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THE SOUND ENGINEERING MAGAZINE

MARCH 1973 $1.00

Tape Issue

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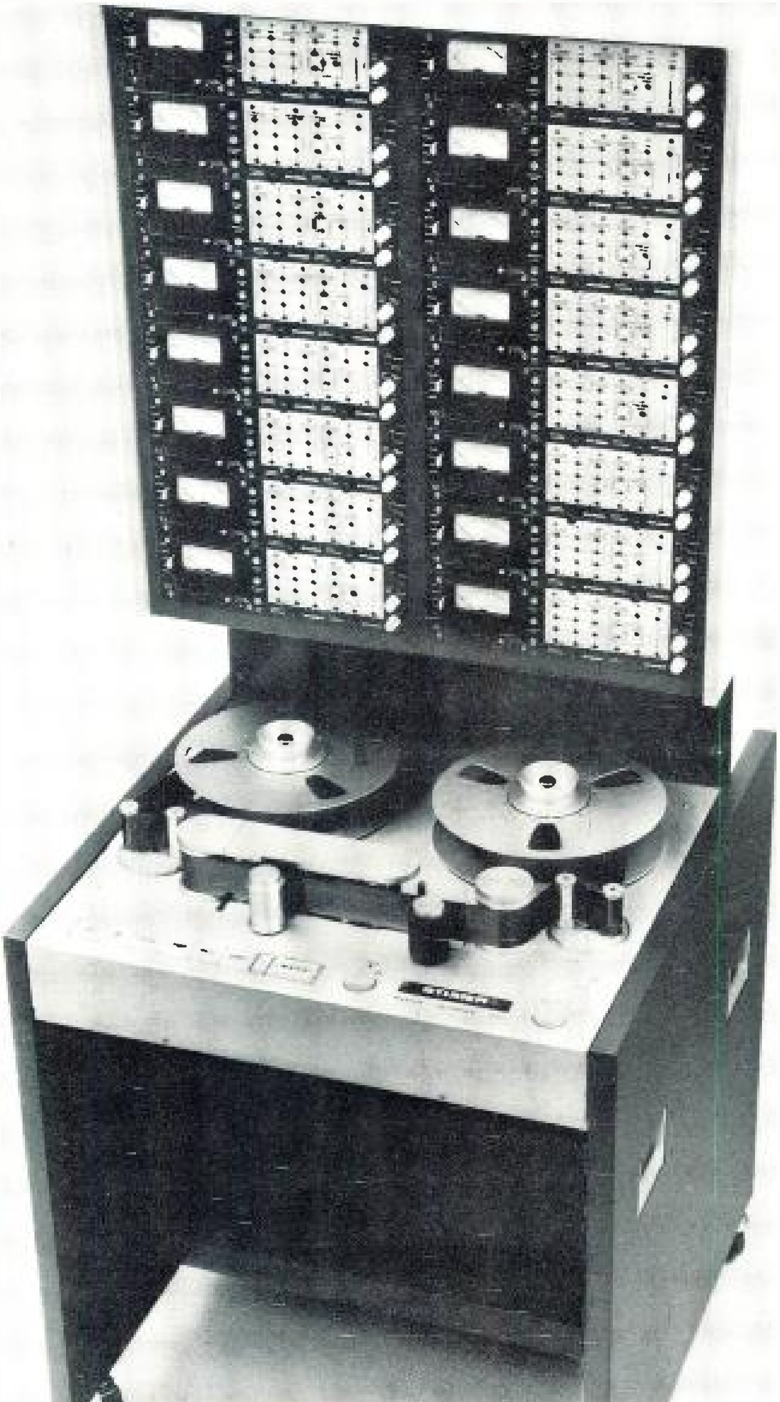

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COMING NEXT MONTH

- April is the pre-AES Convention issue. So we will have a map and guide to the show, of course. But that's not all!

A picture report on the AES Convention that was held in February in Rotterdam, Holland will be included.

There will be **db** VISITS picture and text stories as our camera and notebooks spent time at the following European audio leaders:

Neve in England.
Dolby Labs in England.
Beyer Microhones in Germany.
Studer/Franz and Studer/Revox in Regensdorf, Switzerland.

This issue, then will be a revealing glimpse into the manufacturing techniques and philosophies of European companies that are well known to American audio professionals. It will be an issue not to be missed.

And there will be our regular columnists: George Alexandrovich, Norman H. Crowhurst, Martin Dickstein, and John Woram. Coming in **db**, The Sound Engineering Magazine.

ABOUT THE COVER

- Tape is the subject of every feature article in this issue.

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THE SOUND ENGINEERING MAGAZINE

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letters

The Editor:
The December article about hearing by Marshall King contains so many statements that are merely old wives' tales that I think your readers should be reassured.

(1) King says that the damage from indoor "more concentrated" sounds is "certain to be greater" than outdoor noises. This is not so; all that matters is the decibel level at the ear, and whether indoors or out is irrelevant.

(2) He says that some mixers "can't hear much over eight thousand and very little under a hundred." The first half of this statement may be correct, but one does not lose hearing at low frequencies until everything else is shot. The medium highs (3000-6000) usually go first, then the extreme highs, and then the mediums (2000 and below, progressively).

(3) He is surprised that these people can still do good work despite hearing loss. He is apparently not aware of a phenomenon called *recruitment*. Even when a hearing loss (a permanent shift of auditory sensitivity) is as high as 50 to 60 decibels, a sound played at 100 dB s.p.l. will nevertheless sound just as loud as in a normal ear. Only when the losses are nearly complete (90 to 100 dB or more) will what is heard at high levels be distorted, in a musical sense, enough to matter.

(4) The analogy between t.t.s. (the temporary shift of the auditory threshold) and the process of dark-and light-adaptation in the eye is at best misleading. Visual adaptation is normal, but t.t.s. is not. It's always potentially dangerous.

(5) On the other hand, how much you have inched your monitor pot setting up during the day is *not* a "measure" of the t.t.s. In fact, they are essentially unrelated, although of course the higher you have set the monitor level, the more t.t.s. you will therefore have. But the numbers of decibels in the two cases are not the same.

(6) Infrasonic noise (too low in pitch to hear) has not been shown to produce any effects, the popular press to the contrary notwithstanding.

(7) In general, the most t.t.s. from a pure tone will be found half an octave above that tone, not at the exposure frequency itself.

(8) There is no good evidence for the proposition that hearing degenerates from disuse. The state of your hearing at age 65 will depend on (1) how careful you are not to expose your ears to noises that are loud for too long, and (2) how careful in choice of parents you were.

(9) Headphones are indeed dangerous, if you plug into the wrong jack. But if your eardrum ruptures when this happens, consider yourself lucky; the eardrum can be repaired (it usually does spontaneously), but the hair cells of the inner ear cannot. In two studies of explosions in chemical factories, it has been found that those ears with ruptured eardrums had much less permanent loss than those that did not rupture. In a sense, then, the eardrum is therefore a safety valve.

(10) The notion that swimming can cause a bony growth that narrows the ear canal is utter nonsense.

However, the main point of the article is correct: avoid long exposures at high intensities. Somehow King got to the right recommendation despite the misinformation!

W. Dixon Ward, Ph.D.
Hearing Research Laboratories
Minneapolis, Minn.

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THE SOUND ENGINEERING MAGAZINE

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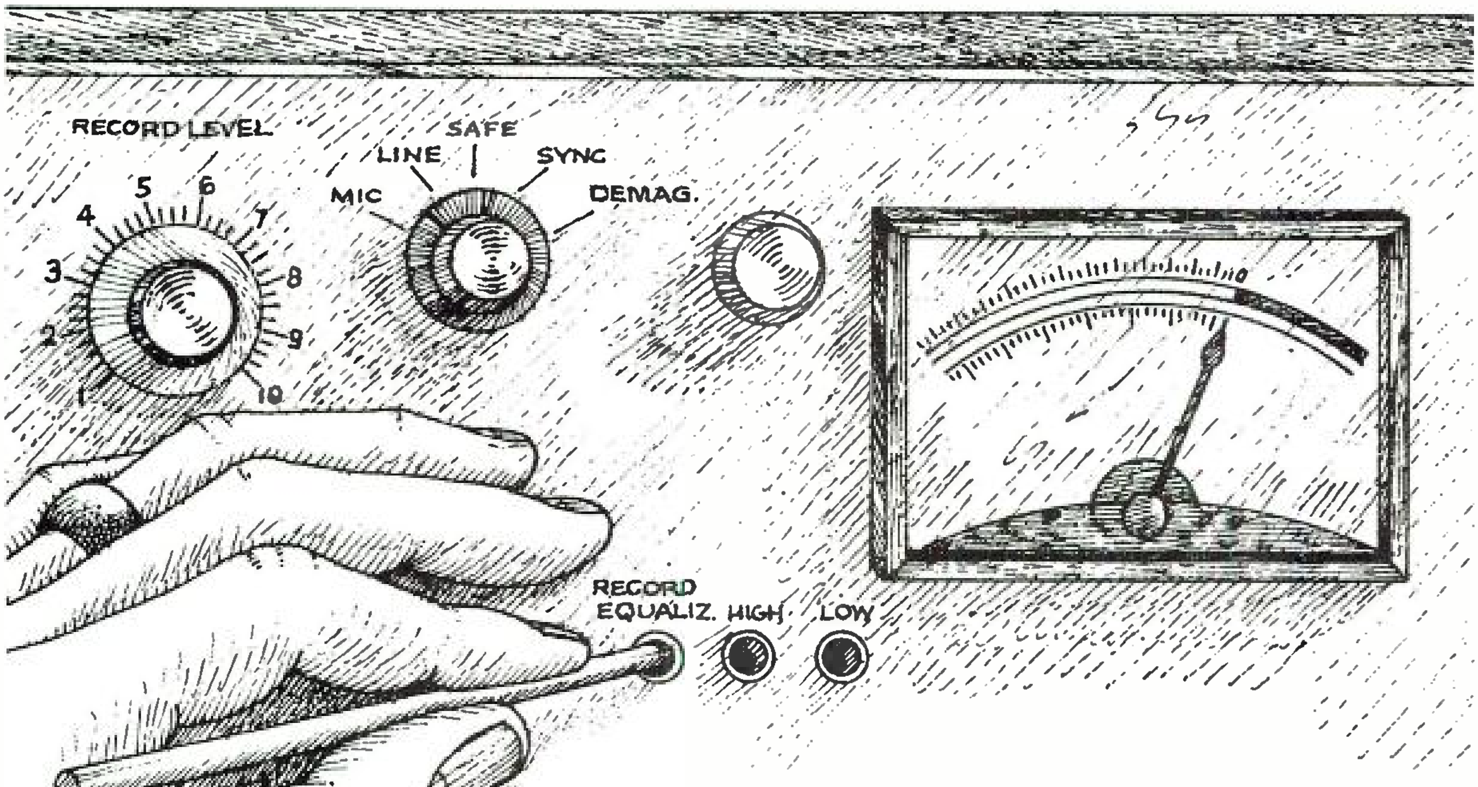

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George Alexandrovich

THE AUDIO ENGINEER'S HANDBOOK

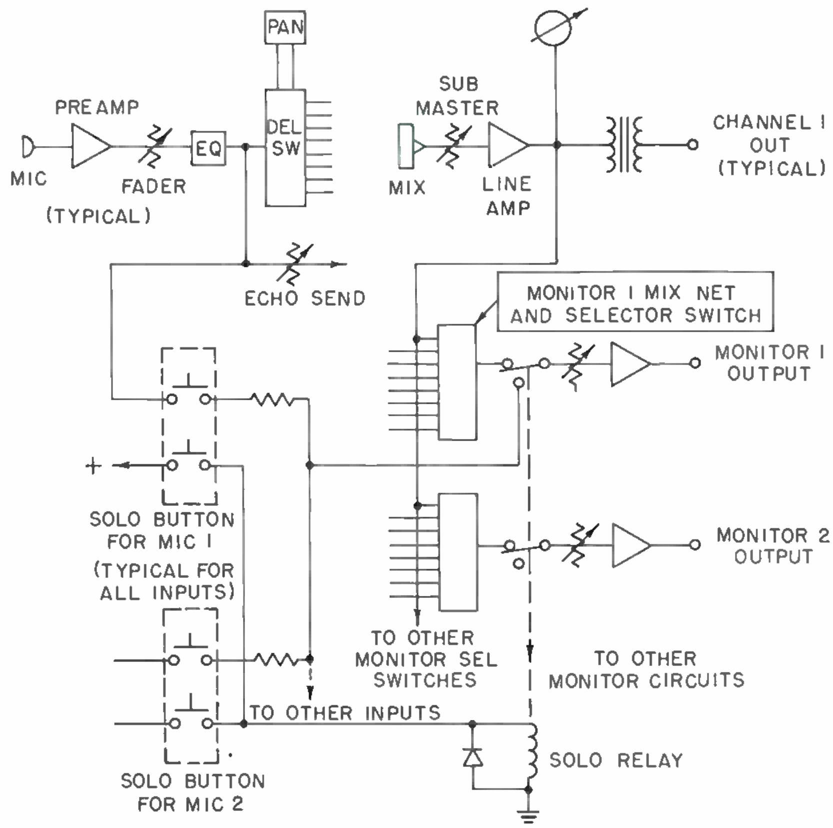
Selective Monitoring

● Today, when more and more radio and t.v. stations are doing their own production, with their systems growing more and more complex in order to keep up with the requirements of modern sound recording, it may be helpful to review the monitoring methods the recording industry has been using to make its job easier.

As the number of microphones increases and the number of separate tracks may be anywhere from four to twenty-four, trying to listen and to evaluate the adjustment of each mic or channel may prove to be an impossible task, even for the most experienced recording engineer, unless he has the means of selecting each mic and listening to it separately.

In the beginning, there was a tendency to monitor all channels separately. But the number of tracks on tape machines jumped from two to three, then to four, eight, sixteen, and now up to twenty-four. As the number of channels reached eight, recording engineers went back to monitoring only four channels maximum, with possible monitoring of two-channel mix and mono, since most of the finished products end up as a stereo recording or mono. Actually, stereo and mono are the hardest to get right from a multi-channel mixdown because of the phase differences between channels. One of the more reliable indications that a mixdown is good is when mono-mix sounds right. If it doesn't sound right naturally, we want to know why. If we are playing a tape, we try to listen to each channel separately; if we are checking a live production, we listen to each microphone or group of microphones separately and try to determine if placement phasing or levels are the cause of a poor sounding mix. In order to be able to do this we need special circuits built into our consoles, which would enable us to pick any channel we want to listen to by merely

Figure 1. Basic selective monitoring logic.



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pressing the button next to this channel's controls, enabling us to hear only this channel while all other channels are silenced. Switches are usually made momentary so that the operator can jump from one channel to another and compare levels, equalization, and sound in general quickly as well as having two buttons depressed at once to check for the combined effect of two adjacent mic or related channels.

FIGURE 1 shows a simplified single line drawing of a typical audio chain, a circuit typical of any recording console. The input channel consists of a mic pre-amplifier, gain control, equalizer, and a delegation switch with pan pot. capability. The output circuit or channel is represented by an active mixing amplifier submaster gain control and line amplifier. Monitoring the console outputs is done in a conventional way—that is, the output of each program channel is assigned to one of the monitor inputs. More than one channel can be monitored through the same monitor speaker, representing thereby a sound mix similar to one we are expected to hear in the finished product coming from this speaker. Assigning all program channels to one monitor represents a mono mix. In the recording consoles, it is possible, by a flip of a switch or the press of a button, to switch all monitor circuits to any preselected mode of monitoring for instant evaluation. FIGURE 1 does not show such facility, but it shows how selective monitoring is accomplished. In the recording industry, a button for selective monitoring of each channel has been named very appropriately the *solo button* and the bus, a *solo bus*. If you follow the signal path, you will see that the signal is tapped off after the equalizer so that the effect of the equalization can be monitored; also, the level can be checked. As the solo button is pressed, one set of contacts completes the circuit, sending the signal to the very input of the monitor gain control while the other set of contacts provides the closure which operates the relay. This relay disconnects all monitor feeds to all monitor amplifiers so that if the button you have pressed was one in the unused channel or one connected with a dead microphone, you would hear nothing but silence in the control room.

The use of a relay for silencing monitor circuits is required in multichannel circuits because there is no other convenient way of accomplishing this (by this I mean any mechanical or electrical device or a circuit which can perform a relay function.) In this category are reed switches, p.d.r.'s, f.e.t.'s, transistors, diodes, etc.

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The world's most advanced stereo power amplifier.

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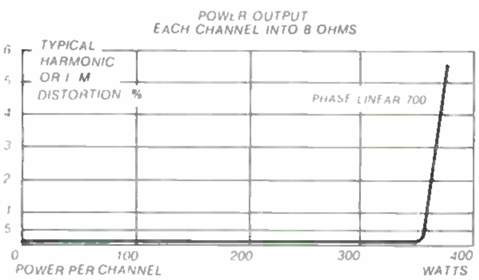

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What happens when you play, for example, Stravinsky's *Rite of Spring* at realistic volume levels on your present equipment? Unless your amplifier is delivering 350 watts per channel to your speakers, you may hear severe distortion caused by "clipping" or "flattopping". Chances are you will turn the volume down until this overload or "speaker breakup" is eliminated. At this point you are settling for something less than high fidelity. When 700 watts is available, instruments can be reproduced at their original levels without discomfort. The advantage of 700 watts to the listener is not in loudness, but in the elimination of the distortion caused by clipping when selections are played at the life-like levels the true audiophile should demand and expect from his equipment.

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If you are a true music lover and own — or are thinking of buying — high quality, low efficiency speakers, the Phase Linear 700 is most definitely for you. The Phase Linear 700 will add a dimension to your listening pleasure you didn't dream existed. You don't have to take our word for it: Ask the speaker manufacturers who use the Phase Linear 700 as a lab standard to test their quality products; ask the reviewers for most audio magazines who use the Phase Linear 700 to test other hi fi equipment; finally, read what the reviewers themselves have to say:

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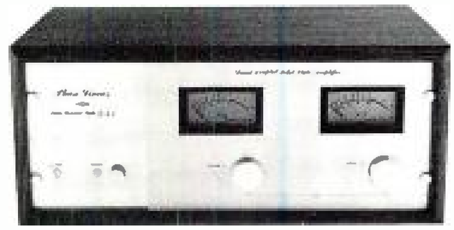
Julian Hirsch, Stereo Review



Specifications

POWER - Greater than 350 watts/channel R.M.S., both channels driven into eight ohms, zero to 20 kHz.

POWER AT CLIPPING - Typically 450 watts/channel R.M.S., into 8 ohms, 730 watts/channel R.M.S. into 4 ohms, 270 watts/channel R.M.S. into 16 ohms.

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RISE TIME - Less than 1.6 micro seconds.

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SENSITIVITY - 1.14 volts for 350 watts into eight ohms.

HUM AND NOISE - Better than 100 db. below 350 watts.

INPUT IMPEDANCE - 100 k ohms, normal input, regardless of input level control position. 10 K ohms, direct coupled input, input level controls bypassed.

DIMENSIONS - 19 inches wide, 7½ inches high, 10 inches deep. Weight: 45 lbs.

FINISH - Light brushed gold, baked enamel, and black anodize.

WARRANTY - Three years, parts and labor for normal use. Phase Linear has warranty stations throughout the United States and overseas.

For a sampling of the best in sound reproduction, audition the Phase Linear 700. To find out if your present or future speaker system needs the 700, ask your dealer, write Phase Linear, or contact your speaker manufacturer.

Phase Linear

THE POWERFUL DIFFERENCE

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When you are dealing with a single monitor circuit, there is a much simpler way to accomplish selective monitoring without relays, using double-pole pushbutton switches, as shown in FIGURE 2. There is only one requirement—the input to the monitor amplifier should be medium to high impedance (contrary to the active mixing amplifiers with a mixing input impedance of almost zero ohms) and the output impedance of the equalizer or other part of the circuit selected to feed solo monitoring be of very low impedance (typical to all modern class AB transistor amplifiers and op amps). Then what happens as the solo button is depressed is that the output of the amplifier with almost zero impedance is connected across the mixing bus with the impedance at the common point, let us say, 1 k ohm (if mixing resistors are 10 k ohms each and there are ten sources mixed. As the voltage from the equalizer amplifier is impressed across the input to the monitor amplifier, all signals coming from ten other sources are attenuated. The amount of attenuation will depend on the change of the impedance of the mixing point. If before connecting, the solo feed impedance was 1,000 ohms and after the solo circuit was connected the impedance became 10 ohms, the impedance has changed by a factor of 100, or 40 dB. This means that all signals will be attenuated to 40 dB, except for the one selected for solo monitoring.

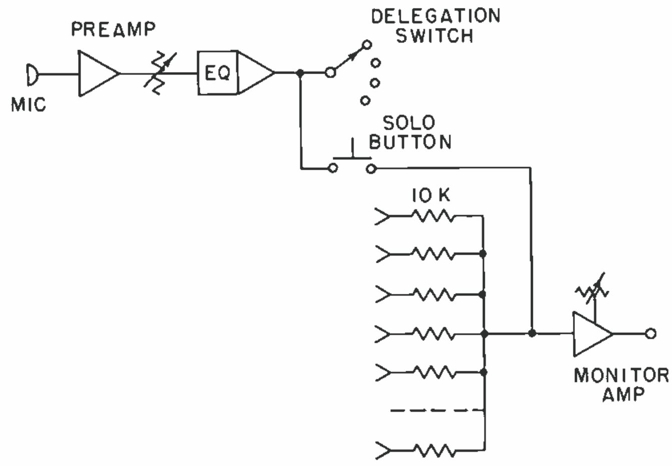

Figure 2. A simple solo monitoring circuit.

Usually you cannot get something for nothing. There is something you have to trade in for achieving simplification of the circuit—the fact that you cannot press two solo buttons at once. If two amplifiers with very low output impedances are paralleled, each is going to be loading down the other so that no output from either one will be appearing at the monitor output. However, this drawback will last only as long as it will take for someone clever to think of a solution.

What I have just discussed with you here were only simple solo monitoring circuits. Quite often, it may be desirable to encompass all special effects applied to the signal in monitoring it. It may mean that we should include reverberation, echo, compression, limiting panning, and other effects for solo listening. Then the switching logic may become quite complicated.

In all fairness to the inventors of the solo facilities, I would like to remind them that the idea of solo monitoring has its roots in the broadcasting field, where there are cue, prehear or audition circuits with functions analogous to solo circuits. Then comes the favorite question—what came first, the chicken or the egg? ■

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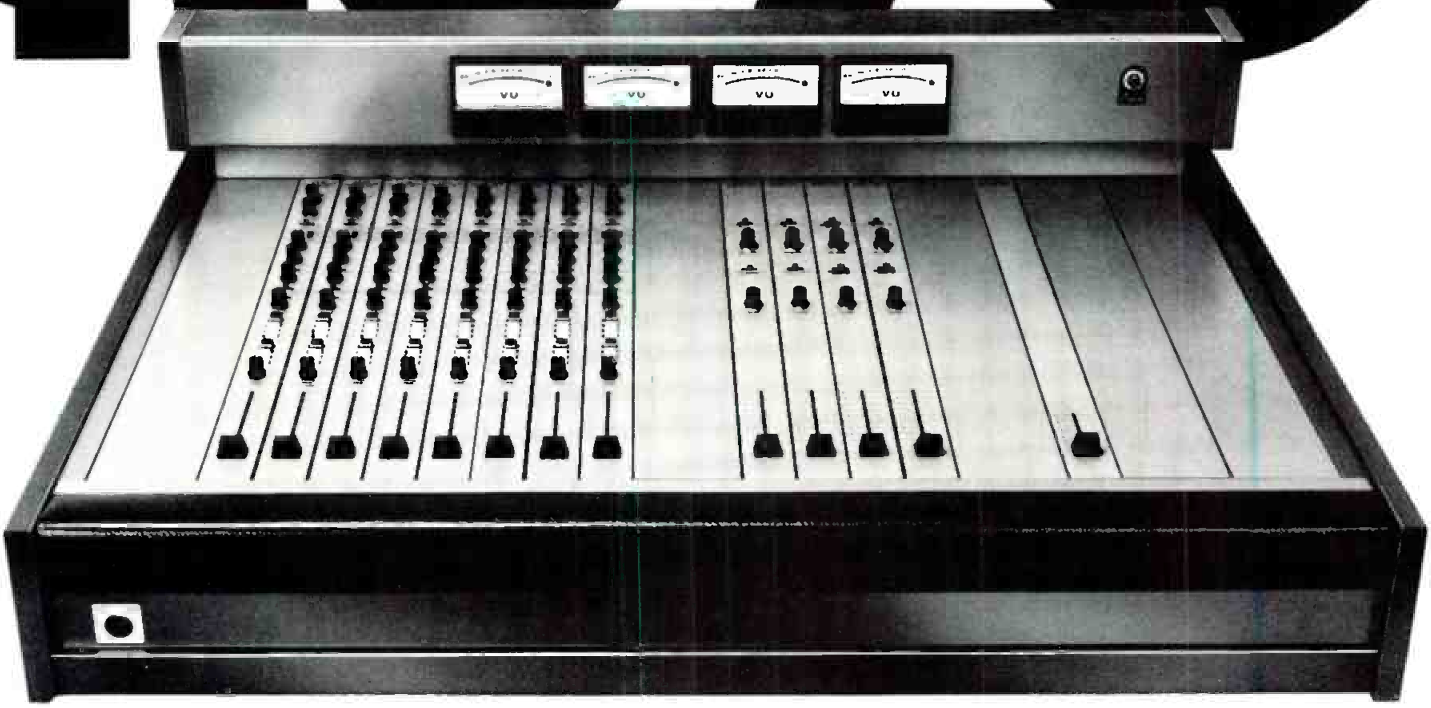

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With the Model 10 you get what you have to have. Without sacrificing a single necessary function.

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TASCAM CORPORATION

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Norman H. Crowhurst

THEORY AND PRACTICE

● During the last month, letters from readers have surprised me, in how many of their writers have one or another kind of linkage with education. Maybe it shouldn't have, because when you think about it, we probably learn more from what we hear than by any other single form of communication, and this magazine is read by people who specialize in processing sound in one way or another.

One reader wrote to comment that the HEW Commission on Instructional Technology report, issued some time ago, recommended a new educator role, that of "Instructional Designer." The reader asked if I had any information about how a person could apply to become a Certified Instructional Designer. "Here we go again," I thought.

Let me ask first whether the role recommended by the HEW Commission's report is really the ideal "new" role for teachers or others connected with education, in whatever way. To address this question, I recently put together a proposal for our State Board of Education, along with a report, "What's Wrong with Education — Some Thoughts on How to Change It." The two together run 15 pages, close typed. (If anyone would like a copy, $1 would cover xeroxing and postage).

I mention that report and proposal, because they were well received by many, at various levels within education (and without). In it, I defined, for the sake of clarifying the issue for people who seem able to think only in compartments, three alternative roles that teacher and school could possibly fulfill.

Role 1 is the traditional one, which sees teacher as a compendium of all "knowledge," the purpose being to transfer all that knowledge to the minds of the students. This role has become an increasing failure over recent decades.

Role 2 is the one proposed by the HEW Commission's report. The notion behind that title "Instructional Designer" is that teachers should design experiences that enable students to "learn."

Apart from criticisms that certain conservative groups would level at this, about it probably being more of the "behavior modification" type psychology, which criticism does not get me uptight, evidence I collected while working on government-funded projects promises that all such a role change could achieve would be a modification of the *method* by which the same irrelevant "information" is programmed into kids' heads.

Even if the role change were successful by its own definition, it would *not* achieve objectives that my report demonstrates to be vital to education useful for the future. Among other details, the report cites many examples to show that when teachers encounter a "learning problem," they treat merely the symptoms, not the cause of the problem.

All they expect of the student is that he be able to *do* virtually meaningless things. He is discouraged from trying to *understand* anything. When he has a difficulty, they seek to help him do what they want of him. Whether he understands what it's all about is irrelevant! So long as he can score more than the required percentage of correct responses in a test, he can forget the whole thing immediately afterward, and usually does.

My first comment about this set of procedures is that they waste effort, because they teach students very little of lasting value, at extremely high cost for the effort. Further, their overall effect is to blunt the mental capacity of our people, giving them a needlessly negative self-image. They come to believe that they cannot do anything, unless they have been shown how in every little detail.

But that is not the biggest tragedy of the whole thing. In years gone by, maybe that was acceptable, for all the menial types who merely did a job for

Dan Wallin
Scoring Mixer at
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which they had to be trained. However today, when computers can absorb facts and directions infinitely faster than people can, and have virtually instant recall with zero loss of memory, why must our educational system continue programming *people* to do things that computers can do so much better and faster?

Nobody showed Mr. Bell how to make a telephone, or Mr. Edison how to make a light bulb! They were using man's native inventive genius. The reason more individuals have not invented things in the past was usually because so many people were absorbed with "earning a living," by doing all the menial chores. Now that is no longer necessary, because machines can do all that. So why could not every human being develop these same inventive capabilities and enjoy the thrills of personal discovery?

The only obstacle I know of is that all inquiry is programmed out of most of our people, during those years going through school. Prescholers are full of "whys," of the desire to explore, to try new things, to find out something they have not found before. My report analyzes in some detail why this repression occurs and suggests some alternatives to eliminate it.

The third role identified is quite different. It does not pretend that teacher knows it all, because in a changing world, the student must learn many things the teacher never knew. It does not dictate *how* individual students will learn, nor *what* they will learn. It does not profess to design experiences that, like bad medicine, will be "good for" the student!

For this role, the teacher needs to know how different kinds of learning occur in different kinds of students. The teacher is ready, as a resource, to help students learn what they want to learn, because they want to learn. The teacher is expert at motivating students to find out how to cope with life, how to become useful, self-learning, contributive citizens.

The proposal suggests practical ways by which such a role change can be facilitated. As most of you are audio people, I will not expand on that aspect here. However, because you are sound people, you can be an important link in this mechanism for change, because sound can often be an essential part of the learning process.

If you prefer to be a "good little boy," and just do what you are bid, as well as you know how, that's fine. That is what good little boys of a bygone era were noted for!

But if your purpose is to improve education, or to convey information perhaps, as effectively as you know how, that is something else. You cannot do that unless you first discover how you yourself can learn best, whether most other people learn best the same way or some other way, and what such differences and similarities are.

For example, the old saw about "expression deepens impression" may have some value, but it applies essentially to the assimilation of pre-digested "facts," the kind of "information" implicit in roles 1 and 2. It does nothing for the kind of self-learning that enables the individual to move ahead on his own — to become truly inventive. No amount of expression deepening impression would have enabled Mr. Bell or Mr. Edison to have made their respective discoveries!

Let us turn things about a little. Earlier, I briefly mentioned the assertive criticisms of conservatives. Similar comments could apply to most groups with assertive "convictions." When you examine literature put out by any group, watch for unfounded assertions.

For example, an article may cite plenty of facts about a government agency that could easily be verified. Then, after showing such an agency's use of coercion against people, the article, being of conservative slant, will point to similar coercion that was or is used in Communist states, such as Russia. Therefore, one is induced to believe, the commies are directing things in our own government.

A simple, intelligent desire to know and understand would ask, "How do we know that?" Does any political ideology have the monopoly on coercion? All *that* takes is a power lust, possibly with an ideology for "cover." To tab the whole thing as anybody's conspiracy is an assertion, *unless you have evidence of such directives or collusion.*

By what means do you learn how a machine operates? You either read the manual that came with it, or else you try things with it, to see what happens, using caution not to initiate too much at once, so the whole thing could get out of hand.

In this column we have pointed to linking theory and practice as a strategy for learning, and it's a good one. Logic is an essential element in good learning too, whether it relates to figuring out why a machine does what it does, or questioning an explanation given for phenomena or human behavior as the only possible one.

The depressing thing about so many modern mediated educational presentations, is that they seek to indoctrinate, rather than to stimulate thought and mental growth. Whether it is a math course (except the one we described in the December issue) or a

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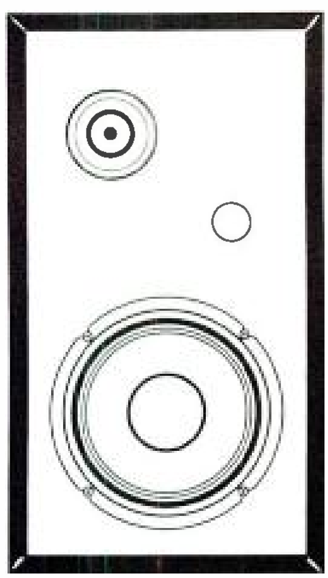

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slide-tape lecture about some political subject, the use of audio and visual is usually combined to *persuade* the viewer to accept some predetermined objective, rather than to stimulate his own faculties to individual, creative thought.

For example, a conservative presentation to which I was invited showed how many cabinet posts in the American government are consistently occupied by members of the Council of Foreign Relations. Because many identified communists were also identified as being members of the same Council, the conclusion quite persuasively developed was that our American government is communist dominated.

Now, varying the same line of "logic" a little, I could equally well argue that the communists are dominated by the American government! Applied more usefully to the problems we address in education, in examining such an assertion we should inquire into the nature of the association: is it in fact one of domination at all? Implicit in that conservative presentation was the notion that any group of people, especially an elite group, such as the Council on Foreign Relations, must have as their objective some form of domination. Thus the only question, apparently, is who dominates whom?

But is domination omnipresent? For years I have been a Rotarian. In any community Rotarians are a sort of elite group. But do they, for that reason, seek to dominate the community? As far as I have observed, they seek only to dominate their knives and forks, while they discuss ways to improve the community's livability. They do not impose such assistance on unwilling "victims." They realize the world is full of needless problems and seek to help in solving some of them. Is that domination?

To apply all this to useful ends, when you are working on an A-V presentation, ask yourself and the people for whom you are making it, what they hope to achieve by it. If their purpose is to get some concepts across, or to help others learn something, do they seek to impose ideas, irresistably or authoritarianly, on the recipients of the program, or do they encourage free, expansive thought on the part of the individual viewer?

The latter choice is what the future needs infinitely more of, as our machine type slaves take over more and more of the menial type chores for which humans at one time had to be trained. As people concerned with the sound link, you are in a unique position to *influence* this in your work, rather than perpetuating the stereotype of a "good little boy." ■

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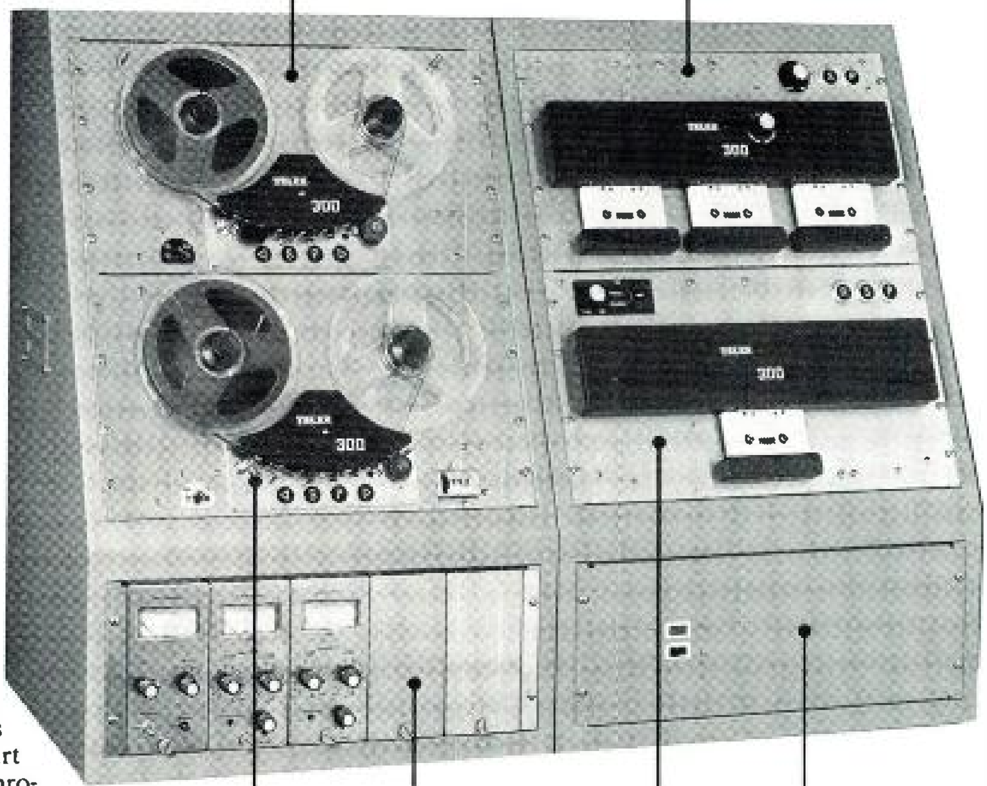

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John M. Woram

THE SYNC TRACK

Getting Down To Basics

• After all these years of feeling guilty about neglecting the "how do I get started?" inquiries, it seems I no longer have much of an excuse for ducking these letters.

Since the last column, I have left my regular job to go into the free lance recording business. Being the type that would rather play with consoles and tape machines than work for a living, I'll now have the chance to record at several studios in and around the New York City area—and also have a little more spare time between sessions for other projects.

For instance, after my continually dumping questions about education on the doorstep of the Institute of Audio Research, they have just retaliated by appointing me their special projects director. Which means I'll be working on the preparation of seminars and workshops geared towards those with a special interest in the recording industry. I'll also be doing a little more teaching there, and, I suspect, trying to find *the* answer to that old question, "How do I get started in recording?"

So, may I suggest that all future questions on the subject of getting started in recording be directed to me at the:

Institute of Audio Research
64 University Place
New York, N. Y. 10003

The Institute has the competence, and the interest, to try to answer these questions as best they can.

However, neither the Institute nor I can tell you where to get a job. We can advise you on how to prepare for employment, but the rest is really up to you, and the job market.

Since this column will in the future be spending more time on the basics, your letters should be of help in determining what needs to be covered here. Though much of the readership is interested in advanced theories and complex design work, there seem to be a significant number who are either just getting started or still trying to get a foot in the door. Between the Sync Track and the Institute of Audio Research, I hope we shall be able to be of better service to both groups.

Speaking of beginners, Walter Sear—the electronic music expert—has just written an interesting little book, *The New World of Electronic Music* 130pp. $4.95. In ten chapters, he painlessly covers the physics and perception of sound, sound recording itself, and the workings of the electronic music synthesizer.

Voltage control theory, envelope generators, ring modulators, and such are explained in such a manner that you don't need an advanced degree in physics to get through the book. In the final chapter, Sear briefly describes the more popular synthesizers; Moog, Buchla, Arp, et al. If the book is not available locally, it may be purchased directly from: Sear Sound, Inc., 235 West 46th Street, New York, N. Y. 10036.

For the more advanced, the National Council of Recording Engineers is now in the final stages of organization. Membership details and such are being worked out and I hope to have more specific information shortly. In the meantime, all those who have previously written for information will be notified as soon as details are available. If you would like your name added to the list, let me know.

THE DECIBEL, AND LOGARITHMS

It's difficult—if not impossible—to discuss any aspect of recording without mentioning the decibel. For whatever it's worth, a decibel (abbr. dB) is 1/10 of a bel, and the bel was named in honor of Alexander Graham Bell. In recent years, the dB has gained some notoriety on the masthead of a certain magazine. (No, I don't mean *DownBeat*.)

Well, just what the hell is a dB anyway? Everybody talks about them, but nobody really explains them. Why, it's 1/10 of a bel, and a bel is defined in my dictionary as a unit representing the ratio of the values of two amounts of power on a logarithmic scale to the base 10.

Now isn't that wonderful? If you now know what a dB is, you're wasting your time reading this. Skip to George Alexandrovich's column.

It seems we shall have to define logarithm before we can get to the decibel. Since that takes a little doing, we can for the moment define the decibel as a ratio of output to input power or voltage. For, if an amplifier raises a small input to a larger output, we may say the amplifier has a gain of so many dB. The actual value in dB is found from the logarithm of the output to input ratio. But not before we understand what a logarithm (abbr. log) is all about.

Our numbering system uses decimal notation (see March 1971 SYNC TRACK). Even the non-math majors will find it easy to multiply (or divide) by 10. 10x10=100; 10x10x10=1,000, and so on. Now this is all very nice as long as you don't get carried away. Expressing billions as 10x10x . . . etc. can take up a lot of room and also be difficult to read accurately. So, we have developed a shorthand notation to make things a bit easier. Since 100=10x10, we can write 10x10 as 10^2, and call it "ten squared" or "ten, raised to the 2nd power." Accordingly, 1,000 would be 10^3, and so on. Since mathematicians (and recording engineers) are basically lazy, we can conserve a lot of energy by simply saying "10 to the 3rd," "10 to the 4th," etc.

The small number above and to the right of the 10 is called the exponent, and it tells us how many times we multiply 10 to arrive at the number being defined. 10^5 means 10 multiplied or raised to the 5th power. That is, 10x10x10x10x10 = 100,000. [not 5x10, which would equal 50].

Now then, these exponents are also known as "logs" of the product of all the tens. So, the log of 100,000 is 5—that is, 5 is the power to which ten must be raised to equal 100,000.

Number	Log	Number	Log	Number	Log
1	0.000	6	0.778	12	1.079
2	0.301	7	0.845	14	1.146
3	0.477	8	0.903	16	1.204
4	0.602	9	0.954	18	1.255
5	0.698	10	1.000	20	1.301

By deduction, we can probably see that 2 is the log of 100, 1 is the log of 10, and even that 0 is the log of 1, although that last one may have to be accepted on faith at the moment.

Well now, if the log of 1 is 0, and the log of 10 is 1, surely there must be logs for the numbers in between. For example, what is the log of 2? By observation, we may expect that it is some number, n, and that $10^n = 2$, just as $10^2 = 100$.

You can stare at that one all day and not come up with an answer for n. The answer may be found by an involved process known and appreciated only by mathematicians. A more practical way is to look in a so-called log table, where it will be found that the log of 2 is 0.30103, or just 0.301. When additional calculations will not be required, we may further abbreviate it to 0.3.

Reviewing, we may say that 0.301 is the log of 2, and is the power to which 10 must be raised to equal 2, that is $10^{0.301} = 2$. Other than the log table, there is no easy way to discover that $10^{0.301} = 2$.

A short table of numbers shown as TABLE I is seen, together with their logs. By studying this table, a few significant facts should be discovered. Notice that when any number is multiplied by 2, the log of the product is equal to the log of the number, *plus* the log of 2. Multiplying by 3, the log of the product is equal to the log of the number *plus* the log of 3, and so on.

example: $4 \times 3 = 12$
$\log 4 + \log 3 = \log 12$
$0.602 + 0.477 = 1.079$

In other words, when numbers are multiplied, their logs may be added to find the log of the product. Similarly, when any two numbers are divided, their logs may be subtracted to find the log of the quotient. Prove this to yourself.

So, what has all this got to do with recording? Well, you probably know that when the power output of a loudspeaker is doubled, the volume appears to be only slightly increased. It certainly doesn't sound twice as loud. You may already know that the volume level goes up by 3dB. Now, where did this figure of 3 dB come from?

When a larger output power (P_1) is to be related to a smaller output power (P_2) in terms of dB, the formula is $\text{dB} = 10 \log \frac{(P_1)}{(P_2)}$. So, if the larger power is double the smaller power ($P_1 = 2P_2$), the formula can be rewritten: $\text{dB} = 10 \log \frac{2P_2}{P_2}, =$ $10 \log 2 = 10 \times .301 = 3.01$ or simply 3 dB. So, we see that when the power is doubled, the level goes up by only 3 dB. If the original power produced a level of 80 dB, the effect of doubling the power would only raise the level to 83 dB—a depressing thought, but nonetheless true.

Another thing—what does 80 dB mean anyway? In this case, it means that the volume level in the room is 80 dB above the threshold of hearing. If the very weakest sound that the ear is capable of detecting is called 0dB, we are now 80 dB above this point. Since 80 dB is defined as 10 times the log of the ratio of the two powers [the power at the threshold of hearing, and the power required to produce 80 dB], we may write the formula;

$$80 = 10 \log \frac{P_1}{P_2}$$

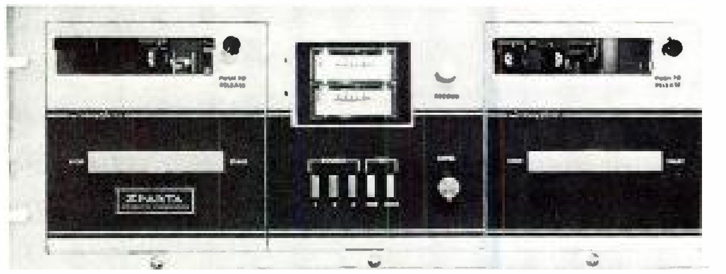
$$8 = \log \frac{P_1}{P_2}$$

$$100{,}000{,}000 = \frac{P_1}{P_2}$$

In other words, the power ratio for 80 dB is 10^8, or, 100,000,000:1.

In this example, we referred to the threshhold of hearing as 0 dB. This should not be confused with 0 dB on a recording console (or tape machine) meter. The latter should really be called 0 dBm, and is a point of reference, just as is zero degrees on a thermometer. Obviously, the temperature can be lower than zero degrees, and in like manner, levels can be lower than 0 dBm. dBm are measured on a vu (volume unit) meter, which is calibrated so that 1 milliwatt of power in a 600 ohm resistor will produce a reading of 0 dBm on the meter scale. The same formula applies in this application, so that if the power in the resistor is tripled, the dB gain would be $10 \log 3/1 = 10 \times 0.477 = 4.77$ dB.

Assuming the resistance value remains constant, we may rewrite the formula in terms of voltage values. In this case, it is $\text{dB} = 20 \log E_1/E_2$. Thus, if an amplifier in a 600 ohm line raises an input voltage of 0.5 volts to a value of 3 volts, the dB gain is, $20 \log 3/0.5 = 20 \log 6 = 20 \times 0.778 = 15.56$ dB of gain. ■



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Martin Dickstein

SOUND WITH IMAGES

Catching Up

• Since it has been some time since these lines appeared in these pages, and this is the first time this year, it might be a good time to look around at the latest in the audio/video field to see what has been happening. In short, a brief synopsis of some of the developments in the video cassette and disc business and some related new inventions. Some of the material mentioned here might already be known to you and some may be outdated by the time you read this, but some of the information might also be new and useful to you in working with your clients.

Back some time ago, we had a brief chart of the various systems which were being developed at the time to provide video recording and playback from different media. Among them were the ½-inch tape and ¾-inch tape cassettes, super-8 film cassettes, video discs, cartridges, and a few systems by more than one manufacturer, and a few of the largest manufacturers not sure of which way to go so they had under development more than one system. What's happened?

Let's start with the video tape. First out of the gate in the financial sweepstakes was Sony with its ¾-inch U-Matic helical-scan system. Almost at once, many of the large industrial firms hopped onto the bandwagon and began setting up internal hookups for training, educational applications, recording and sending material from one office to another. So far, the prime targets have been industry and educational institutions. (Next, the home consumers.) The conventional helical-scan process is used, with two heads on a rotating drum.

Although there has been no agreement on any standards for video tape systems, it seems that other major manufacturers have followed suit and are making machines compatible with the Sony. JVC Nivico, Matsushita, Panasonic, and Concord are some of the names familiar to everyone which are associated with ¾-inch machines similar to Sony. Modifications have been made so no two are identical, but the operation is similar and the sound, video, and sync signals are compatible between the machines. The changes might be a different output plug as in the Wollensak version of the Sony, or an "elevator" type of cassette insert whereby the cassette is lowered into the machine gently, electrically, when a button is pressed and not mechanically as other models. Or a particular model might have fast rewind without the head descending from the inside of the cassette before fast movements begins. This feature allows immediate replay of small segments just played without much delay. Other differences might be "freeze frame" or remote control, perhaps as either built-in or optional features, but the principal of operation is the same for all of these.

Reports are presently available on the use being made by some of the largest purchasers and some of them have just bought, or are in the process of buying, quantities ranging from several hundred to over a 1,000 units each. The Army has adopted this format and is presently using more than 500 machines of the Sony brand. With this many now in use and orders still coming in, it is no wonder that Sony is about to increase its production by more than double to manufacture in excess of 100,000 machines this year.

Following closely behind the ¾-inch systems in the video tape cassette business are the ½-inch manufacturers. The first of these to hit the consumer market was the Avco Cartrivision. In order to accommodate two hours of playing time, in contrast to the present maximum of one hour on the ¾-inch cassettes, it was necessary to design a different type of operation. A rotating drum is used, but with three heads instead of two. This arrangement permits recording of every third field and then three scannings to reproduce the video information. Since this system is not compatible with other ½-inch standards, the recorder/playback unit comes in a cabinet with a color t.v. set as a total package. Presently sold primarily through some of the larger chain stores and selected dealers in certain cities only, reorders in the thousands are being made. Some of the names you will see with this system are Sears, Montgomery Ward, Teledyne Packard Bell, and Admiral.

In the ½-inch cassette field in which the recorder/player is a separate unit and will connect to any t.v. set, as do the ¾-inch units. Panasonic and Shibaden are among the leaders. In this medium, a standard had previously been set up for reel-to-reel machines. Conforming to this EIA-J format in the cassette machines permits owners to use the cassette on a reel type machine with an adapter. (The standard was set up for black-and-white and was to be adopted for color as well, but there was some delay in this move.) The Shibaden brand, coming into the market later than the other, has some differences, among which is a drop-out compensator, built-in, to compensate for defects of the tape or dirt on the tape surface.

Another ½-inch tape development comes from Europe where Philips uses a system not compatible with the EIA-J standard. A two-head helical scan format is used, but the speed is different and the output, at present anyway, is in the European 625-line and 50-field configuration with PAL color, not useable in the U.S. home. European manufacturers, such as Telefunken, Blaupunkt, Grundig, Nordemende, and European Sony may agree to make this their standard.

Some time ago, RCA started out on its own to develop a system they termed SelectaVision based on a very inexpensive medium similar to cellophane wrapping and using a low-level laser and a holographic image. They started shortly thereafter on a crash-type program to develop a tape system and came up with SelectaVision MagTape. Not compatible with the other ¾-inch systems, the system in this machine uses four heads. One different feature is an arrangement to permit the viewer to watch one channel on his set while recording a completely different channel for later playback. (No more missing half that other football game or baseball game, complete with commercials.) At present, Bell and Howell as well as Magnavox will be working with this system. In the next couple of years, over 100,000 of these units will be made.

Before we leave the tape systems, you might ask what happened to Insavideo, the Ampex development. Although Ampex has dropped out of this field, the system will be continued by the Toshiba people in Japan. This system is compatible with the EIA-J standard for ½-inch tape.

Back in November of 1970, just a little over two years ago, **db** carried a full story on the development of the Teldec video disc. This is the year, 1973, that the disc is expected to be on the market. You will recall that an inexpensive, flexible, PVC foil disc is used and the method of pickup is a specially designed stylus. Shortly

after the first demonstration in black-and-white, a color unit was shown and then a unit which permitted "stacking" of discs to permit a longer sequence with virtually no delay.

Since then, two other discs have made their entrance to the video arena, and two others have been mentioned as in development or coming out soon. The MCA Disco-Vision system uses a 12-inch diameter disc rotating at 30 rev/sec, cut on one side, carrying up to 40-billion bits of information and capable of playing up to 40 minutes. The pickup is by a low power laser rated at 9,000 hours. As there is no contact with the record, life expectancy is indefinite. The system is playback only and is capable of stop-action. As with other types of records, random access makes finding material anywhere on the disc simple and quick. The system is also capable of "crawl motion." Single or stack-loading is available. Total playback time up to 6½ hours is possible from unhandled stack.

The other system shown recently (Dec., 1972) is the Arvin development of a magnetic disc system which permits recording and erasing, something the other record methods do not. However, the unit is relatively expensive compared with the other devices, and because of its capability to record 300 individual frames on one side of the disc and then play them back at discrete rates of 1 to 15 frames per second, this system will probably find its application in video stations, production houses, c.a.t.v. studios, etc. The ability to stop action and play at different speeds makes it an interesting special-effects device.

Still another disc system was developed by Philips. Called a VLP (video long playing) the disc records a complete image in a single revolution. A total of 45,000 images, up to about 45 minutes of playing time, is available from the lp-sized record. Here, too, the reading system is optical, using a laser to read the small pit-like grooves on the record. The system allows operation in slow motion, stop-action, and backwards. Here, also, since there is no contact between the disc and the pickup, there is no wear.

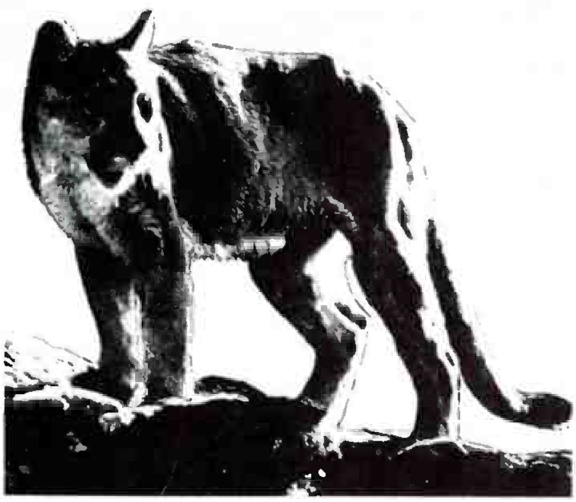
Although there has been no showing as far as we know, there has evidently been a disc developed by Panasonic, apparently to show that they are not hemmed in by either the ¾-inch or ½-inch tapes systems they have. If and when something more becomes available on this disc, we hope to bring it to you with all possible speed.

What else is new? How about color pictures from an audio cassette? Matsushita has shown a system capable of reproducing up to 1,000 still images on a home t.v. set from a standard C-60 audio cassette, with stereo sound. The cassette is played at normal speed.

With all the talk about different tape widths for video reproduction, IVC has developed a 1-inch system compatible with their own 1-inch machines. This permits transfer from one type of machine to the other very simply.

In an associated field, a new development by the Goldmark Communication Corp. is made to work with video cassette units and can be attached very easily. Because of the type of pickup used in helical-scan machines, there is the possibility of a slight time difference in the reading of the two heads as the tape passes. This can be the result of stretched tape or a change in tension. The result is seen on the screen as wavy images along the top of the picture. Some machines have skew correction controls, but in some cases, even this control is not enough. Most times, the distortion will not be seen as it occurs off the screen, but can cause problems if correction must be made continuously. The new device is an automatic skew corrector which reads the time difference in the horizontal signals from the two heads and makes instantaneous and continuous corrections.

There's lots more, but for now let's hold up and save some for a subsequent issue. Look for Vid Expo '73 in N.Y.C. in September. ■



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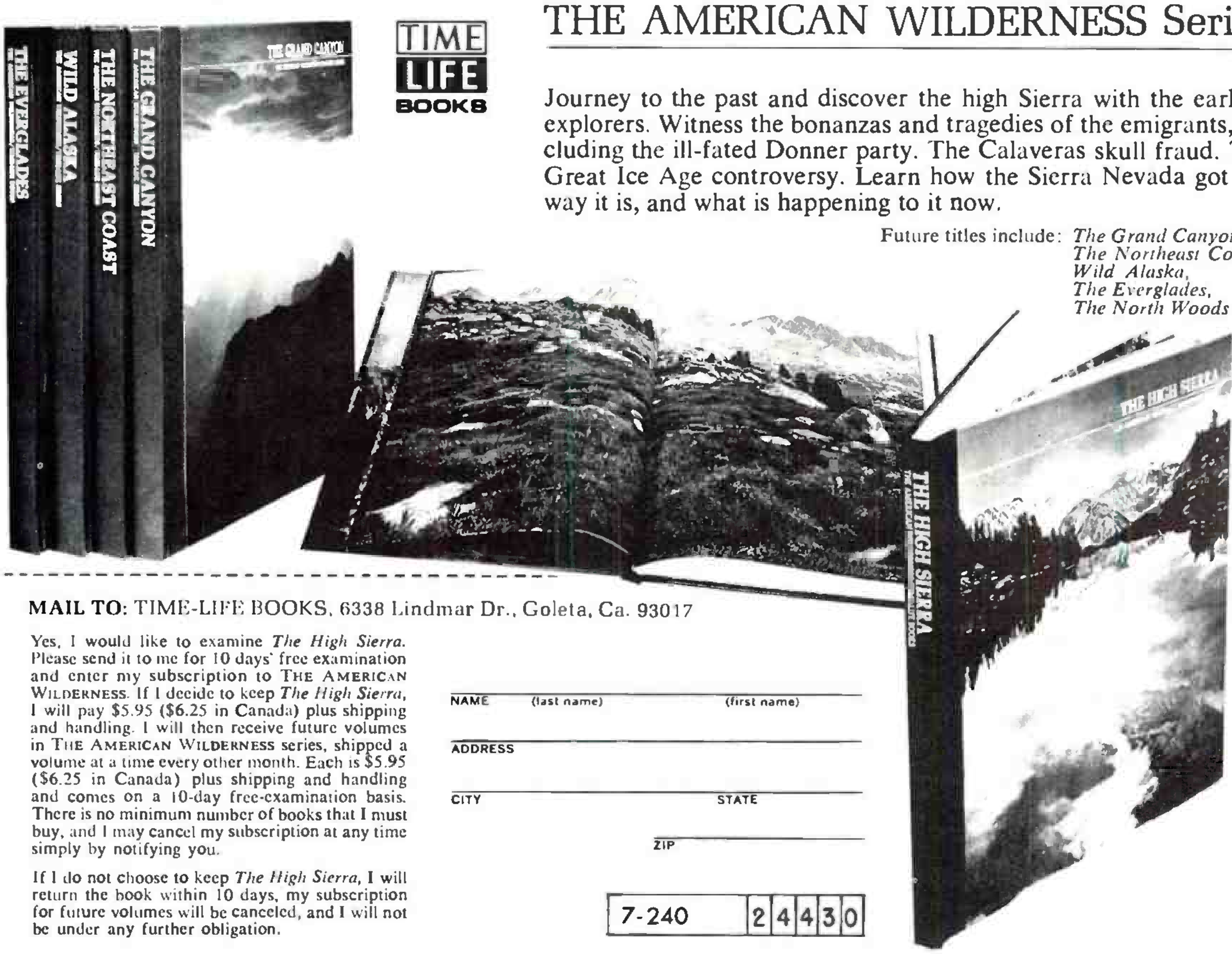

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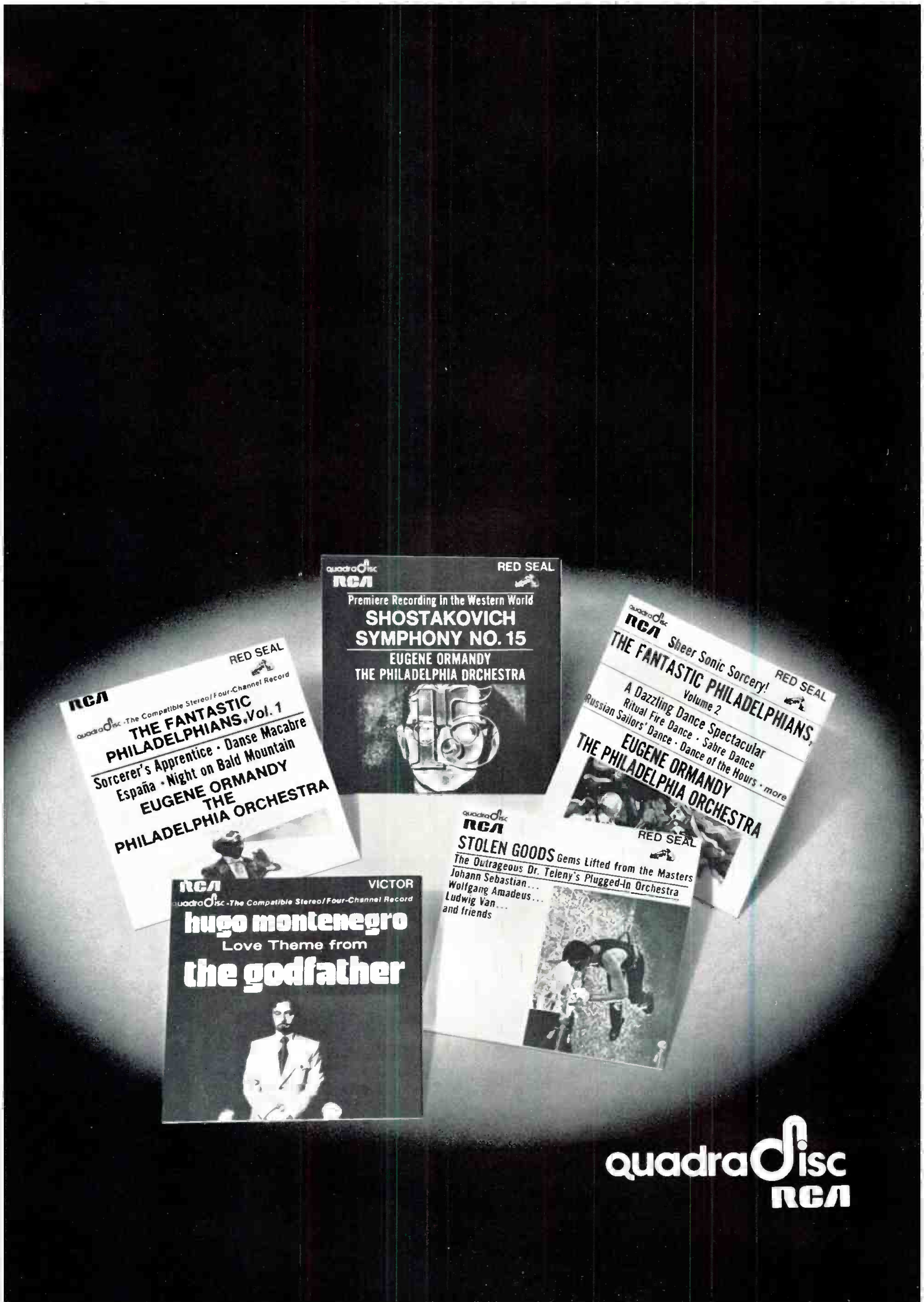
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● This unit contains metering to 0.01 per cent accuracy. Can be used as a voltmeter and contains a built-in oscillator.

Mfr: CCA Electronics Corp. (Rek-O-Kut)
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● This simplified cable tester checks audio and microphone cables fitted with standard XLR-3 connectors without the awkwardness of the clip lead vom method. Cabletest III tests for shorts, continuity, phase, and intermittent connects, utilizes led's as indicators and is housed in a rugged cast aluminum housing.

Mfr.: Xedit Company
Price: $50.00
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M-16 NOISE REDUCTION UNIT

● This small (10½ inch high) unit contains sixteen A-type Dolby Cat. 22 plug-in noise reduction modules and a 115/230-volt power supply. It also has a separate remote control module with which all controls common to the sixteen tracks can be actuated from the studio mixing console. These controls are duplicated on the common facilities panel of the M16; local or remote operation can be selected with a switch. Automatic switching between the record and play modes is remotely controlled by the controls of the tape recorder. Push-button control actuates the calibration oscillator, feeding the Dolby Tone to the recorder; meters show the flux level of the tone on each of the sixteen tracks of the tape. At the same time, small loudspeakers in the M16 and remote control module reproduce the tone from the tape. Indicator lights on each of the interface modules show whether the taped signal or line-in is being metered by the M16. Separate level controls for line-in and monitor output eliminate the need for mixing console level-matching and facilitate adjustment of the system for use with high-output tape. The flexible modular construction enables changeover from M8 to M16 or expansion to M24 if required.

Mfr: Dolby Laboratories Inc.
Circle 72 on Customer Service Card

TRANSPORTABLE SOUND MIXING CONSOLE

● The new BCM 10/2 sound mixing console is designed for high quality mono or stereo broadcasting or recording. It offers ten full mixing input channels with equalization and two principal output groups, each controlled by precision faders. Fully transportable, the equipment includes reverb, studio foldback and communication, cueing, two-speaker monitoring, equipment control interlock, and signalling facilities.

Mfr: Rupert Neve Inc.
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TWO-CHANNEL RECORDING PACKAGE

● Optimal use of discrete and i.c. circuitry permits Model 355 2-channel tape recording electronics package to deliver high performance despite compact size. Features include 3 speed equalization for any combination of NAB or IEC characteristics, remote selectability of operating modes and monitoring functions, 250 kHz bias, separate sync playback amplifiers, adjustable linearization and phase compensation to minimize recorded distortion, and sufficient overload margin to realize the full potential of mastering tapes. 3½-inch rack-mount package. Accessories available: remote control panel, 1A and 5A power supplies, line matching transformers.

Mfr: Inovonics, Inc.
Price: $1,150
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CORDLESS SOLDERING IRON

● Heavy duty industrial cordless soldering iron model 7500, powered by long life nickel-cadmium batteries, with "charge holder" stand for continous recharging soldering performance equivalent to up to 50 watts with over 700 degree tip temperature. Absence of electromagnetic field during heat cycle makes this iron efficient for IGFET and MOSFET work. Built-in work light and on/off indicator.

Mfr: Audiotechniques, Inc.
Price: $19.95
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POWER AMPLIFIER

● Problems caused by a wide-ranging frequency-dependent impedance curve on highly reactive speaker systems are solved by a new output protection circuit design on the DC-300A amplifier. This direct-coupled solid-state amplifier will drive any impedance load, including a totally reactive load, with no adverse effects. The new output protection design eliminates the flyback pulse and has also allowed the elimination of the d.c. fuses and the protection mode switch. DC-300A is designed around a dual integrated circuit, further simplifying the circuit design. For mono use, the DC-300A becomes a 600 watt continuous power (8 ohm) mono amp with the insertion of two plug-in parts to the main circuit board. The balanced 70-volt mono output will drive any load from 4 to 16 ohms.

Mfr: Crown International
Price: $685.00
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COMPACT ELECTRONIC VOLTMETER

● This small sized general purpose voltmeter model 2425, is capable of indicating + and — peak, true rms and average value of signals. Useful for measurements on signals with complex waveforms. Included is a peak hold and a maximum peak function with manual reset for measurement on impulse signals. The amplification of the voltmeter is calibrated and adjustable in 10 dB steps. For this purpose, linear a.c. and d.c. outputs are available. Linear frequency range from 0.5 Hz to 500 kHz, sensitivities from 1 mV to 300 V (full scale deflection), calibrated amplification 60 dB, two built-in meter time constants, interchangeable meter scales. Mains or battery operated.

Mfr: B & K Instruments, Inc.
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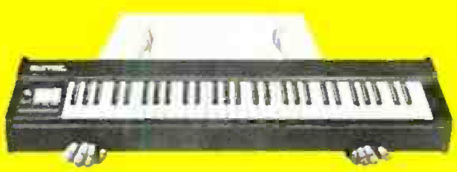
PORTABLE ELECTRONIC PIANO



● Compac-Piano only 39¾-inches wide and weighing just 21 pounds, can be carried under one arm. Plugged into an amplifier, it has an authentic piano sound and can be switched to clavichord or honky-tonk voices. It has a 61 note, five octave keyboard and includes a sustain pedal.

Mfr: Univox (Merson Musical Products)
Price $499.50
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SOUND ISOLATION ROOMS

● These cubicles, offering comfort as well as a controlled acoustical environment, are made from 4-inch thick steel panels filled with sound-retardant and sound-absorbing materials. Floor panels rest on properly loaded vibration-isolator rails providing a natural frequency of less than 7 cycles per second. The silenced ventilation system is either a discharge silencer in the roof panel acting as an intake and exhaust silencer or a forced ventilation system guaranteed to be below the binaural M.A.F. 0 degree azimuth threshold of hearing. Soundproof doors are 3½ inches thick with double acoustic seals. Each door has a window and another window in the cubicle eliminates claustrophobic difficulties. Windows consist of two layers of ¼-inch safety glass separated by an air space and sealed in acoustically tight rubber seals; a desiccant material in the air space prevents misting. The rooms range in size from 4 x 5 x 6 feet 6 inches up to 6 x 9 x 7 feet. Units can be supplied either factory assembled or in component parts for on-the-site construction.
Mfr: Industrial Acoustics Co., Inc.
Price: $1,680 - $3,420 (quantity discounts available)
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MIC-HEADSET COMBINATION

● Especially useful for outdoor on-the-spot broadcasting, CS-90 combination headphone/microphone allows hands-free operation and great versatility. The wide range, dynamic boom microphone has an exclusive non-metallic diaphragm which withstands high humidity, temperature extremes, corrosive effects of salt air and even severe mechanical shocks. Low frequency response produces crisp, clear voice transmission; omni-directional design picks up background sound. An in-line push-to-cough switch mutes the microphone when desired, can be locked in an off position and has a cord clothing clip to reduce direct pull on the headset. The CS-90 is binaural and is supplied with non-terminating cordage, adaptable to equipment in use. One channel can be used for program monitoring and the other for cueing, or the earphones can be wired in parallel for standard mono use. Comfortable foam-filled ear cushions.
Mfr: Telex
Price: Under $100
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MASTERING TAPE

● A new binder system, a new iron oxide, and a new dispersion process provide superior print-through qualities and reduced head-wear on these back-coated tapes. Available either with a base of 1.5 mil polyester, length 2500 feet (type 2506) or 3600 feet long with a base of 1.0 polyester (type 3607). Reel diameters for both tapes is 10½ inches. Ideally suited for copying, overdubbing, duplicator masters, and other applications demanding repeated and hard usage.
Mfr: Audio Devices Inc.
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TRUE RMS TO D.C. CONVERTER

● This unit allows any d.c. meter to accurately measure true rms. It will increase the sensitivity, frequency response, and accuracy of any multimeter or dvm. Converts any wave shape to a d.c. output, has an accuracy of 0.3 per cent, a bandwidth to 500 kHz, and its own input ranging amplifier of 1 mv to 150 V. The signal to be measured is applied to the converter input and measured at the converter output with any d.c. meter, dvm, or dmm. Measures 3x4x 6.5 inches.
Mfr: Universal Filter & Demodulator Corp.
Price: $198.00
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SHEARING TAPE SPLICER

● A tape splicer that shears rather than cuts the tape has been recently announced. The manufacturer claims that shearing results in preparing better and faster splices. The unit, which is self-sharpening, comes in two sizes: standard ¼ inch or 0.150 for cassette tapes.
Mfr: NRP
Price: $16.95
Circle 51 on Reader Service Card

MODULE CONSOLES

● Seven easy-to-plug-in i.c. op-amp modules make it possible to start this console with a few channels and gradually expand, or to move channels from one studio to another. The new integrated circuit broadcast modules provide for mic, medium-level, high-level and remote inputs and outputs, communications and monitoring. Each module is a complete operating channel, with frequency response, distortion and noise characteristics claimed to exceed NAB standards. Two of the modules, the mic ICBM-MI and the medium-level ICBM-LI, contain limiters that make them impervious to overload, no matter how strong the mic signal. The IBM-MI also features a vertical fader with a cue switch and delegation and cough switches; ICBM-LI is similar, except for the cough switch and gain. The high-level input module, ICBM-HI, has balanced input, followed by gain control with a cue switch and assignment circuit. A remote input provides six, switch selectable lines that are fed into an input fader with cue switch and then are delegated into a mixing bus, and a talk-back facility into the remote lines. ICBM-O, the output module, consists of an active mixing circuit, followed by a mono switch, fader and line amplifier and includes transformer isolated output, phase reversal switch and a built-in 6 dB pad for telephone line feed. The monitor module, ICBM-M, has 10-watt and 3-watt amplifiers and a 10-watt monitor with selectable sources; amplifiers can be muted with a built-in relay. The communications module, ICBM-C, consists of a high gain, 2-watt amplifier with relay switching so the talk-back speaker is used as a mic or a speaker. A script panel module is available. The modules measure 2 inches wide x 18½ inches long and are packaged on formica-covered aluminum strips with Blue Ribbon connectors. Console shells are available in widths up to 48 inches.

Mfr: Fairchild Sound Equipment Corp.

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CLIVE ROSS

Electronic Signal Switching for Tape Recorders

The new multi-track professional audio recorders are probably the most challenging application for electronic signal switching, demanding transient free operation and low noise characteristics. This article covers the various circuit configurations and switching elements used in current designs.

UNLIKE OUR OLD FRIEND the relay, the solid-state switching element needs a more subtle approach from a design point of view. But the rewards are greater in most cases, giving a wider range of control and high speed.

The field effect transistor is the most commonly used switching element, and, providing its limitations are well recognized, it is a very successful device, more so than its bi-polar counterpart. Before considering the f.e.t. and its applications, we should look first at other alternatives, because cost is a predominant factor. If in a particular application a simple form A reed switch can be used for a couple of dollars, why use a twenty-dollar f.e.t.? Naturally, I have quoted an extreme case here, but don't lose sight of common sense just for the sake of the magic word *solid state.*

Let us consider each device in turn and discuss the various applications, advantages, etc.:

THE REED RELAY

Cost: Reasonable, a few dollars
'ON' Impedance: Very low, milli-ohms
'OFF' Impedance: Very high
Capacitance: Low, a few pF
Current Handling: High, 1 amp
Operate Time: 0.3 — 1 ms
Size: Reasonable 0.2x0.24x0.8 in.
Operate Power: High

Clive Ross is a senior electronics engineer, professional audio products for 3M Company.

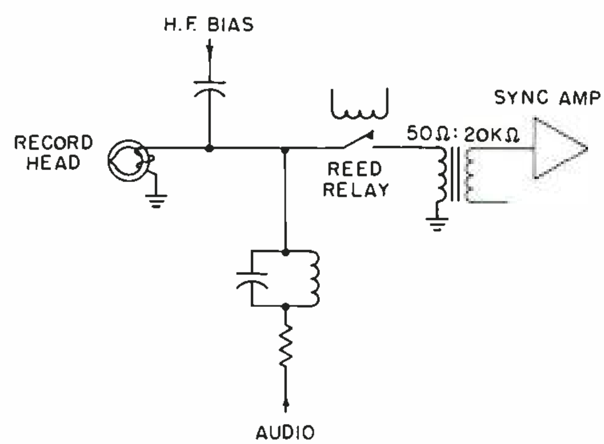
DISCUSSION

Very useful in low impedance, low noise circuits where a step function change in signal off to on or vice versa is acceptable. Keep in mind contact bounce, which can be eliminated using a mercury-wetted contact type at higher cost.

APPLICATION

Record head switch for overdub/sync. function. Generally used where impedance is below 1000 ohms. (FIGURE 1)

Figure 1. A reed relay switch.



THE SOLID STATE RELAY

Generally an r.f. oscillator, isolation transformer and transistor switches packaged in a dual in-line package.

Cost: Medium
'ON' Impedance: Low, 2 ohms or so
'OFF' Impedance: High
Current Handling: Low
Operate Time: Medium 10 μS
Signal Level Handling: High, 50 V.
Operate Power: High

DISCUSSION

Works well in high level circuits with the capability of slow operation by programming the d.c. supply to the device.

APPLICATION

For high level circuits where complete isolation is necessary and *slide on/slide off* characteristics are necessary.

PHOTON COUPLED DEVICES

The lamp and photocell package is frequently useful where a wide range of control is desired with no waveform effects. The l.e.d. units offer high speed in comparison to the filament lamp/photocell units where a time constant characteristic can be provided. Complete isolation between switch command and signal is inherent in these devices. Medium or high *on* resistance available only. (50 ohms — 5k ohms) Characteristics to "watch out for" are: aging (change of *on* resistance with time); effects of temperature upon *on* resistance in some types of devices.

BIPOLAR TRANSISTOR AND DIODE SWITCHING

In the low cost devices, the junction transistor has lower *on* resistance than the f.e.t. A source of bias is always required so that the emitter-base junction can be reversed biased in the *off* condition. This is generally achieved by connecting the transistor switch to a point in the circuit where a d.c. potential is available; for example, the output of an amplifier as shown in FIGURE 2.

In a similar way, diodes are often used for switching signals; the diode is forward biased in the *on* condition and reverse biased in the *off* condition (see FIGURE 3).

In the foregoing signal switching circuits using the pnp transistor or the diodes, the switches rely on a specific d.c. current flow through them to close the circuit and hence pass the superimposed signal. The main reason for using active switching is that the switching command can be remote and have low power requirements.

F.E.T. SWITCHING

One of the disadvantages of the previous semiconductor switches is the transient at the switching point due to the inherent d.c. level changes. The f.e.t. overcomes this, because no d.c. current is required and the device acts as a voltage sensitive resistor. The *on* resistance is an important parameter, especially when designing circuits with low cost in mind. F.e.t.'s with low *on* resistances below 150 ohms are significantly more expensive than those with higher *on* resistances, and the cost increases drastically below 100 ohms.

P-channel or N-channel can be used, depending upon circuit configuration and relative cost. The three circuits shown are frequently used in magnetic recorder circuits giving transient free operation and very low power requirements.

There are limitations in any electronic switch regarding signal amplitude. Obviously, given enough voltage swing the source in 4(A) will be driven close to the *off* bias point and cause the *off* f.e.t. to turn on momentarily, which is undesirable. A good "rule of thumb" is to keep signals in such circuits to below IVP-P. FIGURE 4(B) and 4(C) show various configurations of signal switching using P-channel and N-channel devices.

Another consideration is sometimes important when using f.e.t. switches in recorder circuits. A good example is in a high frequency bias switch, where the waveform during the controlled transition between *off* and *on* may produce side effects which show up as an audible transient on tape.

The diagrams of FIGURE 5(A) and (B) show how the unsymmetrical waveform during the *partially on* period can be eliminated or reduced. In FIGURE 5(A), the filter restores the waveform. In FIGURE 5(B), approximately 50 per cent of the input signal is fed to the gate circuit to reduce non-symmetry during the *partially on* period. In both cases the switches have controlled turn on/off characteristics utilizing the CR time constant in the gate circuit.

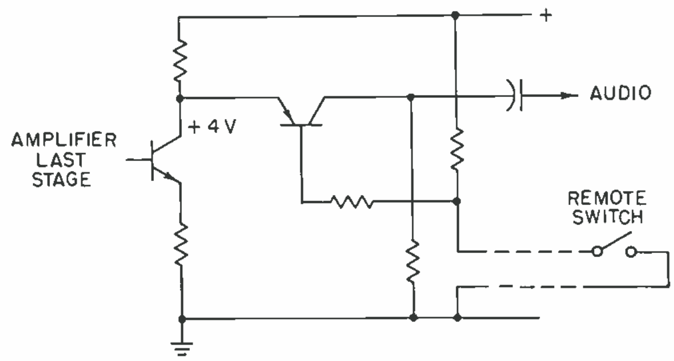
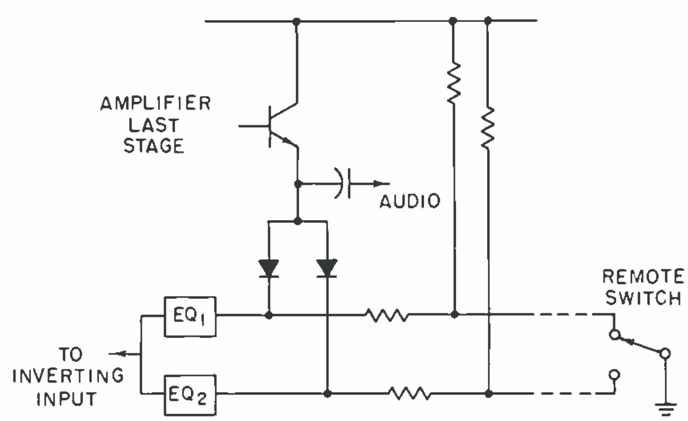


Figure 2. A transistor switch.

Figure 3. Diodes for equalizer switching.



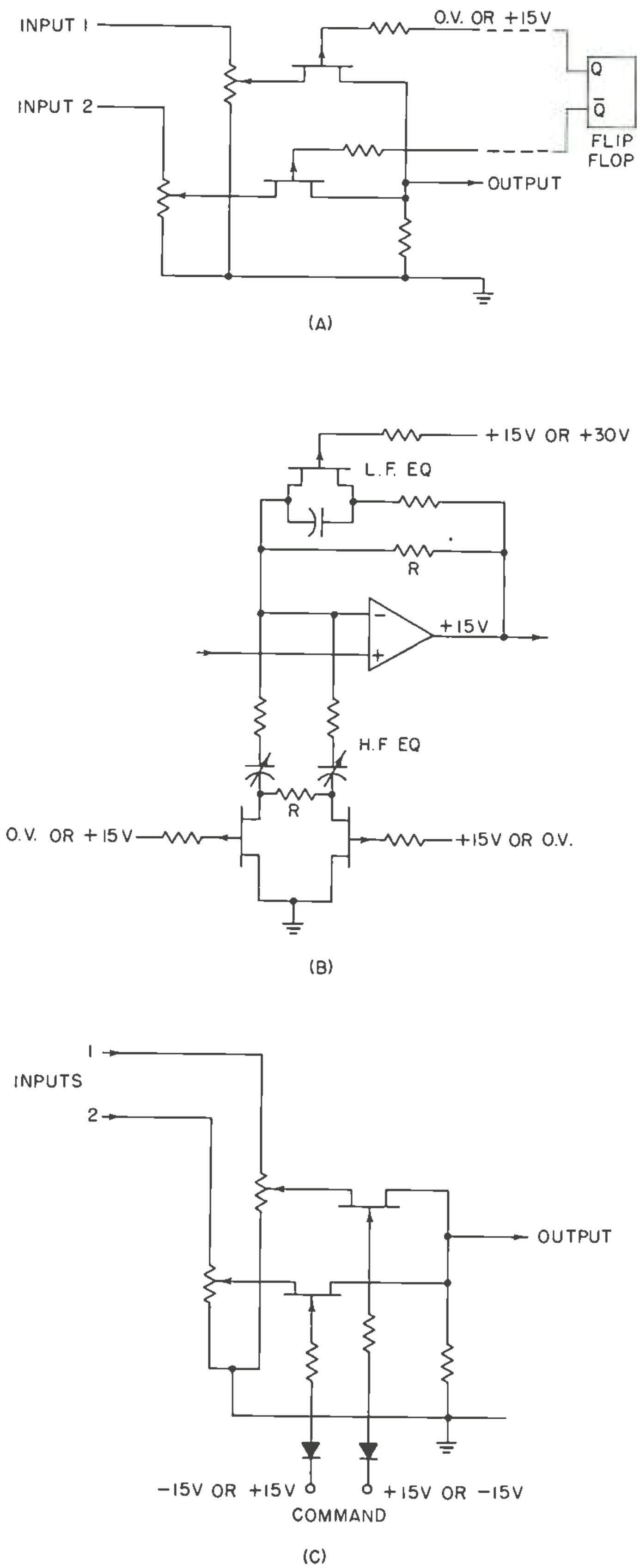


Figure 4. At (A) an all ground configuration, (P-channel); (B) is mid point and grounded switching of record equalizers; and (C) shows mid point switching using N-channel.

SUMMARY

In the audio signal circuit application, f.e.t. switching is commonly used where transient free switching is required. Circuit impedance and signal level are important design parameters. Depending upon requirements, each type of switching should be considered on its merits: Diode, regular transistor, and f.e.t., in ascending order of cost.

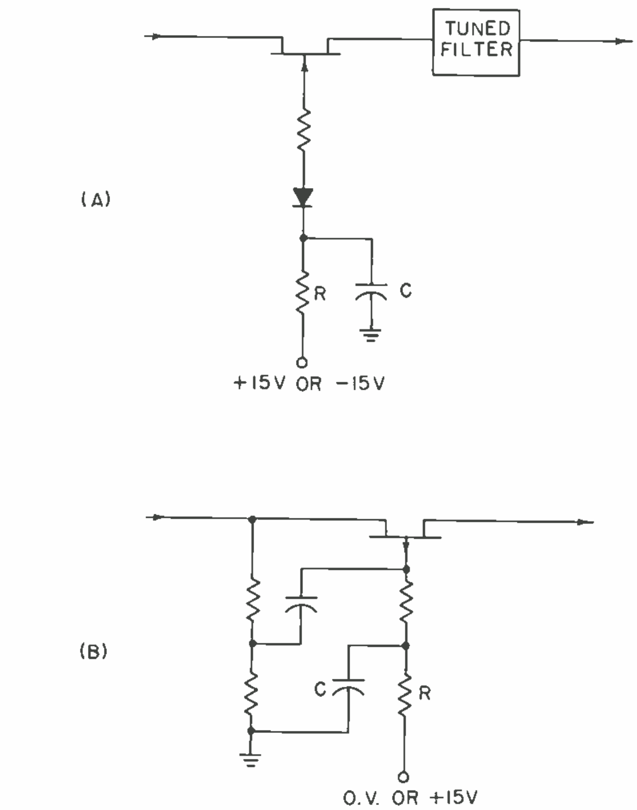


Figure 5. Bias switching circuits. At (A) the filter restores the waveform. At (B) approximately 50 per cent of the input signal is fed to the gate circuit.

When using f.e.t.'s, consider carefully the variations in cut-off voltage and *on* resistance, and avoid reverse bias on the gate circuit. Avoid situations where the source or drain have no external d.c. return path. Use a high value resistor in these cases to avoid accumulation of electric charge which could interfere with reliable switching as in R of FIGURE 4(B).

High-level signals can be better handled by reed relays, solid-state relays, or photon-coupled devices. Low-impedance circuits are best handled by reed switch or solid state relay. In high frequency circuits, self capacitance must be considered when designing circuit impedances. Also consider temperature and aging effects in the case of some photon-coupled devices. ■

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J. ROSS MACDONALD and C. A. BARLOW Jr.

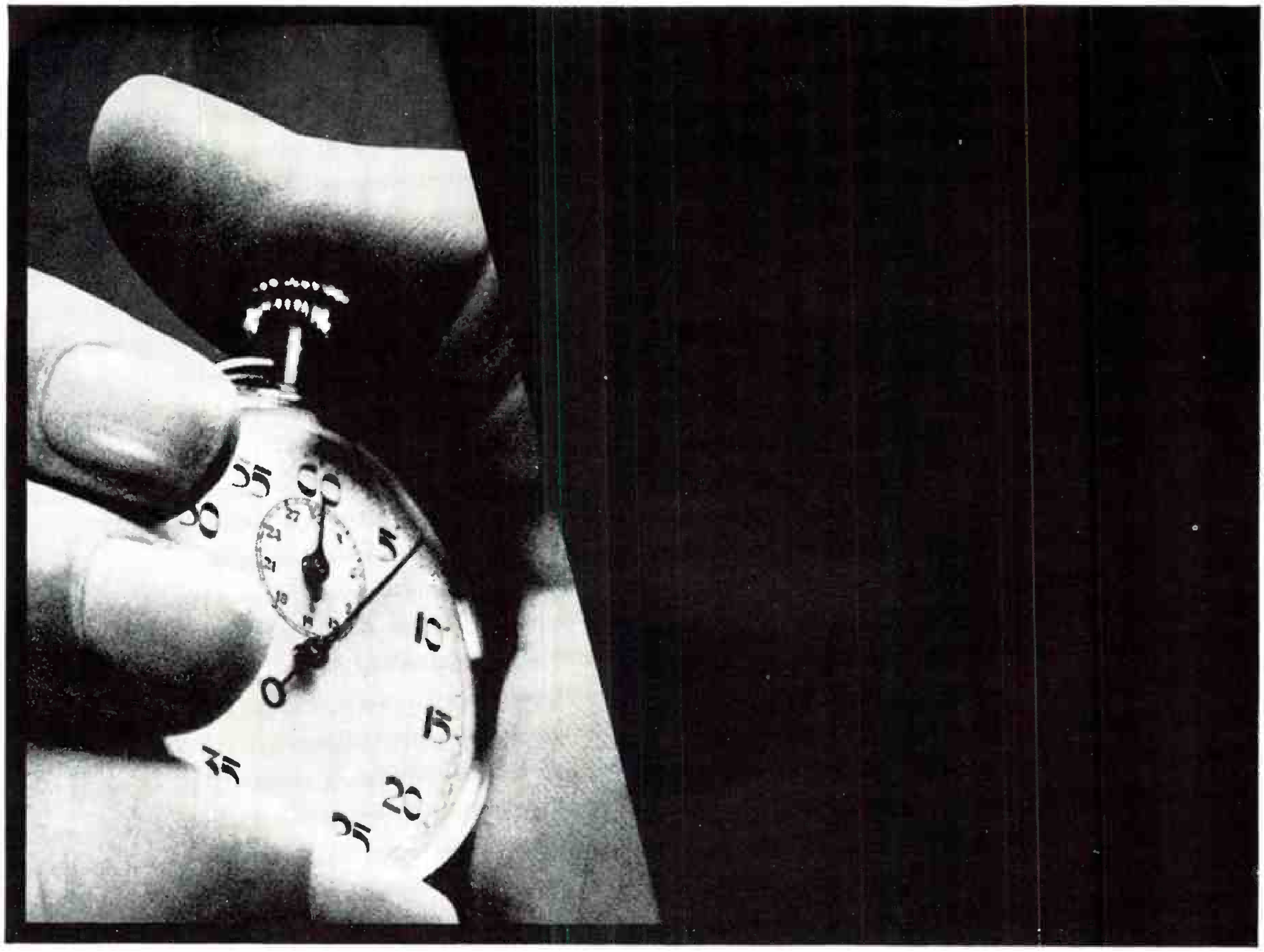
Better Tape Head Azimuth Adjustment

The author details, with full scientific and mathematical justification, the best method to achieve accurate azimuth adjustment on multi-track tape recorders.

CONSIDER a four-track recorder with separate recording and playback heads. It is common practice to adjust the playback head azimuth for maximum output signal while playing a standard tape (e.g. Ampex No. 01-31321-04 for 7½ in/sec. operation) having short wavelengths recorded on the tape. Then, the azimuth of the recording head is, in turn, adjusted for maximum output signal while recording and simultaneously playing back a short-wavelength signal (e.g. 15 kHz). It does not seem commonly recognized that simple procedures exist which allow for higher accuracy (and other benefits described later) in setting the head azimuths than is possible with the usual unadorned amplitude method reviewed above. These methods are only appropriate to those recording arrangements which allow two or more tracks of the tape to be simultaneously recorded; with the advent of quarter-track stereo recording and multiple-track digital recording, many such arrangements now exist.

In essence, the improved methods consist of adjusting azimuth not primarily for maximum output (although this is a corollary benefit) but instead to achieve maximum equality between some aspect of the two output signals from simultaneously recorded tracks. Convenient comparison can be made on an amplitude basis by forming and observing the electrical difference between the two signals $\Delta e \equiv e_L - e_R$, for example, or by osbserving the electrical

J. Ross Macdonald is vice president of Texas Instruments, Inc.



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Circle 16 on Reader Service Card

phase difference between the two outputs $\phi \equiv \arg e_L - \arg e_R$. Because of noise, stability, convenience, and simplicity considerations we believe the phase method is superior. Although we shall hereafter only discuss the phase method, both methods can be far more sensitive than the conventional approach.

We shall describe the phase method initially for the playback head and compare its sensitivity with that of the conventional single-signal amplitude method. The Ampex test tape 01-31321-04 has two forward-play recorded tracks. They are recorded in such a way that insofar as possible points on the two tracks lying on a line perpendicular to the tape edge define regions of the same recorded flux. This is exactly the case, of course, for a full-track test tape. Thus, for ideal playback head alignment, ϕ will be zero for all recorded wavelengths. Therefore, if the tape is played and the two output signals are connected to the *X* and *Y* inputs of a balanced oscilloscope, the resulting Lissajous figure can be used to indicate ϕ, and thus any misalignment of the playback head. For such a measurement of ϕ, it is assumed that the output signals are either taken directly from the head or through phase-balanced preamplifiers. Let θ be the playback head azimuth angle. When it is zero, ϕ will be zero (thus an uncalibrated null-type measurement may be used) and the head gap edges should ideally be perpendicular to the tape edges. It is important to note, however, that the maximum azimuth error of the tape itself is only claimed[1] to be $\pm 2'$ of perpendicularity to the tape edge. Since the phase method will allow, as we shall see, $|\theta|$ to be adjusted to a considerably smaller value than $|2|'$, final more precise adjustment will be with respect to the signals on the two tracks of the tape rather than the edge.

SENSITIVITY OF THE USUAL METHOD

It is readily shown by averaging that the output signal, *e*, from a given track is of the form, when $\theta^2 \ll 2$ radian^2,

$$e = e_0[\sin(\xi(\theta))/\xi(\theta)] \cos\theta, \qquad (1)$$

where $\xi(\theta) \equiv k \sin\theta$ and $k \equiv \pi w/\lambda$. Here *w* is the track width and λ the recorded wavelength on the tape, given by the ratio of tape speed, *v*, to recording frequency υ.

From (1), we find the sensitivity factor, $S_e \equiv d(e/e_0)/d\theta$, of the head azimuth adjustment to be

$$S_e = -\sin\theta[\xi^{-1}\sin\xi + K^2\cos^2\theta((\sin\xi - \xi\cos\xi)/\xi^3)]. \qquad (2)$$

Now at $v = 7.5$ in/sec. and $\upsilon = 15$ KHz, $\lambda = 0.5$ mil. Further, $w = 43$ mil for conventional quarter-track recording. Under these conditions, $k \cong 270$ and when $\xi \ll 1$, θ will be much smaller. Thus, to good approximation we have for $\xi^2 \ll 2$ radian^2,

$$S_e \cong -[1 + (K^2/3)]\theta \cong -K\xi/3, \qquad (3)$$

which becomes about -24, $200\theta = -90\xi$ for $k = 270$. Here, θ and ξ are expressed in radians. Although S_e is thus zero when $\theta = 0$, the point where it really needs to be a maximum, it does increase in magnitude very rapidly with increasing $|\theta|$; and for $\theta = 1'$ it is about -7.1.

[1] R. K. Morrison, *Reproducer Test Tapes, Their Evolution and Manufacture*, presented at 31st Convention, Audio Engineering Society, 10 - 14 October, 1966, preprint No. 445.

Since $S_e(\theta - 0) = 0$, it is virtually impossible to adjust head azimuth to exactly $\theta = 0$ by the above method, even though one can usually readily adjust *e* to within a dB or so of maximum (i.e. $|\theta| \cong 10'$). Yet, as we shall see, very substantial changes in the phase relations of simultaneously recorded stereo or mono signals may occur for even this small (or smaller) $|\theta|$.

SENSITIVITY OF THE PHASE METHOD

Let us associate positive θ with positive ϕ. Further, denote the separation between the two head gap centers as *a* (equal to 0.136 mils for conventional quarter-track recording) and let *s* be the smallest horizontal separation of points of equal phase on the two tracks. Then $s = a \sin\theta$. For ϕ in radians, $\phi/s = 2\pi/\lambda$. Thus (again for $\theta^2 \ll 2$),

$$\begin{aligned}\phi &= (2\pi a/\lambda)\sin\theta = (2a/w)\, k \sin\theta \\ &= (2a/w)\,\xi(\theta) \cong (2a/w)\, k\theta. \end{aligned} \qquad (4)$$

For representative values of *a* and *w*, $(2a/w) \cong 6.33$. With $k = 270$, $\phi \cong 1700\theta$, showing how much more sensitive ϕ is than θ.

Now let $S_\phi \equiv d\phi/d\theta$ be the sensitivity factor for the ϕ measurement. Then for $\theta^2 \ll 2$,

$$S_\phi = (2a/w)\, K\cos\theta \cong (2a/w)\, K, \qquad (5)$$

virtually constant and having its maximum value ($\cong 1700$ for the above numbers) at $\theta = 0$. Since it is entirely practical to reduce $|\phi|$ to 1 degree or less under favorable conditions of tape transport by observing a Lissajous pattern on an oscilloscope, we find that for the above numbers $|\theta| \cong 2''$ when $|\phi| = 1$ degree.

COMPARISON OF SENSITIVITY FACTORS

Let us define θ_0 as the value of θ for which $|S_e| = |S_\phi|$. If $|\theta_0|$ were small enough, Eqs. (3) and (5) could be used to yield $\theta_0 \cong 6a\lambda/\pi w^2 = 6a/kw$. Unfortunately, the above values of *a*, *k*, and *w* yield $\theta_0 \cong 4^\circ$, much too large for (3) to be applicable. When (2) and (5) are used to define θ_0, one finds from an accurate solution, surprisingly, that the only root is θ_0 nearly equal to 90°. For $2a/w = 6.33$ and $k \cong 270$, the root is virtually indistinguishable from 90°; even for $k = 10$, corresponding to only $\upsilon \cong 556$ Hz at 7.5 in./sec. and $w = 43$ mil, $\theta_0 \cong 89.95°$. Thus, there is no region of physical interest where $|S_e| = |S_\phi|$; in practice we always have $|S_\phi| \gg |S_e|$, again showing the great superiority of the phase method to the usual single amplitude method. For $|\theta| = 10.45'$, where e/e_0 is ideally only one dB less than unity, we find, again using the above numbers, $S_\phi \cong 1700$, $|S_e| \cong 69$, and $|S_\phi/S_e| \cong 25$. For this value of θ, $\phi \cong 296°$!

The above results show that if, as is usually the case, θ can only be adjusted by the amplitude method alone such that e/e_0 is within about $\pm$ 1 dB of unity on the average, it will only be pure chance if the final θ should be so small that ϕ be negligible at 7.5 in/sec and 15 kHz. Under these conditions, a relatively small change in θ can result in up to several entire cycles change in ϕ. Thus, even though e/e_0 may be adjusted by the amplitude method adequately close to unity, there will almost always be a large phase shift at high frequencies remaining between the signals from the two tracks when only this method is used.

DISCUSSION AND CONCLUSIONS

Once the playback head azimuth has been adjusted by the phase method until $|\theta| < 2''$ or better, the record head azimuth may be brought into proper alignment by the same method. It is sufficient to record on two tracks and simultaneously play back from them a high-frequency signal such as 15 kHz. Phase monitoring of the two tape outputs with the oscilloscope will then allow the record head gaps to be brought into parallelism with those of the playback head to within about $\pm 2''$ or better on the average. Again it is assumed that any recording preamplifiers used are phase balanced over the frequency range of interest.

The final result of the above procedures will be, besides the best possible alignment of the heads, zero electrical phase shift between the signals from the two tracks, a frequency desirable condition, as we shall see. Although the phase adjustment method using measurement of ϕ can be carried out entirely without use of the amplitude method, the great sensitivity of the former method suggests that a sequential use of the two methods may be valuable. The amplitude method would first be used to achieve a $|\theta| < 10'$ - $20'$; then the ϕ method would be applied to reduce θ to perhaps $\pm 2''$ or less.

If an oscilloscope rather than an a.c. voltmeter were available, the phase method could easily be used alone as follows. First, $|\theta|$ could readily be adjusted to $< 5'$ - $10'$ using a frequency (at 7.5 in/sec.) of say 100 Hz. At this low frequency, there would be no ambiguity in picking the cycle of ϕ associated with $\phi = \theta$-0. Then, $|\theta|$ would be reduced to $< 2''$ by a final adjustment at say 15 kHz. Finally, the same procedure could be carried out for the record head adjustment. The value of $2''$ is based on being able to reduce ϕ to $\pm 1°$. Note that if the horizontal and vertical gains of the oscilloscope channels were then increased considerably, ϕ could be made appreciably smaller provided sufficiently small increments in θ were mechanically possible and noise and tape motion irregularities did not interfere.

It is clear that the phase method requires two tracks and will not work for single-track recording. In multiple track recording, greatest sensitivity will be achieved when those two tracks are employed which are farthest away from one another.

Although the ear is quite insensitive to phase at high frequencies and thus whether $\phi = 100°$ or $0°$ at say 10 kHz will not be audible, there are still advantages to maintaining essentially zero phase shift between two channels over the entire frequency range. In a typical listening room, the instantaneous pressure pattern of a stereo program will be different, probably audibly so, (because of different phase cancellations and partial cancellations) when there is appreciable ϕ within the hearing range than when $\phi \approx 0$. Note that $|\theta| \cong 10'$ corresponds at 7.5 in/sec to a $|\phi|$ of about $60°$ at 3 kHz. At 3.75 in/sec., $|\phi|$ would of course be $120°$ at 3 kHz and larger at higher frequencies. Finally, it may sometimes be desirable to alter electrically the stereo spread of a tape recording in order, for example, to improve the apparent separation of the resulting sound pattern. Such alteration usually involves partial or complete cancellation of those medium and high frequency signal components which have the same or nearly equal phases on the two channels. Clearly for such cancellation to work properly it is desirable to preserve the original phase relations between the stereo signals recorded on the two tape recorder tracks. Again, such preservation will be accomplished when $\phi \approx 0$ for both playback and recording. ■

PAUL BERKOWITZ

Bias Adjustment with a Harmonic Distortion Analyzer

Many studios check the total harmonic distortion of their machines after they set bias. Some set bias for lowest distortion. This article suggests a method of using a distortion analyzer effectively to monitor distortion and noise.

IN A SENSE, the job that requires the greatest skill of the studio maintenance technician is that of aligning the multitrack tape-recorder electronics. Though it is true that day-to-day maintenance may require only minor adjustment of record and playback levels, a thorough "tuning" may require as much as ten adjustments per track. Of these, possibly the most critical as far as noise and distortion are concerned, are those that affect the bias wave form. There is usually one control that sets the bias amplitude, another that tunes for the purest sine wave; and there may be a control called Noise Balance or Bias Symmetry which nulls out any d.c. that may be superimposed on the bias or any permanent magnetism on the record head. There are many theories as to how these controls should be set. Scully recommends that the bias amplitude should be adjusted for maximum record response at 1 kHz. There is another popular theory that the best results are obtained when the tape is slightly "over-biased," meaning that the bias amplitude is increased until the response at 1 kHz falls ¼ to ½ dB from its maximum. The noise balance control is adjusted by ear for the least tape noise and is strictly hit or miss. I remember listening to biased tape noise with the board and monitor fully open trying to decide whether it is preferable to have less hiss or less pops on the tape as I cranked the noise balance pot around.

There is, however, a relatively simple and very effective way to make these adjustments. The technique is to insert a harmonic distortion meter between the output of the tape channel and the board. The distortion meter is not really used to make absolute measurements; it is merely there to allow you to listen to the tape-recorder under actual operating conditions and to hear exactly what is going on and what happens to the noise and distortion as you make adjustments.

Basically, a harmonic distortion meter is simply a very narrow band rejection filter, sometimes called a notch filter. The Notch Frequency is tunable over the audio band and the output of the filter is metered and is also available for an oscilloscope display or just for listening. In operation, a test signal is fed to the device under test (amplifier, tape recorder, etc. . . .), and the output of the device is fed to the harmonic distortion meter. The meter is tuned to the test frequency which is then filtered out. What is left, after filtering, is any residual hum, wideband noise, or any harmonics of the test frequency that have been generated in the equipment being tested. The level of the unfiltered test frequency (at the imput to the distortion meter) and the noise and spurious harmonics after filtering is compared on a built-in voltmeter which has been calibrated to read in per cent, and thus the percentage of distortion can be read.

In the studio, we are not so interested in the exact percentage of distortion. Because the voltmeter circuit measures noise and hum as well as spurious harmonics, the meter indication would not be very accurate anyway. But, if we listen to the output of the filter and watch only the relative fluctuations of the meter, we can hear things about

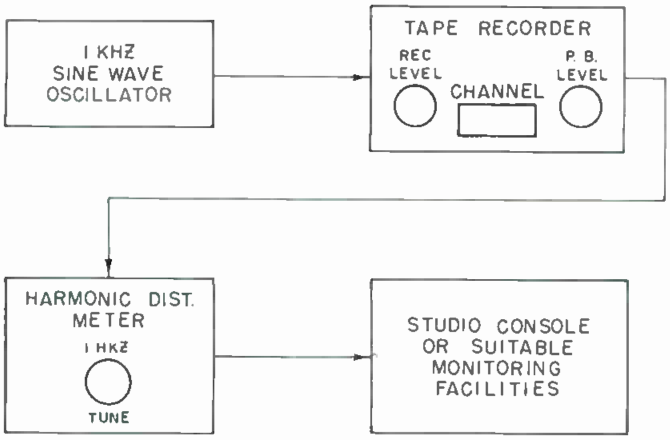


Figure 1. This simple straight-line arrangement can be used, as the author suggests, to measure distortion and noise from the tape.

our tape recorder that cannot be heard in any other way.

The test setup is as follows: After the playback alignment is completed, some fresh tape is threaded up and all tracks are thrown into record. A test frequency sine wave of about 1 kHz is fed to the track under test and the record level is roughly set to zero. The harmonic distortion meter is inserted (through the patch bay) between the tape channel output and a bus that is set aside for monitoring purposes (see FIGURE 1). The meter is tuned to reject the 1 kHz. What is now being monitored is the output of a tape recorder that is recording a 1 kHz tone at zero level, but everything except the 1 kHz is heard! This is what I meant by actual operation conditions.

It should be noted that there is amplification in the harmonic distortion meter, and, of course, additional amplification in the board. This means that the actual level being monitored is an ear-piercing 60 to 80 dB above normal levels. The quality of the tape noise, and the nature and level of harmonic distortion in the machine can be clearly heard. It is putting a stethoscope to the heart of the machine.

What I have found over the years that I have used this procedure with Scully tape recorders is interesting—and in some ways surprising. I have found a considerable and dramatic reduction in popping and frying sounds as well as hiss, by "overbiasing" by one half dB. Though this does cause some loss of high-frequency response, in most cases it is not serious enough to be of concern. The exact point of overbias can be found in seconds, simply by listening to the output of the distortion meter while watching the playback meter of the tape channel. As the response falls between ¼ and ½ dB past peak, there will be a noticeable null in noise. By contrast, the noise balance control has *its* most dramatic effect on the amount of distortion. Again, while listening to the output of the distortion meter, it will be noticed that the distorton products change from a harsh sounding complex waveform to an almost pure sine wave. Some interaction between these controls exists and it is wise to "touch-up" the bias one more time after the noise balance is set. The rest of the alignment procedure is done in the normal way.

The meter I have used is a simple, low cost, vacuum tube unit sold by Heathkit. This meter is ideal for the job as it is light and portable and within the financial range of literally everyone. To simplify and improve those monthly tune-ups, it can't be beat. ■

CLAUDE KARCZMER

A Modern Tape Recorder Design

Not too many people sit down and design a multi-track tape machine from the ground up. But this author did, and built it. He liked so much what it is doing that he has gone into the manufacture of it.

TO A LARGE EXTENT most of the advances in modern tape recorder design have been in the electronics area. A good part of this applied technology can be seen incorporated in the half dozen or so sixteen-track recorders currently on the market. While some of this sophistication is valuable and adds to the usefulness of the recorder as a tool, it is at the same time evident that some of it is applied more to ease manufacturing problems and costs than to improve long term performance and repairability. Due to the constant revolution in electronic technology there has been a tendency to answer all design problems by the application of more and more sophisticated techniques. This overzealous use of state-of-the-art technology has resulted in overall reduced reliability, increased down time, and difficult maintenance requirements that in most cases cannot be met by studio personnel or facilities. In addition, due to this involvement with electronics, one can see relatively little improvement in the basic mechanics of the recorder during the past ten or fifteen years.

What is desired, then, is a recorder that embodies all of the modern outboard devices currently in use and

Claude Karczmer is president of Xedit Company.

the appropriate guide. The platform is also spring-loaded and damped to absorb fast changes in tape motion in the high speed wind modes. When the safety switch is opened, power is removed from the solenoid and the platform is released to a neutral position that facilitates tape threading. In addition to automatic guide changing, this assembly absorbs and isolates tape buckles caused by height feed variations of the tape. This is accomplished by the use of a guide through which the tape can pivot, followed by a center-pivoted roller which distributes an even tension across the full width of the tape. Without this system, if a height variation or other inconsistency occurs, there is a loss of perpendicularity of the tape to the deck. As the tape passes over conventional rigid guides at an angle, the tape has uneven tension placed on it and a buckle is formed which may cause drop outs and improper tracking. The take up guide system consists of a pair of guides; one stationary and one swinging tension arm. Both are operated by one alternate action mechanism with two stable positions, one and two-inch. This alternate action mechanism is similar to that used in a ballpoint pen and can easily be operated manually. It was felt to be an overcomplication to automate this guide as is the feed side guide system; however it would be a simple matter to do so.

NEW SPINDLE DESIGN

If you have ever fought with a full reel of two inch tape in trying to load it onto a recorder in a dimly lit control room, you'll appreciate the awkwardness of orienting the index slot on the tape reel with the pin or bar on the spindle. This misalignment can be as much as 110 degrees if you pick the wrong direction. The improved spindle consists of four spring-loaded compressible pawls, only

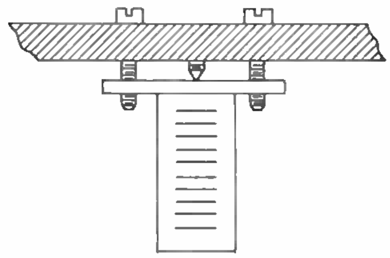


Figure 1. Conventional azimuth systems. How tight is tight?

Figure 2. The system used by the author to permit azimuth adjustment of the head.

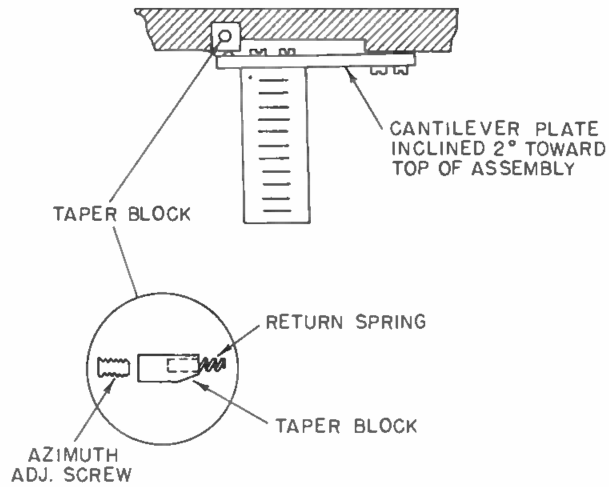
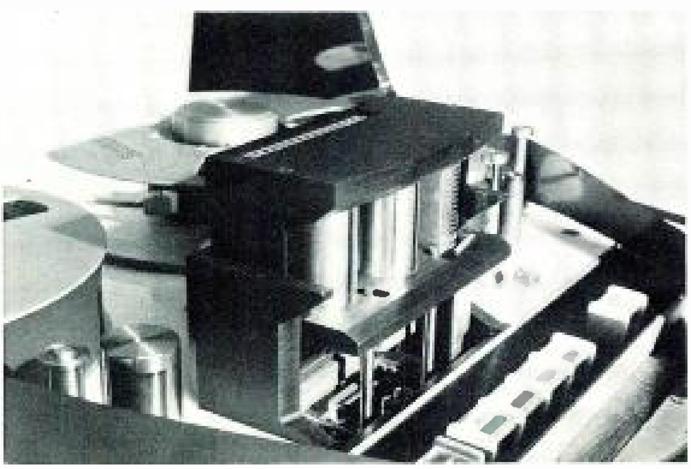


Figure 3. The completed sixteen-track machine.

further, is designed to provide sophisticated performance utilizing reliable proven components and techniques in its basic design and construction. In addition, it would be desirable to have a recorder whose mechanism has been designed for ease of operation and maintenance that is engineered to cope with the more stringent physical tolerances required by multi-track wide-tape recorders.

Figure 4. Rigid guides control the positioning of the head assembly.



The purpose of this article is to point out some of the elements in the recorder that are overdue for improvement and how these have been handled in a new recorder conceived, engineered and built to deal realistically with the stated problems and the general dissatisfaction with current design. There isn't the space here to elaborate on every aspect of this new machine, but an attempt will be made to describe some of the more interesting engineering features and why they were implemented.

HEAD ASSEMBLY

The promise of head assembly interchangeability has generally held widely different meanings and ramifications from one machine to another. At best the process has usually posed one of the more serious threats to a recorder's stability and well being. What we've tried to do here is not only to provide this necessary capability, but to accomplish it in what is a safe and routine mode for the machine and head module. The head assembly is a totally enclosed plug-in module with built-in connectors. The module can be inserted or removed without tools by the use of a manually operated lever on the back of the assembly. When the head module is removed from the machine, it is a rugged package with no exposed wiring and the magnetic heads well protected. The head module also contains playback equalization and level trimmers located on the top of the module. Since the trimmers are part of the removable head module, they re-trim the amplifiers for the head in use, eliminating the necessity of a complete realignment each time the head module is changed. In addition, the head module programs the appropriate tension and mode response for the size tape being used. The tape guides are formed by a hardened channel, structurally part of the head module. Since this channel runs the length of the module, the forces acting on the tape edges tend to be distributed over a broader area than is possible with conventional guide pins or posts.

AZIMUTH ADJUSTMENT

A new design for adjusting azimuth was judged necessary since all of the currently employed methods have serious enough drawbacks to make them a source of instability and a recurrent maintenance problem. The improved azimuth adjustment design consists of a cantilever plate on which the magnetic head is mounted. This cantilever is inclined two degrees toward the top of the module. The azimuth adjustment screw engages a spring loaded taper block; as the adjustment screw is tightened, the taper block forces the cantilever away from the top of the module and in turn varies the azimuth of the magnetic head mounted on it. Since the head mounting is never loosened during the azimuth alignment, this system does not endanger the stability or proper zenith setting of the head. The degree of taper of the taper block is limited so that the cantilever plate cannot be overstressed. A convenient byproduct of this design is that the azimuth adjustment set screw is protected, yet always easily accessible since it is recessed in the front edge of the head module. This eliminates the need to remove a dress cover in order to adjust the azimuth. Very often dress covers are left off, exposing the heads, wiring, and adjustments to external hazards.

GUIDE SYSTEM

Most guide systems currently in use are relatively passive and utilize various ambiguous methods of conversion from one tape size to another. In the subject machine, the feed side guide actually consists of a one and two-inch guide system mounted on a rotary platform. The platform can turn to the right or left, as determined by the size of the head module inserted in the machine, and thus engage one of which is needed to engage the slot on the reel. Since these pawls are completely compressible, it is not necessary to orient the reel, and furthermore, due to a worst case, misalignment of less than 30 degrees, resulting from the combination of the four pawls spaced 90 degrees apart, to the three index slots on the reel spaced 120 degrees apart, the odds of initially engaging are much better. However, even if a pawl does not engage when loading, the four compressed pawls exert enough holding force on the reel for the play mode and will automatically engage the first time the machine goes into a wind mode. In addition, the design includes a locking capability; the lock is activated by depressing a plunger on top of the spindle or pulling it to unlock, both of which can be accomplished with one hand.

CONSTANT TENSIONING SYSTEM

The variation in tension caused by the continually changing diameter of tape on the reels is a problem that has not been dealt with effectively in most machine designs. Where an attempt has been made to deal with it, it has generally been by the utilization of complex circuitry or unreliable high gain servo systems. Since it was our aim to exclude delicate or unstable circuitry from basic machine functions as much as possible, the system chosen is simple, effective, and has proven itself to be reliable in many data recorders. The sensing elements for this system are two arms that engage and track the tape and automatically retract for loading. These arms utilize teflon pads and exert very little force on the tape backing; in fact they represent much less wear to the tape then ordinary fixed guides. The varying diameter of tape is transmitted by the arms to a sensing potentiometer that in turn controls the voltage to its respective reel motor. What we have is a stable open loop servo utilizing very simple proven circuitry. This system will maintain a static or dynamic equilibrium from one end of the reel to the other. In addition to providing this effective tension control, these arms, by the use of limit switches, will prevent the tape from running out at high speed if the machine is left unattended while in a high speed wind mode. The feed side also triggers a five minute end of tape warning in the record mode by flashing the record button.

MOTION AND VELOCITY SENSE

One of the really obvious improvements embodied in this machine is the speed with which it handles two-inch tape. Unlike other machines, *velocity* as well as simple direction-of-motion information is avalable to the logic circuitry. As an example of the speed and smoothness of operation that this makes possible is that when play is selected while the machine is in high speed forward mode, the tape is quickly slowed to the proper transition velocity. When this velocity is equal to the play speed, the play mode is enacted. This occurs without hesitation, delay, or cycling through the stop mode. This transition from high wind speed to stable play takes a maximum of two seconds.

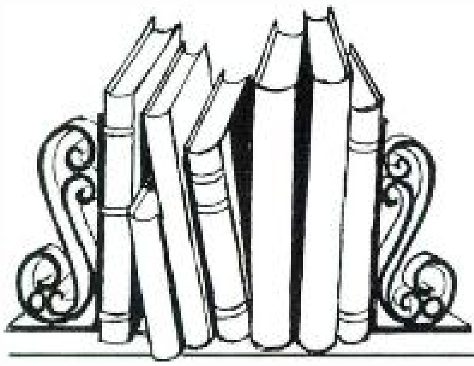
LOGIC CONTROL

Diode and plug-in sealed relay. Relays were chosen because they are far more forgiving than digital modules or transistors. All controls are fully interlocked, with illuminated segmented display to indicate mode of operation and logic conditions during transitional modes, thus aiding in the location of a problem should one occur. The logic circuit does represent a field maintenance problem, but can easily be maintained by the user.

CAPSTAN PRESSURE ASSEMBLY

This mechanism continues to be the cause of much of the slippage and tracking problems in today's machines, and yet has seen little improvement in design. The improved design begins with the use of a large rotary solenoid. Properly applied, rotary solenoids which have many advantages over linear types, are used throughout this machine. This solenoid is coupled with a high mechanical advantage to the pressure roller arm and is damped for smooth operation. The linkage throw is adjustable, utilizing a method that makes it impossible for it to work loose and cause slippage problems. There is an adjustment located on top of the deck that is an integral part of the pressure arm, used to adjust the tension of the pressure roller to the capstan. This is in contrast to the conventional location under the deck that makes it impossible or very awkward to make the tension adjustment in a running mode as it should be. There is also an engraved scale on top of the pressure arm indicating the proper engagement and tension of the roller. Double rollers, as opposed to one large single roller, are used to eliminate the wedging that occurs when running one-inch tape on half the roller. The yoke supporting the double roller system, is center-pivoted, as are the individual rollers. This makes the entire assembly self-aligning to the capstan and self-correcting for wear or variation in roller size.

In summing up, one can see the attention that has been given to some components relatively unimproved since they were first implemented in the recorder mechanism; utilizing solid mechanical and electronic design and attention to detail. This effort has been made in order to produce a high performance, very reliable, recorder that can easily be maintaine din the environment in which it will be used. ■



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31. Solid-State Electronics. *Hibberd.* A Basic Course for Engineers and Technicians. An extremely practical reference book for anyone who wants to acquire a good but general understanding of semiconductor principles. Features questions and answers, problems to solve. 1968. 169 pp. **$10.25**

32. Circuit Design for Audio, AM/FM, and TV. *Texas Instruments.* Texas Instruments Electronics Series. Discusses the latest advances in design and application which represent the results of several years research and development by TI communications applications engineers. Emphasizes time- and cost-saving procedures. 1967. 352 pp. **$15.00**

35. An Alphabetical Guide to Motion Picture, Television, and Videotape Productions. *Levitan.* This all-inclusive, authoritative, and profusely illustrated encyclopedia is a practical source of information about techniques of all kinds used for making and processing film and TV presentations. Gives full technical information on materials and equipment, processes and techniques, lighting, color balance, special effects, animation procedures, lenses and filters, high-speed photography, etc. 1970. 480 pp. **$24.50**

40. Radio Transmitters. *Gray and Graham.* Provides, in a logical, easy-to-understand manner, a working knowledge of radio transmitters for quick solution of problems in operation and maintenance. 1961. 462 pp. **$16.00**

23. Wide Screen Cinema & Stereophonic Sound. *M.Z. Wystozky.* First published in USSR in 1965 this excellent English translation covers wide gauge films, panoramic films, circular panoramic cinematography; technical fundamentals of stero sound recording for film, as well as details of the Soviet systems now in use. 284 pages. **$15.00**

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22. Acoustics of Studios and Auditoria. *V.S. Mankovsky.* Basic theory plus a mass of design data covers the field with special reference to studios and places of public performance. For acoustical designers and specialists in sound transmission in cinema and broadcasting. Features exhaustive treatment of studio acoustics by the statistical, geometric and wave methods in parallel. 416 pgs. **$15.00**

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ALTEC 290 drivers; 1003, 203, 311-60 horns; J.B.L. D-20s. Call **(213) 661-3223** in Los Angeles for information. Equipment shipped F.O.B. New York.

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GATELY/PROKIT SM6A six input stereo mixer; EQ-6 equalizer for equalization on each input, and specially built pan-pot unit for panning on each input. All three units rack mounted, in portable case. Excellent physical and operating condition. Asking only $580. **Ken Newman, 38 Rolling Ridge Road, Upper Saddle River, N.J. 07458. (201) 327-3677.**

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HAECO announces complete repair service and overhaul for all Westrex cutterheads. Conversions of 3D-II and older models to higher performance standards and reliability. Helium cooling systems and hi-temp coils can protect your investment. Repair insurance program available. Rapid service. Lower cost. **HAECO, 14110 Aetna, Van Nuys, California 91401.**

AUDIO EQUIPMENT, new and used. Custom consoles built to your specifications using the components of your choice. Whether you're building a new studio or remodeling your present one, check us first for a package price. **Amboy Audio Associates, 236 Walnut Street, South Amboy, N.J. 08879. (201) 721-5121.**

STUDIO LIQUIDATION. Ampex 350, 354; ProKit Mixer; Presto 8D, 6N; Advent Dolby; other equipment. Write for list. **P.O. Box, Eugene, Oregon 97405.**

RECONDITIONED PRECISION TAPE REELS, as new; 1 x 10½-inch—10/$35.00. 2 x 10½-inch—10/$70.00. Free list. **Wide Response, 2926 Bentley Ave., Los Angeles, Ca. 90064.**

SPLICE FASTER, BETTER BY SHEARING . . . replaces razor; specify .250-inch or cassette: $16.95. With attached splicing tape mechanism, $24.95. Details- **NRP Box 289, McLean, Va. 22101.**

STUDIO with Quad-Eight Electronics 1682 console, Ampex AG440-8 eight-track machine, JBL 4320 monitor speakers, and Marantz monitor-amplifiers and Quad-Eight cue amplifiers. $30,000 full price including installation coordination. **Quad-Eight Electronics, 11929 Vose Street, North Hollywood, California 91605 (213) 764-1516.**

PENTAGON C-1000 cassette duplicator. Two years old, fully operational. **Streeterville Studios, Chicago, Illinois. (312) 644-1666.**

SPECTRA-SONICS CONSOLE, 2½ years old; 20 in. 8 busses out; adapted for 16-track recording; 480 patch points; 16-track monitor section, wired for phantom power; two cue systems. Includes parts complement to expand to 28 in and total spares package. $25,000. Also 24-16 track MCI, two years old. $18,000. **Record Plant. (213) 653-0240.**

CROWN TAPE RECORDERS, amps; IMF monitor speakers; AKG professional microphones; UREI limiting, Little Dipper; Fairchild; Crown warranty service station, more. **Barclay, 503 Haverford Avenue, Narberth, Pa. 19072. (215) 667-3048. or 120 Villa Crest Dr., State College, Pa. 16801. (814) 238-1598.**

WANTED

WANTED: Crown and Ampex tape equipment, any age or condition. **Sound Engineering, Box 4113, Cleveland, Ohio 44123. (216) 731-6563.**

FINANCIAL PARTNER needed to start eastern Alabama recording studio. Only serious replies please. **J. Baldwin, c/o The Music Center, Midway Plaza, Opelika, Alabama 36801.**

EMPLOYMENT

PROFESSIONAL RECORDING PERSONNEL SPECIALISTS. A service for employers and job seekers. Call today! **Smith's Personnel Service, 1457 Broadway, N.Y.C. 10036. Alayne Spertell 212 Wi 7-3806.**

MANUFACTURER of professional quality audio products seeks an aggressive sales-oriented electrical engineer with strong interest in audio equipment for sales position in the most lucrative market area. Person selected will enjoy direct working relations with key personnel in company. Attractive offices in prestige location; basic salary and incentive commissions; high salary potential. **Box 3-2, dB Magazine, 980 Old Country Road, Plainview, N.Y. 11803.**

TOP 16 TRACK NEW YORK STUDIO needs experienced rock engineer. $$$ high. **Smith's Personnel Service, 1457 Broadway, New York, N.Y. 10036. Alayne Spertell (212) 947-3806.**

EXCELLENT GROUND FLOOR OPPORTUNITY with rapidly expanding electronics firm as manager for newly created professional audio products division. Responsible for establishment and implementation of marketing program and product development serving commercial sound contractors. Experience required. Please submit resume to **L. J. Lynn, Director of Marketing & Sales, Sunn Musical Equipment Company, Amburn Industrial Park, Tualatin, Oregon 97062.**

EXPERIENCED AUDIO TECHNICIAN for production testing of professional audio equipment. Requires knowledge of solid-state circuit trouble-shooting/use of test equipment. Send resume to: **UREI, 11922 Valerio Street, North Hollywood, Ca. 91605.**

WANTED: Instructor, Broadcast Engineer Technician; two-year college, southeast Ohio. Challenging and rewarding position; salary open. Contact **Dean of Education, Hocking Technical College, Route 1, Nelsonville, Ohio 45764. (614) 753-3514.** The college is an Equal Opportunity Employer.

PEOPLE, PLACES, HAPPENINGS

● **Audiotechniques, Inc.,** Stamford, Connecticut, has signed an agreement with the **Mastering Lab,** Hollywood, California, giving Audiotechniques the exclusive manufacturing and distribution rights for the Mastering Lab frequency dividing network. Audiotechniques president, **Hamilton Brosious,** and **Sherwood Sax,** Mastering Lab president, said that the manufacture of the crossover units would continue in the Los Angeles area for the present. The Mastering Lab frequency dividing network was specifically designed to enhance the performance of the well-known Altec 604 and 605 series speakers. The device, widely used in Hollywood recording studios, has been recommended by Altec engineers as a major improvement in 604 series equalization. Manufacture and test procedures for the ML network will be under the direction of Audiotechniques vice president, **Bob Berliner.** Sales and service will be through a nationwide group of professional audio dealers, with deliveries commencing shortly after May 1.

● A further involvement with radio stations is evident in the recent purchase by **Fairchild Industries,** based in Germantown, Maryland, of stations **WYOO (AM)** and **WRAH (FM)** of Richfield, Minnesota, closely following the purchase, in January, of KLIF, Dallas, Texas. The Minnesota stations will operate twenty-four hours a day under the direction of **Marlin D. Schlottman,** general manager, and **William A. Stewart,** manager of operations.

● **Edison Electronics,** a division of **McGraw-Edison Company,** has established a parts and service operation servicing the **Daven** and **Measurement** product lines at its Manchester, New Hampshire location. The operation will distribute instrument spare parts and accessories, plus import production. Eventually, it will supply domestic switch and attenuator parts. Repairs of products manufactured under the Measurements trade name will be offered at the facility. The operation will be under the direction of divisional sales manager **Richard H. Smith.**

● **Radio Shack,** announces the appointment of **Dr. Frank B. Roberts** as product development manager, where he will take charge of design and product development functions as well as oversee quality control. Dr. Roberts had been director of engineering for **Symphonic Electronic Corporation** since 1970, and prior to that served as director of research and development for **KLH,** and chief engineer for **National Radio Company.**

● A joint announcement of merger has been made by **Infonics, Inc.** manufacturers of in-cassette duplicators and **Electronic Associates, Inc.** Infonics will continue to manufacture its broad line of tape and cassette duplicators and copiers in its Santa Monica, California facilities under the direction of **Peter Stanton.** Certain marketing activities will be consolidated with those of the educational technology subsidiary of Electronics Associates, **Visual Educom,** manufacturer of Dage television systems, Edex response equipment, Aetna Drivotrainers, Audipointer training equipment, Educam language laboratories, and ATC instrument flight trainers. Visual Educam's new plant is located in Michigan City, Indiana.

● A new distributor division sales arm has been set up by **Ballantine Laboratories, Inc.** to market special low-cost instruments, including precision a.c. voltmeters, standards and calibrators; oscilloscopes; counters and storage devices. According to **Milton J. Lichtenstein,** marketing vice president, the new distribution operation will include Ballantine's present worldwide field engineering representatives already involved in marketing the firm's major product lines. New representatives recently appointed by Ballantine include **Moxon Electronics** of Irving, California, and **Dyna Rep Company** of Springfield, Virginia. Moxon, operating from branch offices in Sunnyvale and San Diego, California as well as Irving, will represent Ballantine's test and measuring instruments in California, Nevada, and Hawaii. Dyna Rep, with branch offices in Baltimore, Md. and Bordentown, N.J., will cover the District of Columbia, Maryland, and Virginia.

● The **Gotham** group of companies, comprising **Gotham Audio Corporation, Gotham Export Corporation,** and **Teldec Sales Corporation,** has moved into its own building, known as The Gotham Building situated at 741 Washington St., New York, N.Y. 10014, in the midst of the colorful west village area between Eleventh and Twelfth Streets, one block from the Hudson River. Because this area is in a district supervised by the New York City Landmarks Commission, extreme care was taken to preserve the attractive facade of the 1912-built brick structure during renovating operations. Gotham anticipates expansion of its staff by some fifty per cent to meet the increased demands of the recording, broadcasting, public address, and related industries.

● **Bruce Marlow** has been appointed to the position of manager, merchandising and product management, by **RCA Records.** Marlow, who will be responsible for coordinating all merchandising functions for RCA's commercial and custom labels, has been with RCA since 1971 and steps up from the position of manager of product and market planning. Before joining the record division, he had worked on corporate staff projects for the **Hertz Corporation** and **RCA SelectaVision.** Marlow was educated at Tufts University and received a Master of Business Administration from Columbia University in 1971.

● Plans by **Sony Corporation** to open manufacturing facilities in San Diego, California should cushion the effect on prices of changes in the value of the U.S. dollar or Japanese yen. By autumn, the company's plant in San Diego will be able to produce more than half of Sony's color television requirements in the United States. Construction of a second facility, manufacturing tubes for all Trinitron t.v. sets made in the United States, will commence in San Diego in the spring.

TIMEKEEPER TAPE TIMERS

NOTE
Price Increase After May 15, 1973:
Professional Model $119.95
Standard Model 59.95
If you have been planning to buy one of the fine instruments, now is the time to place your order. Current prices will remain in effect up to May 15th. Order now!

The well-known TIMEKEEPER TAPE TIMERS are now available for immediate delivery. Our latest shipment has arrived and we are ready to fill your order.

TIMEKEEPER TAPE TIMERS are easily mounted on any ¼-inch recorder. They are fully guaranteed to meet with your complete satisfaction or your money will be promptly refunded. At these low prices you can no longer afford to be without a tape timer.

Difference from the Stop-Watch

Since the stop-watch measures time independently of the travel of the tape, its measurement inevitably varies with the elongation or contraction of the tape and with the rotating speed of the tape recorder, subject to change by voltage and other factors. The stop-watch can be stopped during the travel of the tape, but it cannot rewind together with the tape back to the desired position. With the Tape Timer moving in unity with the tape recorder, fast forwarding of the tape involves the quick advance of the pointer, while rewinding of the tape moves the pointer backward by the corresponding time.

Correct time keeping of the Tape Timer is never deranged by continuous repetition of such actions during the travel of the tape, as stop, rewinding and fast forwarding. Unlike the stop-watch, the Tape Timer is not affected by various factors of the tape recorder, and so the editing, reproduction and revision of your recorded tape can be done at will.

Features

- The recorded portion of the magnetic tape can be read at a glance by a scale division of ¼ second as accurately as a clock.

- The performance of the Tape Timer synchronized with the tape prevents such errors as caused by the elongation or contraction of the tape, and by the variation of speed in the rotation of the machine. Fast forwarding of the tape involves the proportional increase of the advance on the Tape Timer. When you rewind the tape, the pointer will be automatically moved back by the space of time exactly corresponding to the rewound length. You are free to stop, rewind, fast forward, or forward the tape even continuously and repeatedly without deranging the timing on the machine, thus prohibiting errors. These excellent characteristics will enable you to simplify the most complex procedure of editing, revising and otherwise processing your tape recording.

- Every fast rotating part is provided with a precise ball bearing, so that the Tape Timer can be employed at high speed with no need of lubrication.

- This trouble-free, high precision Tape Timer, within an error of 2/1000, can be simply fitted to any recording or editing machine.

Two models are available:

The Standard Model is calibrated for 7.5 and 3.75 ips and can also be used at 15 ips. Dimensions are 1⅞" x 3¼". It is priced at only $49.95.

The Professional High Speed Model is calibrated for 7.5 and 15 ips. It measures 2½" x 3¼" and is priced at $99.95.

TIMEKEEPER P.O. BOX 835 GREAT NECK, N.Y. 11021

NOTE: THESE PRICES APPLY TO ORDERS RECEIVED PRIOR TO MAY 15th, 1973.

Please send______Professional Tape Timers at $99.95 each.

Please send______Standard Tape Timers at $49.95 each.

Name ____________________

Address ____________________

City ____________________

State, ____________ Zip. ________

Total for Tape Timers $________

N.Y. State Residents add 7% Sales Tax $________

Add $1.00 shipping per order $________

Enclosed is check for $________

Dreaming about a pair of $300 condenser microphones?

Think seriously about these: $39.75* each!

Model 1710 Electret Condenser Omnidirectional Microphone

All of the great condenser advantages are here without compromise. Flat, extended range, excellent transient response, high output, low noise, and ultra-clean sound. But the new E-V electret condenser microphones need no high voltage power supply. Just an AA penlite battery to operate the built-in FET impedance converter. The result is studio performance without complications and at a dramatically lower price.

There are 4 new E-V electret microphones, including cardioid models, from $39.75 to just $75.00, audiophile net. Second-generation designs with unusually high resistance to heat and humidity. Hear them today at your nearby Electro-Voice soundroom. Or write for details.

More U. S. recording studios use Electro-Voice microphones than any other brand.

*Suggested retail price. Microphones shown on Model 421 Desk Stand. $12.00 each.

You have some questions about 4-channel?

We have the answers.

EVX-44 Four-Channel Universal Decoder $99.95 suggested retail

Q. *With so many different matrix encodings (E-V Stereo-4™, SQ, QS, Dyna, and all the rest) how do I know which decoder to buy?*

A. Simple. Choose the new EVX-44 Universal Decoder. It plays ALL matrixes accurately without switching, no matter how they are made.

Q. *The EVX-44 has an extra Separation Enhancement circuit. Why?*

A. To keep a soloist firmly in the front of the room by increasing center-front to back isolation to as much as 18 dB (at the cost of some back left-right separation). The enhancement is automatic and unobtrusive, acting only when the center soloist is performing. It can also be switched "on" continuously or "off" completely if preferred. The circuit works equally well with all encodings and even with 2-channel stereo records.

Q. *What if so-called "discrete" records become popular? Won't I be wasting my money buying a matrix decoder now?*

A. Not at all. Major record companies are firmly committed to matrix four channel. In addition E-V decoders enhance 2-channel sources, adding a feeling of ambience and dimension that is rivaled only by actual 4-channel material. Discrete demodulators can't do this. After all, 2-channel records, tapes, and FM won't disappear overnight, no matter what happens with 4-channel sound. Our decoders can even "enhance" the main channels of discrete 4-channel recordings. So your E-V decoder will be useful for years to come.

Q. *Why does E-V offer two decoders?*

A. Cost, mostly. The original EVX-4 is still a great bargain. It does an excellent job of decoding matrix records and is tops for enhancing 2-channel stereo. But the new EVX-44 does a more accurate job with all matrixes, and it has the separation enhancement circuit. It's quite a bit more complex, hence more expensive. E-V thinks you should have a choice.

Q. *I don't want to buy 2 stereo systems to get 4-channel sound. What should I do?*

A. Choose the EVR-4X4 4-channel AM/FM receiver. It has everything including the Universal Decoder circuit built right in. Simply hook up 4 loudspeakers (hopefully E-V!) and whatever tape or record players you prefer, and play.

When it comes to 4-channel . . . there's no question about it. Electro-Voice makes it happen.

E-V 4-channel products are produced under U.S. Patent No. 3,632,886

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