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db

THE SOUND ENGINEERING MAGAZINE
JANUARY 1976 $1.00

IN THIS ISSUE:

- From Disc Master to Pressing Plant
- L Modulators for CD-4 Cutting
- Visit to a Disc Mastering Studio

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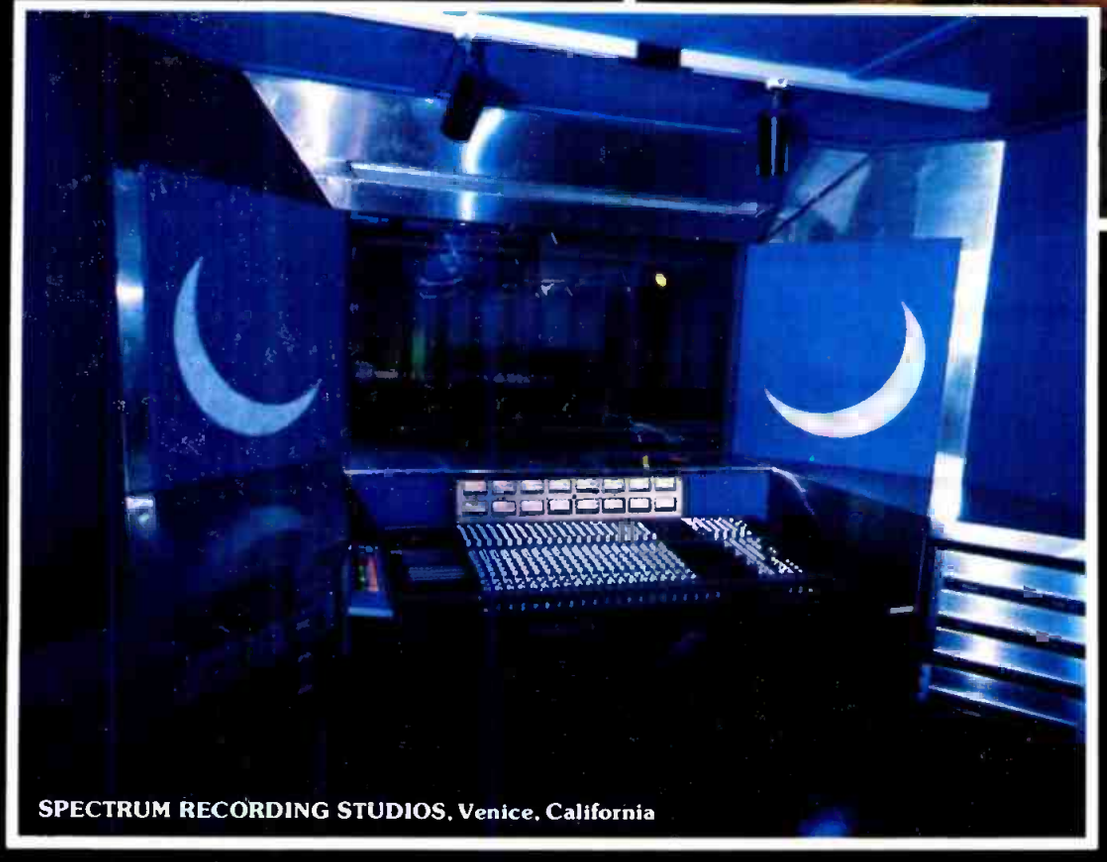

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In February, we consider that often neglected factor in communication, the human being.

- Daniel Queen explores PSYCHOACOUSTICS, a mouthful that refers to the delicate and beautifully parallel mechanisms which control our perceptions, particularly hearing.

- Sidney L. Silver analyzes speech patterns, particularly the pesky sibilants, that crop up in recording, in THE DYNAMIC CONTROL OF SIBILANT SOUNDS.

- Reversing the human factor, when the human brain needs some help, we often turn to our handy calculators. Philip C. Erhorn's practical article, SCIENTIFIC CALCULATORS, takes a consumer-eye trip through the maze of proliferating models.

- February, the month of Presidents, brings Bicentennial to point. Martin Dickstein reports on the fascinating Boston a v presentation about Bunker Hill in THE WHITES OF THEIR EYES.

about the cover

- This disc-recording issue features part of mastering room C at **Kendun Recorders** of Burbank, Cal. The Westlake-designed room features Westlake monitors in the rear wall near the ceiling and one complete Neumann chain fed by a two-track Studer A-80 at the extreme right. A second Neumann chain exists at camera position.

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JANUARY 1976, VOLUME 10, NUMBER 1

db is listed in **Current Contents: Engineering and Technology**

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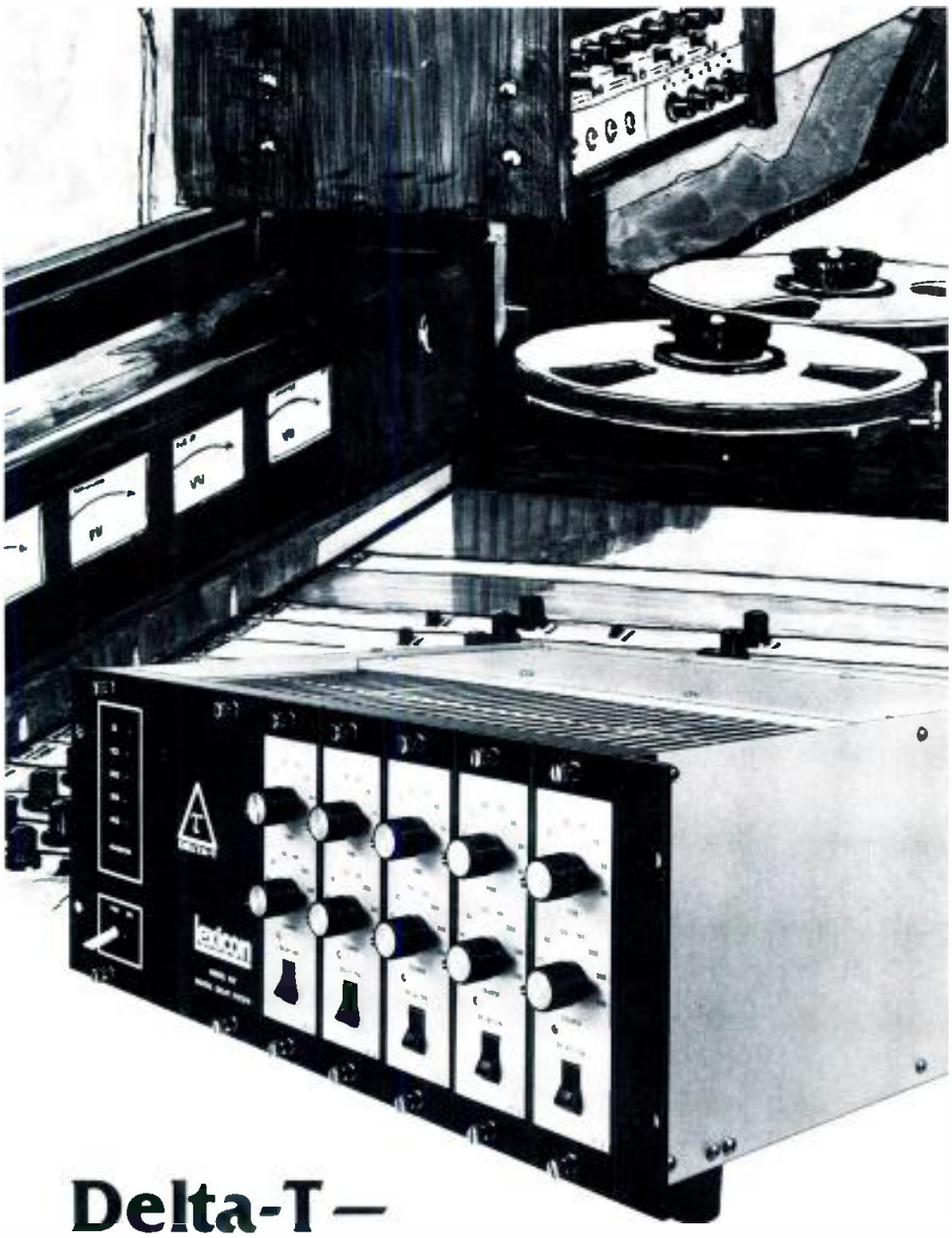

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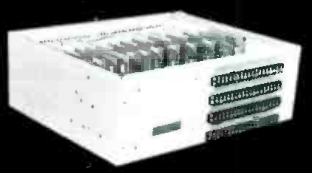

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RAMKO RESEARCH

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db letters

THE EDITOR:

May I submit that R. S. Mintz's *A Simple and Superior Microphone Preamplifier* (**db**, Sept. '75) is neither simple nor superior for the following reasons?

1/f, or "flicker" noise is primarily an input current phenomenon, producing a noise voltage-drop across the source impedance. I hasten to point out that impedances do not produce noise, but noise currents do cause noise voltages when they pass through impedances, as a function of frequency.

Mr. Mintz has used a 0.1 mfd. coupling capacitor which presents a source impedance of 80 kilohms at 20 Hz, so his reference to an 80 ohm transformer resistance pales into insignificance. In the lower frequency spectrum where 1/f noise predominates, he is compounding the problem by presenting an 1/f impedance.

In the range of 20 to 100 Hz alone this will contribute more than 0.1 micro-volts of noise with the LM 331. The capacitor should be at least several microfarads for lowest noise. National Semiconductor says 10 mf.

An equivalent input noise of −130 dBV is claimed, which is 0.316 microvolts. This is nearly 40 per cent below the manufacturer's claim of 0.5 microvolts for a 10 kHz bandpass, so I can only assume that the author has discovered something new, or there is a typographical error. In any event, I must raise serious questions on this point alone. Lowest noise is obtained by optimizing input-stage collector current relative to the source impedance. This is patently impossible when the source impedance changes grossly with frequency over the spectrum of interest; particularly when it goes the wrong way!

If simplicity is desired, why not eliminate the bulk and cost of the gauged pot plus R3, R4, R8, C2, C5 and C8 by simply operating the meter driver as a unity-gain voltage-follower from the preamp output?

Also, I question the soundness in general (pun intended) of operating a transformer unterminated. The usual result is peaked high-frequency response and phase-shift. I suspect the roll-off from C4 is masking this effect.

Finally, if R5 is correct at 6,200 ohms, I wonder where Mr. Mintz found a led to operate at 6 mA.

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FREE LITERATURE

TOOL UP

A plethora of tools . . . hand, power, micro, electronic, etc. are contained in the 112-page catalog. "Tools for Electronic Assembly and Precision Mechanics." Mfr: Jensen Tools & Alloys.

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OSHA NOISE

This booklet discusses basic guidelines for firms beginning to undertake noise measurements and analysis in an OSHA-compliance effort. Covered are noise definitions, measurement, noise control, and personnel hearing conservation. Mfr: B & K Instruments, Inc.

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TAPE CARTRIDGE

This brochure describes the Master Cart cartridge, claimed to eliminate the twisting distortions inherent in conventional cartridges. Mfr: Fidelipac.

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CLOSED CIRCUIT TELEVISION

"The Executive's Guide to Closed Circuit Television" describes types of closed circuit t.v. systems, equipment needed, and actual installations. Mfr: GBC Closed Circuit T.V. Corp.

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RECORDER CARE MANUAL

An updated 32-page booklet, this is the 7th edition of a manual which covers the operation and care of tape recorders, with illustrative instructions in the maintenance of recorders and the splicing of tape. Mfr: Nortronics Co.

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CALCULATORS

A complete listing of their array of scientific calculators is contained in a 31-page booklet published by this manufacturer. Mfr: Hewlett-Packard.

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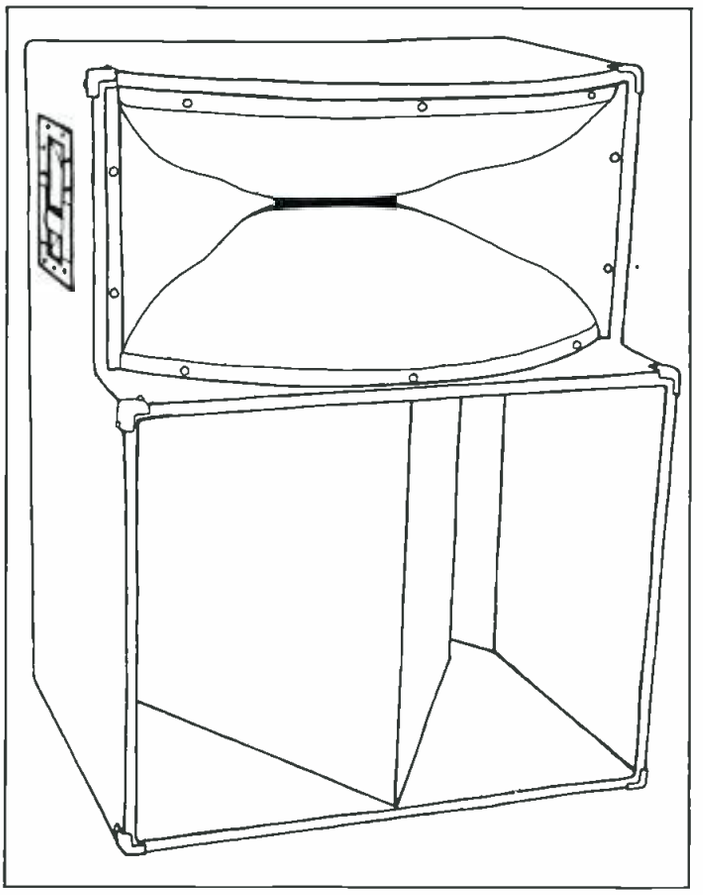

is so great for this system with the SP1's performance that our dealers have ordered over 1,200 units (as of Dec. 1, 1975) based on word of mouth from the few people who have heard samples from pilot production runs.

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CALENDAR

FEBRUARY

17-20 **International Solid State Circuits Conference,** Philadelphia.

MARCH

2-5 **Audio Engineering Society, 53rd Convention.** Hotel International, Zurich, Switzerland.

7-12 **Audio-Visual Institute for Effective Communications.** Indiana University, Bloomington, Indiana. Contact: Audio-Visual Institute, 3150 Spring St., Fairfax, Virginia 22030. (703) 273-7200.

21-24 **National Association of Broadcasters Convention.** Chicago, Illinois. Contact: NAB, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500.

APRIL

5-9 **Acoustical Society of America.** Washington, D.C.

22 **Acoustical Conference.** Hungarian Society for Optics, Acoustics, and Cenematography. Budapest, Hungary.

26-27 **Acoustical Problems of Light-Structure Construction of Buildings.** Acoustical Commission of the Hungarian Academy of Sciences. Budapest, Hungary.

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db theory&practice

NORMAN H. CROWHURST

• If you are going into the educational media business, one thing you need to think about is the hardware you will use. Then you need to think about how you can use the software with it, to best induce learning. Let me quote you a couple of examples. First though, let me say that we will not suggest that one system is inherently better than another. Also, there are cost factors, as well as educational merit factors.

Some three or four years ago, I was working as a consultant on a funded program for rural schools. The project personnel had decided on an inexpensive system that used a carousel slide projector for visuals, with a cassette machine for audio.

For very little over $200 for the complete hardware set, this system provided a second track that enabled the cassette to control the visuals. It had two tones that could be put on the second track, one to pulse the slides on, the other to stop the tape player, requiring the student to push a button when ready to proceed.

We built software to go with this that presented the student with slides at varying rates. Sometimes the same slide would be on the screen for five minutes or more of audio. At other points, each slide might be on for only a few seconds, almost achieving the effect of animation. And then, at strategic points in the learning design, the tape stopped to let the student do some figuring on his own in order to appreciate a concept.

We had students come into the lab to work with the material, and I took a set of material out to a local high school where some more students used it. It worked very well, and the students appreciated the way it helped them develop their understanding. At this point, there could be no doubt that we had a good program.

BUDGETING MIXUP

Now the program had to be installed in the pilot rural schools. However, a budgeting mix-up forced the lab to spend thousands of dollars remaking the visuals on filmstrips instead of slides and re-recording the tape to put beeps in where the filmstrip should be advanced, as well as the words "stop the tape and try this." where the student was expected to do that.

Making this change made the whole program one of utter confusion for the student, whereas it went very well the way it was originally designed. It was not so bad when the student only changed slides every few minutes. But can you imagine a sequence that reads. "Now add *beep* 15, and carry *beep* 10 to the next place, making the total *beep* at this stage 347, then *beep* bring the next place down and *beep*. . . ."?

It is not long before the student is inevitably out of step with what he is supposed to be looking at. Having to try to turn the filmstrip himself, when the carousel should have changed it for him, distracts from what the sequence was supposed to illustrate and, when he is looking at the wrong slide, he then turns back and forth, trying to find the picture he is supposed to be looking at.

Then comes the piece where he is told to stop the tape and try this. Already a bit frustrated, he is slow to follow that instruction, and finds that, by not stopping, the tape tells him what he would have done anyway, so why bother? The net result of this change is that the student learns very little from what had been a good program. mediated the way it was designed to be.

You get the picture, undoubtedly. The student may struggle through, and think he should have learned what the lesson was supposed to teach him. But by not having worked through the pieces he was supposed to do for himself, he definitely has not "got it." He has heard it all, but has not made it his own, as it was designed to have him do.

Probably, for this application, it would have been better to give him a workbook with the pictures in than to try to have him work with the filmstrip, assuming the slide projector with automated advance was out of the question. Of course, if the budget could support video-tape, you have no sync problem, and you could design the whole thing differently.

INVOLVE THE STUDENT

But whether you choose a workbook with pictures in it, an audio recorder with no autostop feature (except the usual one at the end of the tape) or whether you go for some form of video tape, there remains the problem of involving the student in doing the pieces for himself, the pri-

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The system is normally referenced to an internally generated MagLink timing code recorded on one track of the multi-track tape, but the timing reference may be the output of any time code generator, or from a tape timer (thereby requiring *no* tracks of the multi-track tape). Since no data is recorded on the multi-track tape during remix, crosstalk problems are eliminated. The timing code track can also serve to control the audio tape machine and to synchronize additional tape machines by means of a MagLink or Minimag Synchronizer.

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mary object of the whole learning procedure.

If the tape, audio or video, just goes on, merely telling the student to stop and then wait for the solution he may still be lazy, perhaps a carryover from his classroom habit, and not bother to try the operation himself. He merely waits for the tape to go on and tell him, not caring that doing it for himself is vital to learning the material properly.

How can you overcome that? There are several strategies for doing this. In the associated workbook, you print part sentences, to be completed as "notes" that the student makes while listening. Having completed the notes is part of the evidence of lesson completion. Now you can deliberately run through some notes too fast, so that he could not possibly complete successive items, unless he stops the tape, goes back and replays it to catch what he missed, while he was writing the first note.

Or maybe a statement, expressed in its simplest, or most direct way, is just a little complicated to grasp in one run through. Of course, you could take the information piece by piece, and explain it, so he would get it without having to stop the tape. But how about giving it to him straight, and then suggesting that, if he had trouble with it as most people do, he run that piece of tape through again?

That will get him to play it again. He will become accustomed to using the stop and rewind buttons to play a piece over again. That is all it takes, as a rule. Then when the tape suggests he stop the tape and work through a piece on his own, giving him a minimum lead in how to go about it, he will be ready to give it a try.

When you repeat the material on the tape to pick up those students who could not quite make it on their own, do not belabor that. Merely give hints that would enable those who may have had hangups to get started. By using this approach, you can fill in all the details the student needs, or may need, but still make it easier for him to work things out for himself than for him to fit it all in, working backwards.

At the outset, in the instructions, you point out that if he doesn't need additional help, he can use the forward button to skip that part.

Those are just some ideas on how to involve the student. Don't be tricky or mystical about it. Tell him quite openly that the best way for him to learn is for him to figure the subject through for himself. But, having done that, don't make it just as easy for him to sit back and listen to you telling him what he should have done. Instead, make it easier for him to learn it the way you want him to.

TRANSIENT VERSUS PERMANENT VISUALS

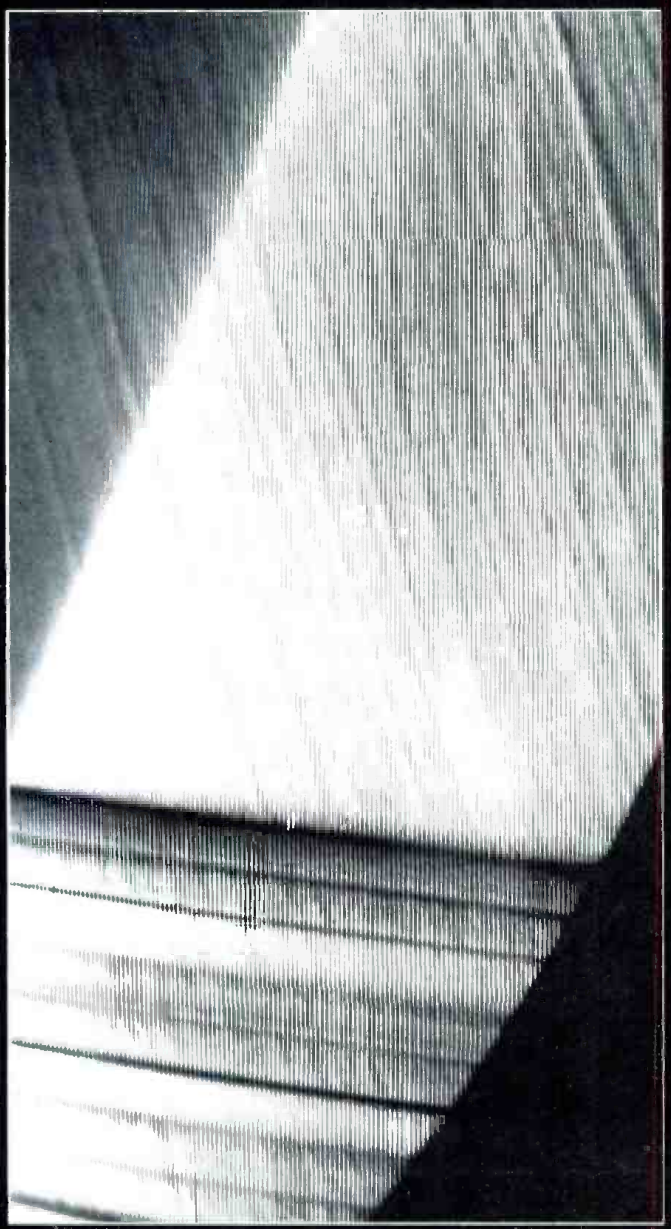
In the previous column, we commented on the transient or permanent nature of visuals. A film or video tape is transient. A book is permanent or persistent. Each has its place in educational media. In our slide presentation, we used the same medium both ways at different times. But for some purposes it is better to use motion video, such as film or video tape, where animation can help convey ideas —with fixed artwork, tables, or what have you, in a workbook, for the materials that need persistence to enable them to be studied at whatever length the individual student needs.

Just as the visual component needs different parts, so should the audio. Some of it will explain the work in a way that requires the student to follow along. This is analogous to the persistent visual. If he does not get it on one play-through, he can play it through again. Some designers use several repetitions of the same sentences, or phrases within sentences, to help the student to retain the material.

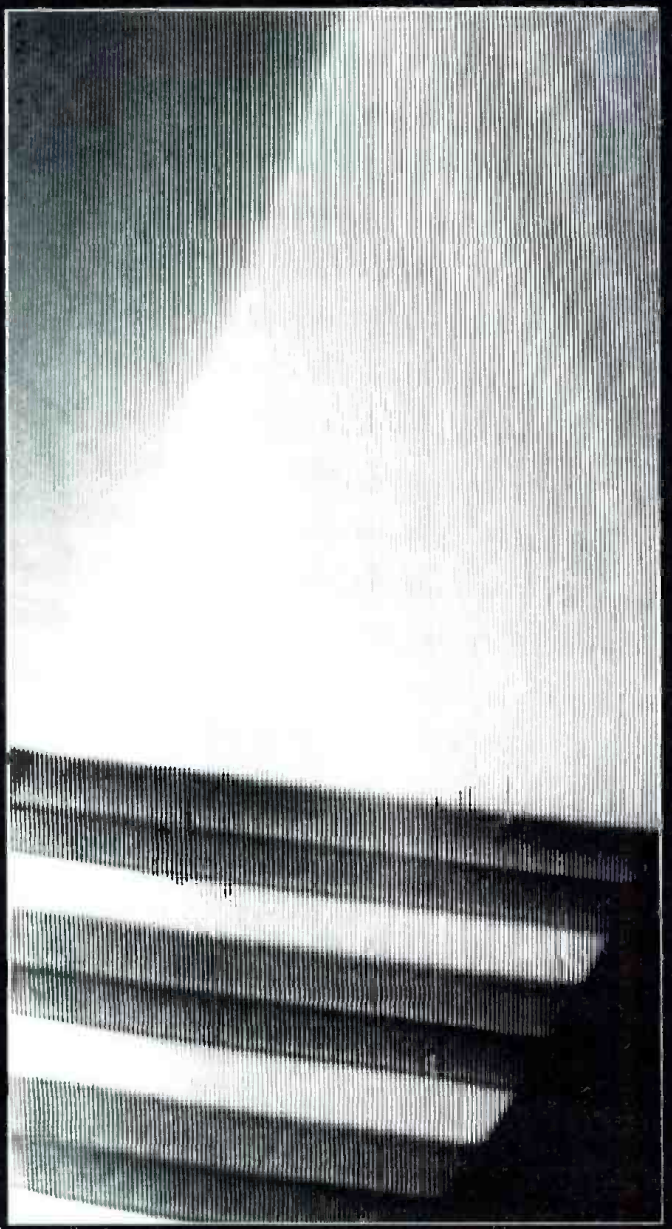
I do not favor that. In my experience, if a student cannot get it the first time, repeating may help, but let the *student* determine whether he needs it repeated. In other instances, due to the peculiar ambiguities of language, if he does not understand correctly the first time, he will continue to misunderstand or fail to understand when he has the same thing repeated for him, whether the designer arranges it that way or whether he replays it for himself.

So we prefer to use the extra time in the audio that other designers might use for repetition, for expressing the same material differently, finding a different approach. Be candid about this too. That is one advantage of audio over the written or printed word: it is much easier to be candid, or confidential in your manner when the student hears your spoken voice.

Tell your students that some people find the subject easier to understand when explained one way, others when it is explained another way, and let them take their pick of which they prefer. By being diligent in this kind of multiple statement, rather than reit-



Master from Transco Products Corporation



Master from Audiodiscs® By Capitol

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The Audiodiscs® master disc by Capitol is magnified 200 times as is the master from Transco Products Corporation. As this close-up reveals, there is a remarkable difference between the two. Even more exciting is the fact that these differences didn't exist 6 months ago.

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At this point, look at the pictures again... they speak louder than words.

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erating the same words, you will make sure that everyone understands it.

There is a side advantage to doing this: you induce the student to monitor, and thus accept responsibility for, his own learning behavior. Natively, most people, probably everyone, prefer to do this. But our educational system has robbed them of this habit. You just try to memorize what they tell you to memorize, do what they tell you to do in the tests, and the score you get, by some mystical process, indicates your success in learning.

DEGREES

I must have had hundreds of teenagers tell me that they have high grades in the math, algebra, geometry, algebra 2 sequence, but that they do not know what it is they are supposed to have learned. What a farce that is! And this goes on into higher learning, so that people come out with PhDs, that mean absolutely nothing except that thousands of dollars have been spent to enable them to sit through countless hours of boredom so they could get that little piece of paper that says they have some sort of education.

If the degree means anything, it is that they have been better programmed to regurgitate what they are told than someone who has not persisted so long to get his last piece of paper. The drop-outs almost invariably have more intelligence than those who stay with it if only because the PhDs believe the piece of paper will mean something when they get it!

We must get back to the question of measurement, some other time. That has to be integrated into any good learning package. But for now, let me say that I do not advocate the abolition of degrees as marks of how much education a person has. I deplore the fact that, for several generations now, such mark-points have become so meaningless. But I would propose that we work to make them meaningful again.

This means that we need to strive to get students to understand what they learn, and to make the tests we design into such learning truly measure and confirm that they really do know and understand what we think we have taught them. Doing that adds a lot more dimension to what we program into the audio and visual components of our course materials. It is a challenging and interesting occupation. ■

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db sound with images

MARTIN DICKSTEIN

• Welcome to the new year, the one in which in our column the word *disc* will also include a first name, *video*. The November '75 column under my banner covered very briefly the TED disc, which was already available in certain parts of Europe, and the two other systems most advanced toward American consumer purchase—RCA, and MCA/Philips. At the recent meeting of the AES in N.Y., representatives of these systems participated in a panel talk/discussion session, and were joined by a representative of Zenith.

Mr. George W. Hrbek, Manager of the Video Disc Player Development Group of Zenith, discussed the approach of his company, indicated where they stood in the development of a video disc system, and then, according to the subject of the AES topic of discussion, related the impact he thought the video disc would have on audio. His comments were made from notes, but he subsequently supplied me with a copy of a talk he gave to the SMPTE in 1974 which was substantially similar.

THE ZENITH SYSTEM

At the AES show, Mr. Hrbek began his comments with the information that Zenith has been studying the field, looking over the units that were being developed, and was also working on a system of its own. No definite entry date into the market was given. The system, still in the experimental stage, uses a thin flexible transparent plastic disc from which the information is read by transmission of laser light through the disc.

Quoting from Mr. Hrbek's 1974 SMPTE report, "Information is stored on the disc in the form of pitted tracks or hill-and-dale modulated grooves . . . A high frequency carrier is frequency-modulated with the chroma and luminance information. Luminance bandwidth is equal to that normally used in NTSC receivers. Tentatively, we have put the sound on its own f.m. carrier at a low frequency. A transcoder converts the disc signal into the NTSC signal on a vhf carrier.

"The Zenith system also uses a thin flexible clear polyvinyl chloride (pvc) disc, as do a couple of the other systems. The Zenith disc is 6 mils thick. However, the big difference between this system and the others that also use a laser beam for readout is that this system can scan both sides of the disc without changing the position of the record and without crosstalk, simply by adjusting the focal plane of the focused laser light. Track spacings as small as 900 tracks per mm corresponding to a playing time of 12 min/inch have been achieved experimentally with acceptable crosstalk between tracks."

Mr. Hrbek described the disc with which most of the experimental work was done. "Diameters range from 8 inches to 12 inches, with a typical groove or track density of about 400 per mm . . . The tracks are separated by about 2.5μ center-to-center. The pits are about 0.3μ deep and about 0.7μ wide. Their length varies from about 1μ on the inside tracks to about 2μ on the outside. Discs are stamped from masters recorded at 33⅓ rpm, 1 54th real time, utilizing a blue HeCd laser. We have recently been successful in recording in real time at 1800 rpm."

To read the information from the disc, the player had a simple optical path and servo system. "A magnetically driven two-axis mirror controls the light beam independently in the radial and tangential direction, providing excellent radial tracking and time base correction . . . A 1 mW HeNe laser provides the light, which is first focused by a simple intermediate lens and then allowed to illuminate the servo mirror. The final lens has a field 250μ wide, which allows the servo mirror to correct over the necessary range. The numerical aperture of the final lens is 0.4. The spot size on the record is less than 1μ. A split photodiode under the record provides the radial tracking error signal and rf output for the video and time base correction."

LASERBEAM/SPLIT

Mr. Hrbek's explanation of the laser beam/split photodiode system indicated how, although the discussion had dealt with pits, the system would also operate just as well if the information were put on the disc in V-shaped grooves. The beam would still have to strike the groove at the precise center for the two diodes to receive equal distribution of power. If the beam were off-center, the unequal distribution between the two diodes would register a corrective signal for the radial tracking servo, through a difference amplifier. The moveable mirror corrects the lateral position of the light beam. (This, then, would permit this system to read discs of other optic systems.)

"Laser light allows low crosstalk between closely adjacent tracks because a very small spot size can be achieved,

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sound with images (cont.)

subject only to the diffraction limit. Along with the small spot size we get to use all the light, hence optical signal/noise ratio can be unlimited, so to speak . . . Spot sizes of 1μ or less are achievable with 6328 degrees A light and numerical aperature of 0.4 in.

"Because of the small spot size, we also have to live with a very small depth of focus in such a system, of the order of plus and minus a few microns. To achieve this, we have employed a system developed by Thomson-CSF Research Laboratories in France.

"The flexible disc lies closely adjacent to two dihedral surfaces and takes on the shape of the surfaces. The disc then enters the jaws of the vertical stabilizer which keeps the upper surface of the disc stable to within about three microns. This is achieved by the pressure of the air entrained by the disc and forced into the narrow space within the stabilizer. Since a flexible record had been our goal all along, we have used this system extensively in our experimental work. It eliminates the need for a vertical focus servo while permitting the use of a simple low cost record.

"Let me say at this point that the experimental work on which I am reporting here was done in close cooperation with the Research Laboratory of Thomson-CSF, and their contribution was by no means limited to the aerodynamic stabilizer."

SIGNAL PROCESSING

On the subject of signal processing, Mr. Hrbek's paper says:

"We have used an f.m. carrier which never drops lower than twice the highest frequency, thus avoiding many intermodulation problems. The only signals which we have tentatively placed into the baseband (below the highest video frequency) are a sound channel and the pilot carrier for the time base correction. There is plenty of space for extra sound channels. A transcoder, not unlike those used in video tape equipment, removes the frequency fluctuations from the signal and transfers the chroma to a crystal-controlled 3.58 MHz subcarrier. Let me add that we are experimenting with alternative signal encoding systems, particularly with a view toward reducing transcoder cost."

The feature of a transmissive system (reading through a disc rather than by reflection) is that it can play mechanically cut, hill-and-dale records and that a 6 mil disc pressed on both sides can be played without turning the record over. Crosstalk between the two sides is not noticeable. The ratio of pit size to record thickness is 300 to 1 and the beam is completely out of focus during its passage through the unused surface. Although it is necessary to record the opposite side backwards, that should be no problem.

"Playing time of about 45 minutes on one side of a 12 in. record are achievable with the increased density (900 tracks per mm). Coupling this with dual-sided recording, 90 minutes of play may be possible on a single disc."

The conclusion of the paper to the SMPTE summed up the system's good points and mentioned some problems.

"The system just described has many advantages. First of all, the transparent, flexible disc is simple, low-cost, and requires no additional processing after stamping. Our stamping yield has been excellent. The optical system is also rather simple, including the lens. There is only a single servo motor. No vertical focusing servo is required. It is possible to play both sides of the record, but even on one side the high density of tracks permits long playing time.

"The system also has its weak points. The flexible disc is easily damaged. Fingerprints are a problem. Clearly, some sort of protection is desirable. The aerodynamic stabilizer does an

excellent job with flat discs but has trouble coping with warped discs. I believe that further work will overcome these difficulties.

"I almost forgot to tell you that this system makes beautiful pictures. Add to this the simplicity of disc and player, and the advantages that all optical systems share: I think you will agree that it seems worth pursuing."

CURRENT DEVELOPMENTS

At the AES meeting, Mr. Hrbek brought the system's position up to date. (Remember, the first talk, quoted here, was given early in 1974.) The fingerprints mentioned evidently created a real problem in handling the disc. A shift has been made to work with the reflective method similar to that used by MCA/Philips. (Recall that in the optic methods which use reflection to read the information, the disc is coated with a protective layer to prevent fingerprint problems but still permit reading the pips.)

Mr. Hrbek said that if the video disc system were used for audio, one great advantage, besides increasing the frequency range capability, would be to extend the dB range from the present audio disc top of about 55 dB to equipment capability of about 80 dB. (The video disc was compared to the audio disc during the talk, with the information that the video disc was capable of 40 million bits of information/sec., and 15,200 tracks/inch compared to the audio record of 750 tracks per inch.)

Just a closing bit of information also given at the AES that we thought you might like to know if you don't already. Although the TED (formerly Teldec) system is presently available in certain areas of Europe, and distribution will be spreading shortly, it will not make its appearance in the U.S. for a while. Systems made in Europe have outputs compatible with the PAL and SECAM color standards used there. For the U.S., the NTSC system has to be used. The machine has this capability, but for this country, the unit will be built in Japan (by Sanyo, probably) under license agreement. Presently, the system is capable of 12 minutes per side and in a changer there is a delay of about 4 seconds between discs. However, the handling problem is eliminated because the user pushes the disc into the machine in a sleeve which the machine automatically removes, plays the disc and then replaces the disc into the sleeve. Well, that makes the fourth contender, depending on what Zenith decides . . . with RCA and TED on the disc/cartridge system and MCA/Philips and Zenith lining up their lasers. ■

db the sync track

JOHN M. WORAM

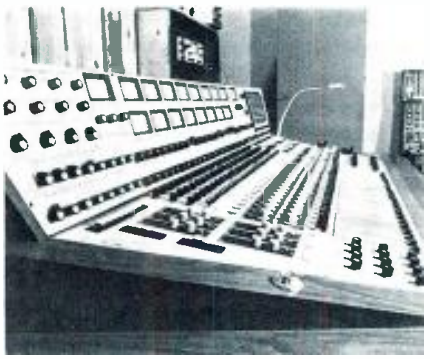


Figure 1. Here's that console you saw rising up the building housing the Institute of Audio Research. It's shown in its new classroom home.

• Some weeks ago, I was invited to join a small group of tape testers for a visit to the 3M home office, labs and tape plant near Minneapolis/St. Paul. As some folks may have heard, 3M has somewhat outgrown your typical Mom and Pop type of operation. As a matter of fact, they've even got their own air force, and one of their air rescue craft was dispatched to New York to whisk us away from fun city for our three day visit.

Since I lead a very sheltered life (the editor grabs all the good trips for himself), I had never seen a tape manufacturing plant before. Well, he couldn't stop me from seeing this one, since we were *both* invited along. A visit to a tape plant may not be the high point of the social season, but it was certainly an eye opener for me. Over the years, I'd been through enough record pressing plants to realize that the real reason for shrink-wrapping albums was to keep the dirt from falling out of the grooves and contaminating the record shop.

But things are quite different in the tape plant. Cleanliness is almost a fetish. Even the air pressure is regulated so that any dust particles drift away from the most critical areas and eventually wind up on the secretaries' typewriters, rather than in the oxide bath.

It turns out the 3Mers are all camera shy, maybe because they—and we—were wandering around in those silly looking yellow jackets that they gave out, while our own jackets and coats, presumably covered with unspeakable horrors like lint and dust, were stored away until our exit from the premises. Anyway, it's hard to describe a tape plant in words only, and I'm not even going to try.

But I can describe some of our discussions at the lab on the day before the factory tour. During the course of our visit, 3M's Del Eilers ran some response curves on various types of magnetic recording tape. Especially interesting were some of the results when a cassette recorder, optimized for one type of tape, was used with another type. As all of us incredibly brilliant professional type geniuses know, you can't just throw any old tape on a machine and expect to get good performance; the tape and the machine have to be matched. But I wonder how many consumers run out to buy the latest super tape and then get confused because—despite the ads—it just doesn't sound as good as the old stuff.

And then sometimes I wonder about the studio engineers who seem to be going mad trying to come to grips with all the new tapes too. What with elevated level test tapes, reference fluxivities, high output formulations and such, there seems to be a lot of

confusion going around. To help spread the confusion, let's take a closer look at some of the operating parameters of magnetic recording tape.

RETENTIVITY

When a tape passes through a magnetic field, it becomes permanently magnetized. Some tapes are magnetized more than others, and the retentivity rating is an indication of the number of flux lines per cross-sectional cm^2 that are stored on the tape.

So, *retentivity* tells us about the tape's flux density, but it doesn't say much about the tape's performance, since we also need to know how large an area has actually been magnetized.

REMANENCE

Since the retentivity of a particular oxide formulation remains constant, the actual number of flux lines per linear inch of tape width depends on the depth of the oxide coating. The thicker the coating, the more flux lines pass under the record and playback heads. *Remanence* is a measure of the number of flux lines per quarter inch of tape width. Therefore, the higher the remanence figure, the higher the output level of the tape.

SENSITIVITY

Sensitivity is an indication of a tape's relative output level, as compared to some specified reference tape. Thus—given the same input level—a tape with a sensitivity of +2 will produce an output level 2 dB higher than the standard reference tape.

HEADROOM

A tape's *headroom* is defined as the difference between standard operating level (+ 4 dBm) and the 3 per cent distortion point. Thus, if a tape reaches 3 per cent third harmonic distortion when the applied input level is +10 dB, it is said to have a 6 dB headroom.

HIGH OUTPUT TAPES

These are simply tapes with a higher sensitivity. For a given oxide coating thickness, a greater flux density results in a higher remanence value, and therefore, a higher output level.

THE CONFUSION FACTOR

As everyone knows, a tape recorder is supposed to be a unity gain device. So, you've just taken your regular test tape and set the tape recorder output level so that the meter reads zero vu. Now you apply a zero vu tone to the input, hit the record button (you *did* remove the test tape, didn't you?) and set the machine's record level so the meter continues to read zero vu. Unity gain.

Now, someone hands you a role of high output tape. You now hit the record button and the meters go off scale to the right. What happened to unity gain? Well, the tape's more sensitive and so its output is greater. You can restore the unity gain condition by simply turning down the recorder's *output* level control.

Or, maybe you get a tape with greater headroom capabilities. That means you can ram the tape with a higher level signal from your console. It also means that your meters will get bent. So don't do it. Instead, turn your tape recorder's output levels down, so that your standard test tape now indicates about −3 vu. Now, when you record a zero vu signal, the meters will read −3 instead of zero. So, crank the record level to the tape recorder up until the meters read zero again.

Note that in all cases, zero vu in = zero vu out. If you're using Dolby noise reduction, there should be no trouble with alignment, provided the tape recorder has been properly set up in the first place.

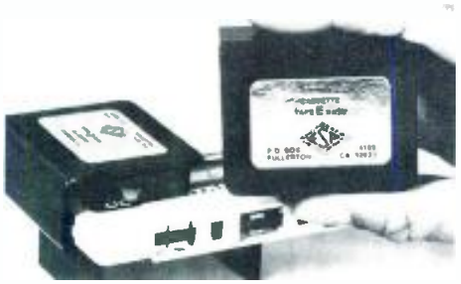
ELEVATED LEVEL TEST TAPES

Elevated level test tapes are now available from several manufacturers. These tapes read about 3 dB higher than the standard test tapes. So you must turn your tape recorder output level down to read zero vu. Then, depending on the sensitivity of the new tape you will be using, the record level is brought up as required to furnish a zero vu output level. Once again, as far as the tape recorder is concerned, zero vu in = zero vu out.

Maybe it helps to think of one role of tape as some sort of amplifier whose gain is unknown. Before and after the amplifier there are potentiometers (the tape recorder's record and playback controls). These pots have been adjusted so that the system gain is unity. Now, the amplifier is replaced by a new one with a different gain. (That is, a different kind of tape is used.) As a result, the system gain changes. But by adjusting one or both of the pots, unity gain can be quickly restored, and as long as this is done, any amplifier (i.e. tape) can be used in the system with a minimum amount of grief. Although for any and every setting of one pot, there is a complementary setting of the other that will produce unity gain, optimum performance is achieved by turning the output level down and/or the input level up. As tapes improve, the output level can be brought further down, and the input level further up—so long as the tape's headroom is kept in mind. ■

db new products&services

CASSETTE TAPE ERASER



• A tiny device called Tape-E-Rase, small enough to be carried in a pocket and weighing seven ounces, erases unwanted tape instantly with a three-to-five twist of the takeup reel spinner. The device requires no batteries or other power. All tracks of the tape are cleared at the same time by an orthogonal unidirectional magnetic field which is idealized with respect to the new signals to be impressed on any of the tracks. Similar erase units which erase larger eight-track tapes, reel-to-reel tapes and videotapes in their cassettes, are also available.
Mfr: Engineered Special Products
Price: $9.95.
Circle 50 on Reader Service Card

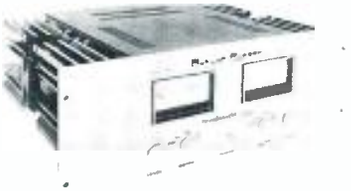
SOUND MIXER

• Designed for quality musical reproduction, QM-8A console has eight input channels, continuously variable equalization at four frequencies, panning between pairs of output channels, two echo sends and a separate headphone/cue mix bus. The monitor may be switched to direct line inputs for separate mixdown without disturbing the front panel program or controls; the monitor section includes a talkback mic and control.
Mfr: Quantum Audio Labs
Circle 51 on Reader Service Card

MINI MIXER

• A keyboard musician who uses multiple keyboards can mix and control the outputs sent to his own monitor stacks or p.a. system with this compact device. The Minimix 12/2 offers 12 input/4 output facility. Each input channel has full e.q. and a pan control, as well as a fold-back and echo send. The input sensitivity is −60 dB to + 20 dB. The output level is ±20 dB into 600 ohms before clipping.
Mfr: Mavis
Circle 53 on Reader Service Card

STEREO POWER AMPLIFIER

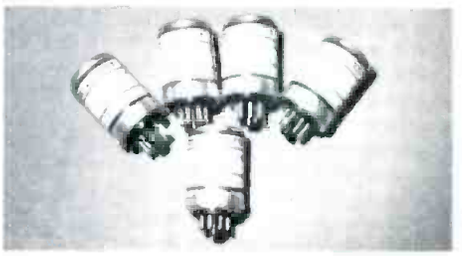


• 500 continuous watts per channel with both channels driven from 20 to 20,000 Hz into four ohms at less than 0.25 per cent claimed distortion is delivered by Dreadnaught 1000 amplifier. The unit is designed to drive studio monitor systems, parallel arrays, sound reinforcement and paging systems and other situations which need more than the power necessary to handle 8 ohms or better. The manufacturer claims that the Dreadnaught will supply increasing amounts of power to over 800 watts, to loads all the way down to 2 ohms, with protection circuitry becoming sensitive well below 2 ohms. The unit is of complementary symmetry circuit design, using ten 20-amp epi base power transistors in each output channel.
Mfr: Dunlap Clarke
Circle 52 on Reader Service Card

CONSOLE INPUT MODULES

• Dual channel, stereo, or monaural broadcasts and/or production console applications are possible with models STM-22 stereo mic input module and STL-22 stereo line input module. Both models utilize the MAP 1731A audio operational amplifier as the active element. Featured are a conductive slide attenuator, preamplification, and switching and control facilities. Independent input to output selection permits left and right inputs to be separately routed to left, right, or to both bus assign switches. The signal can be assigned to either of two output buses, permitting selection of stereo, monaural or combined operation. The modules also offer independent left and right mic trim controls, separate channel on/off switch with provisions for mating logic and on-air control.
Mfr: Modular Audio Products
Price: STM-22, $336, STL-22, $316.
Circle 54 on Reader Service Card

OPERATIONAL AMPLIFIER



• OA-427 operational amplifier has been designed for adaptation to a number of amplifier functions: line-amp, mix-amp, buffer-amp, mic pre-amp, etc. The manufacturer claims zero crossover distortion, large power bandwidth, and low noise. The units are packaged in an octal module.
Mfr: Audio Concepts
Price: $27.50 (1-99)
Circle 55 on Reader Service Card

REVERBERATION SYSTEM

• Two completely independent reverberation channels are provided by model 4400 reverberation system. Each channel has its own built-in graphic equalizer, allowing the operator to duplicate the reverberant quality of any room. Input levels are monitored by vu meters. Each channel features an in/out switch, input level control, input level meter, four band graphic equalizer, reverberation percentage mix control, and output level control. AutoPad circuitry is used throughout. Dual differential constant current amplifiers are used to drive the delay lines.
Mfr: Tapco Corp.
Circle 56 on Reader Service Card

FIBERGLASS RADIAL HORN

• Ninety-degree radial horn BRH90 accepts either 2 in. or 1.4 in. throat drivers. The horn has a 240 Hz flare rate and a 300 square inch mouth area which permits operation as low as 500 Hz. Construction is of one-piece fiberglass.
Mfr: Community Light & Sound
Circle 57 on Reader Service Card

products & services (cont.)

MONITOR SYSTEM

• Both high and low equalization are included for flexible control in the amplifier of the 112TS-2 slant monitor system. The unit features 130 watts (rms at one per cent thd) with infinite dynamic range and will accept any input level from microphones to speaker lines (100 mV – 30V). A sweep filter allows precise feedback control. The slanted enclosures, which are designed to be tilted to three different angles, are tuned and ported with a heavy duty 12-in. speaker and two Piezo super tweeters in each. An attenuating level control is also included.

Mfr: Peavey Electronics Corp.
Price: $499.50.
Circle 58 on Reader Service Card

WIRELESS PORTABLE MEETING AMPLIFIER

• Operating on a standard lantern battery, crystal-controlled amplifier model MA-110 is completely portable. It has a single channel receiver/amplifier driving a 6 x 9 oval speaker and separate bass and treble controls. Simultaneous amplification of a wireless microphone (hand-held or lavalier), an auxiliary input for recorder or turntable, and wired microphone is achieved by three independent slide controls. An optional a.c. adaptor for 110 volt operation is available.

Mfr: Edcor
Circle 59 on Reader Service Card

MULTI-POLE PHONE JACK PLUG/SOCKET

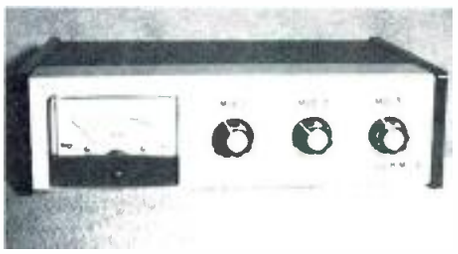
• Designed for use with miniature cable having up to twelve covers plus a screen, Rendar model R414-010-00 opens possibilities for many contact arrangements. The socket can be fitted with make and break switch contacts; electrical contact is made between the plug and socket by a 90 degree clockwise turn of the plug after insertion. A 90-degree anti-clockwise turn releases the plug. A hand locking device preventing the plugs from coming loose due to vibration is optional; the plug cannot be turned in the socket for removal until a button is depressed. The plug is screened via a ground terminal when inserted. This model is one of the Rendar line, including phone jack plugs/sockets with two to twelve contacts; phone jack sockets with isolated auxiliary switching for lamp circuits, etc.; phone jack sockets with changeover contacts; phone jack sockets in sub-miniature, miniature, and standard sizes.

Mfr: Lamb Laboratories, Inc. (Revox)
Circle 60 on Reader Service Card

LOW FREQUENCY LOUDSPEAKERS

• 12- and 15-inch monitoring loudspeakers, Gauss models 2831 and 5831, incorporate a dual spider system, rigid 8-spoke frame and 8½-lb. magnet assembly. Model 2831 has a rated power capacity of 150 watts continuous sine wave power, 8 ohms nominal impedance, 43 dB sensitivity, and free air resonance of 19 Hz. Model 5831 has a rated power capacity of 200 watts rms, 8 ohms nominal impedance, 49 dB sensitivity, and free air resonance of 32 Hz.
Mfr: Cetec Audio
Circle 61 on Reader Service Card

THREE-CHANNEL REMOTE MIXER



• Useful for broadcast coverage of remote events, model I.C.B.M.-3 three-channel remote mixer/compressor features individual compression on each microphone channel, plus overall compression to maintain a constant output level. The clipping point is 310 mV (−8 dB). Balanced microphones with any impedance up to 1,000 ohms may be used with no changes. The line output is 600 ohms, balanced. The unit, which is battery-operated, comes with two headphone packs.
Mfr: H.T.S. Electronics Co.
Price: $180.00.
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NOISE-CANCELLING MICROPHONE

• Noise-cancelling capabilities of the model 562 microphone minimize interference from background noise. The unit has a frequency response of 100 to 6,000 Hz. Low impedance possibilities enable it to be used with unusually long lengths of cable. The mic can be coupled with a high-impedance amplifier input by the addition of a model A95 line matching transformer from the same manufacturer. The unit is designed so that it can be installed in a flexible gooseneck or a general desk stand.
Mfr: Shure Bros.
Price: $55.00.
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AUDIO CONTROL CONSOLE

• Designed for broadcast or discotheque use, sound control model 6440 is a full stereo board that can handle the input from two turntables, one primary microphone, three auxiliary inputs, and one auxiliary microphone. Panel controls have been simplified and enlarged for fast, easy handling.
Mfr: Micro-Trak Corp.
Price: $795.00.
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Figure 1. The new aluminum blanks are lapped on Capitol's specially designed machine seen in background.

Figure 2. After being lapped perfectly smooth, the aluminum blank is etched and cleaned to provide a hospitable surface for lacquer coating. This is the final cleaning process.

LARRY ZIDE

From Disc Master to Pressing Plant

The construction of an acetate master and its subsequent use in the making of a pressing copy are explored in this article.

WINCHESTER, VIRGINIA is nestled pleasantly in apple orchard country. Within this nearly idyllic setting, Capitol Magnetics has several buildings with diverse but related functions. We will explore them in the order I visited them. First, I saw the building in which the basic materials that go into the highly precise product we know as a lacquer blank come together. Then, I went nearby to another building in which Capitol Records has a pressing plant.

It should also be understood that Capitol is a part of the British giant, EMI, which is headquartered in England. In addition, Capitol manufactures raw tape in Connecticut under a brand name familiar to audio pros: Audio Devices. The tape division also markets to the consumer field, using the Capitol name as a brand. But the Audio Devices name also lives on with the lacquer disc, still known as an Audiodisc.

Much of the information contained in this article was assembled by Sue Bohle of Capitol's public relations agency, to whom the author is grateful.

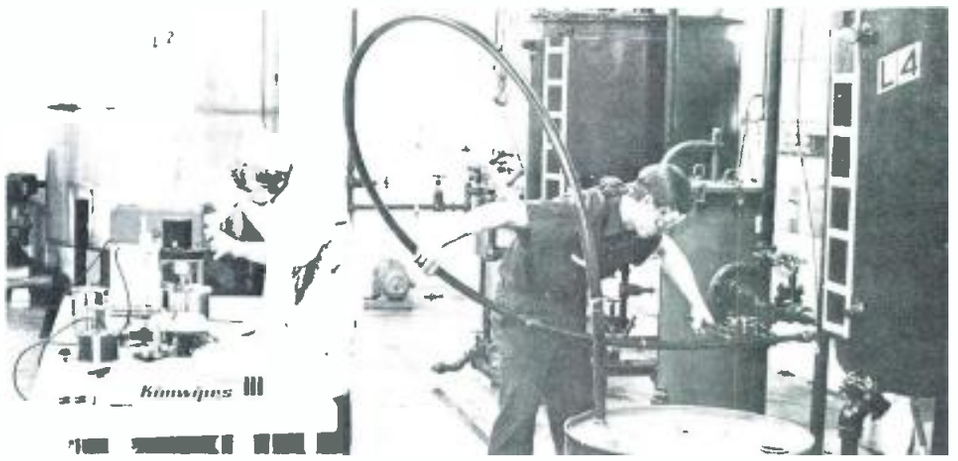

Figure 3. The nitro-cellulose formulation that will form the coating on the blank is blended in these tanks.

Figure 4. The coated discs are dried as they are transported along this temperature- and humidity-controlled tunnel. Entrance is at the far left; this view is from the turnaround position.

LACQUER COATED MASTER AUDIODISCS

Lacquer-coated master Audiodises have been made by Capitol Magnetics Produets (then Audio Devices) continuously since 1937. Audiodises are being used successfully in all disc mastering applications today, including the latest high-information-density carrier recording methods as employed in discrete 4-channel records and in video discs.

The basic construction of a disc appears deceptively simple. It is just a thin coating of nitro-cellulose lacquer on an aluminum substrate, with a hole in the center. Yet the formidable performance requirements belie this apparent simplicity. It takes a highly critical manufacturing process to produce a disc with the cutting properties and processing requirements of a quality mastering disc.

ALUMINUM SUBSTRATES

Aluminum substrates, commonly called blanks, are made from a special pure aluminum alloy developed by a major aluminum producer in a joint effort with Capitol Magnetics engineers. This alloy is free from all impurities which could cause undesirable chemical reactions with the lacquer coating and thus contribute to stability or adhesion problems. The blank must be perfectly flat, free from dirt or oils and have a smoothness exceeding two micro-inches (500 angstroms) rms.

Most manufacturers use calendered aluminum blanks as the base for lacquers. Capitol Magnetics precision laps their own blanks, however, creating a totally new surface on the aluminum discs which has proved to be far superior to the surface created by the old process. (See Figure 1)

One of the main incentives for Capitol's development of its own lapping operation was to eliminate former problems with surface imperfections. Because calendering, or *flagging*, as it's usually called, is done by passing the blanks between rollers, surface dirt and gases can be ground down and into the surface of the disc. These imperfections later show up in the finished lacquer. By lapping, a totally new surface is created which is far smoother and is without lines, rolling marks, pits or other imperfections which could degrade the lacquer surface. This surface also results in better adhesion between aluminum and lacquer.

Another important reason for the development of Capitol's lapping machine was for the disc flatness. Absolute flatness is critical if the disc is to have uniform cutting properties. Early tests show that lapped discs are far more

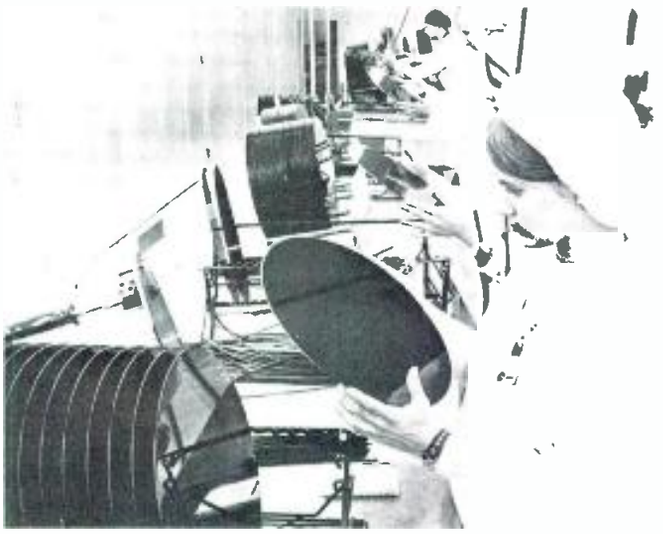

Figure 5. These quality control inspectors examine 100 per cent of the finished lacquers. The room is an environmentally-controlled clean room.

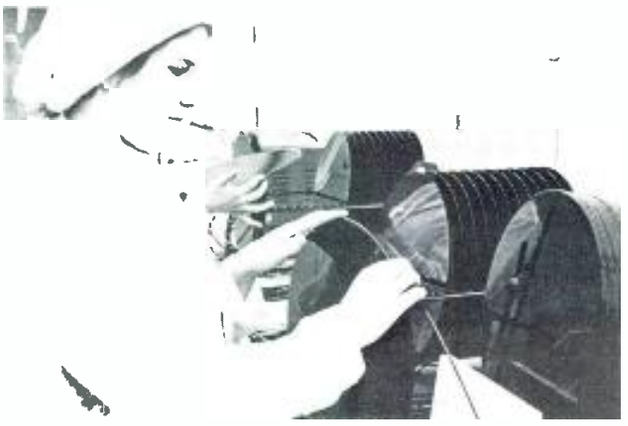

Figure 6. Still in the clean room, the grooved plastic edge is applied to the lacquer disc so that it cannot surface-touch its neighbor when packed.

Figure 7. The last step in the clean room is the punching of the center hole and loading on spindles for final packing and shipping.

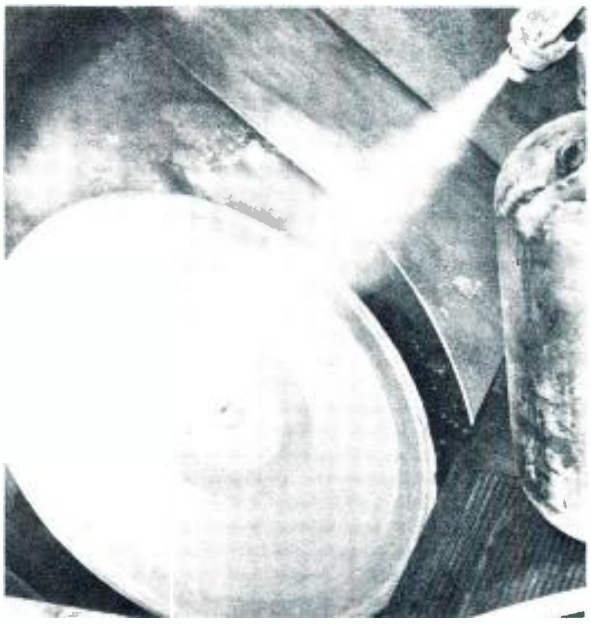

Figure 8. The first step toward a finished recording is the spraying of the lacquer with silver to form a reverse image master.

uniform in flatness than the calendered discs used previously.

After lapping, the aluminum disc undergoes an etching process involving five different chemical baths (FIGURE 2). These baths are designed first to remove the lapping compounds and then to prepare the aluminum disc for coating.

The expensive, non-migrating plasticizers used in lacquer production assure excellent stability with age and adverse atmospheric conditions. The extremely smooth texture of the lacquer is of optical smoothness. In fact, the smoothness of a properly cut groove must be so fine, it is impossible to measure with optical microscopes. Studies using a scanning electron microscope should indicate a peak roughness not exceeding two micro-inches (500 angstroms). This assures the finest signal-to-noise ratio of any recording medium.

The lapped, cleaned and dried discs come together with the finished lacquer at the coating machine. The coating operation is housed in an environment-controlled "white room" filtered for class 100 air. This means that the room must have less than 100 particles of debris, all less than 0.5 micron in size, per cubic foot of air. This cleanliness factor is comparable to the critical air standards necessary for space vehicle components or surgical drugs. At no time is the coating surface of the disc touched by human hands. A final bath cleans the blank of all chemicals and debris.

After the blank is completely clean and free of all surface contaminates, it is dried and then enters the coating area.

While aluminum blanks are being lapped, etched and dried, a special nitro-cellulose lacquer formulation is being blended, filtered, refiltered and then de-aerated in a series of large tanks such as are shown in FIGURE 3. Samples are tested hourly to determine the lacquer's chemical purity, composition, viscosity and dispersion and to check aeration. Any lumps or bubbles in this complex mixture must be removed during this process or they will later rise to the surface of the coated disc and cause hot spots and noise when the disc is cut.

An exact balance of ingredients is also required so that the product will perform reliably through all the various electrical and chemical processes that will be done on it during the manufacturing of a record. For instance, a lacquer must not only cut well in the recording studio, but also process well once it has been cut and then sent to a manufacturing plant for plating and creation of *stampers*, metal molds from which millions of records will be made.

LACQUER COATING

The lacquer formulation is a complex structure consisting of a number of carefully selected and blended ingredients designed to provide the ultimate in cutting quality, lowest noise, best frequency response and reliable metal forming process. The formulation is carefully adjusted to assure a delicate balance between various conflicting requirements: lubricity versus friction, compliance versus stiffness, elasticity versus hardness, flow characteristics versus resistance to groove deformation, and other critical properties.

DRYING

After the disc has been coated with lacquer, it enters Capitol's drying tunnels (FIGURE 4). Long, slow drying at the correct temperature is necessary to cause the even evaporation of gases and the solvents used in the blending of all materials in the lacquer. Rushed drying at high temperatures would boil off solvents too quickly and create surface variation.

When the lacquer disc is dry, it is placed in a controlled oven to be cured. It is then brought back into the coating room and the process is repeated for the other side.

This entire process is also conducted under class 100 or better air conditions.

INSPECTION

Now that manufacture is completed, the discs undergo quality inspection (FIGURE 5). Each disc is visually in-

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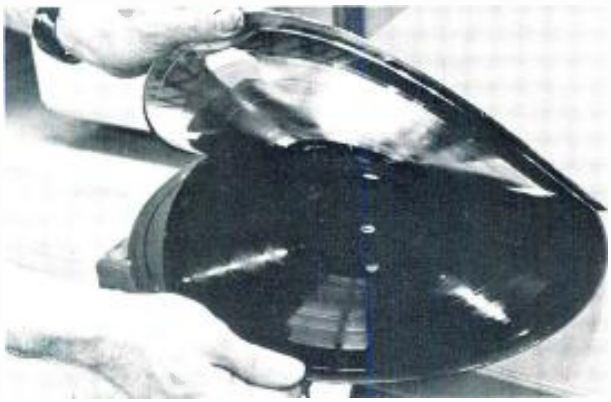


Figure 9. The silver master is stripped away from the lacquer, forming the first mold made from the cutting surface. This silver master will now go through an electroplating process to make the next mold. This new mold is the mother.

Figure 10. Mothers are made in these electroplating tanks. Plating is accomplished by the deposit of nickel on the surface of the master. This nickel mother is a positive of the original lacquer. It will be used to make the final mold, called a stamper, the reverse-image mold that actually is used to press discs. Many stampers can be made from a single mother.

spected by experienced quality control checkers. They look for flatness, smoothness and a blemish-free surface. All discs which have passed inspection are then punched with a spindle hole (FIGURE 7) and stamped with date, batch, and coding information.

PACKAGING

After final inspection, the discs are packaged for shipment. Because of their critical surface, great care is taken to separate each disc and to ensure that no scratches or blemishes will occur during shipment. This is done with a U-shaped plastic edge rim, seen in FIGURE 6, which was wound onto the disc during inspection. The edge rim acts as a wedge, allowing air space between each disc in final packaging.

All packaging used in the shipment of lacquers must be selected for its compatability with the disc formulation. No chemical changes can be permitted to occur because of the proximity of non-compatible materials.

QUALITY CONTROL

Nearly continuous tests are performed on the discs throughout the manufacturing process to ensure batch consistency and quality. Raw materials are evaluated before production is authorized and production discs are sampled and examined for adhesion, lacquer or aluminum defects, drying properties, solvent retention and surface smoothness. Finally, finished discs are examined and then cut under both typical user and more strenuous conditions to determine product quality. Tests detect the degree of static, advance ball scoring, noise versus stylus temperature and other criteria of interest to the cutter, going far beyond user standards.

In addition, discs are regularly sent to a pressing plant to ascertain plating properties.

All these tests not only assure product quality, but also contribute useful information regarding manufacturing improvements. For future reference, test logs are kept on all disc shipments. Finally, Capitol Magnetics constantly requests feedback from recording company sound engineers and platers, which further adds information useful to the improvement of the product.

The completed lacquer then goes to a mastering room, perhaps at Capitol Records, perhaps elsewhere. Once the lacquer has been cut, in a manner such as is described elsewhere in this issue, it comes back to a pressing plant such as that is exemplified by the Capitol Records plant in Winchester.

Here, the lacquer undergoes transformation into forms that will end up on the actual presses and from which plastic molds will pour out.

SILVER COATING THE LACQUER

Since lacquers themselves will not withstand pressing, a metal mold must be made. Silver is used as the first agent because it will adhere to the lacquer surface, harden, and then peel away in perfect reproduction without harming the original master. It is applied by spraying, as in FIGURE 8, and peeled as shown in FIGURE 9. This silver mold, however, is still not tough enough to withstand high volume record manufacturing demands, so a nickel alloy mold is the next step.

PRODUCTION OF A MOTHER

A nickel mold is achieved by electroplating. The silver master is placed in a highly diluted nickel sulfamate solu-

Figure 11. The nickel mother is played on special equipment. Minor groove problems can be corrected by manipulation of the groove wall with a pointed tool.

Figure 12. Once the stamper has been made, it is cleaned and trimmed and taken to the centering machine with which this worker will punch a center hole. To assure precision in the placing of that hole, she has a microscope equipped with a lined graticule. Following this operation, the stamper is back-sanded, die-punched, and formed to fit mold configuration requirements.

Figure 13. One of Capitol's many molding machines. A stamper is being inserted. During operation of the press, a biscuit of vinyl is extruded, labels are applied, and then the biscuit is pressed between two stampers, one for each side of the record, forming the final disc that will be trimmed, packaged, and sold at retail.

tion at a precise temperature and for a precise amount of time. During this process, the nickel adheres to the master and forms a new mold. This mold is commonly called a *mother* because it will be used to produce the final plate from which records will be made. (FIGURE 10.)

Each mold formed from the original lacquer master must be stripped away from the previous mold, cleaned and trimmed before the next process can take place. In each case, the mold is placed on a revolving turntable and carefully cleaned to remove any stray particles which might have lodged on the surface or in the mold's grooves. Alcohol is used to clean silver masters; jewelers rouge is used for nickel molds.

When the mother is finished, it is sent to the testing area to be checked for sound quality. Using special playback equipment, the quality control inspector listens to the audio signal. If any pops or groove damage are evident, the inspector either rejects the mother outright, or, if the problem is minor, inspects the mother under a special microscope and then makes the repair. (FIGURE 11)

THE STAMPER

Since molds must be exact copies (in reverse) of the final product, one final step remains. The lacquer master was a positive; the silver mold was negative and the nickel mother a positive. Since the final mold must be a negative, the nickel mother is sent back to electroplating for a final mold, called a stamper because it is later inserted in a pressing machine and used to stamp out records. Several stampers are usually made from each mother because stampers wear down during the manufacture of records. For extremely long runs, such as for a record made by one of the Beatles, as many as 1,000 or more stampers may be used.

After a stamper is made, trimmed and cleaned, it is taken to the centering machine where its record spindle hole is punched, as seen in FIGURE 12. Using a microscope with a graduated screen, a worker determines the exact center of the mold. At this point in manufacture, the stamper is also back-sanded, die-punched and formed to fit the mold configuration. It is inserted into the stamper as shown in FIGURE 13.

PRESSING

While stampers are being made in the electroplating area, vinyl compound is being mixed for the final pressing of records.

Bulk resin for the manufacture of vinyl is stored in giant holding silos outside the Capitol plant, then automatically pumped into the compound area, where it is mixed automatically via weight monitoring and then pumped to the pressing machine area.

Vinyl compound is released down through the pressing machine in small lumps known as *biscuits*. Labels are attached and then the stampers clamp down, pressing out a record. Each pressing machine holds two stampers at a time, one for each side of the record. The process is fully automated.

The Capitol Record plant has 48 12-in. pressing machines and is capable of producing more than 90,000 12-in. records a day.

INSPECTION

Visual and audio inspection is done throughout all pressing runs. Quality control inspectors take record samples from the pressing machines hourly, checking for chemical stain, scratches, nickel peel, dents and damaged grooves.

Each record is also visually inspected after it is taken off the machine. Then the completed record is sleeved and sent to the packaging area.

In the collating area, the sleeved records are inserted into album jackets along with other materials, such as librettos and photos of the recording star. The albums are then shrink wrapped, packaged 25 to a box and prepared for shipment to record stores all over the world. ■

JOHN EARGLE

PLL Modulators For CD-4 Cutting

PLL simplifies modulation systems used in quadriphonic disc cutting.

RECENT ADVANCES in discrete quadriphonic disc cutting have included the simplification of the earlier modulation systems through the use of pll (phase-lock loop) technology. Two recent embodiments of this technique are the new Mark III system, designed by the Victor Company of Japan, and in operation at the JVC Cutting Center in Los Angeles, as well as the Quadulator system designed by RCA Records and soon to be in use in their studios as well as in a number of independent studios. The basic principle of the pll system was presented in a paper by Messrs. Bogantz (RCA), Ishigaki (JVC), and Fukui (Matsushita), given at the May 1975 Convention of the AES in Los Angeles. We present here a simplified explanation of this system.

In order to understand fully the simplicity and elegance of the pll solution, let us go back and examine briefly the early modulation technique, the *serrasoid* modulator used in the Mark I and Mark II systems. (The word serrasoid derives from the Latin, describing a jagged or sawtooth contour.) Although long appreciated as a modulation technique for f.m. broadcasting, the serrasoid approach as of just a few years ago offered the widest range of frequency swing at the low center frequency of 15 kHz (for half-speed cutting). The basic flow is as shown in FIGURE 1.

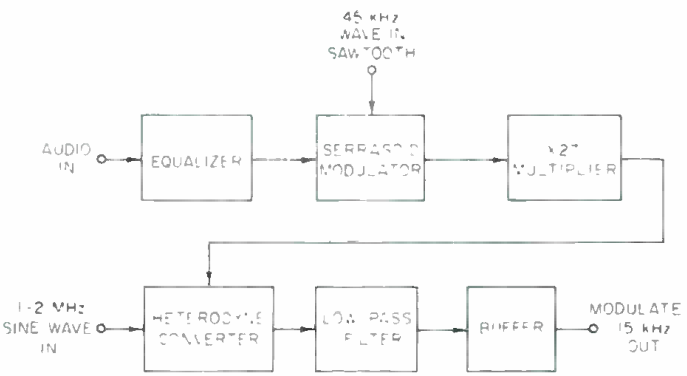


Fig. 1. Block diagram of a serrasoid modulation system.

PWM WAVE

The audio input for one of the carrier channels is equalized and then fed to a serrasoid modulator along with a 45 kHz sawtooth wave form. The output of the modulator is as shown in FIGURE 2. Note that the audio is added directly to the sawtooth wave form, and a slicing action is performed which yields a pwm (pulse-width modulated) wave.

The first fourier component of this pwm wave constitutes a phase-modulated 45 kHz signal; the deviation of this signal is quite small, and additional processing is necessary to secure the wide swing required for CD-4 modulation. Thus, the 45 kHz pwm wave form is multiplied by 27, yielding a center frequency of 1,215,000 Hz.

It is important to note that in multiplying the frequency up, we have also multiplied its deviation by the same amount. The multiplied signal is then fed to a heterodyne converter, along with a 1.2 MHz signal. This action produces both sum and difference components—the difference components are simply 1.215 MHz − 1.2

John Eargle heads JME Associates audio consultants, of Hollywood, California.

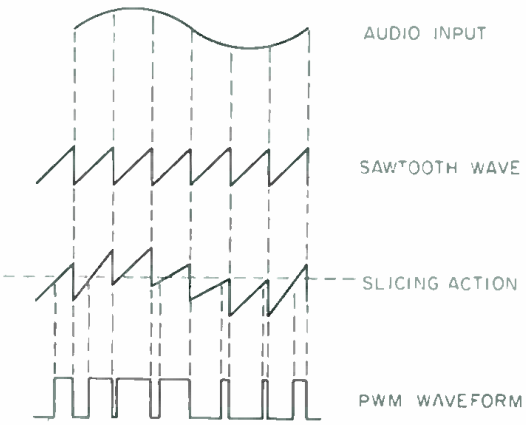


Fig. 2. Wave shaping in the serrasoid modulator.

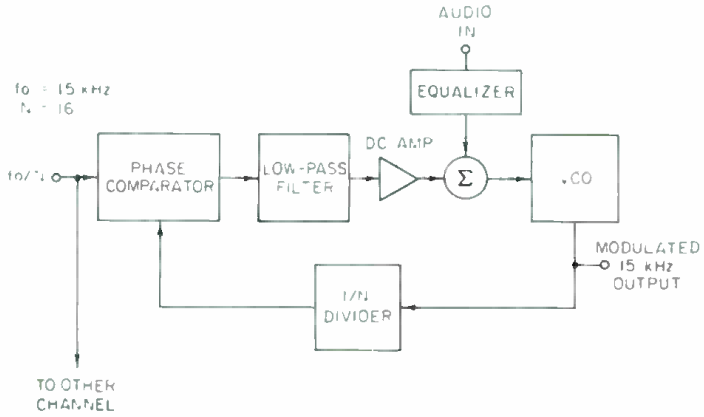


Fig. 3. Block diagram of the pll modulator. The LF feedback loop provides an error signal at the output of the phase comparator when the vco center frequency departs from 15 kHz. The error signal is amplified and fed to the vco, along with the audio input, and the center frequency is corrected.

MHz = 15 kHz. Low pass filtering removes the sum signals, leaving only the difference components as the modulated output. In the heterodyning action, the wide swing is transposed downward, thus providing the large range required.

AUDIO FED TO A VCO

The pll technique is shown in FIGURE 3. The path from audio input to modulated 15 kHz output is quite direct; the audio is equalized and fed through a summing junction to a wide-range high-linearity vco (voltage controlled oscillator). The output of the vco is simply the modulated 15 kHz output. There is no feedback path or servo control loop for this action. It is not needed because of the high linearity of the vco.

It is of utmost importance that the center frequency of the vco be maintained *precisely* at 15 kHz. The reason for this is that there are two modulated signals in the groove and there can be no departure from absolute synchronism if proper performance is to be realized. Thus, a phase-lock loop is established in which the center frequency of the vco is referred back to a reference frequency through a phase comparator.

F_0 is the reference frequency of 15 kHz and N has been established as 16; thus the reference frequency divided by N is equal to 937.5 Hz. The output of the vco is likewise divided by 16 and fed back to the phase comparator. If the center frequency of the vco should shift upward, the output of the phase comparator would be a negative voltage tending to stabilize the vco. A similar action happens if the vco drifts in the other direction.

The purpose of the 1/N division is to stabilize the system for all operating conditions, thus assuring the widest possible modulation index for system operation. In CD-4 cutting, modulation indices often run as high as 90 radians at low frequencies. (Modulation index *m* is defined as *frequency deviation divided by the modulating frequency*. For an f.m. system, the modulation index doubles for each halving of the modulating frequency; this accounts for the large index at low frequencies.)

Most of the components used in the pll modulator are convenient and low-cost integrated circuits. The use of the pll principle in modulator design, along with several other system simplifications, has resulted in total system design in which the cost of the modulating package does not exceed $10,000, quite a reduction compared with the earlier cost of the Mark I system of $60,000. ■

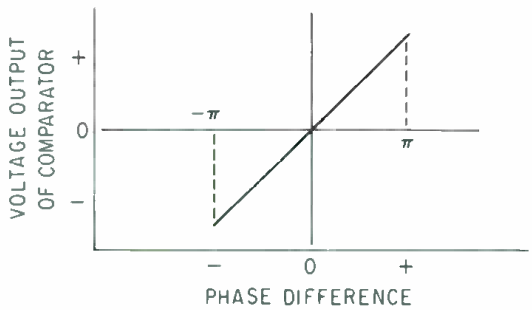
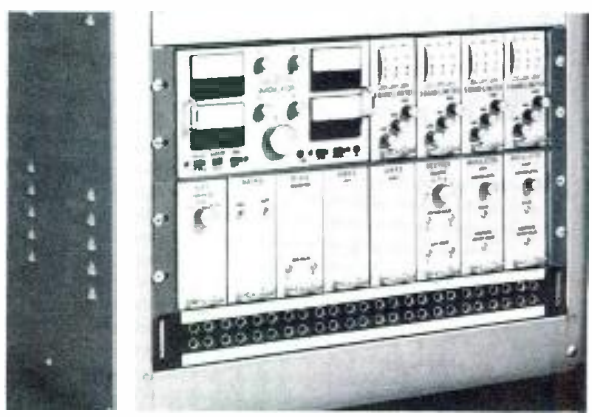


Fig. 4. Characteristics of a phase comparator. The comparator has zero voltage output when there is no phase difference at its inputs. The output can be positive or negative, depending on the angular direction of phase differences at its inputs.



The RCA Quadulator is the complete encoding electronics for cutting CD-4 discs (assuming, of course, that you do have a lathe). This unit is designed for half-speed cutting.

Figure 1. The office shot. Left to right, Leila Greenstone, office manager, Kim Paladino, and Kent Duncan.

A Visit to a Disc Mastering Studio

This is a report on our visit to Kendun Recorders in Burbank, California where a most sophisticated disc mastering room exists.

KENDUN RECORDERS is located on the Burbank flats close on to everything in audio that happens in southern California. But their business has grown into one that is known all over the nation both for the disc mastering service they provide and for their recording studio facility.

THE RECORDING STUDIO

Kendun has two rooms and a disc mastering area, all clearly evident of the design work of Westlake Audio. As this article is primarily thrust toward their disc mastering, let's have only a brief description of one of the studios. Studio two is new—it features a new Automated Processes board with full provision for later addition of automated mixing capability. The console, a 32-in/24-out model feeds to one of two 24-track machines. one an Ampex, the other a 3M. There are also Studers for 2- and 4-track work, and a 3M 79 model four-track with dbx and vso for tape delay. Outboard equipment includes an Orban stereo synthesizer, Neve stereo expander, and enough channels of Dolby to handle all the machines.

The studio is a typical (and that means handsome and functional) Tom Hidley room. The inevitable Hidley drum booth is there, of course.

THE CUTTING ROOM

The studio operation at Kendun is first rate, but this story is about their disc mastering operation which is certainly one of the most sophisticated we've seen. The Hidley woodwork and angles are everywhere and amply dis-

played on our cover, as is one of four Neumann lathe systems, each equipped with the Neumann SAL 74 cutting systems and the TS-66 tracing simulators. The present setup has two lathes in each of two nearly identical rooms—studios 3 and 4 in Kendun's numbering system. The lathes are all fully automated and are capable of producing truly superior disc masters.

Kendun's disc mastering has come, in only a few years, from nowhere to its present position—one of the top four mastering rooms in the country. Along the way, a big help to Kendun was given by the Grammy winner *Innervisions* album by Stevie Wonder. It was a difficult cut, but Kendun did it well, helping thus to share in the engineering Grammy that *Innervisions* won.

Kendun Recorders *is* Kent Duncan who is owner, president, and reputed resident slave of the place. He does much of the cutting. Most of the sales to feed those cutters is channeled through Kim Paladino, vice president of marketing and client relations, our hostess during our visit.

But Kent runs the place, and it is perhaps best that he tell the Kendun story for himself.

Figure 2. Kent Duncan in his more familiar pose, hard at work on a new lacquer master.

THE FACILITY

"How do we do it?" says Kent, "We started with the very best stock equipment available and redesigned and modified it beyond 'state-of-the-art'. Our Neumann cutting systems have had their final output stages modified to deliver nearly double the power and the computers have been improved to better conserve space on the disc and cut a better groove on any given material. We have installed only the highest quality equipment—from our Studer tape machines and our Neumann console and lathes, to a 30-frequency equalizer of our own design.

"What does this mean to the producer? The improved cutting system with more power results in a cleaner sound due to the transient response. The better control of the cut gives us the ability to put more level and/or more time in the same space. Every setting is precisely calibrated and detented for exactly repeatable cutting, an important feature when the master is cut long after the reference discs.

"We have participated in comparative cutting situations with every major cutting installation in the country and I am very pleased with the phenomenal string of successes in this area. In order for established labels to justify the expense of sending mastering to an outside cutting facility, rather than using their label-owned cutting room, we must be remarkably better and as such, we are looked to as the standard setters.

"We provide a full complement of accessory signal processing at no extra charge, including: Dolby, dbx, and Burwen noise reduction. ITI parametric equalization, EMT limiting, Haeco CSG, QS or SQ decoding, echo chambers, and more. All equipment is regularly aligned and maintained to assure trouble-free operation and unparalleled frequency response.

"Equipment, however important, is only as good as the people who use it. So our engineers are more than skilled technicians; they are artists, striving to satisfy the client's needs. Hardly a week goes by when a chief engineer or studio manager from another cutting facility in the country doesn't call to ask our advice on how to deal with such varied problems as standards relating to acceptability of cut, discs, styli, processing problems, choice of equipment, or just plain 'How did you do it?' The answer is having unforgiving perfectionists, using the very best equipment money can buy, that has been modified and improved beyond manufacturing standards, and an uncompromising set of values that may result in the sides being a few hours late, but a rejection rate of under one-eighth of one

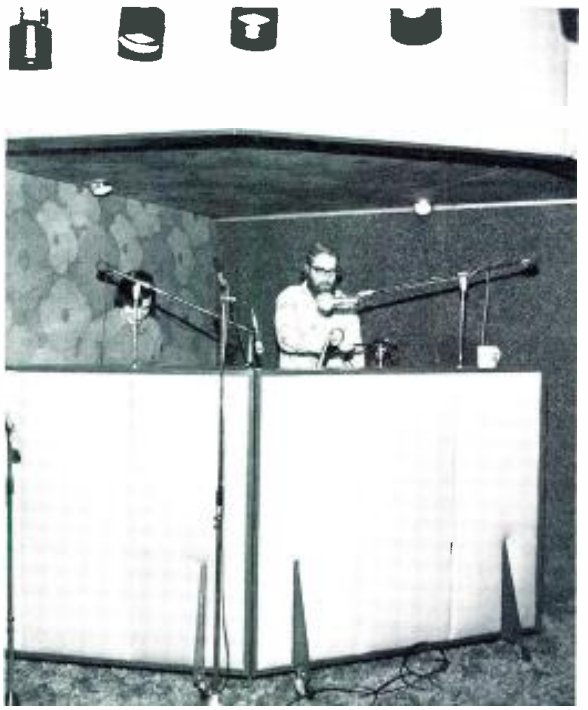


Figure 3. The drum booth in the smallest of two studios at Kendun. That's boss-man Kent adjusting a mic at the right. The larger studio, not illustrated, has the classic Westlake raised drum booth.

per cent—unheard of in master cutting. Another answer is that we spared no expense with our four-monitor, acoustically perfect room by Westlake Audio. The sound you hear at Kendun is truly representative of the tape or disc —no hype!

THE TECHNIQUES

"There's no substitute for a good master tape, but many corrections can be made during the mastering, saving up to a thousand dollars a night in remixing costs. We have had unusual success in correcting problem tapes, doing in one afternoon what would otherwise require many evenings in the mixdown room. Part of our secret is our unique parallel signal processing chain, enabling instantaneous crossfades or switching between different equalization and level structures.

"In addition, each device is really a ganged, two-channel unit, so that any changes in the signal fed to the cutter head are automatically performed on the preview signal that feeds the computer. We even re-program the cutting computers in our Neumann lathes for optimum performance within the parameters of the specific program material. We avoid the convenient shortcuts like rolling off the bottom end, brute-force limiting, or sacrificing level. which are the common outs of lazy mastering engineers.

THE QUESTION OF TONES

"It never ceases to amaze me that tapes still come to us missing one or more of the usual tones at the head. A tape sent to any cutting room should be assembled as far as the interval between tunes and ready to master. Leaders should be omitted—biased tape is quieter than paper leader across the heads of many mastering machines. Also. omitting paper leaders prevents that common 'pop' when the tape goes into the leader.

"What tones to use:

15 kHz to align azimuth
1 kHz or 700 Hz for zero level
10 kHz for high frequency response
50 Hz for low end response
(Some people use 100 Hz; however most machines' low end eq is at 50, and if you use that to align to 100, 50 Hz will often be down 2 or 3 dB.)

"What about Dolby tones? A full set of NAB tones followed by a full set of noise-reduced tones is best. Aligning without stretching tones assumes that all Dolbys are flat, which is a long way from the truth. If the Dolby and machine are properly interfaced, the Dolby tone and the zero tone will be identical. If they aren't, then we know the recordist did not have his system properly aligned and we try to make an educated guess as to whether we should underdrive or overdrive the Dolby in relation to which tones."

SUMMARY

This kind of dedication and attention to fine detail has not gone unnoticed or unrewarded. Producers wanting the best quality possible in a tape or disc transfer choose to, and even demand, that their records be mastered on this system. Just to quote from the roster of artists who have used the Kendun facility over the most recent past gives us names such as Lily Tomlin, Commander Cody, Dan Fogelberg, the Isley Brothers, Billy Preston. Dionne Warwick, Hot Tuna, Jefferson Starship, Ella Fitzgerald, Oscar Peterson, and more—much more. That's a lot of fine masters—let's hope they all got good pressings. ■

db classified

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• **Robert D. Pabst** has been appointed executive vice president and general manager of **Electro-Voice, Inc.** of Buchanan, Michigan. Mr. Pabst will relieve E-V president **Philip Garnick** of some of his responsibilities so that Mr. Garnick may devote himself further to the affairs of the parent company, **Gulton Industries.** Mr. Pabst was formerly with **Litton Dental Products.**

• **William W. Weismann** has been promoted to the position of retail branch sales manager of ten western states for **3M Company's** Magnetic Audio/Video Products division. In this newly created position, Mr. Weismann will be regionally responsible for the sales of Scotch and 3M brand retail products, and located in Los Angeles.

Ampro Corporation has moved to larger quarters, with expanded assembly, testing, and storage facilities. Their new address is 850 Pennsylvania Blvd., Feasterville, Pa. 19047. Their telephone number is (215) 322-5100.

• **Teac** tape recorders will be permitted to offer **dbx** noise reduction under the terms of a license agreement with the dbx firm. The system used will be the same 2:1 double ended compression/expansion configuration presently sold as an outboard accessory by dbx.

• Two new representatives for the recorder care products division of **Nortronics, Co.,** of Minneapolis, have been appointed. **James H. Podolny Company,** Medina, Ohio, will service western Pennsylvania, West Virginia, and Ohio. New representative for northern California is **Moulthrop Sales, Inc.**

• Two new officers, filling unexpired terms, have been elected by the **Institute of High Fidelity. George DeRado,** of **Teac Corporation,** has been elected president, filling the term of **Herb Horowitz** until June, 1976. **Victor Amador,** of **Audio Dynamics Corporation,** will serve as a board member until June 1977, filling the unexpired term of **Alan Novick.**

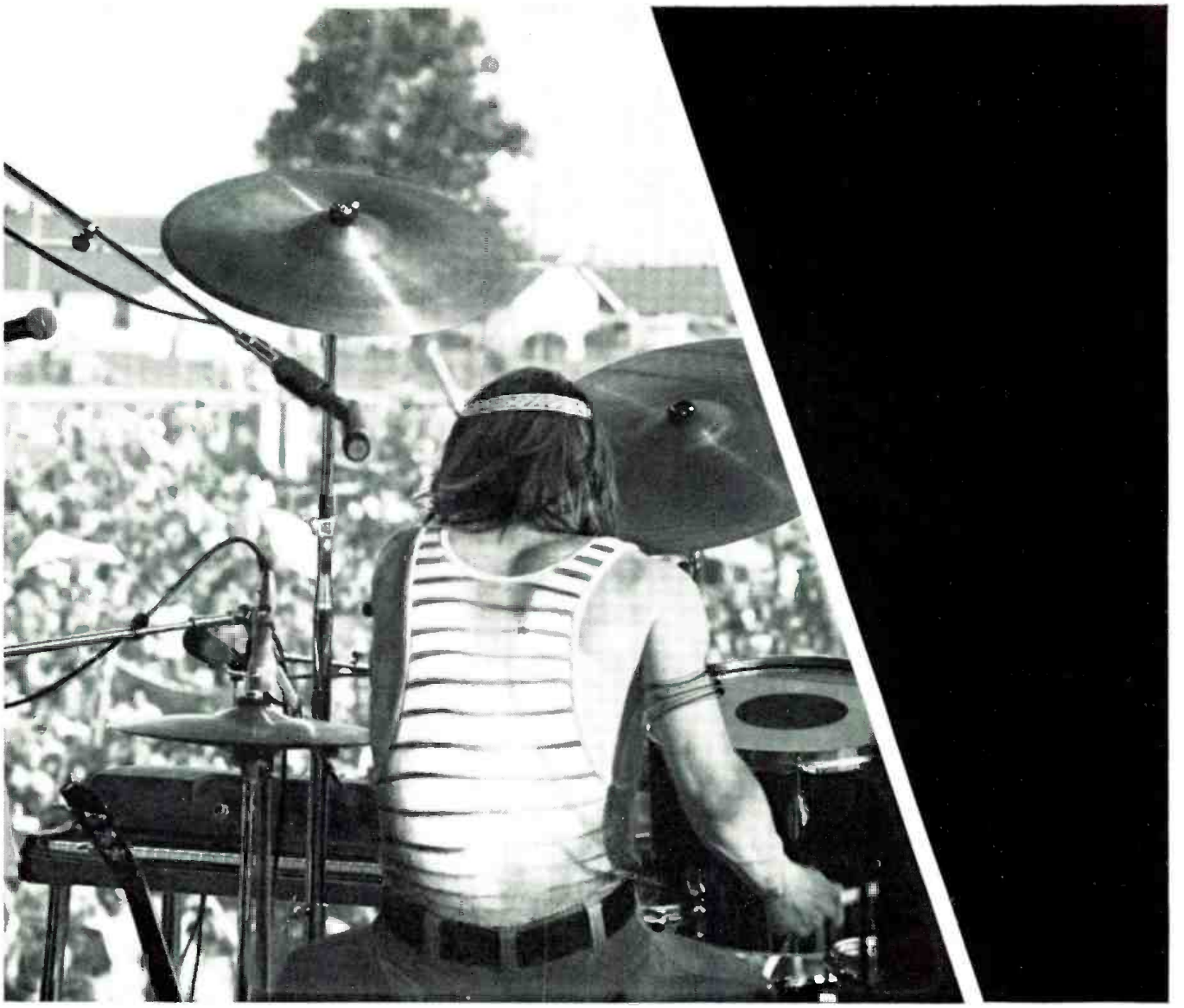
• An additional interpretation of the audio amplifier rule for the high fidelity industry has been incorporated in a letter addressed to **Leonard Feldman,** technical director of the **Institute of High Fidelity,** and signed by **Carthon E. Aldhizer** of the division of special statutes, **F.T.C.** The letter states, in part: ". . . use of the automatic recycling methods, ie., permitting a piece of equipment to recycle (thermally cut off or on) automatically until 'on time' of one hour is accumulated is not inconsistent with the language of Regulation 3(c) testing and would therefore constitute compliance with the rule. Where thermal build-up presents a problem at the point of 3(e) testing, tests may commence at, for example, 250 milliwatts to permit cooling." This section of the rule (3c) requires that amplifiers deliver one third of their rated power output for one hour before measurements are made to determine final publishable power ratings.

• Three new national sales managers have been appointed by **Cetec Audio** of North Hollywood, California, to head up the sales of their principal products. **Robert Slutske** will be national sales manager in charge of Cetec consoles and audio components. **Thomas D. Carlile** will head the marketing of Gauss loudspeakers, and **Gerald Chapman** is responsible for Gauss high-speed tape duplication equipment. Mr Slutske comes from **Skirpan Lighting Control Corporation,** Mr. Carlile from **JBL,** and Mr. Chapman from **Electro-Optical Mechanisms.**

• **George Alexandrovich** has been appointed vice president, field engineering and professional products manager for **Stanton Magnetics,** of Plainview, N.Y. Mr. Alexandrovich, who comes from **Fairchild Sound Equipment,** is a well-known designer and writer, familiar to readers of **db.**

• Appointment of **S. L. "Sid" Gordon** to the position of national sales manager has been announced by the Fanon div. of **Fanon/Courier Corp.,** of Pasadena, Ca. Mr. Gordon was formerly president of the **Southwest Marketing Company.**

• **Bettan Sales Inc.** of Flushing, N.Y. has increased its staff of sales representatives with the addition of **Jonathan Nelson.** The firm serves the metropolitan New York area.



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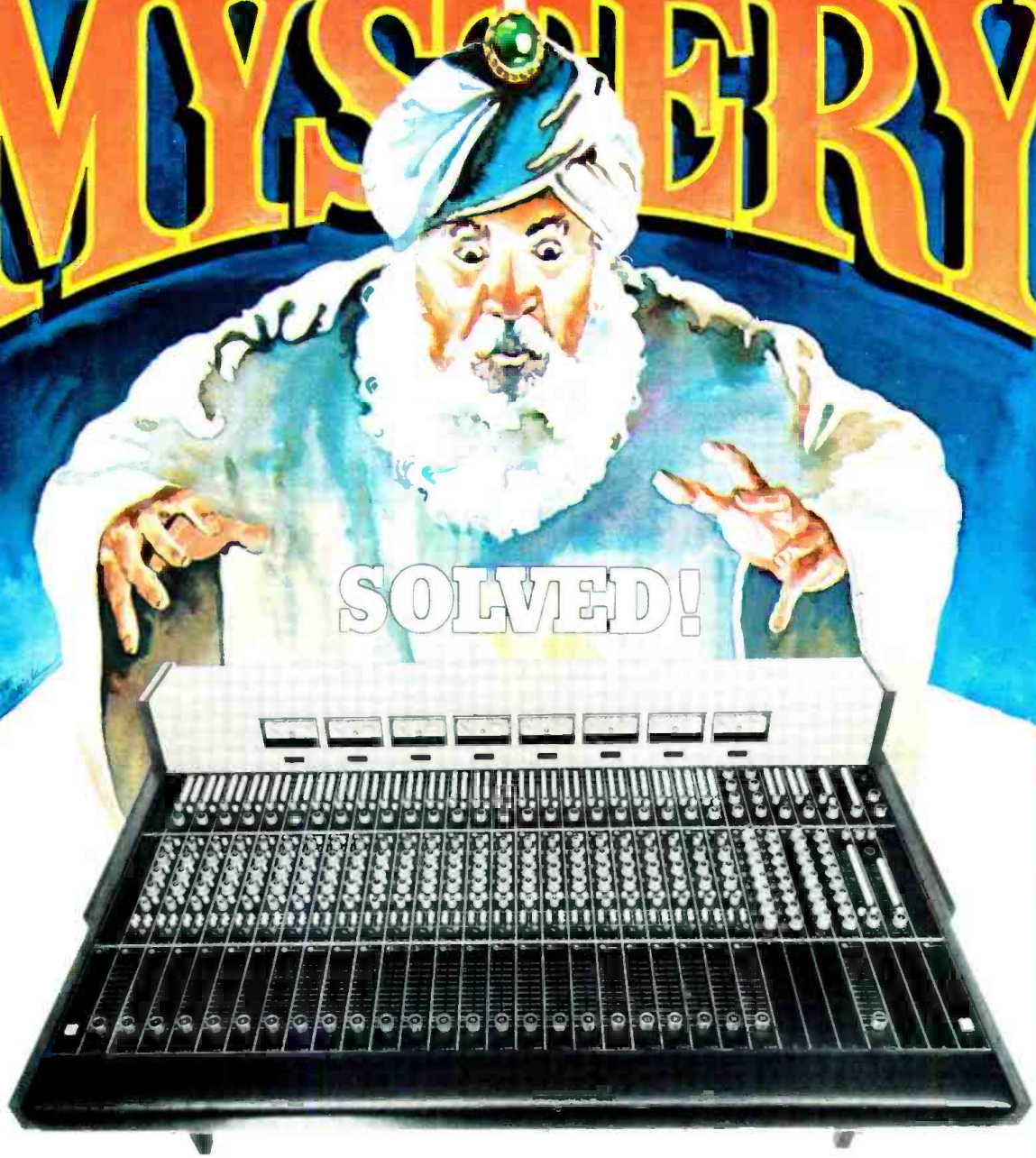

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