this process is perfected, sheer high volume production is the only way to make ceramic chips costs more competitive with tantalum. ▲

A Small CCTV System

(Continued from page 37)

will be moved around, as solid conductors will break if the cable is bent frequently at the same point. Foil or braided shield can be chosen. Theoretically, the foil is slightly better in shielding and somewhat easier to handle when wiring.

To facilitate troubleshooting as well as setting and measuring signal levels, signal levels and impedances should be kept the same throughout the system. Video should be run at 1 or 1.4 volts peak-to-peak, depending on the equipment. Usually most of the equipment will run at either level. The author prefers to run everything at 1 volt. The audio should be run at 0 dBm at 600 ohms. The r.f. can be distributed at levels of from +10 to +40 dBmV and fed to the receivers at from +2 to +4 dBmV. Splitters and attenuators and passive equalizers can be purchased to meet almost any requirement. A good oscilloscope is the best way to measure video level. A special scope, called a waveform monitor, is available for just this purpose. An a.c. v.t.v.m. or vu meters can be used to check the audio levels. A field-strength meter, made especially for cable TV, should be used to check r.f. levels. This allows a channel-by-channel check of both audio and video carriers.

The XLR type of connector is a good choice for balanced audio, while phone plugs work well for unbalanced audio. For video, although BNC's have their advantages such as quick connect and disconnect, they are (in some brands) harder to put on the cable, while u.h.f. connectors are a good all-around choice. For r.f., u.h.f. connectors can be used, as can CATV connectors, of which there are several types for different applications.

As mentioned earlier, supers can be provided through the switcher. When doing a super, be sure not to run the video level too high or this will cause over-deviation in the VTR or clipping in the monitor. A good idea is to monitor the production switcher output with a scope. When using the split screen, be sure the black level in each half of the picture is equal in level. This can be set by eye or by using the scope sweeping at a horizontal frequency rate. The adjustment is provided in the special effects unit.

When recording in a studio, a lavalier microphone or fixed boom mike is generally used. Microphones should be low impedance (150-250 ohms). In the field, unless a mixer is available, a single omnidirectional mike should be used at the center of the area of interest. Although this does not give the best audio, it is the best method to use if an inexperienced person is making the tape.

Audio tape recorders can be added to the audio system in the studio for background, opening and closing audio, music, special effects, etc. The best choice would be a 600-ohm output, 600- or 20,000-ohm balanced bridging inputs, half-track mono machine. Separate record and playback heads are nice to have. However, by using high-impedance to 600-ohm transformers, almost any tape recorder can be used, even a cassette machine.

Repairs

An area should be set off to work on disabled equipment, and contain, at minimum, one v.o.m., an audio oscillator, and a scope (TV service type). In addition, a spare head assembly and spare belts for the VTR, a set of universal replacement transistors and diodes, a resistor assortment, electrolytics of suitable sizes, and spare tubes for any tube-type equipment should be stocked.

Recently, pre-wired consoles have become available containing a switcher, audio mixer, special effects, sync generator, monitors, and several camera controls. If you are thinking of one of these, be sure it will do everything you want your production system to do. Keep in mind future expansion too; as some of these units are not flexible in that respect. ▲

NEW PRODUCTS & LITERATURE

For additional information on items identified by a code number, simply fill in coupon on Reader Service Card. 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

COMPATIBLE 4-CH STEREO

A new system enabling broadcasting and recording of four-channel stereo sound using two-channel equipment has recently been demonstrated.

The new system requires only a simple "encoder" at the broadcast or recording source and an inexpensive "decoder" in the home. The encoded signal is completely compatible with existing equipment and techniques and will be received and reproduced as regular two-channel sound in existing standard home stereo systems where a decoder is not used. Prototypes of the home decoder have been demonstrated. It consists of a small unit that plugs into an existing stereo system. In order to receive four-channel stereo sound, four amplifier channels and four speakers are required, but with this new system, no changes need be made in stereo tuners, record players, or tape machines.

Use of the Model EVX-4 home decoder will also expand any existing two-channel source material (FM broadcast, records, or tape) to four independent channels of sound. Records and tapes now owned do not become obsolete and two-channel stereo-FM broadcasts, even if not encoded, are enhanced, according to the company.

Additional details on this new system will be supplied on request. Electro-Voice

Circle No. 6 on Reader Service Card

IC TESTER

A new self-powered IC tester which features a clip probe and a flexible cable for in-system testing of both 14- and 16-pin dual-inline TTL or DTL integrated circuits is now on the market.

The unit's exclusive flexible-cable design permits in-system testing of IC's in normally inaccessible or difficult-to-reach locations. Standard cable length is 24 inches but longer cables can be supplied if required.

The tester displays the logic states of all pins simultaneously. Thus, when clock rates are slowed, sequential operating relationships among pins can be seen at a glance and trouble-shooting thus facilitated.

Suitable for design or service testing of gates, clocks, flip-flops, counters, and adders, the new tester is easy to use. Tester lamps are "on" for IC logic highs and "off" for lows. This positive 100% correlation between tester display lamps and IC inputs eliminates complicated time-consuming interpretation of measurements.

Full details and price are available on request. Emcee Electronics

Circle No. 7 on Reader Service Card

MIKE-MIXING STEREO RECEIVER

Mike mixing in any mode is provided on the new Model KR-6160 stereo receiver. The unit comes complete with its own dynamic microphone and sound-level control so that "live" performances can be mixed with phono, tape, or broadcast reception to achieve "add on" parts.

The tuner section features a three-FET, 4-gang tuning capacitor front-end, two IC and mechanical filter i.f. stages, a new FM/AM signal-strength meter, and FM zero-center tuning meter for fast, accurate tuning.

The silicon-transistor amplifier has 260 watts power output at 4 ohms (±1 dB) and has output terminals for three sets of stereo speakers (plus center channel) and a speaker-selector switch to control each set separately, or speakers A and B or A and C together. Inputs for two phonographs and two pairs of auxiliary lines, plus terminals for a tape deck provide for an adequate growth factor. Kenwood

Circle No. 8 on Reader Service Card

VARIABLE ATTENUATORS

Two variable-attenuator models which have specifications tested to 300 MHz and are usable to 500 MHz are now available as the AT-42 and

AT-82. All sections are shielded to prevent leakage. Both units may be specified in either 50- or 75-ohm impedances.

The Model AT-42 provides an attenuation range of 0 to 42 dB in 1-dB steps while the AT-82 covers 0 to 82 dB in 1-dB steps.

Accuracy is 0.2 dB from d.c. to 150 MHz and 0.4 dB from 150 to 300 MHz. The v.s.w.r. is less than 1.2:1 from d.c. to 100 MHz and 1.3:1 from 100 to 300 MHz.

Power rating is ½ watt. Standard connectors are BNC jack but TNC, N, or Sealectro are available on special order. Hope Electronics

Circle No. 9 on Reader Service Card

SOCKET WRENCH SET

A 14-piece, ¼" square drive socket wrench set has been introduced as the No. 1001. This versatile set contains components that can be combined in seven different ways to drive both hex and square fasteners. Reach of the assembled components varies from 1½" to 9¼", depending on the combination selected.

Included in the set is a precision-made, reversible ratcheting handle with a short swing for close-quarter work. The ratchet mechanism is fully enclosed to keep out dirt and grit.

A unique 5¾" spinner/extension has a drive socket insert in the end of the plastic handle which permits its use not only as a regular nut-driver, but also as a ratchet extension. Nine sockets have hex sizes from 3/16" through ½". Two dual-purpose sockets, with openings of ¼" and 5/16", fit both square and hex nuts, bolts, drain, and pipe plugs.

The set is housed in a snap-lock case molded of high-impact plastic. Xcelite

Circle No. 10 on Reader Service Card

TOOLS FOR IC WORK

A tool kit that has been assembled especially for use with transistorized and integrated circuits features 19 handy tools—each selected for its applicability in servicing work.

Technicians and lab workers will find every-

thing needed for handling a variety of jobs. Included in the zipper-cased kit are ten screwdrivers of various kinds and sizes, tweezers, nippers, scissors, magnifying mirror, pliers, a 35-watt miniature soldering iron, and a 1 to 80 power microscope.

Each tool has its own slot in a bed of plastic foam for easy accessibility. The case measures 13⅜" × 5⅛" × 1½" and weighs about 2½ pounds. C.H. Mitchell

Circle No. 11 on Reader Service Card

240-WATT RECEIVER KIT

A stereo receiver which delivers over 120 watts of r.m.s. power is now offered as the Knight-Kit Model KG-996.

All silicon transistor circuitry is used for highly stable, distortion-free reception while an FET front-end provides 2-μV sensitivity on FM. IC's are used in the i.f. stages, thus eliminating hundreds of soldered connections.

The rated response of the receiver is 20-30,000 Hz ±1 dB, with less than 1% harmonic distortion. Stereo separation is over 30 dB and signal-to-noise ratio is 50 dB. Allied Radio Shack

Circle No. 12 on Reader Service Card

SOLID-STATE FLASHER

The Model FS130 solid-state flasher is designed to operate incandescent, inductive, or resistive loads of 100 watts or less with a surge rating of 10 amperes maximum.

With a flash rate of 60 per minute at a duty cycle of 50%, this unit provides standard octal plug-in termination, encapsulated circuitry, series connection for design flexibility, and economical pricing, according to the manufacturer.

A data sheet with full electrical and mechanical specifications is available on request. SSAC Precision Products

Circle No. 13 on Reader Service Card

SQUARE-CAP FUSEHOLDERS

Littelfuse, Inc. is currently introducing a new series of low-profile square-cap fuseholders that snap into a chassis without mounting hardware and are styled to complement modern instrument panels.

The holders, on which a patent is pending, project only 3/16" above the panel and snap into

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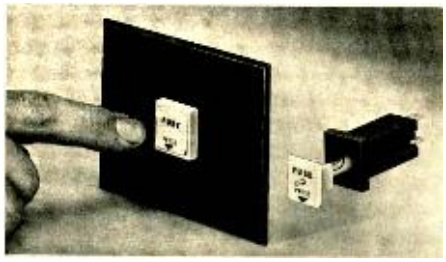


a 5/8" square mounting hole in chassis thicknesses from 1/32" to 1/8".

Two basic series are available. The Series 348000 accommodates standard 3AG fuses as well as the popular indicating-pin-type 3AG fuse. The Series 378000 holder is made to accommodate the 8AG fuse. Both types are available with 3/16" or 1/4" wide quick-connect or solder-type terminals.

For additional details, write the Sales Dept. of the firm at 800 East Northwest Highway, Des Plaines, Ill. 60016.

CRYSTAL FILTERS

TMC Systems (Arizona), Inc., 930 W. 23rd Street, Tempe, Arizona 85281 is now offering 8-pole, 4-zero design crystal filters at 21.4 MHz that require less total volume than comparable monolithic crystal filters. Package size is 1.2 x 0.6 x 0.4" high.

Standard filters are available with 6-dB bandwidths of 20, 40, or 60 kHz. These filters provide 2:1 selectivity from 60 to 6 dB with ultimate rejections of 85 dB minimum. Prototypes are available from stock while custom designs of 2-, 4-, 6-, or 8-pole configurations are available using similar advance packaging techniques.

Write on your business letterhead for a copy of Data Sheet SXF 214 containing additional details.

ALL-CHANNEL PREAMPLIFIER

An outdoor, all-channel (54-890 MHz) preamplifier, designed to improve color and black-and-white pictures in deeper fringe areas is now available as the "Powermate Plus" Model 4287-S.

The preamp is a 75-ohm output device connected to shielded cable that eliminates power-line and ignition interference. It features high gain and low noise to improve picture quality from 300-ohm antennas in locations of normally poor TV reception. The unit is mast-mounting with an indoor-mounting power supply, both housed in functionally styled Cycolac covers.

The manufacturer will supply complete specifications and additional details on request. Jerrold

Circle No. 14 on Reader Service Card

POWER-SUPPLY KITS

An expanded line of "Power Kits" which permits engineers working on a breadboard, preproduction, or production model to assemble their own a.c.-d.c. power supply, is now available in four circuit series.

The power-supply component parts are supplied in various forms, depending on the circuit selected and the d.c. voltage and current required. Over 200 pre-designed circuits of the most commonly required combinations of voltage/current and regulation are available.

In each group of circuits a wide selection of voltage and current ratings, both single- and dual-output are offered. Voltage ranges are from 5 to 48 V d.c., current ranges from 0.25 to 50 A, and regulation from 20% to 0.01%. Lambda Electronics

Circle No. 16 on Reader Service Card

TRIMMING POTS

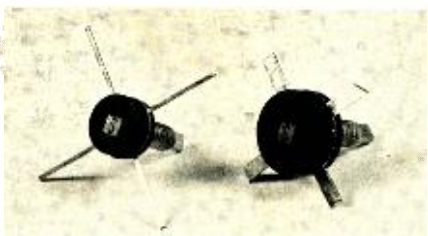
The Electronics Group of TRW Inc. has announced a new 1/4" round "Pillpot" trimming potentiometer series. The 170 Series features an exclusive infinite-resolution metal glaze (Cermet) element produced with several different screw adjustments and pin configurations.

Designed for PC board applications, the new series is available in a resistance range of 10 ohms to 1 megohm and has a temperature coefficient of +100 ppm/°C max. (±50 ppm/°C available) over a temperature range of −55 to +150 degrees C. Standard resistance tolerance is ±20%, with ±10% available, and a power rating of 1/2 watt at 85 C.

Additional technical details are available by writing Milton Book, IRC St. Petersburg Division of TRW Inc., 2801-72nd Street, North, St. Petersburg, Florida 33733.

POWER TRANSISTORS

The Semiconductor Division, Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, Florida 33404 has recently introduced a



line of ultra-reliable mobile communications transistors. These devices are capable of delivering up to 28 watts of output power at 175 MHz. Each unit is individually tested to insure infinite v.s.w.r. capability.

According to the company, the low-input "Q" makes them ideal for broadband applications in the 100 to 200 MHz frequency range. They are designed especially for marine and mobile radio and portable v.h.f. radio functions.

For complete information of available units and circuit application assistance, write the company on your business letterhead.

INDUSTRIAL PANEL METER

A jumbo-size 8" industrial-type panel meter, Model 820, is being introduced by Triplett Corp., Bluffton, Ohio 45817. The first of its size with a non-static glass front, long scale, dust-proof gasket, and new shallow barrel for applications where back-of-the-panel space is limited, the new model is expected to find use in industrial processing equipment, switchboard instrumentation, computer networks, ground support, electronic equipment, education teaching labs, etc.

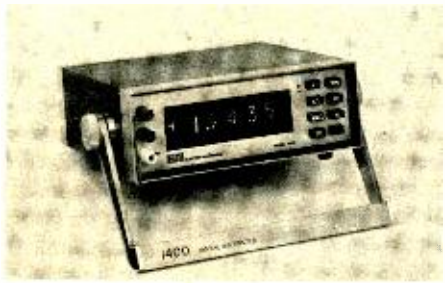
The Model 820 has a black matte finished front and special panel inserts are available for the meter front. The panels can be painted or printed with customer trademarks. The panel meter weighs 25 ounces and its mounting studs are located on 6" x 4 1/2" centers.

The Marketing Department of the company will supply any additional information required, upon letterhead request.

DIGITAL MULTIMETER

Electro-Numerics Corporation, 2961 Corvin Drive, Santa Clara, California 95051 is marketing the Model 1400 digital multimeter which it claims is the first such unit featuring a full ±39999 count display—5 digits—with ±0.005% reading ±1 digit accuracy and 100 microvolt resolution.

The meter has four d.c. voltage ranges (1 to 1000 volts d.c.), six resistance ranges (1000 ohms to 10 megohms), and push-button range/function selection. All ranges (except 1000 V) have 400% over-range capability. Polarity indication is automatic.



The instrument measures 3 3/16" high x 9" wide x 9 1/2" deep. To obtain additional information on the Model 1400, address your letterhead request to the attention of Russ Walton at the company.

REEL/CARTRIDGE RECORDER

A reel-to-reel and 8-track cartridge record and playback unit which features its own amplifier and stereo speakers has been introduced as the Mark 8. It functions independently or may be used as a tape deck in conjunction with other stereo components.

The instrument provides for direct recording onto either a 7" reel or 8-track cartridge from a microphone or any external music source (AM-FM receiver, record changer, or tape deck). It also plays back either original or pre-recorded tapes or cartridges.

A unique feature is the ease with which 8-track cartridges can be duplicated from original or pre-recorded 7" recordings. No external connections are required. Recording the material onto the 7" tape assures a quality recording plus the application of splicing or editing, sound-with sound, or other special effects.

Additional details on the Mark 8 will be forwarded on request. Concord Electronics

Circle No. 17 on Reader Service Card

STEREO RECEIVER/AMP

A new stereo receiver/amplifier which features an automatic tuning system equipped with a remote-control unit has been introduced as the Model SX-2500.

Power output is 340 watts. The automatic-tuning system is controlled by a special servo-control circuit which permits pinpoint tuning of stations for optimum tonal quality. The remote-control unit enables selection of stations and even adjustment of volume from a distance of 23 feet.

The tuner section uses five IC's and two crystal filters for maximum sensitivity and stability. Pioneer

Circle No. 18 on Reader Service Card

RHYTHM ACCESSORY

The Knight-Kit Model KG-393 rhythm console is designed to provide either percussive accompaniment for backing a soloist or adding ten rhythms to the band's sound.

The console electronically creates the sounds of bass drum, snare drum, claves, cowbell, maracas, and high- and low-bongos which are fed through the microphone or instrument amplifier.

At the touch of a button, the unit produces

perfectly timed rhythms for swing, twist, slow rock, rhumba, mambo, beguine, cha-cha, bossa nova, tango, or waltz. The volume and tempo of the beats are controllable and the sound of cymbals can be added in varying amounts to all rhythms except the rhumba, mambo, and cha-cha.

The solid-state kit is of modular design, making assembly easy and quick. The console comes with a 10-foot output cable for connection to any amplifier. The unit is a.c.-operated. It measures 3½" × 12¼" × 11½". Allied Radio Shack

Circle No. 19 on Reader Service Card

AM/STEREO-FM RECEIVER

A moderately priced, 82-watt AM/stereo-FM receiver has just been added to the firm's line as the Model 631.

The receiver incorporates the company's silver-plated FET front-end circuitry, FET's in the

tone control to provide a wider range of bass and treble tuning than heretofore available, and IC's in both the i.f. strip and in the preamplifier section.

FM sensitivity is 2.2 μV with 80-dB cross-modulation rejection. The stereo multiplex section features time-switching multiplex, separation is 35 dB, and capture ratio 2.5 dB. The amplifier output is direct-coupled, using silicon transistors for optimum reliability. H.H. Scott

Circle No. 20 on Reader Service Card

STEREO AMP/PREAMP

A solid-state stereo amplifier/preamp which puts out 160 watts has just been introduced as the Model 1200. It can also serve as a complete stereo control center.

Besides its application in the home, the new unit can be used as a p.a. system for businesses. Plug-in receptacles provide inputs for tuners, two turntables, tape recorders, or other external sources.

Special features include a blackout glass panel which lights up to spell out the function selected, built-in microphone jacks permitting use of the unit as a p.a. system or amplifier for live music performances, separate bass and treble controls for each channel, large vu meters for visual as well as aural balancing of stereo channels, and a tape-monitor switch for comparing tape-sources.

A four-page data sheet giving complete specifications on the Model 1200 will be forwarded on request. Nikko

Circle No. 21 on Reader Service Card

STEREOPHONIC RECEIVER

The Model 19 stereo-FM receiver has just been introduced as the top of the Marantz line of audio components.

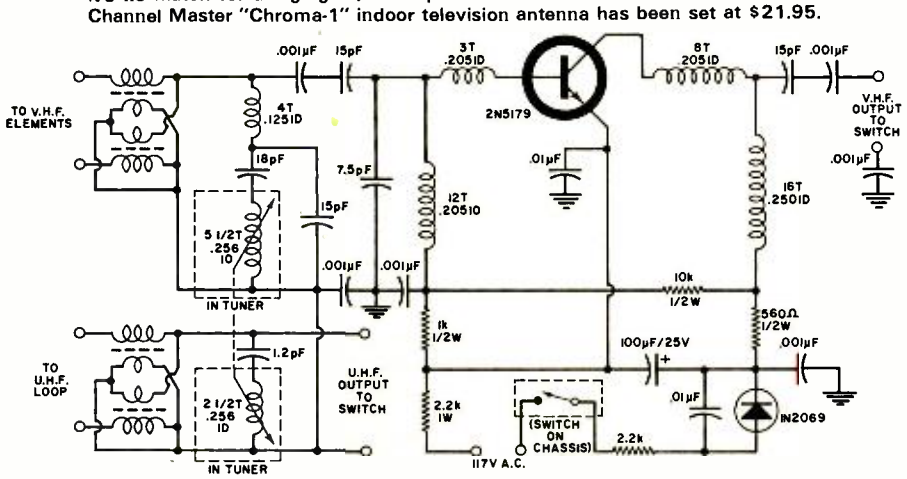
The receiver contains the Model 20 tuner which features a sophisticated multiplex circuit. Stereo separation is in excess of 45 dB at 1000 Hz and in excess of 30 dB at 15 kHz. Automatic stereo switching is accomplished by electronically triggered photoelectric circuits.

The new receiver can be readily adapted to four-channel, quad-radial sound. A jack providing a direct output from the detector circuit makes it ready to accept an adapter for any future developments in four-channel FM broadcasting.

Among the special operating features are two stereo dubbing jacks for a second recorder's input and output, a tape monitor switch, separate bass and treble controls for each channel, high/low filters, a front-panel antenna attenuator, and a front-panel headphone jack. Superscope

Circle No. 22 on Reader Service Card

Channel Master's new "Chroma-1" indoor TV antenna (see diagram below) has a number of features that are unique. Both the v.h.f. dipole and the rotatable u.h.f. loop are tuned by means of a variable-inductance tuner operated by a sliding control on the antenna's weighted base. The control moves a ferrite core in and out of the coils shown within dashed boxes in the schematic. By tuning out the reactance of the antennas to provide improved impedance matching, there is no need to adjust length of the dipole. The user simply tunes for best picture and minimum interference. When switched to the v.h.f. position, the single transistor amplifier is inserted to boost signal strength on channels 2 to 13 (and the FM band) by about 17 dB. Either the amplifier v.h.f. or the u.h.f. output is switched (not shown) to a short length of 75-ohm shielded coax. A splitter at the end of the coax routes the respective signals to the TV set's v.h.f. and u.h.f. antenna terminals. The new antenna, which should be used only in strong-signal areas, does a better job on v.h.f. than the set's built-in dipole or monopole antenna, although it's no match for a high-gain, rooftop-mounted outdoor antenna. Price of new Channel Master "Chroma-1" indoor television antenna has been set at $21.95.



MANUFACTURERS' LITERATURE

CAPACITOR CATALOGUE

Wesco Electrical Co., Inc., 27 Olive Street, Greenfield, Mass. 01301 has just issued a comprehensive catalogue covering its line of film-coil and metalized capacitors. Seven product lines are described in detail and feature precision-type capacitors intended for a wide variety of applications.

Of special interest is data sheet #401 which outlines metalized polycarbonate miniature capacitors.

This catalogue, intended for design and component standards engineers, is available on letterhead request.

STANDARDS INDEX

The EIA's Engineering Department has revised and updated its "Index of EIA and JEDEC Standards and Engineering Publications" which lists 376 such publications.

The Index includes prices for such standards and explains how specific items can be ordered. For a copy of the Index, write on your business letterhead to Irma Edwards, Publication Supervisor, EIA Engineering Department, 2001 Eye Street, N.W., Washington, D.C. 20006.

DELAY LINES & FILTERS

Custom-built, standard fixed, variable, and lab-type delay lines are covered in a new 12-page catalogue (#14) just issued by Allen Avionics, Inc., 224 E. 2nd St., Mineola, N.Y. 11501.

Detailed is the recently expanded "Spiradel" line, including the "Mini-Spiradel," a small delay line having a time delay to rise time ratio greater than 5:1. Descriptions and specifications for various types of custom-built and stocked LC filters are also included.

INDUSTRIAL CR TUBES

The Electronic Tube Division of Westinghouse Electric Corp., P.O. Box 284, Elmira, N.Y. 14902 has just issued a new, illustrated catalogue which provides important data on over 100 cathode-ray tubes for industrial and military applications.

The 20-page catalogue is both a guide to specific CRT's and a demonstration of capability for the design and manufacture of such tubes for special applications.

Included is a master index to industrial and military CRT's and pertinent data on electrostatic focus and deflection CRT's, on round and rectangular magnetic deflection types, and on ruggedized tube-yoke-shield packages. Data on fiber-optic faceplate and high-brightness phosphor tubes is also included.

When making your letterhead request for this publication, please specify Catalogue B-9474B.

SOUND EQUIPMENT

Audio Distributors, Inc., 2342 South Division Ave., Grand Rapids, Mich. 49507 has issued a comprehensive new catalogue of sound equipment and accessories for broadcast and TV studios, theaters, schools, auditoriums, and other such applications.

The 128-page publication lists the complete product lines of 58 leading manufacturers of quality sound reproducing, recording, and broadcast equipment. Off-the-shelf delivery is available on any item listed in the catalogue.

CERAMIC CHIP CAPACITORS

A new product catalogue describing "Kemet" solder-guard ceramic chip capacitors is now available from the Components Department of Union Carbide Corp., P.O. Box 5928, Greenville, S.C. 29606.

The catalogue announces a new generation of ceramic chip capacitors, designed for hybrid-circuit use, which contains a unique copper barrier layer in the end termination that prevents silver

scavenging or leaching during solder reflow assembly operations. The chips protected with the conductive barrier will withstand 260°C exposure for 20 minutes with little or no degradation of electrical continuity and performance.

SPECTROPHOTOMETER

A 12-page catalogue that provides full details on the AC2-20 spectrophotometer which operates efficiently as an atomic absorption, flame emission, and ultraviolet-visible spectrophotometer without instrument modifications is now available from the Analytical Systems Division, Bausch & Lomb, 820 Linden Ave., Rochester, N.Y. 14625.

The catalogue, illustrated with explanatory photographs, charts, and drawings, covers the three operating modes of the instrument in full detail. Other sections of the publication describe the unit's precision components, unique design and operating features, accessories, applications, and specifications.

Ask for Catalogue 33-2225 when making your letterhead request.

MONOLITHIC CHIP CAPACITORS

Monolithic Dielectrics, Inc. is now offering copies of a 6-page technical bulletin describing its line of Type NPO and K 1200 monolithic ceramic chip capacitors and discoidal feedthroughs for use in the hybrid, high-voltage, and RFI/EMI filter industries.

The publication provides complete specifications and includes a handy reference chart showing actual physical sizes as well as dimensions and maximum capacitance values available.

When writing for Bulletin No. 123, address your request to the attention of Jim Waldal at the company, P.O. Box 647, Burbank, California 91503.

POWER-SUPPLY CATALOGUE

Christie Electric Corp., 3410 W. 67th St., Los Angeles, Calif. 90060 has issued a newly revised version of its catalogue AC-70 which covers a complete line of high-current, d.c. power supplies.

The catalogue provides electrical and mechanical specifications on over 300 basic and modified power supplies. Regulation options include magamp, SCR, series transistor, load-regulated only, and unregulated. An integral index helps in locating the correct supply for a specific job.

PUSH-BUTTON SWITCHES

A new "Decorator Line" of push-button switches for a wide variety of electronic equipment applications is described in a six-page brochure which is available from Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill. 60525.

The new line of switches combines panel style with the contact systems of the firm's Series 30 or Series 46 push-button switches. The line includes 32 different switch combinations (without consideration of button color).

Requests for a copy of Bulletin No. 179 should be addressed to the attention of Ed Langille at the company.

INSULATION PRODUCTS

A new four-page catalogue which lists a complete, up-to-date line of electrical and electronic insulation products is now available from Electrical Insulation Sales Co., 1435 51st St., North Bergen, N.J. 07047.

The company also offers a technical-assistance service, staffed by sales-oriented engineers, to help meet electronic research and new product development requirements and applications.

TRIMMER POTS

Weston Components Division, Archbald, Pa. 18403 has issued a compact, but comprehensive 6-page catalogue which illustrates and lists in a single table the latest additions to the company's line of off-the-shelf trimming pots.

The quick-ordering table lists the sizes, model numbers, mechanical and performance characteristics, as well as prices of 73 general-purpose Cermet, general-purpose wirewound, and military-grade pots in square, rectangular, and round styles.

POWER-SUPPLY DATA

Publication of a new 2-page bulletin describing a line of solid-state variable-frequency power supplies has been announced by MEM Controls, Inc., 1450 E. 289th St., Wickliffe, Ohio 44092.

The bulletin provides a full list of features and product applications for a variety of multi-drive situations. It also lists the many optional arrangements offered as standard plus special options. Complete dimensional data and specs for power-supply units of up to 25.5 kVA are also included.

Address your letterhead request to the attention of Thomas R. Wiseman, Marketing Manager, at the above address.

TV PARTS GUIDE

The new 108-page Stancor color and monochrome television parts replacement guide is now available in pocket-sized form for the convenience of TV technicians.

This new part-to-part cross-reference guide complements rather than replaces the full-sized Stancor TV replacement guide and is designed to be carried conveniently in a tool kit or pocket. Essex International

Circle No. 23 on Reader Service Card

TOOL-SET DATA

Bulletin N770 illustrates and describes three new socket wrench and ratchet screwdriver sets recently added to the firm's line of professional hand tools.

The bulletin provides specifications on the various items in each set and gives details on a "personalized" case that is available to house each set. Xcelite

Circle No. 24 on Reader Service Card

MONITOR RADIOS

A four-page, two-color catalogue which pictures and describes the complete line of CRX "Portamon" special frequency-monitor radios, lightweight pocket-portable, and table models that permit the monitoring of police communications, fire departments, commercial aircraft, CD, business and industrial radio, U.S. weather reports, CB, and 10-meter ham radio service is now available for distribution. Hallicrafters

Circle No. 25 on Reader Service Card

CLEANER BROCHURE

A single-page data sheet, Bulletin ZB-1, is now available describing the properties of "Zip Bright" industrial jelly for cleaning aluminum, copper, brass, chrome, stainless steel, and nickel.

The product exceeds Army, Navy, and Air Force specification MIL-C-5410B and can be used for various jobs around the service shop. The product is marketed in ½ pint and quart containers. Devcon

Circle No. 26 on Reader Service Card

ELECTRONIC COMPONENTS

A new 76-page catalogue containing comprehensive listings of components for industrial, military, and commercial electronics is now ready for distribution.

Catalogue C-560 covers a full line of 148 types (22,764 items) of capacitors, transistors, resistors, filters, and pulse transformers which are available as standard stock items. Condensed technical data, ratings, and sizes are included. Sprague Products

Circle No. 27 on Reader Service Card

S. W. RECEIVER DATA

A two-page bulletin that features the new SX-133 advanced communications-type receiver, which covers the AM broadcast band and 81 short-wave services from 1.7 MHz up to 31.5 MHz in four tuning ranges, is now available for distribution.

The publication points out the special features of the new receiver such as the electrical bandspread, crystal phasing, antenna trimmer, controls, bandspread calibrations, external connections, and the various accessories available for use with the SX-133. Hallicrafters

Circle No. 28 on Reader Service Card

COMPONENT SELECTOR

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61	Audio Equipment Co.

Answers to C.E.T. Test, Section # 10

Published in Last Month's Issue

1. **(d)**
2. **(a)** Silicon transistors have bias voltages of .5V to .8V or about twice that of germanium transistors.
3. **(d)** Higher scales on most v.o.m.'s include decade resistors which limit the current to safe levels.
4. **(a)**
5. **(b)** One characteristic of a FET is its high input impedance, opposite to that of ordinary transistors.
6. **(c)**
7. **(c)**
8. **(c)** Six readings are necessary to properly check a transistor.
9. **(c)** The highest forward reading will normally be between emitter and collector
10. **(d)**

1970 INDEX
Volumes 83-84

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ELECTRONICS WORLD

December 1970

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5 new RCA VOM's* Priced from $9.95** to $48.00**

*Complete with test leads, batteries and full RCA warranty (12 months parts and labor).

Input resistances from 2000 to 100,000 ohms per volt.

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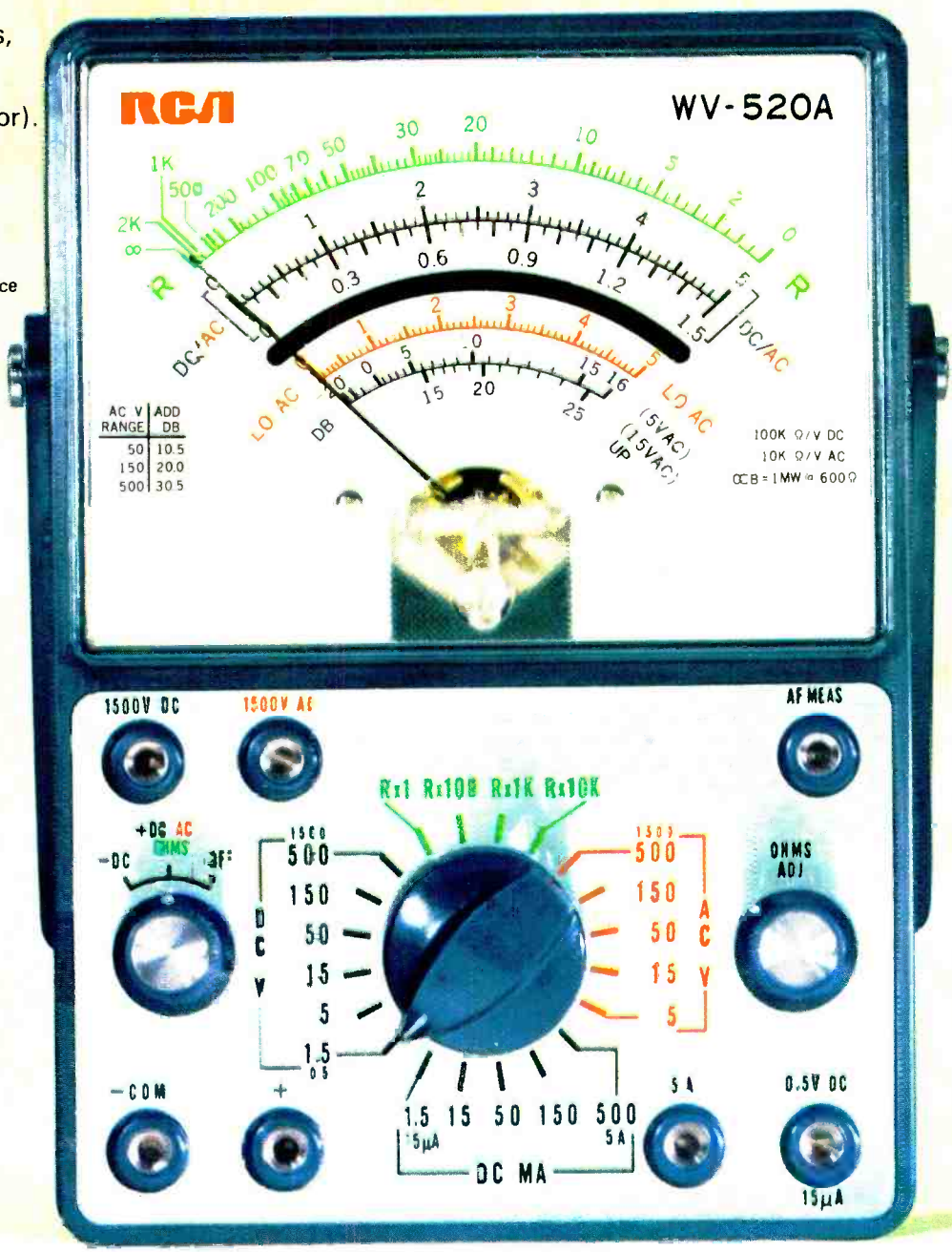

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CIRCLE NO. 109 ON READER SERVICE CARD

LANDMARK™ 100

This ad entitles you to peek under counters, behind displays, and around curtains at any E-V LANDMARK 100 showroom, to see where that great sound is coming from.

(A clue: don't rule out those little speakers...)

When we first demonstrated the LANDMARK 100 system at hi-fi shows we noticed a peculiar reaction. Knowledgeable listeners seemed to be looking everywhere but at the system.

So we asked them why. "We're trying to find the hidden speakers and amplifiers," they admitted. And some wouldn't be content until they had personally checked behind display walls, in closets and under tables.

We let them look to their heart's content. And to listen with a growing conviction that this system was indeed unique. With deeper bass and bigger sound than seemed possible from such modest proportions. Plus uncannily low distortion.

The questions came thick and fast. How? Why? How did we do it? Our brochure provided the facts (the same booklet we'll be happy to send you). It explains about our Acoust-Array* speakers that have to be just 10" on a side to provide the right blend of direct and reflected sound for best control of stereo dispersion.

And we also tell you about Servo-Linear* motional feedback. This ingenious circuit senses actual cone motion — continuously comparing and correcting it to agree perfectly with the original signal.

The brochure tells more: about the performance of our sensitive AM/FM stereo tuner, 100** watt stereo amplifier, exclusive Stereo-V magnetic cartridge, and the 4-speed component-quality automatic turntable. And the price, just $399.95 suggested retail.

But no printed word can duplicate the listening experience. It can only attempt to explain it. That's why a LANDMARK 100 is waiting to be heard at your nearby Electro-Voice showroom. In just a few minutes you can receive a liberal education in the state of the art.

Enjoy yourself. Soon.

*Electro-Voice trade mark. Patents applied for Acoust-Array design.
**Music power, ± 1 dB (80 watts IHF). 40 watts continuous sine wave.

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high fidelity systems and speakers • tuners, amplifiers, receivers • public address loudspeakers • microphones • phono cartridges and stylii • aerospace and defense electronics

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