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THE SOUND ENGINEERING MAGAZINE

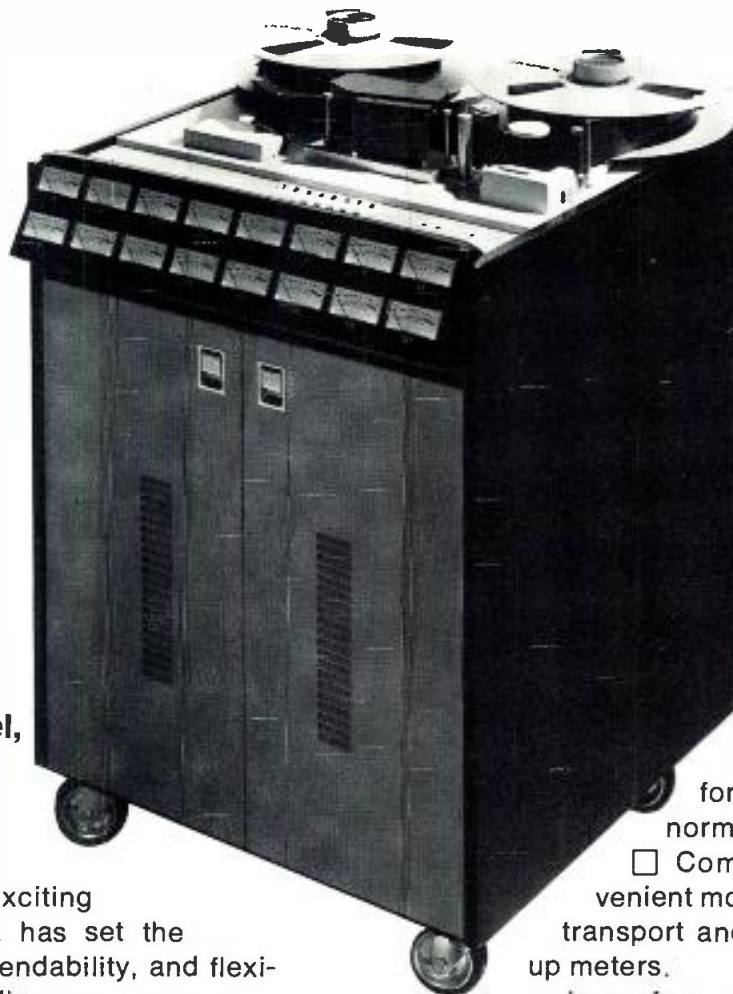
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SPECIAL NOTICE

● It will be obvious to subscribers that this issue, and the previous one are quite late in their arrival. An explanation is due. The disastrous floods that swept the Eastern U.S. in June had their severe effect. Our printer, Telegraph Press of Harrisburg, Pa. found itself with water pouring into its press rooms as the river rose. Several feet were inside at the river's crest. It was a long and laborious cleanup effort afterward.

We were caught with the June issue on press—this was not available for mailing until the early part of July. The consequent pushback of printing schedules will continue to affect us at least until the August issue. We regret the inconvenience, but we trust you appreciate the conditions that have led to it.

COMING NEXT MONTH

● David E. Blackmer has prepared an article that discusses a wide dynamic range noise reduction system such that is exemplified by his dbx System.

Part 3 of **AUTOMATING THE AUDIO CONTROL FUNCTION** by Walter Jung continues in the vein of his earlier parts, but moves toward more practical applications of the digitally programmed switch.

db VISITS—**AUTOMATED PROCESSES**. Our camera pokes its lens into the factory of this manufacturer of devices that range from a tiny opamp to a complete console.

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

● High power amplifiers (see Norman Crowhurst's definitive article beginning on page 26) mean a special thing to our art director, Bob Laurie. We certainly wouldn't like to see audio amplifiers achieve anywhere near this type of operation, but we think it is related in a forceful and striking (!) way.



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db July 1972

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letters

The Editor:

We certainly have had a lot of revisitations to the Fairchild 641 Cutter System, and it seems that the cause of clear thinking has been promoted. For this sincere thanks are due to **db Magazine** for being willing to devote space to this subject.

In the most recent revisitation a letter from Peter W. Tappan of BBN was discouraging. We should by now be well inured to the daily assaults of blind orthodoxy, but it is still shocking to be asked to take propositions on faith because of "expert testimony" by "prestigious institutions". Unlike Mr. Tappan, who admits he hasn't bothered to verify for himself the "expert testimony" which he embraces so eagerly, there have been plenty of A-B comparisons of the Fairchild 641 with and without vertical rolloff. I am here to tell you that if a contrabassoon

located at the extreme left has its fundamental tones moved toward the center while all its overtones remain in their true locations, the apparent directionality of the contrabassoon will not change *one whit*.

Far more refreshing was the letter from Warner Clements, who understands two important things:

- a) If a "logical deduction" conflicts with actual experience, it has to be the "logical deduction" that's wrong.
- b) The derivation of algebraic expressions does not necessarily constitute discovery of laws of physics.

If we look at a listening room as a sealed resonator and regard the two speakers as pneumatic pistons, Boyle's Law tells us that if speaker cone No. 1 moves to and fro two inches and speaker cone No. 2 moves zero inches, the net compression and rarefaction in the room are the same as if speaker cone No. 1 moves one inch and speaker cone No. 2 moves one inch. (By the way, the law of inertia being what it is, the two cones probably don't even have to be in phase.) If the amplifier power equations do not verify this, there is something wrong either with the equations or with their application. Clements understands this, and so should we all if we are willing, as he is, to shed narrow, orthodox patterns of thinking.

Richard Schulze
President
Philharmonic Standard Corp.
Acton, Mass. 01720



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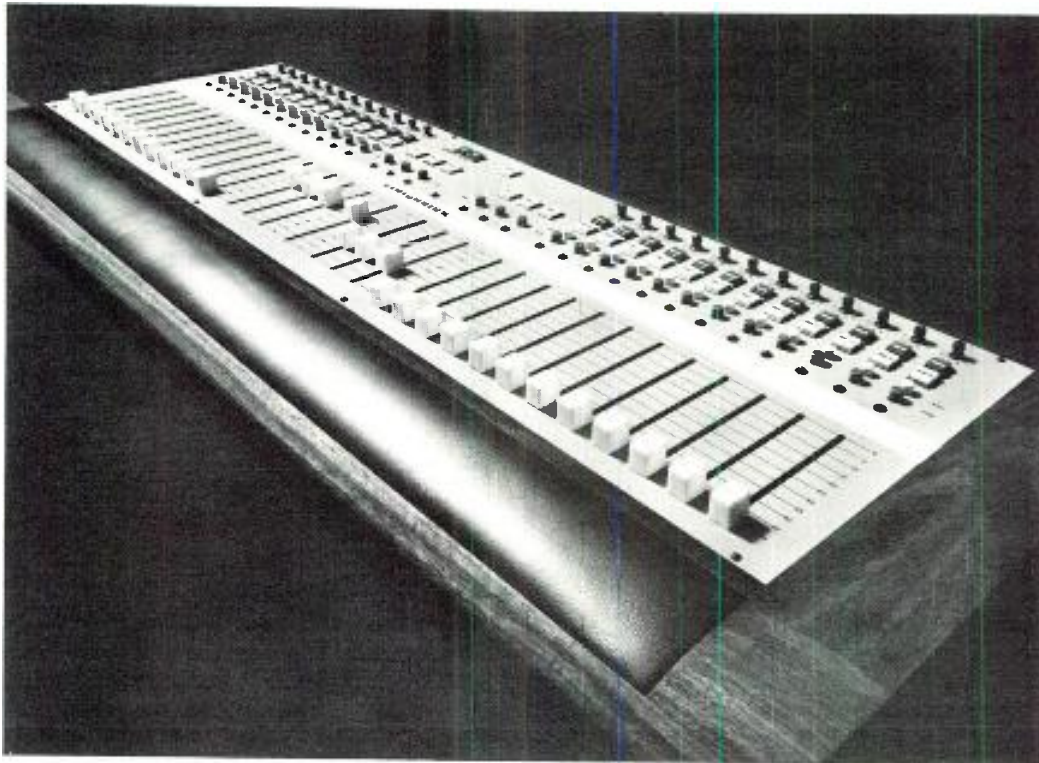
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The Editor:

I have just read Mr. Crowhurt's discussion of *tremolo* vs. *vibrato* in the April issue and would like to offer the following discussion in hopes of further clarifying this controversy:

First of all, it seems that *tremolo* is the result of a musician's conscious effort to produce a periodic amplitude fluctuation by production of a rapid sequence of attacks. This happens when a violinist strikes the string with the bow in rapid succession or when a flautist produces a flutter-tongue effect. On the other hand, *vibrato* results from an attempt to produce a smooth, periodic modulation of the tone. This can result in simultaneous frequency, amplitude, phase and waveform modulation of the tone, even in an extremely dead room where reflections are negligible.

To understand how this complex form of vibrato can come about, one should think in terms of the acoustic behavior of a musical instrument from a systems point of view. This can be modeled as simple excitation waveform which is applied to a multi-resonant filter. The excitation waveform is the pressure or velocity wave-

form which occurs in the mouthpiece of a wind instrument or the string vibration waveform of a string instrument. The multi-resonant filter describes the frequency response of the tube or box of the instrument as it amplifies and attenuates the various harmonic frequencies of the excitation. This can be approximated by a series of fairly narrow, simple band pass resonators. In wind instruments, the harmonics of the excitation line up approximately with the resonances (but only approximately) whereas the relation between the body resonances of a string instrument and the harmonics is random.

Now, if we assume that when vibrato is produced, the excitation frequency is modulated periodically, it is clear that the *n*th harmonic will deviate in frequency *n* times as much as the fundamental. The frequency varying harmonics which make up the excitation waveform are applied to the multi-resonant filter which acts in such a way as to produce different phase and amplitude modulations at each harmonic. The amount of phase and amplitude modulation for a given harmonic depends on its proximity to

a resonance. If a harmonic were to lie at the center of a resonance, the amplitude change which would result from a frequency change would not be as great as if the harmonic were to lie on the skirts of the resonance. If the skirts of the resonance are sufficiently steep, considerable amplitude modulation could result from simple FM. Also, the phase vs. frequency slope is maximum at the center frequency of a simple resonator.

From the above discussion, we see that when a excitation waveform rich in harmonics is frequency modulated and applied to a multi-resonant filter which produces sound that we hear, different amplitude and phase modulations will appear at each harmonic. This results in a modulation of the waveform and is to a considerable degree responsible for the variety and warmth of tones produced by acoustical musical instruments.

James W. Beauchamp
Department of Electrical
Engineering and School
of Music
University of Illinois
Urbana, Illinois 61801

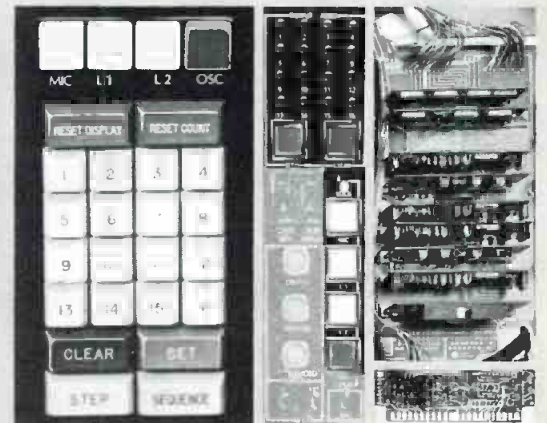
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In the beginning, our every thought was to reject compromise in designing the Series 2000 console. For the audio routing matrix, conventional switching was found to be inefficient, inflexible, noisy and costly.

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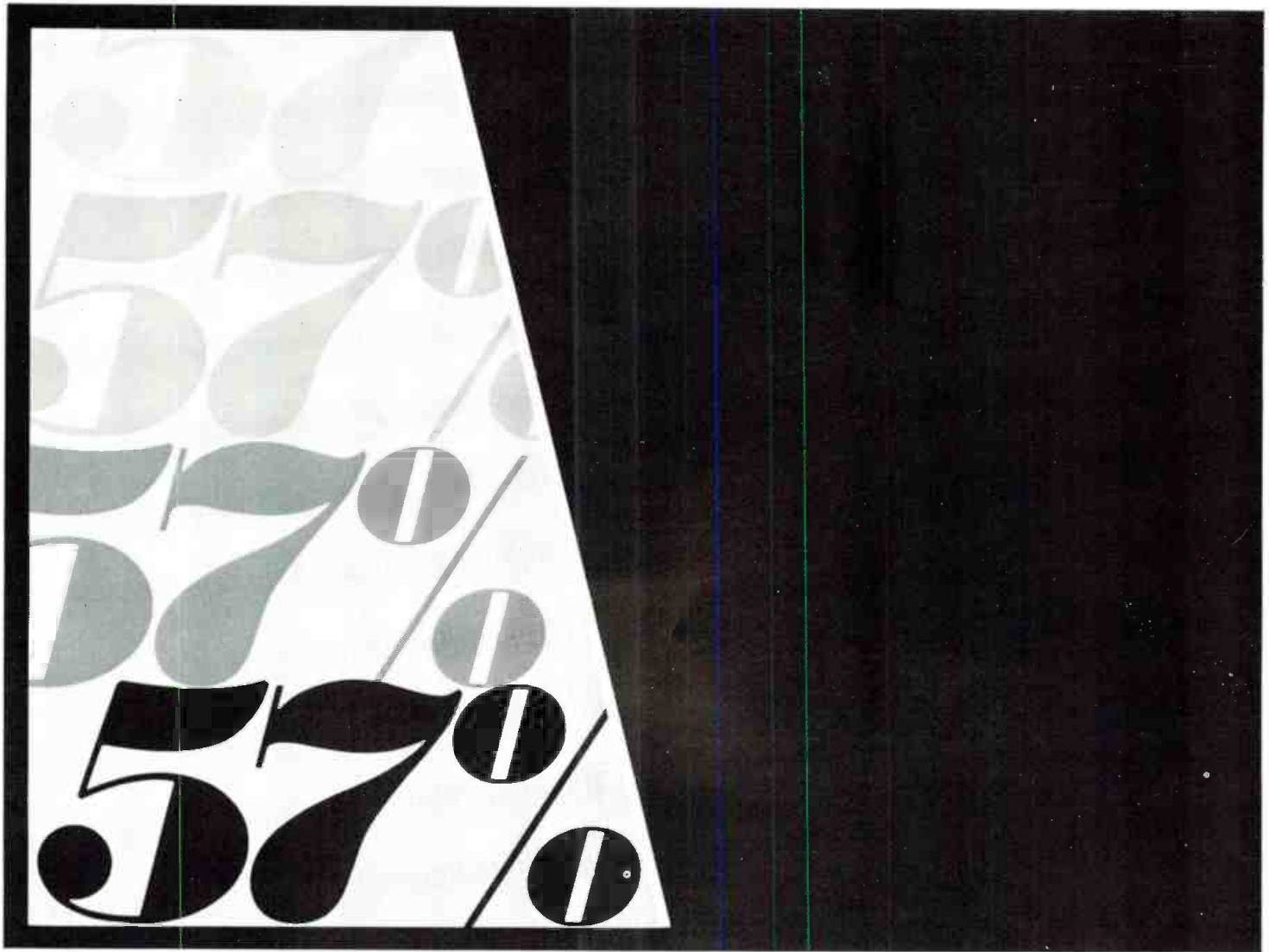
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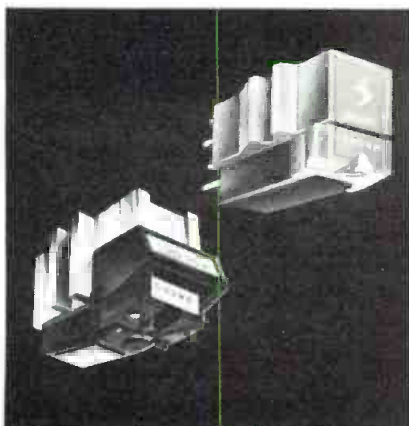
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Norman H. Crowhurst

THEORY AND PRACTICE

● About 35 years ago, the doctor who headed up the research department of one of London's leading hospitals invited me to dinner, through a mutual friend who was just launching a medical electronics company. My friend told me I would enjoy this doctor's company, and a very interesting evening it was.

A book the doctor showed me stands out in my memory. It was *Modern Practice in Medicine*. I particularly remember a photographic plate that portrayed a patient on the operating table, surrounded by surgeons who were not in the familiar white garb. Instead, they wore black silk top hats, white ties and tails—with surgical rub-

ber gloves.

Over on the far side of the table, well in evidence, was a cathode-ray oscilloscope of that vintage, being used to monitor cardiac impulses. That must have been a revolutionary concept in those days. The sheer incongruity of the whole picture struck me quite forcibly. The caption—the book was in French—said something about the importance of using proper equipment and procedure for performing a specific surgical operation.

The book had chapters on the use of electronics in medicine, which I looked at, but do not remember in detail. I do remember that they contained statements on electrical matters

that were flagrantly erroneous.

The good doctor had made his point. The medical profession could use some help—their notions on the diagnostic and therapeutic uses of electronics were even more absurd than the combination of top hat, white tie and tails with surgical rubber gloves as apparel for the operating room!

The upshot of that dinner was that I devoted considerable time for a few years as a consultant, helping to introduce electronics to the medical profession. Medical electronics is doing fine now, thank you. I doubt whether any such incongruities can still be found in that field. But, as I say, the good doctor made his point. Right here, I have a very similar point to make, with a slightly different context.

During the past 18 months, my personal involvement in and investigation of education has shocked me, no less than what the good doctor showed me did. The way I have heard words like video tape and educational tv, along with audio-visual, slide tape and a lot of other expressions being used, suggests that technology *is* getting used in education. But what I see about the way it is used is strongly reminiscent of that photograph in the book the

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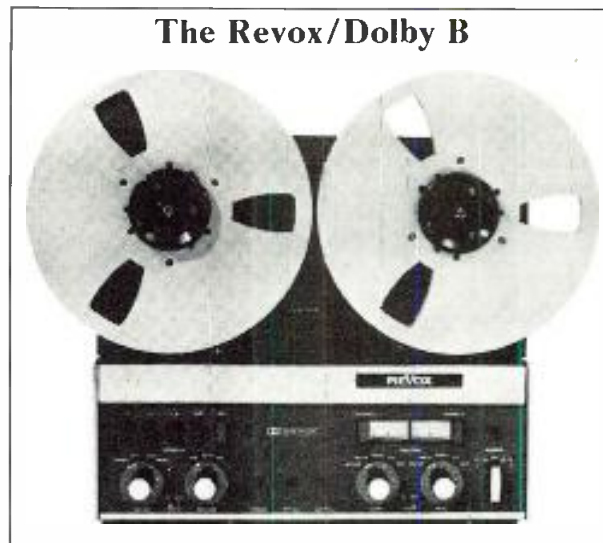
But no mere description of the

Revox/Dolby B can adequately convey the experience awaiting you the first time you listen to a tape made on this remarkable machine.

Your nearest Revox dealer will be delighted to audition the Quietest Revox

for you. Once you've heard it, you'll understand why we say...

Revox delivers what all the rest only promise.



doctor showed me!

Research projects, some of them funded at millions of dollars, aim to determine the effectiveness of new media. Would you believe that, to compare video tape, audio tape with slides, classroom presentation with a live lecturer, self instruction from a textbook, and motion-picture film, one of these projects put a whole course into all of these media, careful to see that the content was identical in all of them?

For example, the video tape used the exact same words that the lecturer was required to read from the textbook. At one stage, they even made video tapes in which the lecturer was required to read his material in a monotone, the reason given being that students get no verbal expression from reading a book! Need I report that this video tape did not score very high in the test?

I remember some film I saw right after World War Two, developed by Disney Studios during the war. It presented all a navigator needed to know about electronic guidance systems, including a really good coverage of basic electricity, all in no more than 10 to 20 minutes. It would have taken a student at least six months to learn the same material from conventional classroom instruction. Recently I met an engineer who had been trained by that same film during World War 2. He remembers the film today as clearly as the day he saw it, over 30 years ago. He never forgot the principles it conveyed.

But they do not use anything like that in today's educational media. True, I have seen some quite attractive stuff, as well as a lot of very mediocre material. Educators seem to have no idea what to do to convey that kind of dynamics.

For the last six months I have been preparing a course in math analysis for slide-tape presentation, which has started to be experimentally tested in local schools. These materials could undoubtedly be improved upon. However, they are already so good, compared with other available materials, some of them costing ten to a hundred times as much to produce, that people who have seen them are really turned on. My point in mentioning this is that one person (myself) can only do what is such a very small drop in a very large bucket.

There are many facets to the problem of effecting this kind of improvement, most of which still require answers, before we can begin to implement them. Big in education, for the last couple of years or so, have been behavioral and instrumental objectives. For sure, it is better for the teacher

to have some objectives in teaching than merely to pour forth dull words without caring whether any of the students ever learn anything!

However, so many of the objectives I looked at during my investigation seemed to have been based on the kind of experiments reported in *Scientific American*. You have read about the kind of experiment where rats are conditioned so that they will always press the green button that gives them food, rather than the red button that gives them an electric shock—sharp creatures, rats! Practically all the objectives used for standardized tests in schools are based on such notions of conditioned responses.

They prove, for example, that the student can solve something called simultaneous equations. They do not prove that he is capable of applying his grey matter to use the *principle* of such equations in solving a practical problem. Small wonder that teachers, without exception it seems, complain about math students not being able to solve verbal problems! So how much math have these students truly learned, whatever the standardized test scores say?

They have learned to give the responses that get grades (if they are lucky), but they do not know how to do anything intelligent with mathematics. In short, students can do the same things that computers can do—what they are programmed for—only much more slowly. What kind of preparation is that for tomorrow's (or even today's) world? I use mathematics for illustration here, because it is a subject with which I am more familiar. But the same problem exists across the whole curriculum.

The measurement system used is an obstacle to change. If the tests used measure only conditioned responses, then attempts to train a child to think for himself are apt to produce negative results according to those measurements, because he is supposed to respond *without thinking*. So one job we must tackle is to introduce educators to meaningful measurements that will determine that the student can really apply concepts supposedly learned, rather than merely regurgitating them!

Another problem, as teachers repeatedly moan to me, is that most students are turned off to learning. They want to turn them on, as if that involves some secret and highly complicated switching mechanism! It is very secret, unless you are willing to listen as well as talking! It consists of finding and challenging what interests these youngsters, and steering that in a useful direction. It's not complicated and it does not take years, as some teach-

ers insist it must. Usually it takes only minutes—possibly an hour or so for the worst cases of turn-off. I know, because I've repeatedly and unflinchingly done it, and I know others who have found the same remedy.

Another part of the job ahead is to catalog what is available for us to use: equipment, different ways of approaching various types of subject matter, as well as what those types are; how different students think about things, or the way of thinking that individually gives them confidence in what they do (for example, some prefer intuitive approaches, some prefer rational, for the same subject matter).

All over the place, you read about "individualized instruction": that is another phrase that's big in education today; you would think it should include suiting the presentation to the individual student's needs. It seldom or never does. All it ever seems to mean is that each student can learn the same rigidly prescribed course at his own pace, whether or not the approach used happens to suit his needs.

We have all this technology going to waste, while educators reshuffle the same old stuff and call it new! We have media coming out of our ears, but it is being used only to produce nicely dressed up lecture or textbook format presentations of the same old stuff. Time and again, when I ask questions to suggest what could be done, teachers or administrators will tell me, either that they are already doing what I suggest, or that it's impossible. When I check for myself, I find they didn't even understand what I meant.

What can we do? A tremendous amount of help is needed, that really requires the kind of talent developed by working with audio systems. This problem-solving technique needs to be applied to a totally new field—how to effectively provide learning experiences.

People in general seem to realize that education is not doing what needs to be done, in any direction, although they have no solutions to offer. Students also recognize the deficiency when they say, simply and directly, "What they are teaching us is not relevant," time and again, although they do not have solutions, either—nor should they be expected to have. Educators seem to be listening, or else they do not know what *relevant* means. But can we blame them?

As I see the picture, our teachers are trained in conventional subject-matter classifications. With such conditioning, the best use that they can make of media, such as video tape, slide tape, overhead projectors, or what-have-you, is as an adjunct to

their existing, worn-out approaches to material that is obsolete, or at best obsolescent.

They may be truly concerned with updating it, if only in self defense. But they can never move fast enough in today's ever more rapidly changing world. A totally new and challenging approach is needed—one that engineers can comprehend, because they have worked with such dynamics all their lives. But such an approach is totally strange to educators. The curriculum must itself incorporate the natural dynamics of the subject matter as an integral part—not as an add-on—so the student can move forward with the times, instead of continuing to struggle vainly to keep up.

Curiously, all these things tie together. Dynamics, challenge, updating, making material meaningful, using effective measurements of learning, handled aright, all work together, instead of being umpteen different things needing to get done, that add up to utter impossibility.

From the foregoing we may be able to identify what needs doing and to develop a large slice of how to do it—a solution on paper—and we will learn a lot more by the doing. I learned to teach by being put in a classroom with students who wanted to learn what I already knew. Oddly enough (really!) learning happened, although I never took any courses in educational technology or psychology. Today we have so much more to work with than we had almost 40 years ago!

But the last—and probably most difficult—problem is that of implementation: how to get to do what needs doing! It is largely one of overcoming the resistance of hide-bound educators. We have friends on the inside of the system, but we cannot count too much on their help. The vast majority are hide bound, and highly devoted to hide protecting—theirs!

Implementation is going to take concentration on all fronts: finding ways to effect real improvement and proving that they work; getting exposure for such success; demonstrating that such effective education need cost only a fraction of what the wasteful, ineffective variety of which we presently have a surfeit, costs us. Such an effort will have to be a whole new vocation, because today nobody, or virtually nobody, is doing it.

Let us get together and pool ideas, enrich our conceptions. Our country's future depends on it and a job well done always brings its own reward. I have suggested to our editor that we set a date in September to Tele-Sessions this subject. If you are interested, drop a line to **db!**

Son of U47



It looks a lot like the old man.

What a mike he was. What presence. What a shame he had to go.

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THE SYNC TRACK

Nuts and Bolts

● Anyone involved in the day-to-day operation of a recording studio probably spends a lot of time searching for the proper wire and cable, plugs, relays, and other assorted what-nots—The nuts and bolts of our industry.

Once you've acquired that exotic console and all those fancy tape recorders and super speakers, you must turn to more mundane matters, like; how do you tie them all together and with what? Or—how do you modify them to fulfill your particular requirements?

Obviously, you need a supply of the nuts and bolts mentioned above. Why not just go out and pick up what you want?

Try it—you won't like it! Sometimes I really believe it's easier to buy a stock console than a stock relay. And the salesman who would gladly meet you on a tightrope over the Grand Canyon to discuss your kilobuck needs is rarely in the country when you want advice about light bulbs.

I suppose its a "sign of the times" or something like that. But if you're not ready to drop a lot of cash, don't look for great service. Of course, this is not a condition unique to the audio industry.

I bought a brand new Oldsmobile some time ago—4000 bucks. It was no trouble at all—the salesman anticipated my every whim. But now that I've been parted from my cash, what about service? Forget it.

Prentice-Hall sent me a little note about a *Miracle Sales Guide* they publish. To quote, "Get rid of little buyers . . . Stop wasting time on customers who 'buy small' and will always buy small . . ." The guide goes on to tell you how to switch to bigger game—whom to drop—how to move up to bigger people.

I wonder where we'd be if a Prentice-Hall salesman was in the store when Wilbur and Orville dropped in for a few more nuts and bolts?

Prompting all this grumbling is a soon-to-be-completed project that I've been involved in for more weekends than I'd care to remember. In our control room, we have a complete complement of tape recorders—all of which are used, when required, with Dolby Noise Reduction units, of

which there are 20. It gets to be a formidable task just moving them from one machine's lines to another's. So—we've been installing an automatic switching system that will take care of our changing needs at the flick of a switch. To plug a complete set of Dolby 361 units into a 16-track machine involves 128 pairs of plugs—128 opportunities to make a mistake. The switching system will certainly make life a lot easier. I'll get to the details in a later column (if it works, of course).

In what's left of this one, I'll describe our adventures in locating the requisite hardware. Some of this might be of interest to the smaller studios that do not have the time or budget to go hardware hunting. Unfortunately, it can very easily become a full-time job.

Since the project involved extensive rewiring of our tape-recorder lines, it seemed like a good opportunity to re-think the entire cable-to-tape recorder hookup. A 16-track machine, even without external Dolby units, involves a lot of Switchcraft (or Cannon) plugs. And of course, most tape-recorder manufacturers have gone to a lot of trouble to locate their input and output plugs as inconveniently as possible. Usually, they're about as close to the machine's wheels as modern technology will allow. This is so that everytime you move the machine, you will be sure to foul the cables in the wheels. With a little practice, you can be assured of ripping a few plugs off every time you touch the machine.

Now this is great fun at first, but after a while it gets tiring. So, we're relocating all our connections at the top of the machine. And, while we're about it, we're replacing the sixteen pairs of 3-pin plugs with four 24-pin plugs. Each plug will contain eight lines (4 in and 4 out). Therefore, plug 1 will contain tracks 1 thru 4 in and out, plug 2 will be for 5 thru 8 in and out, and so on. On the wall near the machine, at a height of about 4 feet, will be a junction box with four cables hanging down and almost touching the floor. When the machine is plugged in, it can still be wheeled almost four feet away from the wall, and when it is rolled back in place, the cables do not get in the way of the wheels.

Our eight-track machine will use

two of these plugs, and the four-track needs only one. The two-track machine will also use one plug, but of course only half of the pins will be used. By using the same plug for all the machines, it becomes a very easy matter to change them around quickly, should the need arise.

Finding the plugs was quite an adventure. Of course, all the military suppliers make them, but try getting information once they know you don't plan to buy in 1000-unit quantities. Suffice it to say, we got absolutely nowhere, until our friendly (and patient) "hardware store" came to the rescue. Eventually, we came up with an Amphenol connection known as MS-3102a-24-28-s. MS means Military Standard, 3102a describes the style, which is a solid shell construction, suitable for chassis mounting, 3101a would be the equivalent cable plug. 24-28 indicates a size 24 shell (about 1½-inch diameter) with a 24-contact insert. Note that the 24-contact insert is described by the —28 part of the coding. In other words, the number of contacts is not necessarily indicated by the actual number in the coding. The s indicated a socket. A plug would be specified by p. This way no one can accuse the military of being an exploiter of male (M) or female (F).

Multi-pair cable is a little easier to specify and locate. At least three manufacturers produce the proper cable for microphone and tape lines. Two popular sizes are the 9-pair and the 19-pair format. A cross reference of three manufacturers is given below.

Format	Alpha	Belden	Manhattan
9 pairs	6014	8774	M 3109
11 pairs	6016	8775	M 3111
19 pairs	6020	8769	M 3119

A 100-ft. reel of 19-pair cable costs about \$82.00. The various pairs are color coded, and each supplier publishes his own color-code chart. Although there are differences in the charts, any cable bought from one manufacturer will contain the same colors as found in cable from the other two. So, if you change cable suppliers in mid job, make sure you don't change color codes too.

On the subject of cable, the Beyer people import an excellent microphone cable for use in the studio. It's remarkably flexible, and doesn't fight back when you're trying to coil it up after the session is over. It's their catalog number MK 72, and it lists at \$70.00 for a 268-yard coil. One small point though—they use blue and white for lead colors, so you'll have to keep this in mind when you're using it along with the more standard black

and white, or black and red product.

We're using a lot of relays in our switching system. From experience with tape machine relays, we've come to appreciate the value of sealed relays. Our recorder came equipped with a lot of Potter & Brumfield KHP 17 D 11 relays. KHP means a nylon dust cover over the contacts, and 11 indicates gold-flashed silver contacts. Some time ago we switched to KHS 17 D 13, which is the same relay in a hermetically sealed metal enclosure, and with gold alloy contacts. They cost a few dollars more, but we've reduced our failure rate from very often to hardly ever. I don't know how much of a problem relay failure is outside the metropolitan areas. Here in Fun City, the air is apt to be on the unfriendly side, and relay contacts need all the protection they can get. A nylon dust cover seems to offer very little protection against the contaminants wafting in on the breeze, but I don't recall any failures with the sealed units. And on a multitrack selsync session, the relays get a lot of action. Failures can be awfully expensive—far more than the additional cost of sealed in protection. Before buying a relay for any audio use, it's worth it to find out if the same format is available in a sealed version. For convenience, and standardization, we're using the relay mentioned above in the switching system. In addition to the characteristics already mentioned, it's a 4pdt, 24vdc, plug-in type.

Needless to say, the switching panel got awfully confusing when it came time to wire it up. A 4pdt micro switch, with four pilot lamps, winds up with 20 solder terminals on it. We found it a help to breadboard the circuit first, using E-Z Hooks. These are plastic covered probes that can be inserted in very cramped areas. Depressing a plunger at one end exposes a minihook at the other. The hook easily grabs any solder terminal or exposed wire and will not short out adjacent terminals by accident, as may happen with an alligator clip.

One final point on nuts and bolts. Magazines like *Electronics Design* or *Electronic Products* list page upon page of plugs, switches, pilot lamps and so on. They are valuable sources of information for anyone planning a construction project of almost any kind. However, when discussing your needs with a manufacturer who deals with government-type quantity orders, don't expect too much in the way of assistance. Also, most of these odds and ends are not commonly stocked by regular audio industry suppliers. So, although there is a wealth of space age technology out there, getting to it is not always an easy matter. ■

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SOUND WITH IMAGES

Happenings and Convention Follow-Up

● Last month I tried to bring you up to date on conventions that had been held or were upcoming. I left out quite a few that might have been of great interest to some, but I felt that the ones we mentioned were of the greatest general interest and would be, in a few instances, new to some of our readers.

This time, I should like to bring you abreast of what was said at one of the meetings (in case you missed it), and tell you about another one that will be of great interest to many of the audio and a/v specialists.

The past convention of which we're talking is the 111th SMPTE Technical Conference and Equipment Exhibit. Some of the fields covered in the talks were Motion Picture and tv Production Techniques, Laboratory Practices, Cartridge and Cassette Systems-Videoplayers, TV Systems and Equipment, Education in Motion Picture Technology, Theater Projection and Screening-Room Practices, and Post Production and Editing Techniques. The conference took place the first week in May in New York, and I have selected a few of the many papers that were given to provide you with an idea of some of the thoughts that were expressed.

In one of the sessions on Laboratory Practices, Mr. John D. Lowry of Image Transform, Inc., Hollywood, Calif., discussed the process he invented for improving the image that results on a film made from a video tape using this new process. His idea, generally, was that it was now possible to produce a very acceptable film image, comparable with original film material, from video tape by using his company's equipment and method. Therefore, original shooting could now be done in tape giving the advantages of being able to view the results and reshoot in minutes, if necessary, rather than hours or days as in the case of film; being able to

reuse the tape, which is not possible with film; greater possibility for dramatic mixes and effects by using several cameras and other sources. Film has the decided edge in worldwide distribution as it can be played anywhere.

Up to the time of the development of this new process, a transfer produced a "kine" which was a poor reproduction compared to direct film. Now, by taking the video image through a computer's reprocessing magic before sending the signals to the film for recording, noise is reduced, detail is enhanced and colors are corrected. Each of the primary colors as well as black and white are handled separately as is the gamma value. A completely reconstructed image is then recorded on the film, with remarkable results, as demonstrated at the session.

No details of the technical process are presently available nor were these divulged at the meeting, but the quality and results of the process were visible to the viewers watching the tv transmissions of the recent Apollo 16 moon shot. It was this process that was used to improve the live pickups from the moon. NASA sent the decoded signals to Image Transform for improvement before feeding to broadcast lines.

New developments are forthcoming to permit even better tape-to-film transforms so that the results will be indistinguishable from an original film. These include automatic conversion from a tv camera to the 24 fps rate of film and including the required change-over to the proper aspect ratio for film as compared to tv.

In the session on Cartridge and Cassette Systems, Mr. William J. Hannan of RCA/David Sarnoff Research Center presented a paper on the RCA video-player which uses holographic recording. "Holotape", as it is called, is actually very thin film-like material

(similar to that used for foodwrapping) on which has been reproduced a continuing sequence of holograms which, when played back through a laser beam, provides images for a video camera pickup and resulting signals for viewing on a standard tv set.

The material can be placed into cartridges easily and offers the advantages of low-cost reproduction, imperviousness to scratches or dirt or even partial mutilation, and the inherent capability of flicker-less images at any speed and no mechanical shutter to synchronize.

The process for providing a finished product was discussed, the techniques used in color-coding the visual information, and the means used to suppress noise in the final reconstructed images.

In the same session, Mr. Edward D. Baars of the North American Philips Corp. discussed another system for the reproduction of both visual and audio material on a home tv screen. This system, called PIP, is the Philips entry in the cassette-cartridge field.

This system utilizes two separate cassettes, one for the visual information and a completely separate one for the sound. The images are reproduced from a silent super-8 film while the audio is played back from a similar cassette which has standard cassette audio tape. Synchronization between the two is accomplished by a series of pulses recorded on the second track of the audio tape, one pulse for each frame.

This permits changing the speed of the film at any time by control of the pulses while the audio continues at normal speed. Still-frame is simply the absence of pulses at any point on the tape to any other desired point.

This same system can also be used for different languages without changing the entire program. All that is required is a different audio cassette with the required language which has been coded on the second track with the necessary trigger pulses. The visual cassette can remain the same.

In the category of Post Production and Editing Techniques, Mr. Richard S. Marcus of Rombex Productions discussed the technical modifications and techniques for electronic editing of video tape recorded on a helical-scan machine.

The special feature required of the editing machine is the capability of switching from a playback to recording mode with no transient signals being recorded on the tape during the switchover. The total system requires the use of master playback and record

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Features

- The recorded portion of the magnetic tape can be read at a glance by a scale division of 1/4 second as accurately as a clock.
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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 rewind 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.

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Two models are available:



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db July 1972

13

machines which can be perfectly synchronized or at least controlled simultaneously. By feeding the signals from the control track on the tape to an electronic counter and pre-determining the number of pulses necessary for the machine to stabilize from a standing start, both playback and recording machines can be preset and started together so that the recording machine will switch into the record mode at the precise instant desired. For proper presetting of both machines, they must be capable of being rewound at a slow speed so that the proper number of pulses can be counted and the machines stopped automatically at the required point. The electronic edit will then take place at the desired spot.

I have selected only a miniature sampling of the more than 75 papers presented, and these were in the fields I thought might be of greatest interest to most of our audio, a/v, and video specialists. I wish only to indicate the great variety of subjects covered that are directly related to the field of audio-visual systems and techniques. I hope that interest has been whetted so that further inquiries will be made for more information on these and the other subjects covered at the SMPTE convention.

The convention to watch for which

will be coming up shortly is the Second International Cartridge TV/Video-cassette/Disc Conference, sponsored by the The Billboard Publishing Group. This video media conference and exhibit will take place at the Hotel Roosevelt in New York from August 21 to August 24.

This, being the first user-oriented international video marketing exposition, should be of great interest to a/v specialists who are now or will be involved with video and/or video cassettes. Speakers at the convention will include experts in all phases of the video cassette field. Among them will be Messrs. Kevin O'Sullivan of the National Audio Visual Association; Robert O'Boyle, acting director of the Army Audiovisual Agency; Sol Schildhouse, Chief of the FCC Cable TV Bureau; Don Segal of Cable Shows Video Corp., and several of the heads of the audio-visual departments of industrial concerns.

Among the many hardware and software manufacturers in the video fields that will be at the exhibits are Panasonic, Videorecord Corp., Telectronics International, S/T Videocassette Duplicating Co., and Retention Communications Systems.

At least two dozen other companies have reserved space at the

exhibit and all will show the latest equipment and ideas in video and associated fields. I plan to cover this one and provide you with a report in a forthcoming issue, but I recommend strongly that if you can, you should see this one first hand.

Further information is available from Mr. Stephen Traiman, Director of Public Relations, Billboard Publishing, Inc., 165 W. 46 St., New York 10036. (Incidentally, should you not be familiar with The Billboard Publications Group, it includes such magazines as Billboard, Merchandizing Week, High Fidelity, and others in the U.S. and overseas.) The subjects have been scheduled as Corporate Video, Educational Video, Consumer Video, and 'In-House' Video. The video cassette (or cartridge, or disc, or videotape, or . . . industry is growing fast and requires constant vigilance to keep up with the latest developments in both technology and marketing. One way to keep abreast is to attend meetings dealing with the field and to inquire from the organizations involved how you can become part of the growth.

When you do inquire, mention that you saw it here. Another way to keep in touch, of course, is to stay with us. ■

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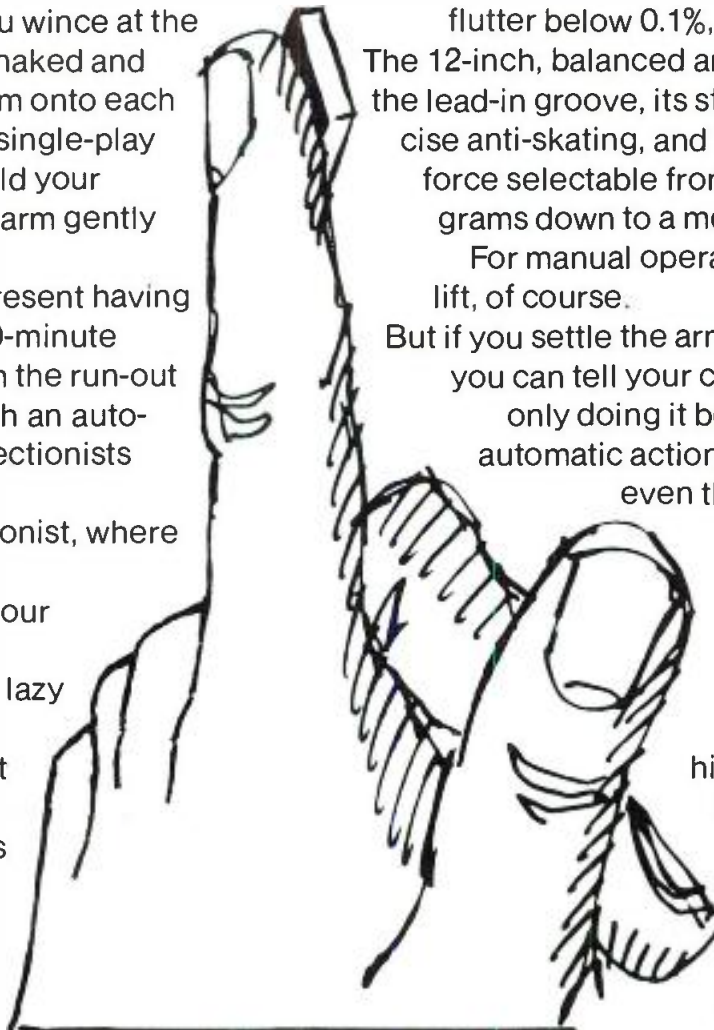
If you're lazy, though, you resent having to dash across the room at 20-minute intervals to lift the stylus from the run-out groove. And you wind up with an automatic turntable. (Which perfectionists still call "changers.")

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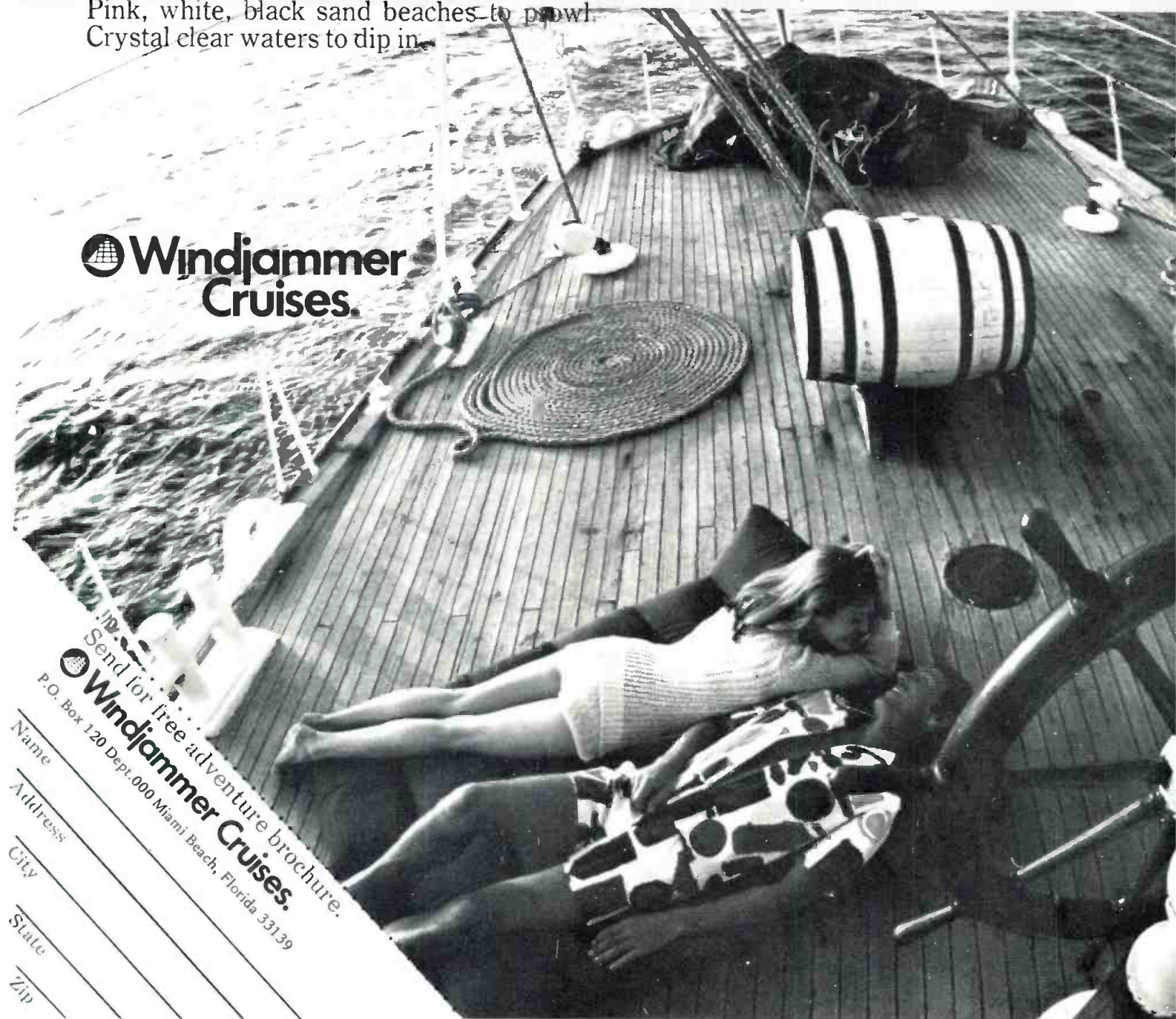
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Picture Gallery— 42nd AES Convention

ONCE AGAIN, it is time to show what our camera saw as it travelled an AES Convention. This one took place May 2nd to May 5th at the Los Angeles Hilton. It was the biggest and best show yet—well organized and well run.

This picture gallery presents as many views as space permits—by no means all that there was to see. If you want information directly from the respective exhibitors on the subject shown, all that is necessary is to send in the number indicated with a circle around it—on the card to be found at the back of this issue.

CONSOLES/MIXERS



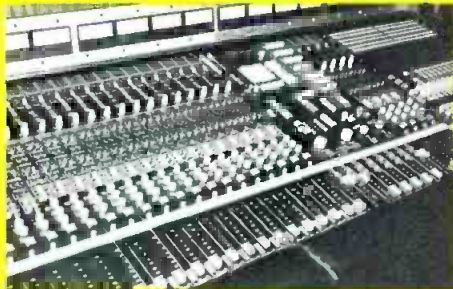
José Feliciano gets this quad 16 channel Electrodyne. *Circle 71 on Reader Service Card.*



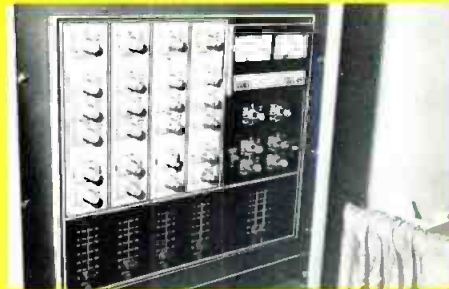
Quantum Audio showed an 18 in, 8 out console. *Circle 63 on Reader Service Card.*



Tascam's (TEAC) low cost 8 in, 4 out quad board. *Circle 65 on Reader Service Card.*



Olive's big board can be computer programmed. *Circle 70 on Reader Service Card.*



Limeters and eq. in the Lamb 4 in, 2 out portable mixer. *Circle 66 on Reader Service Card.*



Quad-Eight's newest 16 channel board. *Circle 64 on Reader Service Card.*



There's more than zebra wood appearance to Zero-Impedance's new boards. *Circle 75 on Reader Service Card.*



Quad pan pots on Automated Processes big board. *Circle 73 on Reader Service Card.*



Harvey Radio sells this Stevenson portable mixer. *Circle 72 on Reader Service Card.*

MONITOR SYSTEMS



James B. Lansing's 4350 studio monitor. *Circle 50 on Reader Service Card.*



Stanton has a new line of headphones. *Circle 51 on Reader Service Card.*



Big throated E-V horn studio monitor. *Circle 52 on Reader Service Card.*

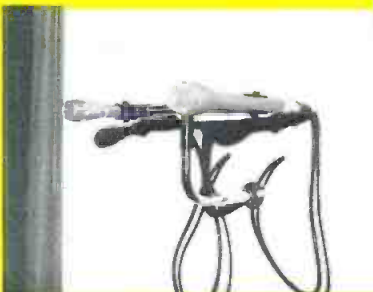


BGW, new name in high power amplifiers. *Circle 54 on Reader Service Card.*

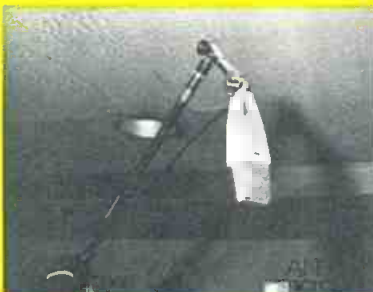
MICROPHONES



Schoeps mics are distributed by Gately Electronics. *Circle 61 on Reader Service Card.*



New Shure microphone is the (closer). *Circle 62 on Reader Service Card.*



New Condenser from AKG, C-412. *Circle 60 on Reader Service Card.*

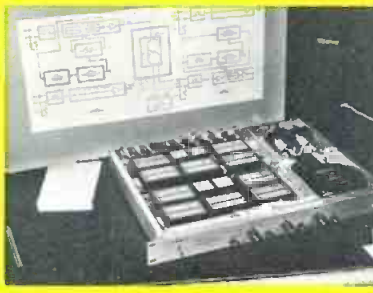


The MD 441 microphone from heiser Corporation. *Circle 53 on Reader Service Card.*

SIGNAL PROCESSORS



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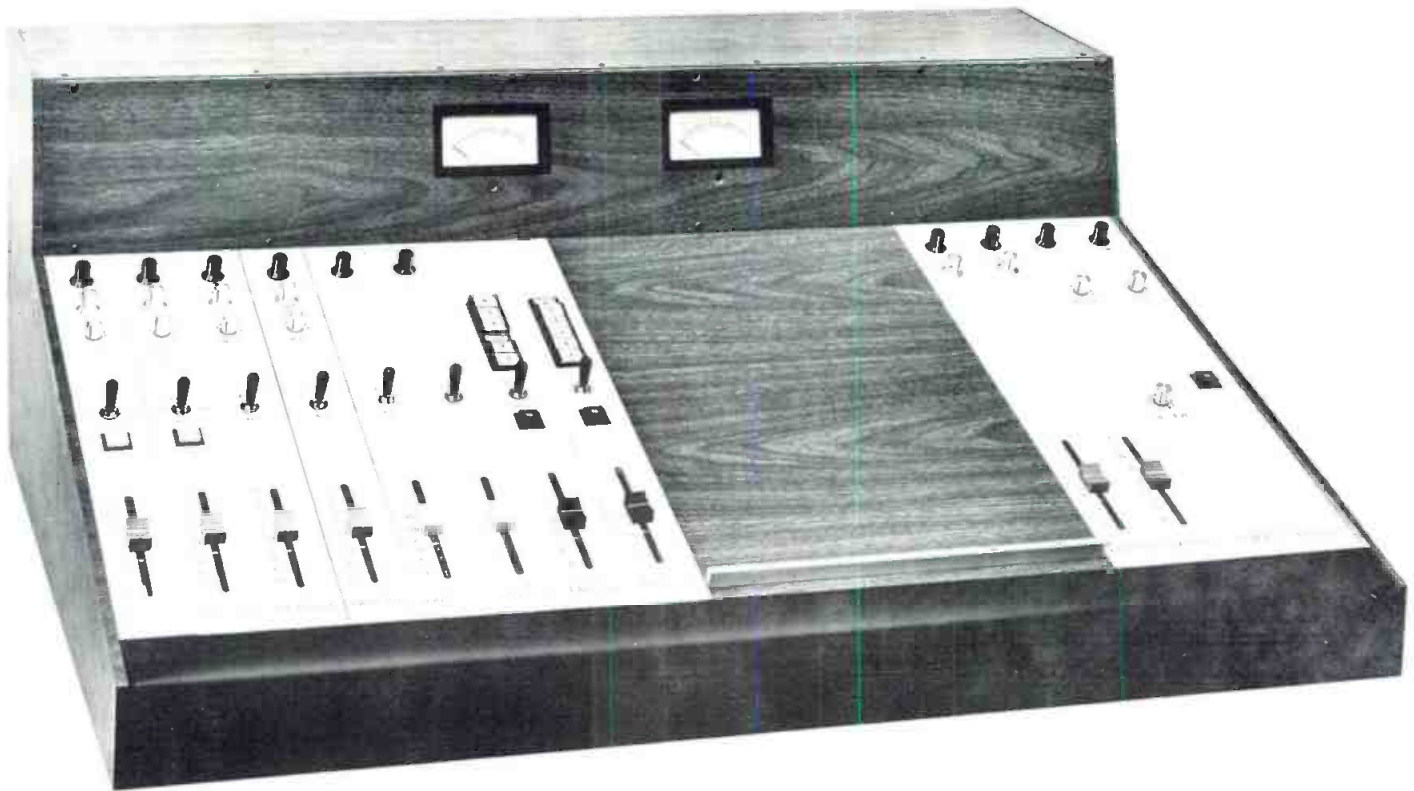
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- Monitor Module, ICBM-M**
- Communications Module, ICBM-C**

A revolutionary new modular approach to broadcast console design and construction using the unique FAIRCHILD/ROBINS building block concept in conjunction with the latest integrated circuit technology. With the Integrated Circuit Broadcast Module system, you can have complete broadcast consoles with only seven different plug-in modules, consoles with custom features that you select at the price of a "standard" wired-in unit. Each compact "packaged" module is a complete operating channel. The modules plug in (and out) as simply as a household plug, giving the units tremendous economic and service advantages.

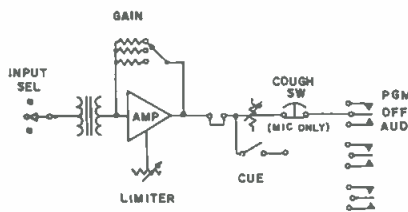
With these unique plug-in units a broadcast studio can be started with a few channels and gradually expanded, or channels can be moved from one studio to another as programming requires. The miniaturized solid state units provide reliability, economy and efficiency because of the close proximity of components. Down time for testing or repair is eliminated by the plug-in feature.

Utilizing the latest in solid state circuitry and the highest quality components, the ICBM Modules are packaged on rugged Formica covered aluminum strips with all input and output connections on "Blue Ribbon" connectors. All markings are engraved and filled for lifetime use without wear. Standard color is black, but almost any color can be supplied to match your studio decor. The modules are available individually, in kit form with console shell, or as a complete factory wired console. The units' flexibility allow for individualized "human engineering" for most efficient operational placement of modules.

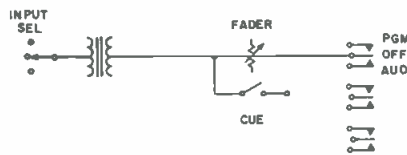
All ICBM modules are built with the latest operational amplifiers combined with the latest circuit design, so that frequency response, distortion and noise exceed NAB standards required for proof of performance. Equivalent noise of -127 dbm and distortion of 0.1% are typical for every amplifier used in the modules. Simplicity of the intermodule circuitry makes them ideal for do-it-yourself assembly where mere interconnection of the modules is required. Modules are 2" wide and 18½" long and are designed to be plugged into FICM () console shells, which are available in standard widths up to 48". A Script Panel Module, FICM-SP10, with a lip for supporting the script is also available.

FAIRCHILD ENGINEERING DATA

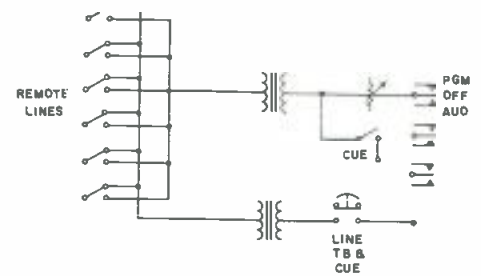
MODULAR BROADCAST CONSOLES &
INTEGRATED CIRCUIT BROADCAST MODULES, ICBM ()



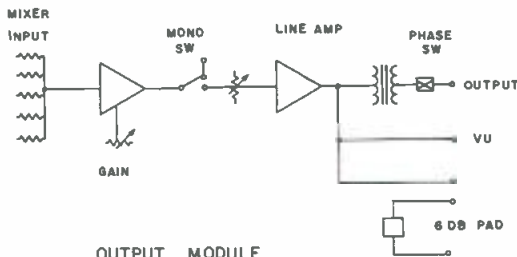
MIC & MEDIUM LEVEL B'CAST MODULE
ICBMMI & ICBMLI



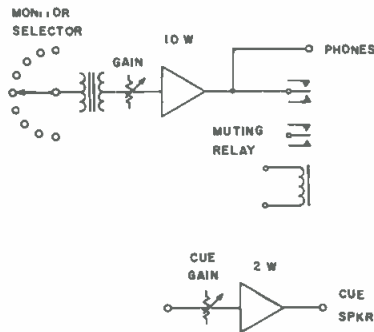
HIGH LEVEL B'CAST MODULE
ICBMHI



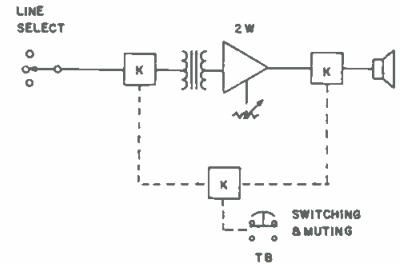
REMOTE INPUTS MODULE
ICBMR



OUTPUT MODULE
ICBMO



MONITOR MODULE ICBMM



COMMUNICATIONS MODULE ICBM-C

MIC INPUT MODULE, ICBM-MI — A basic input module accepting three ranges of microphone levels from three selectable sources. A built-in limiter with variable threshold makes this input module *the only* module not susceptible to input stage overload, no matter how strong the mic signal. The ICBM-MI module has a vertical fader control with cue switch in the off position. A cough switch for the announcer and a delegation switch make this circuit a typical input chain to the broadcast mixing board.

MEDIUM INPUT LEVEL MODULE, ICBM-LI — Similar to the mic input module except for the omission of the cough switch. This module allows selection of the three medium level inputs with selection of the appropriate gain for the selected signal sources.

HIGH LEVEL INPUT MODULE, ICBM-HI — This module allows three high level sources to be selected and processed into the program chain of the board as is normally done in standard broadcast consoles. Gain control with cue switch and delegation switching are the main controls.

REMOTE INPUT MODULE, ICBM-RI — Six remote lines are switch selectable, and are fed into the input fader with cue switch and then delegated into the mixing bus. Talk back facility into the remote lines with momentary pushswitch are part of the circuit.

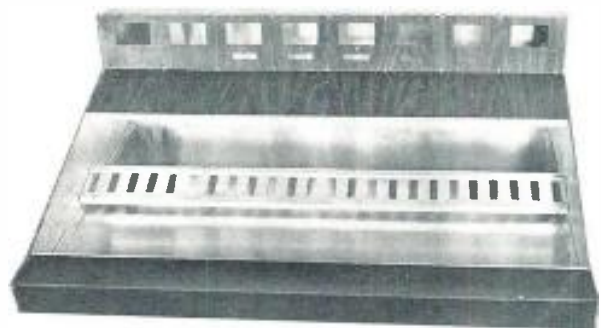
OUTPUT MODULE, ICBM-O — Represents the active mixing which is followed by the mono switch, then fader and line amplifier. Transformer isolated output, phase reversal switch and a separate 6db pad provides telephone line feed.

MONITOR MODULE, ICBM-M — Provides means for monitoring program and cue channels of the system. Selection of the different sources with muting facility of the 10 watt amplification system, together with 2 watt amplifier for the cue circuit complete the facilities required for flexible monitoring.

COMMUNICATIONS MODULE, ICBM-C — This module consisting of a high gain 2 watt amplifier with relay switching so that the talk back speaker is used as a microphone or speaker. Muting is also tied into the relay circuit to prevent accidental actuation of the circuit.

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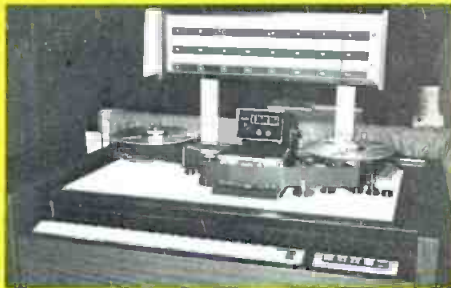
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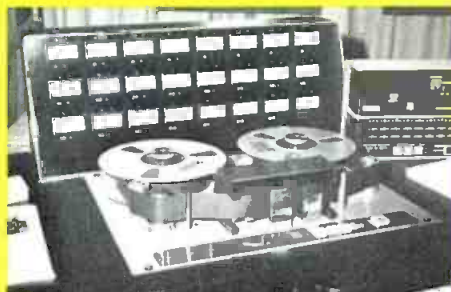
New 24 track 3M was headed for Wally Heider. *Circle 77 on Reader Service Card.*



Scully's 24 track mounts a digital timer. *Circle 81 on Reader Service Card.*



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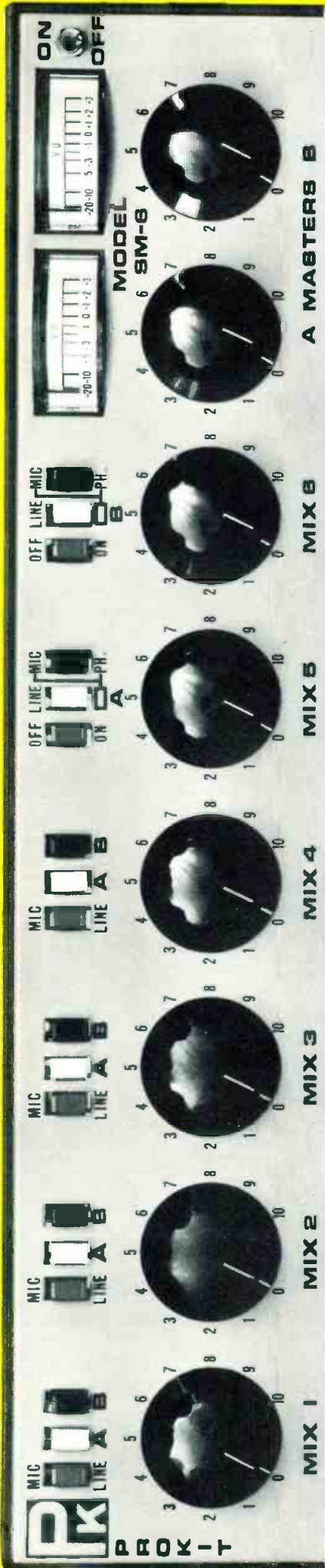
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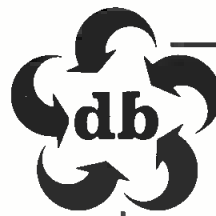
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LOU BURROUGHS

Make a Quality Differential Microphone



TeleSessions

You're invited to use a brand new communications medium to build on the ideas in this article with a group of people as involved in the subject as you. By means of a new "electronic meeting place" called **db TeleSessions**, you'll be able to dial into a group telephone conference with other db readers across the country. You can reserve your spot in the discussion now by turning to the inside back cover for details and information on how to participate.

Broadcast and recording studio grade differential microphones for noise cancelling purposes are easily made and utilized, providing the principles involved are fully understood.

EVERYONE involved with the use of microphones has from time to time found himself with microphones or cables wired electrically out-of-phase with the rest of the microphones. The original mistake probably was in assuming all new microphones are in place with each other. This is not true. Each manufacturer has his own standards. All U.S. companies use pin 1 as ground on an xl type connector, but pins 2 and 3 may be reversed on some you may have. Be certain to check this before placing new microphones in service. Electrically out-of-phase microphones will cause cancellation as indicated by the curves in FIGURE 1.

MICROPHONES ELECTRICALLY OUT-OF-PHASE

This illustration shows what will occur when the microphones are located various distances apart. In this instance we will assume the individual microphones have flat response as shown at 3 feet. As the microphones are brought closer together, cancellation at various distances will occur as indicated, with maximum cancellation occurring when the units are at zero. This situation can be disastrous in some situations—and a real help in others—depending on how it is employed.

The following case history will show the problems with which one production group were involved. I was asked to sit in on the rehearsal of a tv production involving an orchestra and vocalists. They were having recurring response variation that they were unable to solve. Every week when the show was set up the same group of microphones were used in relatively the same location, but each week variations in control-room equalization were required to maintain the desired balance.

I wanted to make certain microphones were not at fault so I brought along sufficient units to make a comparison with those in use. Since the two vocal microphones were the most accessible, I disconnected the cables and connected them to mine. As I connected each one we checked

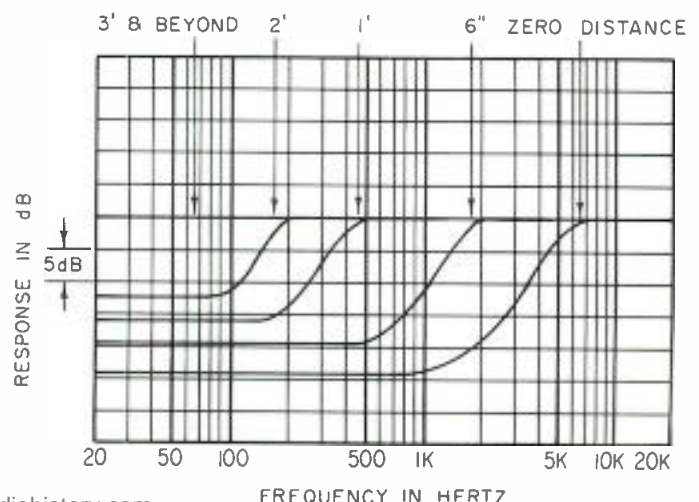
it out. All was normal until I held both in one hand and tried to communicate with the control room. When this occurred, the level dropped to a point where I was barely audible. This meant just one thing, either one microphone or a cable was electrically out-of-phase with the other. It turned out to be the cable. On checking the remainder of twelve microphones used in the orchestra, four more were found wired opposite to their standard.

Locating these cables also solved the problems occurring from variations in response. Each session these out-of-phase cables had been used, but had not been returned to the same location. This caused the variation in equalization observed from show to show. With the vocal microphones being hand held, there was no chance of solving the problem through equalization, since they were in continual motion with wide variations in separation. In the above instances the results of out-of-phase microphones were all bad, but there are also problems that can be solved through their deliberate use.

THE DIFFERENTIAL NOISE CANCELLING MICROPHONE

Differential microphones as they are available on the market are not normally considered of broadcast or re-

Figure 1. Electrically out-of-phase mics will cause cancellations.



Lou Burroughs (Mr. Microphone) has been with Electro-Voice since its inception—he was one of E-V's founders. This means that he has been with the microphone since its beginnings.

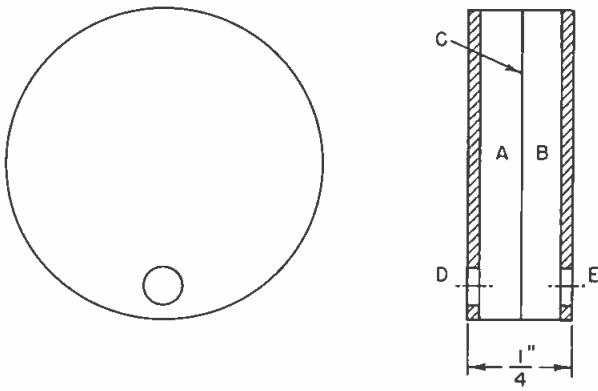
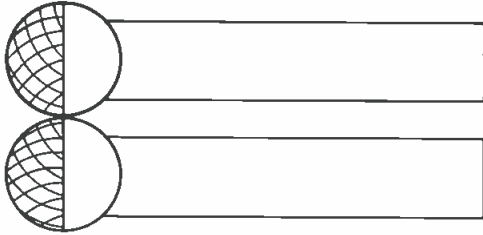


Figure 2. The T45 differential microphone of World War 2.

Figure 3. Two matched omnis can be used to assemble a quality differential mic.



cording frequency response range. One, however, can be assembled quickly that will have adequate frequency range.

But first I want to go back to the beginning and discuss the principal on which it works. The first production differential was designed and manufactured by Electro-Voice during World War II. It made communications possible in tanks and other extremely noisy places. The model T45 was a single button carbon unit, operating on the principal of two balanced acoustic chambers as in FIGURE 2. A and B are the acoustic balanced chambers on opposite sides of a single diaphragm C. Each chamber has an aperture D and E through which sound enters. Sounds originating at a distance of 1/2-inch or more, arrive with equal intensity or pressure at the opposite sides of the diaphragm. Since the pressures are very nearly equal and opposite there is little movement of the diaphragm, hence little unwanted sound is reproduced.

On the other hand, when the unit is worn this acoustic balance is upset by the close proximity of the voice, since the voice is fed into one aperture at a distance equal to less than half the distance between the two. By the time the sound of the voice reaches the back aperture it is 180 degrees out-of-phase with the front and the voice is unaffected.

A BROADCAST QUALITY DIFFERENTIAL MIC

A differential microphone may be assembled using two matched omnidirectional microphones as in FIGURE (3). By this method two microphones are used side by side with diaphragms parallel to one another and in the same place, for maximum cancellation. The microphone should be small—on the order of 1 1/2 inches or less—to cancel over a wide range. The two units are now connected out-of-phase using the cable assembly in FIGURE (4).

Here, unlike the T45 which cancels acoustically through balanced sound pressure on opposite sides of the diaphragm, the two-microphone assembly cancels electrically due to equal and opposite voltages being produced by equal sound pressure on both diaphragms. One voice coil produces negative, while the other produces positive voltage. One cancelling the other.

With two microphones and an out-of-phase cable you are in business in case of an emergency. The two microphones may be quickly assembled to talk through extremely high level noise. Should the need arise and you

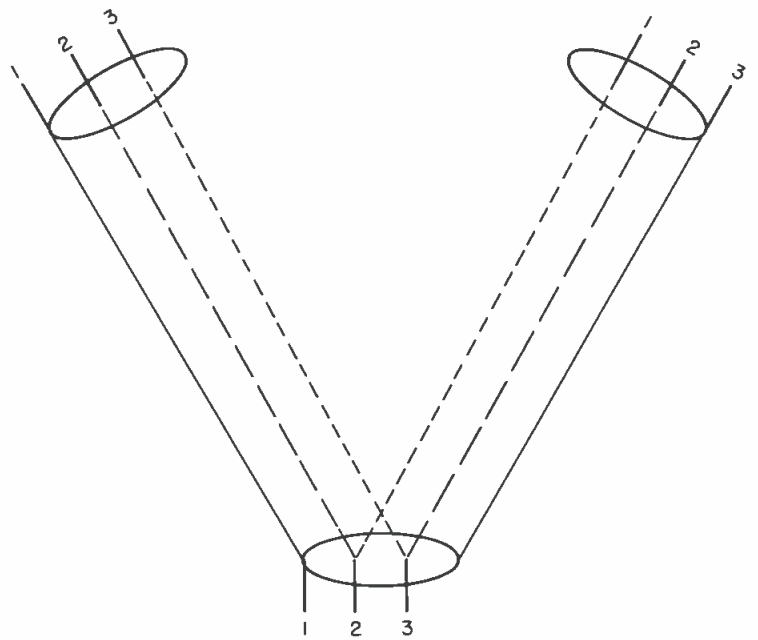
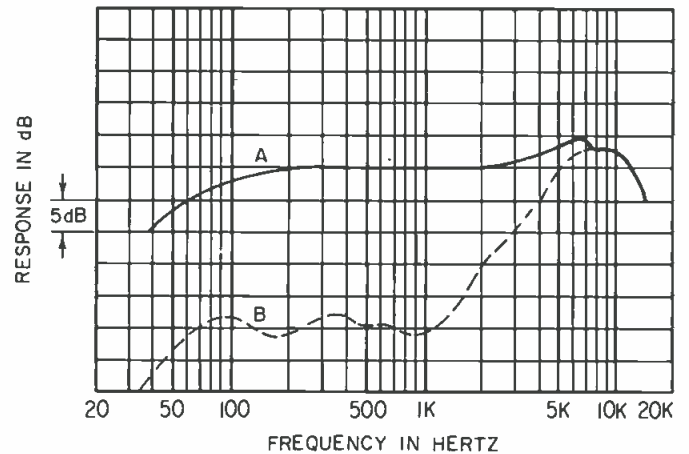


Figure 4. Use this cable assembly for the mics of Figure 3.

Figure 5. Two 1 1/2-inch mics connected electrically in phase (A) and out of phase (B). The physical assembly of the mics is that of Figure 3.



don't happen to have two matched units, try anything. They may not cancel as well but some noise reduction may be better than nothing when help is required. The smaller the individual microphone the more response range they will cancel. (A) in FIGURE (5) is the curve of two 1 1/2-inch diameter microphones connected electrically in phase, the dotted line curve at the bottom (B) is the result of connecting these same microphones electrically out-of-phase.

Many differential units similar to the T45 have been made, some carbon, some dynamic, some wearable and some hand-held but most have been of the communication type, not intended for broadcasting. The two-unit microphone, however, will maintain the frequency response of each of the units involved just as though they were used singly. FIGURE 6 shows how they may be easily assembled in a semi-permanent fashion. A strip of wood or other material may be cut to fit between the microphone as a spacer to keep the handles parallel and yet allow the heads to be located one against the other. Tape the two together using plastic electrical tape and then cover with decorative chrome colored plastic tape.

Be certain the user understands how he must use a differential mic or his voice will also be cancelled. In FIGURE 7 the user has a choice of either of the two units

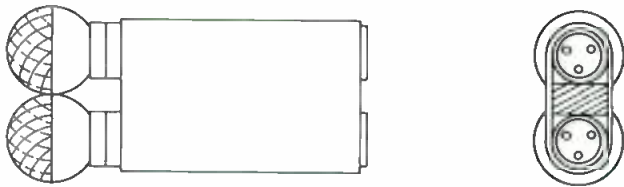


Figure 6. A block of wood and some tape can be used to make a semi-permanent differential mic.

Figure 7. The user has a choice of either of the two units to pick up his voice, but don't try to talk between them.



to pick up his voice, but should he try to talk between the two his voice will be cancelled. The distance at which he works is critical. Here as you see the upper lip is touching the grille screen as he talks. This exact distance is a must, if it is varied as little as a 1/2 inch the voice level will drop in half or more. It is important for the user to train himself to work where he can feel the grille touching his upper lip continually. This is not as difficult as it may seem. I have used it this way for extended periods many times.

Two out-of-phase units may also be employed as an equalizer to control ambient conditions such as air-conditioner noise in a studio or low frequency rumble either in or outside.

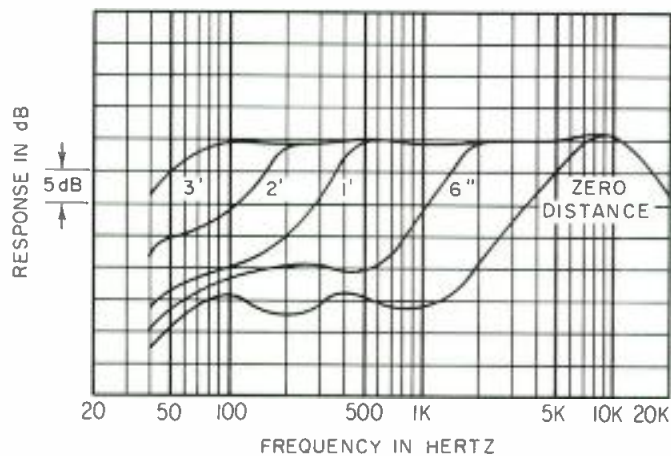


Figure 8. These curves have been run with the microphones spaced at various distances from each other.

Figure 9. Each mic can be used by two individuals without affecting either of their voices, provided a 3:1 ratio is applied.

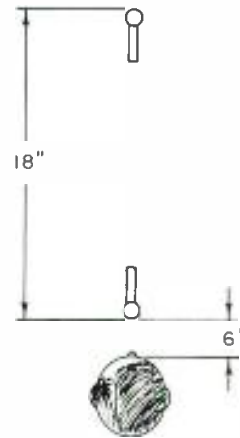
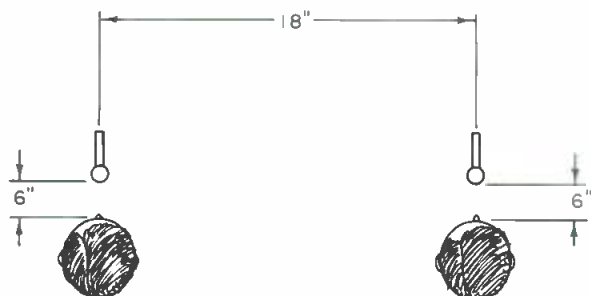


Figure 10. Do not use cardioid microphones for this application.

Figure 11. Where noise is extreme, try this variation of mic placement.

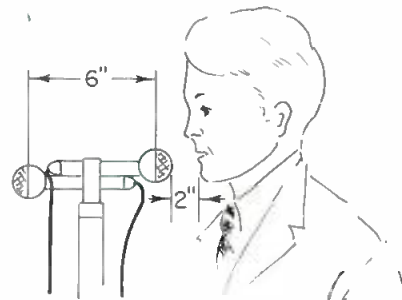


Figure 12. A hand-held application of the arrangement of Figure 11.



FIGURE 8 shows curves run with the microphone spaced at various distances. Each microphone may be used as in FIGURE 9 by two individuals at the same time without affecting either of their voices providing a 3:1 ratio is applied as shown. The two units are still effective in cancelling low-frequency noise such as that occurring at a football game. Here they will help reduce roar of a crowd to the extent that you may talk through it and still not eliminate the back ground effect entirely. For ringside at a fight where the crowd surrounds you, a cardioid microphone cannot help control the crowd noise since much of the noise will be on axis, and picked up along with your voice.

If no one is to use the second microphone it may be located at any convenient place as long as there is no obstruction separating one from the other. It may be located as in FIGURE 10 facing the other way but do not use cardioid microphones for this application, since when placed back to back electrically out-of-phase the pattern will be bidirectional and not differential. They may also be mounted as in FIGURE 11 where the noise is extreme, or they may be hand-held as in FIGURE 12 which will allow greater variation in working distance than the assembly of FIGURE 6, but they will not control ambient noise as well. ■

The Amplifier Power Spiral

Amplifiers keep becoming more powerful. It's become commonplace to speak in terms of kilowatts. Why this quest is going forth, and what its consequences are, are answered in this article.

The need for power must be inter-related with efficiency of the loudspeakers used.

EVER SINCE we can remember, the audio industry seems to have had an insatiable urge to push for more and more. This is partly justified on the basis of need, but partly it fulfills only a sort of on-upsmanship thing: "my system has more watts (or kilowatts) than yours." The advent of solid state has witnessed a resurgence of this upward trend. This article will examine the reasons and what has happened.

THE OVER-ALL PICTURE

The need for power must be inter-related with efficiency of the loudspeakers used. Some system designers favor the compact, low-efficiency units, working at fractional percentage efficiency, or at the most, around one per cent. Others prefer the high-efficiency type units, employing various types of horns, the best of which may be of the order of 50 per cent efficient.

What this says is that low-efficiency units may require 100 watts of electrical power to produce 1 acoustical watt output, while the more efficient units only require 2 watts electrical to produce the same acoustical watt. When you talk about systems, if a high-efficiency system can do a satisfactory job with a 50 watt amplifier, a designer who prefers the low-efficiency type loudspeakers will need 2.5 kilowatts of electrical power to do a comparable job.

In the old days of tube amplifiers that would probably have been an installation consisting of 50 amplifiers each rated to deliver 50 watts. The high-efficiency system enabled its designer to use only one such amplifier. The immense saving on amplifiers justified the somewhat higher cost of loudspeaker units to achieve the higher efficiency.

There was another factor. All those amplifiers generated a considerable amount of heat just by being on, and

when it came to delivering power, maybe they generated more heat. Now that solid-state amplifiers are available, this aspect of the picture has changed considerably. Transistors make almost perfect modulators of power and thus can convert a maximum of the supply power into output power.

To get more power from a solid-state circuit, all that is necessary is to find transistors with larger junctions, and to provide them with more efficient heat sinks, to prevent them from overheating. Thus, by moving into solid-state designs, the whole picture changes again. Obtaining kilowatts of power from relatively smaller units has now become a feasible and economic proposition.

There remains the psychological appeal to the uninitiated, that a system capable of 2.5 kilowatts sounds much more impressive than a mere 50 watts, even if, with the loudspeakers used, each is equally capable of the same job. There are factors that say that the more efficient system does a better job, because a high-efficiency unit is inherently smoother than a low-efficiency unit. And the question of over-all system noise and dynamic range, one relative to the other, has not been explored extensively.

For the purposes of this article, we will take the viewpoint of the problems that face the amplifier manufacturer: how to safely give as much power as the customer wants. What he does with it is someone else's business, at this stage. The amplifier manufacturer is concerned with giving his customer a unit that will work, and stay working, however the user may abuse it, within reason.

DIFFERENCES BETWEEN TUBES AND TRANSISTORS

As we have already stated, transistors can deliver audio power far more efficiently than tubes. But this brings with it a hazard that very seldom bothered tube designers. Tubes were seldom destroyed by momentary overloads, from whatever cause: too much input, incorrect output loading, or whatever. Keeping them running at maximum

power for too long might cause damage, but the situation with transistors is quite different.

Provided the bias and supply voltages for a tube circuit were correct, a tube's plate current could not seriously exceed its rated maximum. In a high-output transistor circuit, it is quite easy, unless very careful protection is provided, for safe currents and dissipation ratings to be exceeded, several times over.

In a transistor, the volume of the space in which heat to be dissipated is generated, is very much smaller than in tubes with the corresponding dissipation rating. However, its thermal contact with its surroundings is very much better. In a tube, most of the dissipation occurs at the plate, or the surface of other electrodes. While the surface where the heat is generated is relatively large, its only escape is by conduction through itself and its supports, unless temperature gets high enough for radiation to be significant. The vacuum surrounding the electrodes does not help remove heat.

In a transistor, the heat generating place, which is the junction area whose resistance changes with operation, is quite small, but it is in good metallic contact with the rest of the transistor, which in turn can be mounted in good contact with a heat sink and radiator fins that can rapidly disperse the heat generated.

Because of the relatively large heat generating area in tubes, with relatively poor means of getting the heat away, tubes have a relatively long time constant for heat rise. An overload condition which, as stated earlier is less likely anyway, must be maintained for an appreciable time before damage occurs.

In a transistor, the smallness of the heat generating space means that heat rise occurs almost instantaneously with the presence of the heat generating it, after which the good conduction of its mounting can do a good job of removing it. But the possibility of a sudden overload causing damage to a transistor so quickly means it is imperative that some means be adopted to protect it.

THE NATURE OF TRANSISTOR RATINGS

Before examining the nature of overloads that can occur to present danger to transistors, we should first see what ratings of the transistor are likely to be in danger. Only then can we examine the variety of means adopted to protect them intelligently.

We first assume that the transistor is operating at low dissipation, so its heat sink is not much above ambient temperature in the room. Then dissipation is limited by the instantaneous rise in temperature that it caused the transistor to develop, above its immediate surroundings, the sink. Then, if it continues at this dissipation, the sink temperature will rise, so that a lower dissipation is permissible in the transistor.

This maximum instantaneous dissipation is simply the watts dissipated in the transistor by the product of current flowing through it by voltage across it. This forms an exponential curve across the collector characteristics. (FIGURE 1). This is one piece of the instantaneous limit on the transistor's operation.

When the transistor saturates, so the voltage drop across it is quite small, the dissipation is concentrated in the low-resistance junction as an I^2R loss. This means there is an absolute maximum current that forms another part of the instantaneous limit. Finally, even when the transistor is cool, it has a maximum voltage from the collector to base (and/or emitter) beyond which it breaks down, zener fashion. To be safe, it must stay below this zener voltage.

Those are the instantaneous maximum ratings, applicable when the sink is almost cold—not heated to sufficiently change ratings. Now if the transistor is operated at appreciable dissipation, even though not at maximum, for a

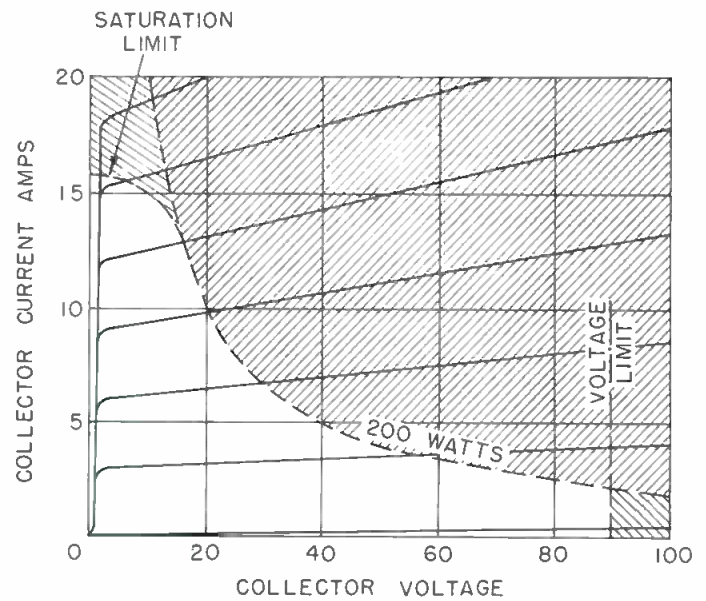


Figure 1. Basic safe operating limits of a power transistor. Shaded areas represent prohibited operation.

Figure 2. How the safe area can change with operating temperature, not shown in Fig. 1. Rise in temperature means that only 100 watts, instead of the 200 watts starting from cold, can be dissipated.

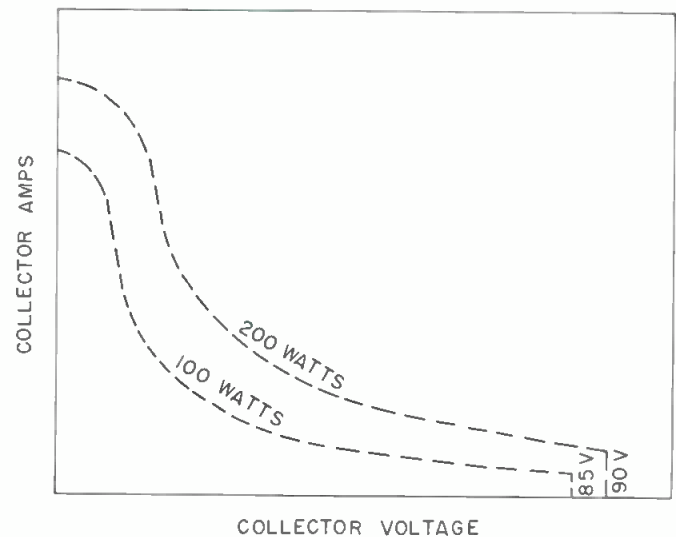
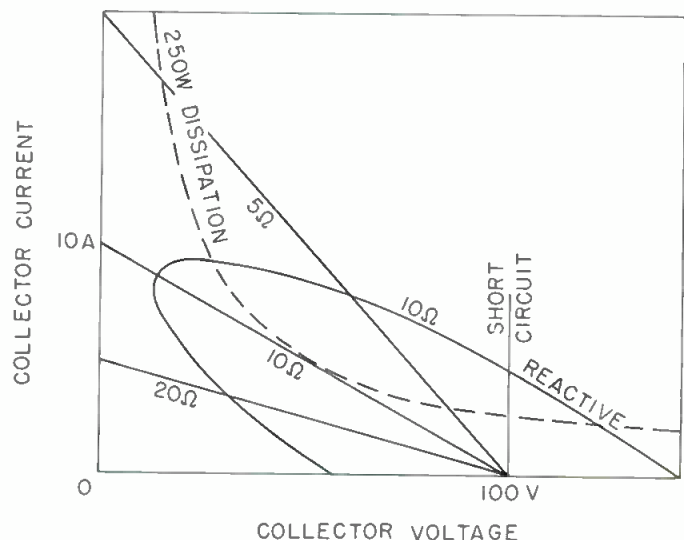


Figure 3. How load lines can transgress the danger points. Dashed line is 250-watt dissipation. The 10-ohm load line is safe. The 20-ohm load line is well within safety, but the 5-ohm load line goes well into the danger zone. So does the 10-ohm reactive load ellipse, of which only half is in this transistor's domain.



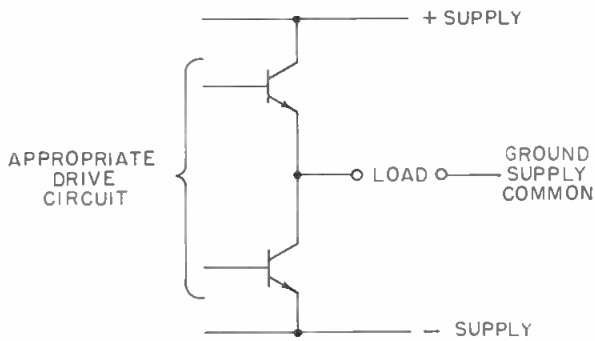
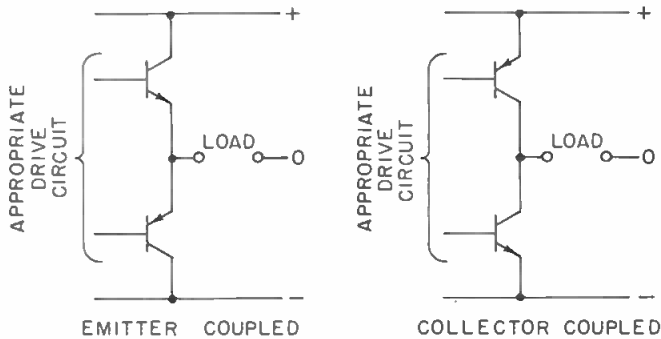


Figure 4. The most common (at the moment) basic output circuit uses identical transistors in single ended push pull, shown here for npn type. For pnp type transistors, the polarities are reversed.

Figure 5. Use of complementary symmetry power transistors renders possible a choice of emitter or collector coupling.



while, the sink temperature will rise, in the course of dispersing this continued dissipation. This will have the effect of shrinking the area under the exponential dissipation curve, and usually also of reducing both maximum current and maximum voltage (FIGURE 2).

In addition to these effects, the change in working temperature will change the contact potential of the transistor, so that bias current and voltage requirements alter materially from when the transistor and its mounting were cold. This is usually cared for by mounting the diodes or other components that control bias so their temperature is changed with sink temperature. All these components are usually mounted within the same sink component.

Those changes all occur within the transistor and are limitations intrinsic to it. Next we move to the considera-

tion of the way its load circuit—the output to which it is connected—can affect it.

KINDS OF LOADING

Most output circuits use class B operation, so that a transistor only handles half the audio waveform. Another transistor handles the other half. All the theory and design of amplifiers is built around the notion of operating the output into a resistance load, preferably of the value specified in the design. Thus, if the output is designed to feed a 70-volt line at 500 watts, the design load is found by

$$W = \frac{V^2}{R}$$

to be, in this case, 10 ohms. Half of each a load line is illustrated in FIGURE 3, together with some ways in which the load can deviate from this ideal.

The problems that high-power transistor amplifiers can run into are mostly caused by these deviations. If the resistive load line has double its value, 20 ohms, maximum dissipation is never approached; this is quite safe. But if the value is halved, to 5 ohms, the transistor is in serious trouble, because the operating condition cuts across the dotted dissipation limit badly. A short circuit, which needs only to occur momentarily while signal is feeding into the amplifier, causes even worse trouble.

Those are deviations that, it may be argued, never normally occur. You would never connect a load value lower than the design value, and a rule of not working on the circuit with the power on would safeguard against accidental short-circuit. Okay, so what do you do when a connection needs making, or modifying, without interrupting service? Be extra careful, I suppose? And then the nervous technician's screwdriver slips and you have a momentary short-circuit!

But the idea of a resistive load is seldom met—only at a few frequencies in audio spectrum. A load consisting of loudspeakers is reactive at most frequencies. The half ellipse on FIGURE 3 represents a load of 10 ohms reactive. Notice that this takes a bite into the forbidden dissipation zone, just about as much as the wrong resistance value of 5 ohms does. And this load is only slightly reactive, equivalent to about 5 ohms in series with 10 ohms resistive, or 20 ohms in shunt. Practical reactance deviations may be worse than this.

This is not the only trouble that the presence of reactance in the load can cause. Compare the resistance load

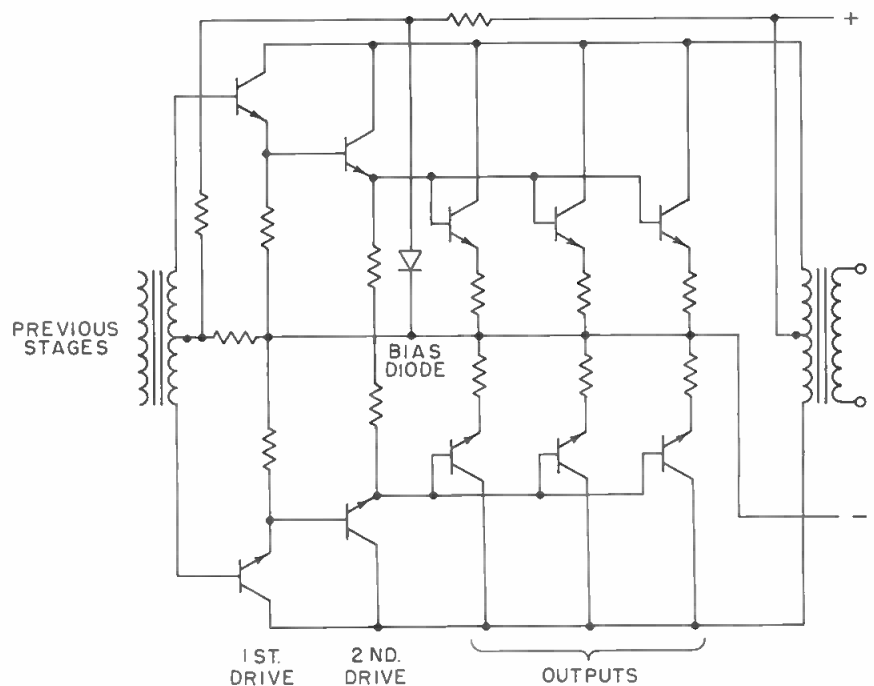


Figure 6. Basic circuit of drive and output stages of typical Altec Lansing amplifier, all emitter coupled and using input drive and output transformers with identical transistors for "push" and "pull."

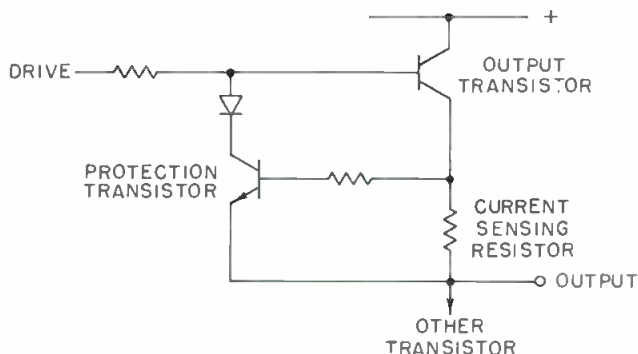


Figure 7. A simple, basic, current limiting circuit, applied to one half of an output stage. The other half would be similar.

line with the reactive one from another viewpoint. Along the resistance load, output current and output voltage move together. Maximum current which, in the transistor, coincides with minimum (close to zero) voltage, occurs at maximum drive (base) current. For this reason, if drive current goes beyond that for maximum output, all it does is to more thoroughly saturate the transistor at this point. So long as base current rating is not exceeded, nothing adverse happens.

But with the reactive load line, if this is an inductive reactance, the peak of voltage is reached *before* the peak of current, in the load. This means rotation round the loop will be clockwise. Now maximum voltage across the load can be reached while the current in both load and transistor is still rising. If you enlarge the loop, which would represent increased drive, or even a reactance of higher value, so that the highest point on the ellipse, which represents maximum current, is at zero voltage, which is where saturation occurs, then the voltage will have *already* swung beyond the line representing zero collector voltage, for the ellipse to reach this point.

But when voltage across the transistor occurs, which it does not normally, when only supply voltage is used, the transistor behaves quite differently. This reverse voltage, or tendency to reverse voltage, because the something different that happens will change it, reverses the transistor's mode of operation. Normally, the base-emitter junction is conducting, and the collector-base junction is non-conducting, except as modified by the conduction current in the base-emitter junction. Thus a smaller base current controls a larger collector current.

When the polarity reverses, the action reverses too. The collector-base junction becomes conducting and probably the base-emitter junction becomes non-conducting. This means that the current between collector and base is no longer controlled by the base circuit, but rises in response to the voltage. Exactly what happens here is difficult to

predict and depends on the exact circuit and its parameters, but the likelihood is that the base current will suddenly jump to collector-emitter current magnitude, which will most likely prove destructive.

This means that an additional protection is required, to prevent the collector-base or collector-emitter voltage from ever going into reverse, due to reactive "kicks" from the external load impedance.

PROTECTION NEEDED

Having thus taken a look at the things that can happen, we can summarize the kinds of protection needed and, from there, take a look at possible conflicts in these requirements.

1. We need to protect against exceeding maximum current rating.
2. We need to protect against exceeding maximum voltage rating which, however, is much less likely, if transistors are chosen to suit the supply voltages used, or vice versa.
3. We need to protect against reaching both maximum voltage and maximum current at the same time, which would then exceed dissipation rating. Preferably, this need should protect against exceeding dissipation rating at any point, or combination of voltage and current.
4. We need protection against reversal of polarity on the transistor, due to inductive kicks from the load.
5. In some way, the protection provided must adjust itself, in items 1 through 3 above, for change in temperature at which the transistor is momentarily operating.

This set of requirements is, unfortunately, only one possible way of expressing them. For example, several thermal time constants are involved in determining how temperature rises with dissipation, integrated over time. The requirements could equally well be spelled out in terms of instantaneous dissipation limits, modified successively by the thermal time constants, operative under various circumstances.

It is this sheer complexity of the total problem, coupled with the variety of approaches that individual designers have adopted in approaching its solution, that makes it difficult to inter-relate these approaches, and say what does what, or what one circuit does relates to what another circuit does.

HOW TO PROTECT?

Quite apart from how the danger conditions are detected, as enumerated under the preceding heading, there comes the question as to how protection should be provided. There seem to be two schools of thought here. Perhaps, if this article does nothing else, it will serve to air this problem, for the future guidance of designers.

One school, based on the desirability of maintaining continuous service, detects the various components of possible danger, and modifies the input drive to protect the transistors. In general, this merely restricts the movement

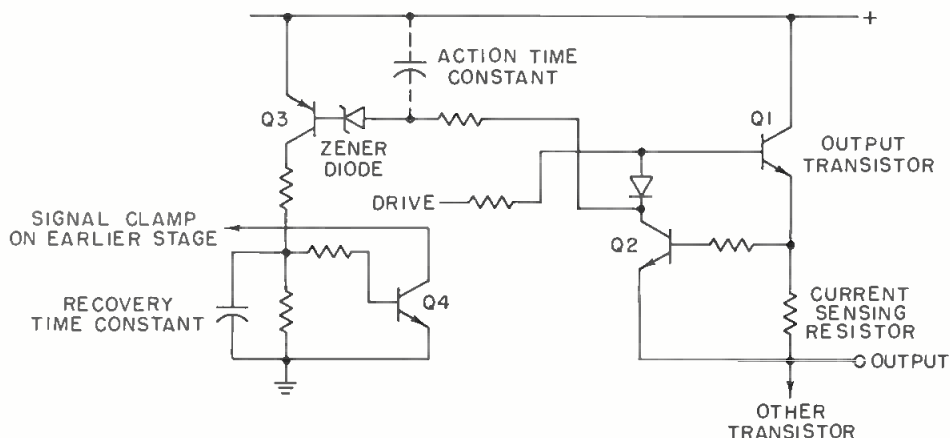


Figure 8. One form of combined control, that shuts down the amplifier when dissipation is exceeded, and can have time constants built in to cater for various kinds of overload.

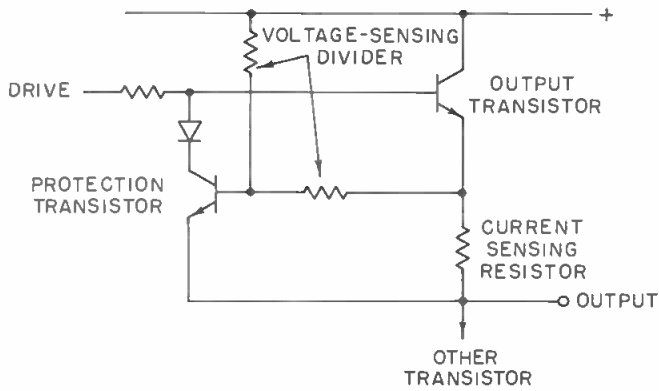


Figure 9. A simple circuit that provides combination voltage and current protection.

of the instantaneous operating point, so it cannot move into the danger area. This means that all of the signal that remains in the safe area is undistorted, while the tops or other portions of the signal waveform that could cause trouble are curtailed, resulting in distortion of these portions.

Whatever means is adopted to allow for thermal effects will then reduce the level at which the distortion sets in (by providing protection earlier), as the components warm up. This could suffer from the objection that raising input level beyond a critical point results in reduction of output level and increase of distortion.

The other school prefers to give the transistors a deliberate opportunity to cool off, after such a thermal condition has been set up, before resuming operation. This involves interruption of service for whatever the system determines is an appropriate cooling off period for the condition that prevails. The objection to this is that interruption of service might cause embarrassment, under certain circumstances.

A third possibility, that might conceivably be a workable compromise between the foregoing two major schemes, would be to use the protection control to cut back gain, so that undistorted service is maintained, but when necessary for protection purposes, the available output is reduced by gain reduction, until sufficient cooling off has occurred.

THE AMPLIFIER AS PART OF THE SYSTEM

So far we have discussed the internal operation of the amplifier. When transistorized power amplifiers first "made the scene" designers seemed to view them as an ideal opportunity to perfect the transformerless amplifier. Most circuits used some form of phase inversion to drive a pair of output transistors (or a pair of multiples, con-

Figure 10. The protection possible by a simple combination of current and voltage, such as in the circuit of Fig. 9.

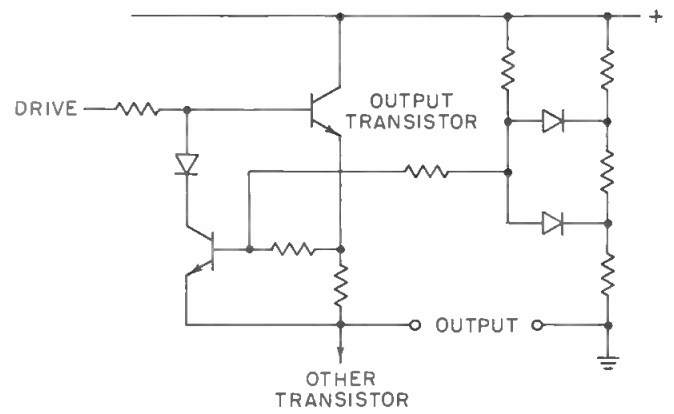
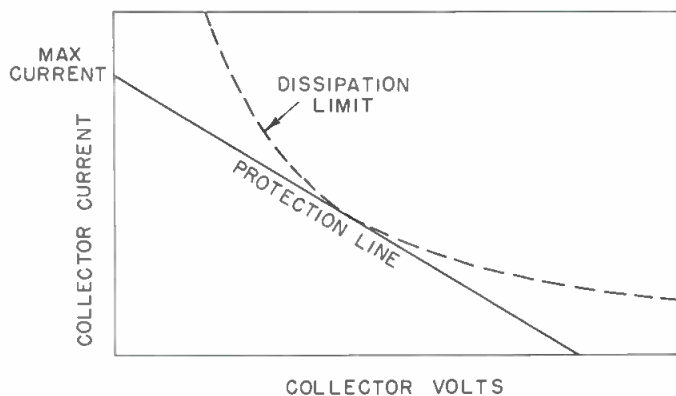


Figure 11. The kind of modification to the circuit of Fig. 10 that will enable it to more closely duplicate the dissipation curve protection.

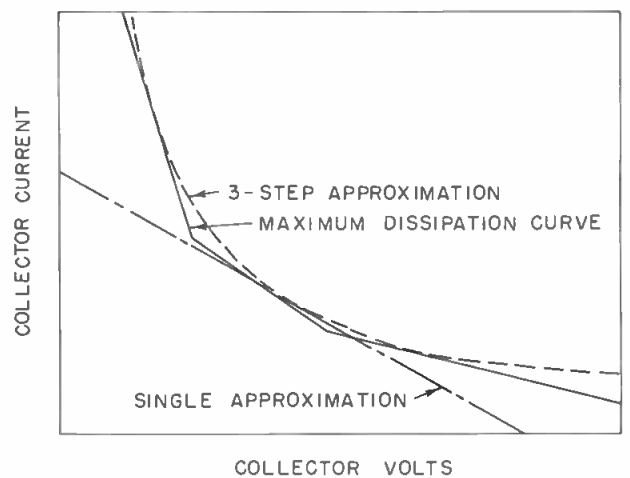
nected in parallel, to get more power) operated in what used to be called "single-ended push-pull" in tube days (FIGURE 4).

Complementary symmetry was talked about a lot and has been used extensively in drive or phase inversion stages, but little in the outputs themselves, although some semiconductor experts assure me that it is now possible to obtain complementary symmetry pairs at output power levels. With the single-ended push-pull circuit, one of the pair is emitter coupled and the other collector coupled, by the nature of the circuit. With complementary symmetry at the output, there is a choice of emitter or collector coupling (FIGURE 5).

The previous two paragraphs cover the basics of many transistor power output stages, but there is one more factor. The transformerless notion from the beginning came from a purist faction—those whom others would call "hi-fi nuts." The practical systems people who used amplifiers for professional purposes were not so crazy about it. And some experience with transistorized amplifiers has confirmed the basis for their skepticism.

Each of the circuits in FIGURES 4 and 5 is single-ended. Power is fed to one output terminal and the other is ground. The only way to render such a circuit balanced is to double up on everything, with opposite phasing, so an equal amount of power is available "the side of ground." When you are distributing at 70-volt line level, which is 10 ohms at 500 watts, system stability would very like to use balanced outputs. Single-ended can be inviting system problems.

Figure 12. The difference between a 3-step approximation (e.g. using the circuit of Fig. 11) and a single approximate, as compared with the maximum dissipation curve.



So there has also been a move to re-introduce transformers, not only at the output, but also for input isolation. Some amplifiers still use one of the single-ended circuits of FIGURES 4 and 5, and merely use a high-power audio transformer to isolate the output electrically, so it can be balanced or unbalanced at will.

Another possibility, preferred by Altec Lansing, who have a long background in professional amplifiers, looks more like a translation from tube amplifiers of long ago. Identical transistors are used for both halves of the push pull, with transformers at both ends, for phase inversion and output (FIGURE 6).

PRACTICAL PROTECTION CIRCUITRY

Whichever configuration of output is used, the method by which protection can be applied is largely a matter of adaptation to that configuration. So we will simplify the protection part to show how each transistor of an output arrangement is protected in various ways, thus avoiding the need for showing the vast number of permutations and combinations possible.

Current limitation is possible by inserting a low value resistor in the output lead from the output transistor (FIGURE 7) and applying the voltage developed across it to the base of the protection transistor. By using a silicon transistor (most, if not all, are anyway) in this spot, no conduction occurs until the base-emitter voltage exceeds the contact potential, which coincides with just below maximum current rating for the output transistor. Then this protection transistor bypasses the base drive current for the output transistor, limiting output current at the maximum rating.

Limiting output current at the maximum rating, where this occurs at voltage peaks, which correspond with close to zero voltage left across the transistor, is one thing. But if that current peak occurs with appreciable voltage across the output transistor, either because of abnormally low load value, or because the load is reactive, then dissipation can be exceeded, as well as current rating.

One way to take this into account is to use the protection transistor as a gate, that links the junction between its collector and the diode in series with it (which is there to avoid exposure of this transistor to reverse polarity) to the output drive voltage, *only* when current limiting is activated. Comparing this voltage with peak voltage, which is supply in that direction, enables a decision to be made, relative to the safety or otherwise of the operating condition indicated. (FIGURE 8)

If the maximum current occurs only on peaks, nothing happens. But if it occurs below peaks, where appreciable voltage is across the output transistor, then the zener diode will conduct, putting Q3 into the conduction mode, which in turn is used to kill signal with Q4. Time constants can be added to provide cool-off time dependent on the amount of warm up, determined by the severity of the dissipation condition. This approach causes an interruption in the program, while the amplifier recovers.

INSTANT LIMITING

At present, the trend is toward instantly limiting the operating of the output transistor, so the program is not interrupted. This entails ensuring that at no time does the operation swing into the forbidden dissipation zone. One basic way of achieving this is to combine voltage and current triggering of the protection.

If a resistor (FIGURE 9) leaks enough current through the series resistor in the base, before any current flows in the output transistor at all, to almost trigger the limiting, then any current at all in the output transistor will start limiting. But, as the voltage across the output transistor drops, so will the leakage through the series base resistor, so that more current is required to trigger limiting, until

A Stainless Steel Stradivarius

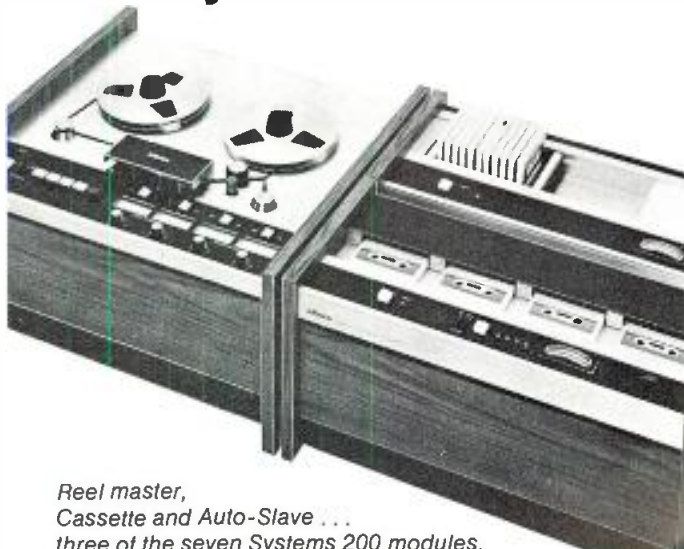
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Figure 13. Half of the output portion of a Marantz amplifier (simplified) to show how protection is applied. This design uses complementary symmetry throughout, so the other half is the same, except that each corresponding transistor is of opposite polarity.

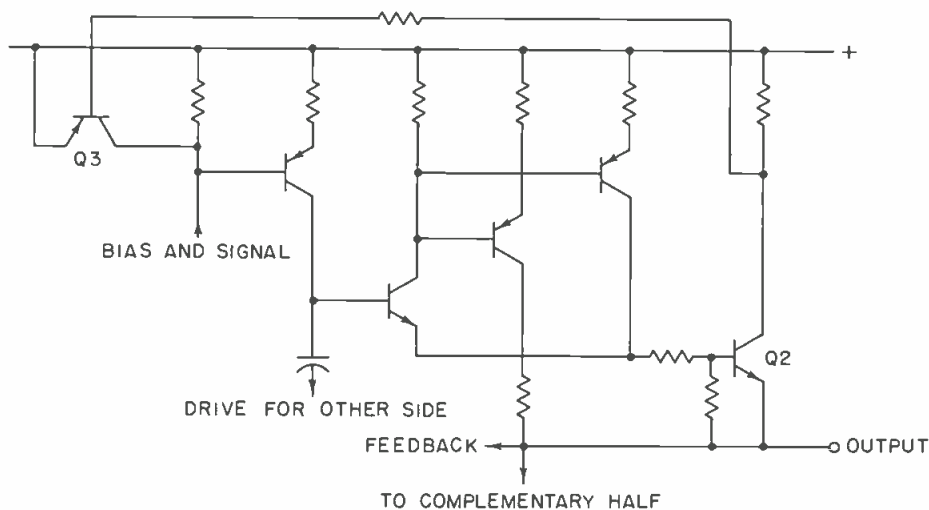


Figure 14. Half of the Altec Lansing circuit of Fig. 6, with the protection features added. It has been simplified somewhat, to make the action easier to follow.

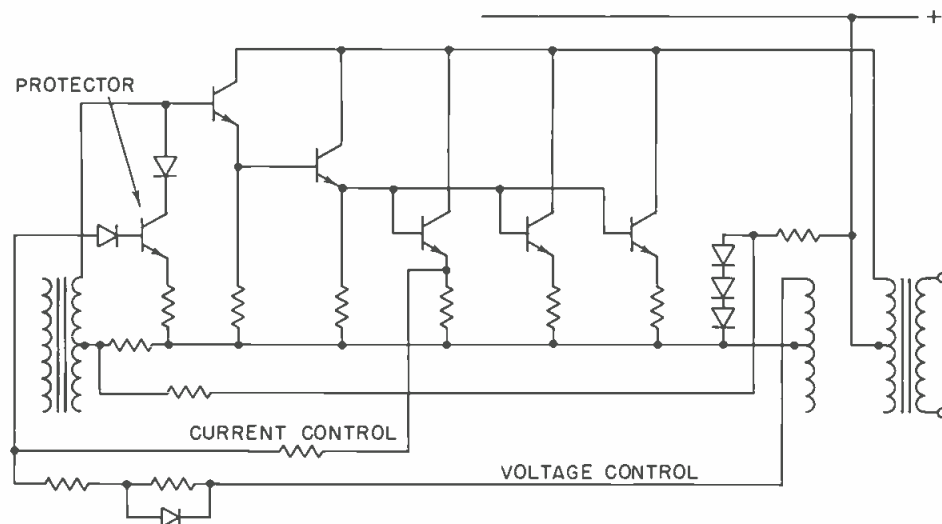
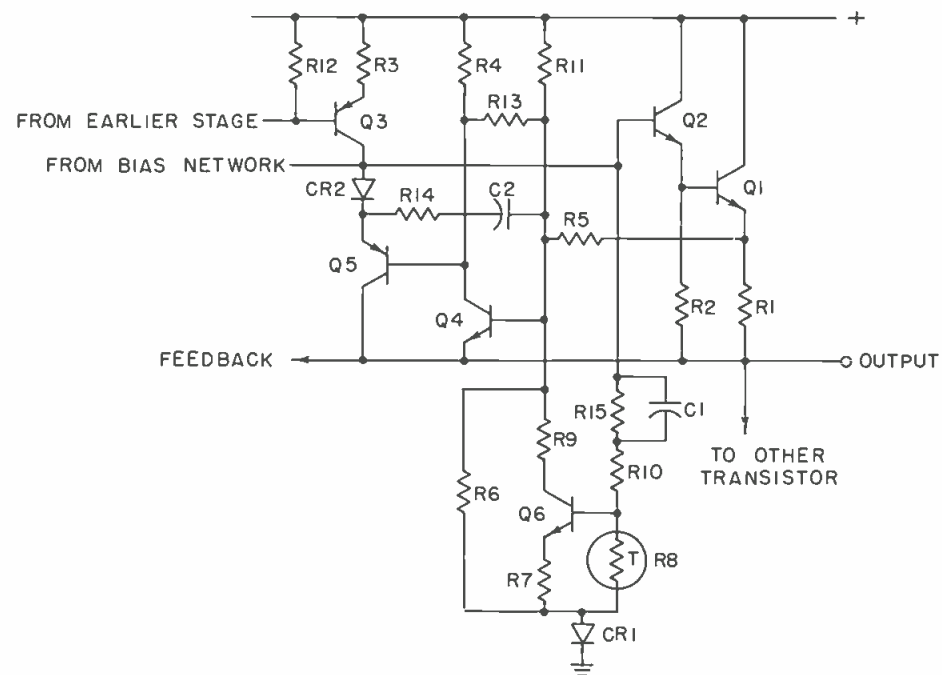


Figure 15. The much more complex protection circuit of the Automated Processes amplifier includes current and voltage sensing, time constants and an elaborate thermal compensation scheme.



when voltage peaks on the load mean there is no voltage across the output transistor, current is limited only at its maximum value, as before.

This means limiting occurs, for the output transistor, at a diagonal line joining its operating voltage (or some other voltage point) with its maximum current (FIGURE 10). For most purposes this is adequate. To academically allow dissipation that is safe, although over this line, an

approximation to the dissipation curve can be substituted for the line, by using a leakage resistor value that changes with voltage, as diodes pass from conduction to nonconduction (FIGURE 11). Most designers do not feel that the occasional instances when this would allow operation prevented by the straight line control, with quite complex signal and loading conditions, do not warrant the more complicated circuit (FIGURE 12).

A (Partial) List of Amplifier Manufacturers

The following companies all make separate power amplifiers of high power. Write to them directly if you wish literature or other details.

Altec, Professional Studio Products
1515 S. Manchester Ave.
Anaheim, Ca. 92803

Automated Processes
80 Marcus Drive
Melville, N.Y. 11746

B & W Systems
P.O. Box 3742
Beverly Hills, Ca. 90212

R. T. Bozak
Darien, Conn. 06820

Citation-Harman Kardon, Inc.
Ames Court
Plainview, N.Y. 11803

Crown International
Box 1000
Elkhart, Ind. 46514

Dynaco, Inc.
3060 Jefferson St.
Philadelphia, Pa. 19121

Fairchild Sound Equipment Corp.
15-58 127th St.
Flushing, N.Y. 11356

J. B. Lansing Sound, Inc.
3249 Casitas Ave.
Los Angeles, Ca. 90039

McIntosh Laboratories
2 Chambers St.
Binghamton, N.Y. 13903

Marantz Company
P.O. Box 99
Sun Valley, Ca. 91352

Opamp Laboratories
172 S. Alta Vista Blvd.
Los Angeles, Ca. 90036

Phase Linear
405 Howell Way
Edmonds, Washington 98020

SAE
P.O. Box 60271
Terminal Annex
Los Angeles, Ca. 90060

Spectra Sonics
770 Wall Avenue
Ogden, Utah 84404

Sony Corp. of America
47-47 Van Dam St.
Long Island City, N.Y. 11101

AMPLIFIED LIMITING

Those forms of limiting are somewhat soft in their action. To achieve absolute limiting at the maximum, be it current or dissipation, the action must begin, with its attendant audio distortion, before maximum is reached. More sudden limiting, which makes its incidence more definitely audible, as well as providing freedom from distortion up to that point, can be achieved by amplifying the control action.

One circuit that does this, based on current limiting, is found in the Marantz circuit (FIGURE 13). Here the current sensing transistor, Q2 is normally non-conducting. As soon as it starts to conduct, the resistor in its collector develops a voltage that causes Q3 to conduct, limiting signal drive current at an earlier stage in the amplifier.

The Altec Lansing circuit combines voltage and current derivation for triggering the limiting a little differently (FIGURE 14). This is then used to hold down drive current at the base of the drive transistor, which gives amplification to the action, as compared with limiting it at the output stage.

INCLUDING THERMAL EFFECTS

All amplifiers include provision for adjusting bias and thus operating point, to compensate for changes in temperature. This is commonly done by mounting the diodes that provide bias control on the same heat sink as the output transistors, which may also accommodate the drive transistors in some instances.

What this part of our article refers to is not this aspect of protection, without which any modern amplifier would not work at all, after any signal had been applied to it that would cause the transistors to warm up. It is with

reference to the change in limits of operation, also brought about by changes in temperature. The fact is that maximum dissipation and current are also affected.

Without including such provision, either the protection must be effective when the amplifier is as hot as it is supposed to get, which means that it will unnecessarily limit when the amplifier is running at the normally cool condition of no signal, or low signal. Or else some additional time constants must be built in (as they were in the circuit of FIGURE 8).

A circuit that derives its compensation in protection limitation from actual temperature is one by Automated Processes (FIGURE 15). The limiting transistor (that initiates action) is Q4. If a resistor is substituted for R6, R9, R7 and Q6, the principle of operation would be much the same as any other amplified limiting circuit, using voltage and current input to effect dissipation protection, but without temperature compensation. These are the components that modify the action, to compensate for temperature change. And the components in the base circuit of Q6, particularly the thermistor, R8, are responsible for sensing the temperature and providing the necessary control.

In this discussion we have shown partial diagrams to save space, and to make the operation more easily understood, by not showing parts irrelevant to the operation being discussed at the moment. Also, this method shows principles used, rather than the elaboration in various combinations in individual circuits.

As a state-of-the-art report, it tells what is being done. What the future will bring, and whether future designers will combine limiting of the kinds discussed here with a gain-reduction stage, to keep operation within safe regions, instead of trimming off the dangerous tops remains for the future to tell. ■

LARRY ZIDE

Build a Six In, Two Out Mixer

Facility for six balanced mic inputs, or six line inputs, or two RIAA phono inputs. All are standard on this a.-c. d.-c. powered mixer kit.

OVER THE YEARS, I estimate that I have built over half a hundred kits, ranging from small hi-fi amplifiers to big color tv sets. In between, I've managed to build a triggered 'scope or two on audio generator, various voltmeters and an fm stereo generator. But up to now, I had never built a mixer—possibly because no one has offered one before.

Being a mixer is not the only thing different about the Gately Prokit SM-5. No kit I have ever built has had the quality of componentry that exists in this unit. On occasion, I have made a product with pretensions of professional utility, but in reality a consumer audio unit. This unit is fully professional in every way—nothing about it is consumer.

This was evident in the unpacking. Allen-Bradley pots are not found in hi-fi gear. Neither are transformer mic inputs—particularly when the transformers are from Beyer. There are a number of phone jacks used. I often see Oriental imports that are not too bad, but not good for frequent use and reliability. The Switchcraft units supplied with the kit are good. So are the Switchcraft xlr-type mic inputs. Finally, the two circuit boards employed are glass, not phenolic. No, this is not a hi-fi kit at all. It's fully professional gear, made to last.

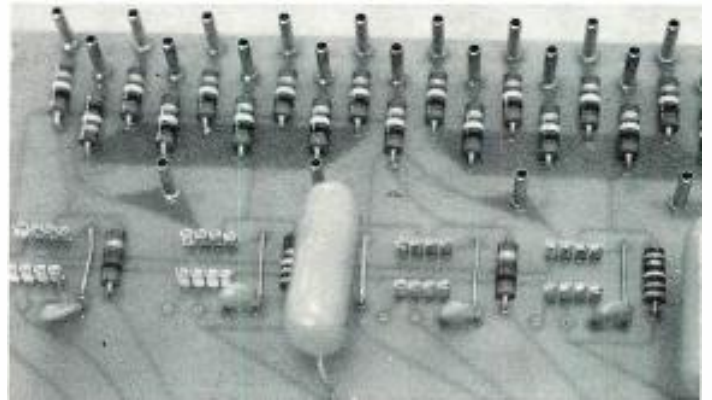
BUILDING THE KIT

The manual that accompanies the mixer is complete and totally adequate. I was sent a page of corrections that should be with all kits sold, until they get around to reprinting the manual. When they do this, I hope they will print the construction illustration of the main circuit boards on a separate sheet. This will avoid the necessity as it now exists to have to turn pages back and forth as you are assembling componentry onto that circuit board.

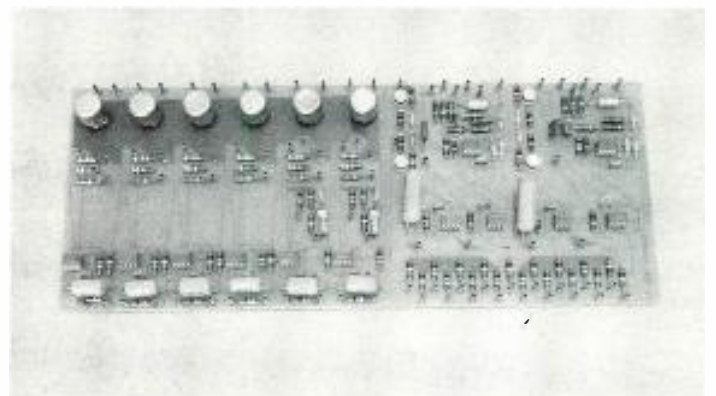
I used the office copier to duplicate the board construction illustration, so I had it conveniently in front of me at the angle I wanted it.

I've just mentioned *all* the fault I found with the manual. There is nothing tricky about building the unit. The only super care required is when the front-panel switches are being prewired: it takes care to avoid shorting nearby lugs.

The illustrations that follow show the assembly of the kit. A week of evenings is more than ample for completion. The finished product is everything its touted to be. Well worth the asking price of \$299.00 kit. (If you are lazy or inept you can buy the unit factory wired for \$499.00.)



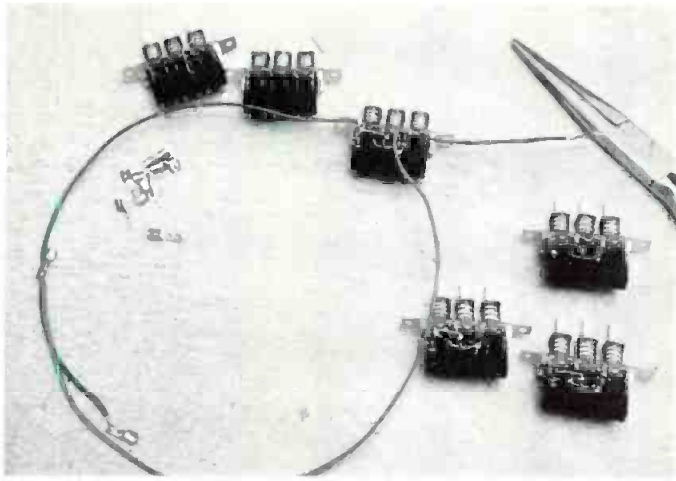
The main circuit board is assembled first. Integrated-circuit socket strips are attached to the board. These will later accept the twelve i.c.'s used.



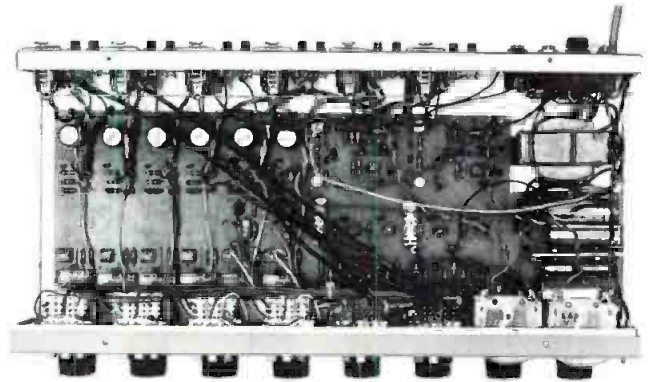
The board with components on it, including input transformers. Selector switches will attach to the board later.

The power-supply board with its components attached. Note the transistors and heat sink in the center.





The front-panel selector switches. These must be prewired, as partially shown. Later they plug into the circuit board.



With the boards on the chassis and interconnection completed, the kit is finished. It only remains to wire the meters so that they read 0,+4, or +8 dBm outputs.



The finished SM-6 Prokit, one week after the start. A lot of fun can be had in the building, a fine product results, and money is saved.



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BOOKCASE

20. The Audio Cyclopedia (2nd ed.). *Dr. Howard M. Tremaine.* New and updated, here is the complete audio reference library in a single volume. It provides the most comprehensive information on every aspect of the audio art. This new edition includes the latest audio developments including the most recent solid-state systems and integrated circuits. It covers all subjects in the fields of acoustics, recording, and reproduction with more than 3400 related topics. Each topic can be instantly located by a unique index and reference system. More than 1600 illustrations and schematics help make complicated topics masterpieces of clarity. 1760 pages; 6½ x 9¾ hardbound. **\$29.95**

1. The Technique of the Sound Studio. *Alec Nisbett.* This is a handbook on radio and recording techniques, but the principles described are equally applicable to film and television sound. 264 pages; 60 diagrams; glossary; indexed; 5½ x 8½; clothbound. **\$14.50**

7. Acoustical Tests and Measurements. *Don Davis.* Provides solid understanding of the entire subject of acoustical measurements; based on actual field test work, using commercial equipment. 192 pages; 5½ x 8½; hardbound. **\$6.95**

8. Handbook of Electronic Tables & Formulas, (3rd edition). A one-stop source for all charts, tables, formulas, laws, symbols, and standards used in electronics. Includes an 8-page, full-color fold-out chart showing latest FCC allocations for the entire frequency spectrum. 232 pages; 5½ x 8½; hardbound. **\$5.50**

24. Basic Electronic Instrument Handbook. *Edited by Clyde F. Coombs, Jr. Hewlett-Packard Co.* A basic reference background for all instruments. Offers saving in time and effort by having complete information in one volume on how to get the most benefit from available devices, how to buy the best instrument for specific needs. Reduces chances of costly errors. Ideal reference book, it is an excellent source for the beginner, technician, the non-electrical engineering man, or general non-engineering scientific and technical personnel. 800 pages. Hardbound. **\$19.50**

25. Operational Amplifiers-Design and Applications. *Burr-Brown Research Corp.* A comprehensive new work devoted entirely to every aspect of selection, use, and design of op amps—from basic theory to specific applications. Circuit design techniques including i.c. op amps. Applications cover linear and non-linear circuits, A/D conversion techniques, active filters, signal generation, modulation and demodulation. Complete test circuits and methods. 474 pages. **\$15.00**

26. The Design of Digital Systems. *John B. Peatman.* Textbook for students desiring to develop a creative approach design capability through digital systems approach. Answers these questions: Under what circumstances it is desirable to implement a system digitally? What are some of the components available for implementing the system? How do we go about designing it? 448 pages. **\$15.50**

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. **\$9.95**

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. **\$14.50**

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 stereo sound recording for film, as well as details of the Soviet systems now in use. 284 pages. **\$15.00**

33. Noise Reduction. *Beranek.* Designed for the engineer with no special training in acoustics, this practical text on noise control treats the nature of sound and its measurement, fundamentals of noise control, criteria, and case histories. Covers advanced topics in the field. 1960. 752 pp. **\$19.50**

27. Noise & Vibration Control. *Edit. by Leo L. Beranek.* Practical design and regulatory information; formulas, choice of materials and structures, city codes and hearing protection; indispensable for design engineers, public officials who prepare regulations for noise control, safety and environmental engineers involved in noise and vibration controls. Covers data analysis, transmission of sound, psychophysiological design criteria, hearing damage risk, etc: Wealth of detail, comprehensive index and concise appendices. 650 pages. **\$29.50**

28. Environmental Acoustics. *Leslie L. Doelle.* Applied acoustics for those in environmental noise control who lack specialized acoustical training. Basic information in comprehensible and practical form for solving straightforward problems. Explains fundamental concepts; pure theory minimized. Practical applications stressed, acoustical properties of materials and construction listed, actual installations with photos and drawings. Appendixes illustrate details of 53 wall types and 32 floor plans and other useful data. 246 pgs. **\$18.50**

21. Acoustics—Room Design and Noise Control. *Michael Rettinger.* 1968. The enormous problems and hazards presented by noise are dealt within an orderly and practical manner. With many charts, graphs, and practical examples, the text covers the physics of sound, room acoustics, and design, noise and noise reduction. 392 pages. **\$17.50**

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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PEOPLE, PLACES, HAPPENINGS

● Word from **Fairchild Sound Equipment Corp.** is that **David Bain**, sales manager of the firm, has resigned to form a new manufacturers' representative firm to be known as **David Bain Associates**. The firm will be based in Port Washington (L.I.) New York and will specialize in the broadcast and commercial sound fields. Prior to his association with Fairchild, he held various management posts with **RCA's** broadcast division, and had been manager of **Muzak's** product division.

● **HAECO, Holzer Audio Engineering Corp.** announces the issuance of U.S. Patent number 3,646,574 to **Howard S. Holzer** on February 29th, 1972 for his Compatible Stereo Generator (CSG). The patent was applied for January 8, 1968. Licenses are being offered to interested recording companies and broadcasters under this patent which encompasses the production of a compatible output from phase encoded quadriphonic or stereo matrices wherein the common information can be controlled in amplitude and/or maintain direct aesthetic quality with the quad-to-stereo and stereo-to-mono reproduction.

● An announcement from the board of directors of **Switchcraft, Inc.** tells of the election of **Clyde J. Schultz** as vice-president marketing. Mr. Schultz has been industrial sales manager of Switchcraft since 1966; he now assumes executive responsibility for all marketing, sales, and advertising. He originally joined Switchcraft in 1960 as manager of sales promotion for industrial and distributor sales operations. Prior to that he was sales promotion manager for **Admiral Corporation**, worked in sales for **Shure Brothers, Inc.**, and was a buyer for **Allied Radio Stores**.

● **Columbia Records** and **Electro-Voice** have announced an agreement in principle for a non-exclusive exchange of patent rights and technology related to their respective four-channel matrix systems. This agreement follows issuance of basic matrix patents to **Peter Scheiber** (assigned to E-V).

● The formation of **Audiotechniques, Inc.**, a new company to serve the professional audio industry has been announced by two former Scully executives. **Hamilton (Ham) H. Brosious**, is president and **Robert Berliner** is vice president of the new firm. Audiotechniques will concentrate on sales and service of a number of quality professional lines in the twelve north-eastern states. Among franchises already secured are the entire line of **MCI** multi-channel tape recorders, **Dolby** Noise Reduction Systems **Standard Tape Laboratory Test Tapes**, **Taber** bulk tape degaussers, **Videotechniques** cctv products, and **Eventide Clockwords** digital delay line.

● **Donald V. Kleffman** has been named marketing manager of the audio-video systems division of **Ampex Corporation**. He replaces **A. A. Sroka** who has been appointed manager of corporate marketing services. In his new position, Mr. Kleffman will be responsible for domestic sales of Ampex audio, broadcast, and industrial television products. He has been with Ampex since 1959 rising from a video applications engineer to various management positions before this present promotion.

● Things got misfiled and we know it's probably too late to tell you about the **Institute of Audio Research's** current expanded program. During July, **Practical Disc Recording #102** and **Audio Systems Design #301** were offered in addition to **Studio Technology and Practice #101**. The Institute's educational work is receiving impressive accolades. They have attracted students from distant points within and without the United States. They are offering accelerated courses that began on July 10th and run 2, 3, and 4 weeks.

The success of their work has prompted them to require more classroom space than they began with and accordingly they have announced their new offices and classrooms at **64 University Place, New York, N.Y. 10003**. And you can still reach them by phone at **(212) 677-7580**.

● **C. Victor Campos** has been promoted to be manager, acoustics engineering by **KLH Research & Development**, a division of **The Singer Company**. The announcement by **Irving Grossman**, president of KLH points to the fact that Mr. Campos is a veteran of 18 years in audio and has been with the company since 1963 where he has held several technical and marketing positions. In his new position, he will be responsible for design and product development of the KLH line of loudspeaker systems.

● **Bell Sound Studios** of New York City tells us that they have added a new mixing theater designed for four-channel sound. A custom-designed console is used to make mixdowns to quad simple. **Dave Teig**, studio general manager has said that they feel that (four-channel) is a giant record industry potential and they would like to offer the industry the best possible tools with which to record and mix.

● A note from **Fred Ohman Inc.** the rep organization in Twinsburg, Ohio tells us that audio industry veteran **Paul A. Stone** has purchased an interest in the corporation and has joined the company. He brings with him over fourteen years of engineering and marketing experience. His most recent position was with **Elpa Marketing** and has previously been with the **R. T. Bozak Mfg. Co., Utah-American Corp.**, and the **Heath Company**. The Fred Ohman firm covers Indiana, Ohio, Kentucky, West Virginia, and Western Pa.

● **Donald F. Smith** has been appointed director of marketing of the recording automation group of **Dictaphone Corporation**. This group comprises the **Scully** and **Metrotech** divisions. He will have his offices at the company's recently opened 41,000 square-foot facility in Mountain View, California. He comes to Dictaphone from the **Ampex Corporation** where he was a regional manager and national sales manager in professional audio and video equipment sales.

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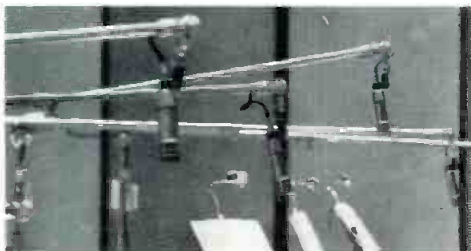
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