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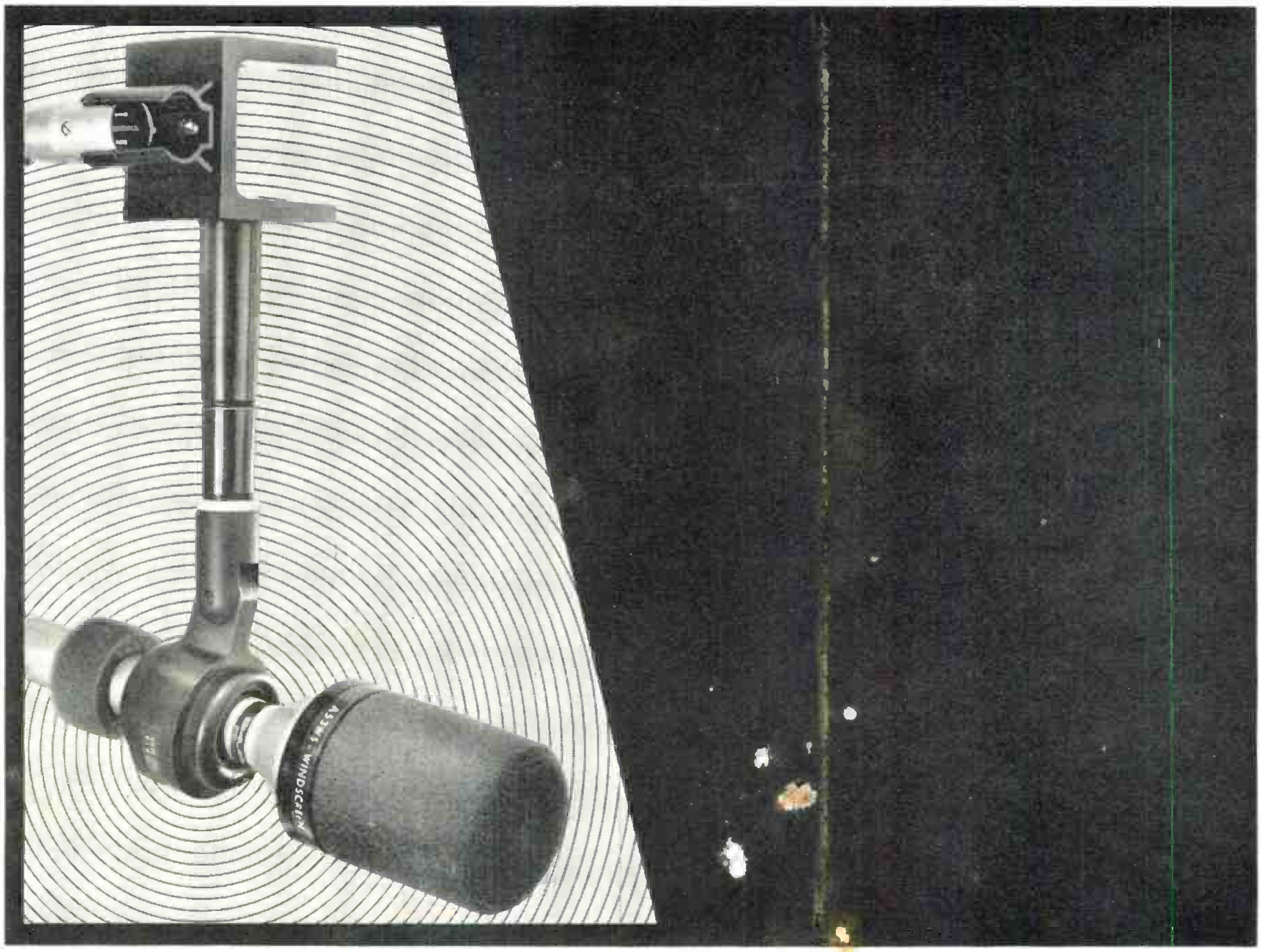
THE SOUND ENGINEERING MAGAZINE

JULY 1971 $1.00



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COMING NEXT MONTH

• Marshall King returns to our pages with an article that details the functions and use of the sync pulse in television audio. As he says, a motion picture has little credibility if the sound and picture are not in sync. So too for t.v. tape!

Eric Small of New York's WOR-FM discusses some problems of mono/stereo compatibility as it pertains to broadcasting. His paper, is revised from one which was given to the Broadcast Symposium of the IEEE Group on Broadcasting, late last year, and published in their journal.

Last, but not least, an up-to-the-minute report on 4-channel stereo systems with both recording and broadcast requirements kept in mind.

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

ABOUT THE COVER

• Through the courtesy of GRT Corporation, our cover shows a typical recording studio mastering room. The photo is by Jeff Lowenthal.

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THE SOUND ENGINEERING MAGAZINE

JULY 1971 VOLUME 5, NUMBER 7

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letters

● In the April issue we managed to slight the people who make and distribute Sony mics not once but twice. None of their microphones graced the cover art—which might have been correct on the pure grounds of cover artistry but not correct on the grounds of professional quality mics. So, to Sony (and any rightful others who do not recognize their product on April's cover) was assure them that no slight was intended.

To compound the error against this particular manufacturer, the FORUM ON MICROPHONES in this same issue listed the microphones mentioned in the discussions and failed to list the Sony C37 and C-22, both of which are mentioned on page 26, and again (for one) on page 27. Our apologies are given.

The Editor:

Please allow me to make a few comments regarding the letter sent in by Mr. Stephen F. Temmer, President of Gotham Audio Corp., New York, N.Y. (**db**, Feb. 1971) in which he corrected some of the information included in my portion of the Teldec articles (**db**, Dec. 1970).

The thickness of the disc is indeed 0.1 mm. The literature distributed at the Teldec demonstration gave the erroneous information that the disc was "one millimeter" thick. This was later corrected in the discussion period and my notes did pick up the correction, but a little something was lost in the translation to the final copy submitted for publication.

The sound is indeed inserted in the interval between the blanking pulse and the beginning of the next line of video information. Here again, in reproducing my copy for submission, the words ". . . between frame lines" in the original were inadvertently typed as ". . . between frames."

The matter of who will have the first disc cutting equipment will, of course, depend on the cost, the space requirements, the need for extensive duplication, etc. At the meeting, it was mentioned that only the larger concerns would be able to get the necessary equipment. The process will probably start with recording houses (as at present with audio discs) but according to the discussion, this is not necessarily the place where it will end. Much also will depend, it can be supposed, on the complexity of the duplication process and whether it is worth having at all on the premises or whether it will be better to send the material to a duplication facility.

On the subject of the method of moving the transducer across the disc, Mr. Temmer says that the "reproducer is driven towards the center of the disc by a thin wire, not by a gear box and is returned (as of this time) by hand." The reproducing head of the demonstrated model was moved by a *string*, not a wire, but the technicians told us that the wire was the method that would be utilized on the forthcoming models.

However, Mr. Temmer did not tell us how the string is moved. Without some help, the string and transducer would not move at all. To provide a means to move the transducer the necessary distance of 0.008 mm with each revolution of the disc, a gear box is built into the unit. This box is coupled to the drive motor of the unit and translates the rotational speed to a lateral movement. It is this gear box which we said moved the transducer. However, there is a string attached.

Regarding the method of returning the reproducing stylus to the beginning of the disc, the technical people who operated the equipment at the demonstration told me that the head is returned by the same string (or wire) that moves the head across the disc.

(Continued on page 16)

advertisers index

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The Promise

Thousands of people have heard 4-channel stereo reproduction at hi-fi shows and special demonstrations in the last few years. Others have read about this fascinating and rewarding technique that promises more faithful reproduction of musical performances. Early experiments have also shown 4-channel to be an effective tool in creating new sonic environments for both serious and popular musical forms. The concept has met with almost universal critical acclaim, and strong general approval.

The Problem

But alas only a handful of enthusiasts are actually enjoying this advance today. Because only a few 4-channel tapes have been produced for sale. The problem is simple, but basic: 4-channel means just that—four separate signals. And to reproduce it properly demands four of everything, right down the line.

It's possible (albeit expensive) with reel-to-reel and cartridge tape. But the stumbling block has been to put four completely independent signals in a record groove, or to broadcast them over a standard stereo FM station.

And if you can't make 4-channel discs, or play them on FM, the market is limited to a precious few 4-channel tape owners. But their numbers are so small that the record industry just can't afford to release four channel material. So the industry continues to produce 2-channel stereo that anyone *can* play (and that can be sold in volume).

The Way Out

Now Electro-Voice has moved to break the impasse. With a system that can offer the significant advantages of discrete 4-channel, yet is compatible with present record manufacturing and playback equipment and present FM broadcasting. It is called STEREO-4.

STEREO-4 is a system that encodes four channels into a stereo signal that CAN be transmitted over FM or recorded on a disc, stereo cassette or cartridge. The home listener adds a STEREO-4 decoder, plus another stereo amplifier and a pair of rear speakers. The result is reproduction that closely rivals the original 4-channel sound. Four different signals from the speakers, with a feeling of depth and ambiance you have never before heard from any record.

Admittedly, STEREO-4 is not quite the equal of 4 discrete signals. But while there is some loss of stereo separation, there is no reduction in frequency response or overall fidelity. We might note that this reduced separation actually seems to aid the psychoacoustic effect for many listeners in normal listening situations. And on the plus side, STEREO-4 offers an advantage that even discrete 4-channel cannot provide.

The Remarkable Bonus

Playback of almost all present 2-channel stereo discs and tapes is greatly enhanced when fed through the STEREO-4 decoder. It's the result of multi-microphone recording techniques that include a remarkable amount of 4-channel information on ordinary stereo discs and tapes. Adding STEREO-4 releases this hidden information for all to enjoy.

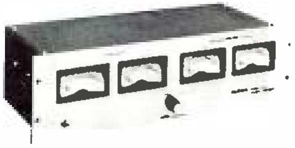
Model EVX-4 STEREO-4 decoder

The Decoder

A STEREO-4 Model EVX-4 Decoder costs just $59.95. And with it, plus 4 speakers and dual stereo amplifiers, the listener is equipped for almost any kind of sound available. Encoded 4-channel, enhanced stereo, regular stereo, *and* discrete 4-channel (assuming suitable source equipment). Even mono. So STEREO-4 is the one system that is compatible with the past, present, and foreseeable future.

The Present

And what about encoded 4-channel discs and broadcasts? Well, that's where you come in. Already recording companies have started mastering STEREO-4 records, and their ranks are growing. And STEREO-4 is now being broadcast in many major cities around the country.



Model 7445 Professional STEREO-4 Encoder

The Encoder

All that is needed is a Model 7445 Professional STEREO-4 Encoder $795.00 net, direct from the factory. The encoder is patched into your console. No other changes in equipment or handling, whether broadcasting or recording (except that you'll want to add 4-channel monitoring, of course). No increase in costs. And your performance standards are unaffected. The encoder doesn't add noise, distortion, or limitations on response. And listeners without a decoder still enjoy all the music in conventional 2-channel stereo. Some record producers even feel that the STEREO-4 encoder results in better 2-channel stereo than conventional mix-down techniques.

The Future

Like you, we hope for the day when discrete 4-channel sound will be commonplace on records and FM, and when STEREO-4 decoders will be relegated to enhancing present libraries. But that day will have to wait until some very knotty design problems are solved. And probably after a host of new FCC regulations define an utterly new system. Indeed, there is serious question whether these problems can be solved at all.

In the meantime, the STEREO-4 system is getting 4-channel recordings into the marketplace in increasing numbers, in a form that people can enjoy. EVX-4 STEREO-4 decoders are now on the market in quantity. And STEREO-4 decoder circuits are being designed into mass-produced stereo phonos and receivers. Even STEREO-4 juke boxes are now in use!

What Can You Do?

Write us today for all of the technical details, plus up-to-date news of STEREO-4. Make news yourself by adding compatible STEREO-4 for your audience. It's not too soon to start planning for tomorrow!

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overloads before they can be detected by hearing them.

Once while riding the famous Long Island Railroad I was thinking about possible applications for led's in audio and I came up with no less than 30 different uses. They can be used as simple power amplifier output stage balance indicators, all sorts of null and peak detectors, overload protectors with infinite isolation, substituting a transformer by using led's in conjunction with a phototransistor. Now that we have mentioned the phototransistor, let's talk about it.

It is a device which is nothing more than conventional transistor except it is sensitive to the variations of light level as seen by its base. If we modulate the light with audio, a phototransistor will amplify it and deliver into its load a signal identical to the modulated audio, without changing phase or response (when properly biased). There may be some changes because of some nonlinearities of optoelectronic devices but an over-all picture is this:

Isolation previously achieved by using transformers (except where power transfer and conversion are needed) led's and phototransistors can out perform any transformer in ability to function at the lowest frequencies down to d.c. without distortion saturation or phase shift. Some phototransistors can be used in communications with modulated laser beam. Think of replacing relay by using light from LED as an activator to turn on phototransistor.

Some time ago, I was drawing your attention to the usefulness of cadmium sulfide and cadmium selenide cells for light-operated circuits. Many pieces of professional audio equipment have been designed using these cells. For the light source conventional incandescent bulbs were mostly used; sometimes fluorescent lights including neon bulbs, phosphorous screen lamps and panels and others were used. Here is an excellent chance to make use of led's where applicable, and I emphasize *applicable* since although the incandescent bulb is not a very fast turning on device (thin filament bulbs turn on in about 1 msec) it retains its illumination for considerably longer time when the current is shut off (thermal inertia). Therefore, in compressor circuits where operation of the unit was dependent on this slow decay for prolonged release time, using led's would be a mistake, unless a special driving circuit was devised providing slow current shut off to the led (a form of a latching circuit).

Another variation in combining new devices includes use of phototransistor and a ldr (light-dependent resistor) where one responds to nanosecond light pulses as emitted by a led and the ldr provides smoothing action and long release time.

Just to name a few applications for new optoelectronic devices: tachometers, optical commutators, tape tension and breakage sensors, numerical readouts (already in wide use), optical track generators, d.c. feedback control with infinite isolation, warning flashers, and many others.

Special care should be taken in reducing ripple from the power supply feeding the led's which control light sensitive circuits. Where incandescent light sources are not fast enough to respond to ripple frequency and modulate its emitted light, led's can.

A first attempt to use led's extensively, could be seen at the AES Convention and Exhibit in April 1971. A recording console from Olive, a newcomer to the field, used led's as indicators in their channel assignment display panels.

In the past several years we have witnessed an almost complete conversion to solid state equipment in recording field. I wish I could say the same for broadcasting audio. It seems that the final outcome is clear. Gaps left open in semiconductor technology are closing at a fast pace and led's are closing one of these gaps.

A few other facts bout led's. Although I have mentioned that the led is small and uses on the average 10 MA of current, units have been developed by Monsanto which draw as much as 2 amps, are about ⅜-inch in diameter and are meant for uses such as illuminators for photographic dark rooms, high intensity indicators, or warning flashers. It's needless to say that such diodes have to be mounted on a heatsink. In this case a metal panel is an excellent surface. Spectral response of the diodes depends on the material of the junction. Diodes emitting red light peak around 6700 Angstroms. Red light led's are easiest to manufacture, therefore, they cost less. Yellow and green light led's are much more expensive, but it is only a matter of time before their cost will drop too. ■

moving

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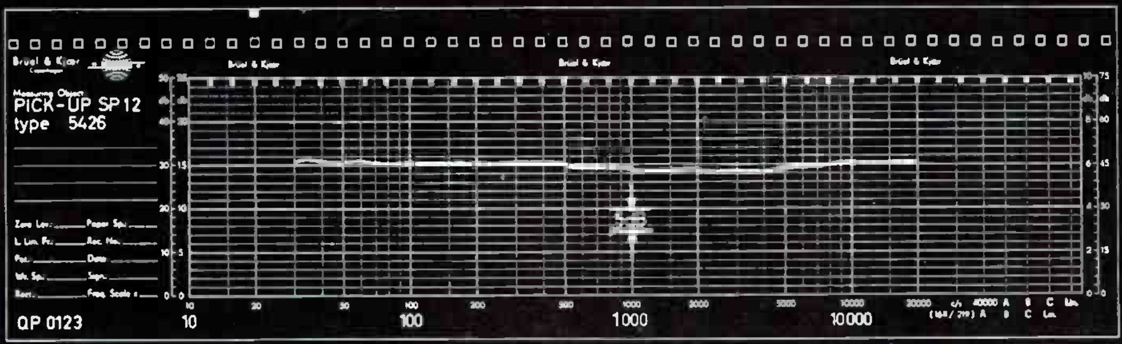

The BANG & OLUFSEN SP 12 cartridge with bi-radial elliptical diamond stylus, has an outstandingly smooth frequency response.
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John M. Woram

THE SYNC TRACK

• Sometime ago, I got the idea that it might be worthwhile to compile a list of books of interest to the recording engineer. Many of the letters that arrive at **db** request information about how to learn more about recording. Well, then, why not write a short review of the various books on the subject? This shouldn't be difficult at all—just contact the various book publishers and ask for lists of books in this field, and review copies if possible.

Don't try this unless you've got a lot of time and patience. It turns out that most publishers seem to have little idea about what they turn out these days. Although I now have many titles in front of me (persistence pays!) I don't recall one publisher who would admit over the phone (maybe they feared wiretappers?) to having a book that would interest me. About the best I could get was a promise of a catalog. I did get a nice letter from one company in response to my request for books about recording, music, or acoustics. Sorry, they wrote, we don't make recordings about acoustics.

And then the catalogs arrived! One lists almost 5000 titles. Unfortunately, they are listed alphabetically by author. Another is over 550 pages long, and should itself be reviewed.

Now that we're all impressed with my troubles, let's get on with the reviews. Probably the most well known book is;

The Audio Cyclopedia, by Howard Tremaine, Howard Sams & Co. $29.95.

This book contains more than 1500 pages of reference material in question and answer format. The book is divided into 26 sections. Typical sections are; Basic Principles of Sound, Microphones, Cutting Heads, Test Equipment, and so on. A fifty-page index makes it easy to find the answer to just about any question you may have about almost anything from A-B tests to "Z" sets. If you can only afford one book on audio, this may be the one to buy.

The Technique of the Sound Studio, by Alec Nisbett, Hastings House. $13.50.

Although written with the interests of the radio broadcaster in mind, much of the text will be of value to the small recording studio operator and perhaps the more advanced home recordist. There are chapters on microphone techniques for speech and music that should especially interest the latter.

For the studio that finds itself getting involved in ad agency work, the Fades and Mixes chapter may be worth the price of the book. Here, *mixes* mean a segue from one signal to another, and has nothing to do with tape mastering (16 tracks to 2 track, etc.) The successful programming of short announcements with equally short musical intros and closes is an art which may not be the specialty of the full time multi-track studio engineer. Although there's nothing like first-hand experience with a nervous client and a stop watch, a little homework with this book may make for an easier session. The short discussion of sound effects can be of interest to anyone looking for an occasional effect.

Microphones, by A. E. Robertson, Hayden Books

This book was also written with the needs of the broadcaster in mind, however unlike the previous book, some knowledge of electrical engineering is assumed. Likewise, the reader without a firm grip on algebra may find the text rough going.

The book begins with a thorough treatment of the physics of sound and contains frequent mechanical/electrical analogies. Polar patterns are derived mathematically, and the various directional patterns are described in great detail. However, the approach is strictly theoretical and will probably be of greatest interest to students, microphone designers, and the recording engineer with a more than routine interest in the mathematics of the microphone. Definitely not easy reading.

Handbook of Magnetic Recording, Finn Jorgensen, TAB books. $7.95 hardbound; $4.95 paperback.

I'd recommend this little book to anyone who has occasion to go near a tape recorder. Its value will depend on your knowledge and experience, but there should be something of value here for just about everyone. Often, the tape recorder is given little thought by a busy studio staff. With all the activity in the studio, and the confusion at the console, the tape recorder is expected to sit quietly in the corner and behave itself. Spend a little time with this book, and you may remember that *Console Out* is not the end of your responsibility. It might be a good idea to read this book before studying the instruction manual that comes with your new sixteen-track machine.

Audio Systems, by Julian Bernstein, Wiley & Sons. $8.50 clothbound; $4.95 paperback.

This is another book fo anyone's audio shelf. There is an excellent chapter on decibels and volume units which should clear up the occasional confusion about the various reference levels. Also of more than routine interest are the chapters on attenuators and mixing and bridging systems.

At the rate at which technology advances, the chapters on amplifier systems and equalizers may be of less interest. (The book was published in 1966.) At this point in the state of the art, it is usually most convenient to consider an amplifier or equalizer as a black box 'system', where only the input and output values are important. However, these pages will give the reader a good background in classical amplifier design parameters and if nothing else, an appreciation of the sophistication that has been crammed into the latest ultraminiature i.c. circuits which are already being taken for granted.

Understanding Digital Computers, by Ronald M. Benrey, Hayden Books. $4.75.

Boolean Algebra, Principles and applications of, by Adelfio and Nolan, Hayden Books. $7.95.

Introduction to Switching Theory and Logical Design, by Hill and Peterson, Wiley and Sons. $14.50.

It is no longer essential for the studio engineer to have a complete knowledge of the innards of amplifiers, equalizers, and what not. New equipment is systems engineered and troubles are usually cured by locating the faulty system and replacing it. More often than not, this means nothing more exciting than pulling out a printed circuit card and replacing it with a new one. However, as technology develops, systems get more sophisticated. Complex switching systems are already in frequent use, and automation will surely contribute to the complexity. The new Gotham Audio Delay System is fair warning to all that the age of the computer has arrived. Tomorrow, the successful recording engineer will have to have at least a nodding acquaintance with the new technology. **Understanding Digital Computers** may be a good place to start. Although the book has nothing to do with audio, it does explain the basics of computer theory, including a short discussion of analog and digital computers, memory devices, and Boolean algebra.

For a complete course in Boolean algebra, the Adelfio-Nolan book can be recommended. In addition to the fundamentals of Boolean algebra, the book discusses truth tables and later on, diode and transistor logic circuits and electronic counters.

If you still want more, the **Introduction To Switching Theory and Logical Design** book will give it to you. Certainly not written with the recording studio in mind, it may be a little more involved than the average reader would care to go. Yet, this is the direction in which we seem to be moving, and for the serious student, the book should provide a solid foundation in switching devices, sequential circuits, threshold logic, and relay circuits. ■

you write it

Many readers do not realize that they can also be writers for **db**. We are always seeking good, meaningful articles of any length. The subject matter can cover almost anything of interest and value to audio professionals.

Are you doing something original or unusual in your work? Your fellow audio pros might want to know about it. (It's easy to tell your story in **db**.)

You don't have to be an experienced writer to be published. But you do need the ability to express your idea fully, with adequate detail and information. Our editors will polish the story for you. We suggest you first submit an outline so that we can work with you in the development of the article.

You also don't have to be an artist, we'll re-do all drawings. This means we do need sufficient detail in your rough drawing or schematic so that our artists will understand what you want.

It can be prestigious to be published and it can be profitable too. All articles accepted for publication are purchased. You won't retire on our scale, but it can make a nice extra sum for that special occasion.

Norman H. Crowhurst

THEORY AND PRACTICE

• Last month we discussed some of the more basic aspects of microphone choice. Sometimes obtaining the performance desired extends beyond merely picking a microphone that is good for the purpose. Room acoustics, or perhaps the pickup problem itself, impose demands that the best microphone in the world cannot handle, without more help.

Of course, the machine-gun mic, superseded (far more efficiently) by some of the super-directional types, provides a direct improvement over the cardioid or super-cardioid, enabling a particular sound source to be picked up at considerable distance with pin-point accuracy. However, for some jobs, that very pin-point accuracy is its weakness.

The fact that its angle of pickup is so narrow means it cannot pick up sound over a wider source area, such as a theatrical presentation. The pin-point accuracy is fine, if you want to have an operator behind the mic all the time, aiming it at the precise spot where the sound comes from. But if you want to pick up sound over an area, all at once, or without having to man the mic, this solution is no good.

It is surprising how often in life we find that a circumstance that is undesirable in one setting can prove desirable in another. This happens here relative to the old question of phasing. When multiple mics are connected to the same amplification equipment, phasing is important, especially if they cover the same area. This was touched on last month. And speaker phasing can be important too. If an average home-town auditorium is covered with two speakers, one on each side (FIGURE 1) they must be in phase to achieve uniform coverage of the seating area.

If they should be out of phase, there is a section down the center where direct sound cancels. As you sit there, or move your head through it, you encounter an experience of "losing the source." Virtually, you hear only reverberated sound, with all the confusion it brings.

But by changing things a little, such out-of-phase connection can have an advantage (FIGURE 2). Now, by putting the microphone carefully equidistant from the two speakers, it does not pick up the speaker sound, because they neutralize each other. This enables the volume to be turned up more, so the seating area, except for this narrow line down the middle, can be more effectively covered.

From the performer's viewpoint, the sound may seem a little strange, because his two ears may hear the same sound out of phase, giving him an unreal sensation about his own voice. However, any sound a performer hears from a loudspeaker system, reproducing his own voice, has a certain unreality about it—it differs from the way his voice sounds to him in the absence of amplification. On the other hand, the presence of this unreal reinforced sound is evidence to him that his voice is getting across. Apart from the oddness occasioned by sound reaching his two ears antiphase, the arrival of this sound will quickly be accepted as evidence of such arrival.

But this does not solve the problem equally for the line of auditors down the middle of the room and, for this reason, this solution to the problem has usually been rejected as impractical. However, on either side of center, it would presumably be quite acceptable: auditors there would be unaware of the deficiency in the middle.

Modern technology has made electronic amplification one of the least expensive items in a reinforcement system. Stereo has encouraged the development of multi-track sound systems for other purposes: why not for reinforcement? Now, replace the single system of FIGURE 2 with a double system (FIGURE 3) in which each microphone is in a position of null for the two loudspeakers that amplify its sound, and what do we have?

For each track, or channel, there is a line down the center, but the two lines are not coincident. So auditors in each line will receive acceptable sound from the speakers connected to the other channel. And what about auditors who hear sound from both channels?

Here another possibility should be considered: the possibility of sound arriving at a location antiphase, from the two systems. This will not happen if the two microphones are connected to their respective amplifiers in identical phase, and if speakers on the same side are each connected to their

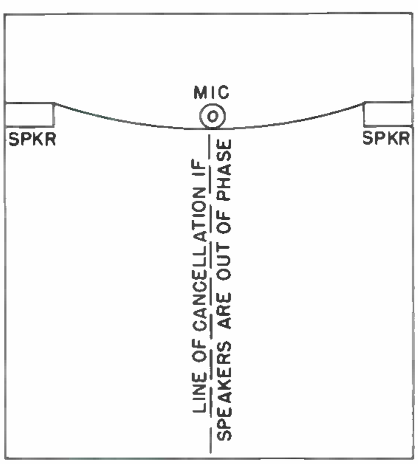


Figure 1. The conventional single microphone, two loudspeaker system in a small auditorium: speakers out of phase give trouble down the center.

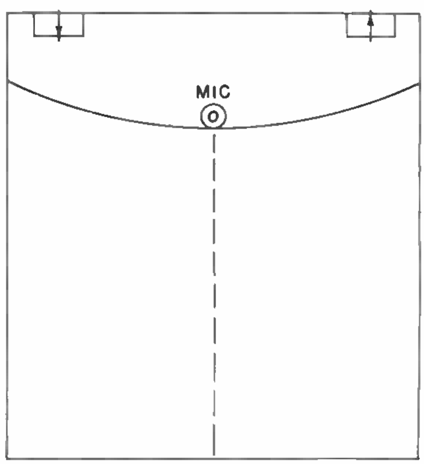


Figure 2. One advantage of having the loudspeakers out of phase: the microphone can be in the null zone.

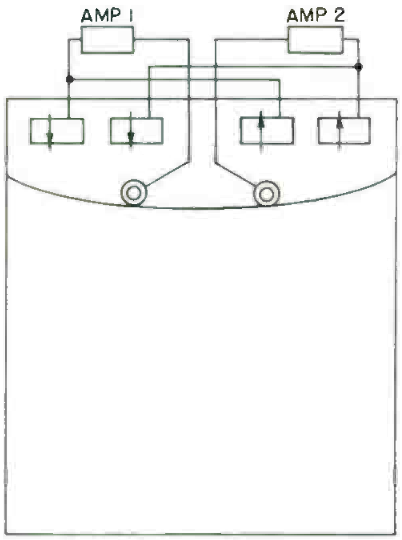


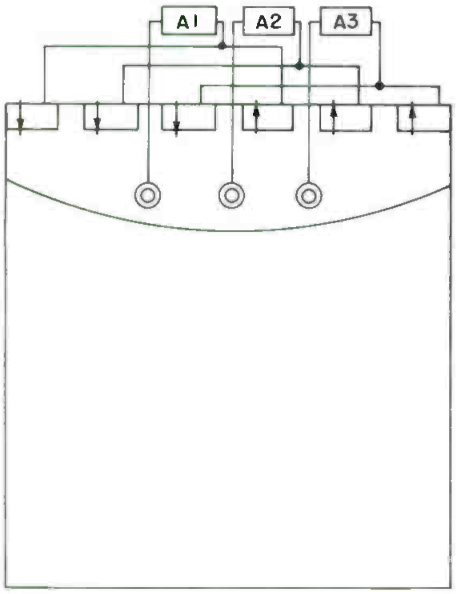
Figure 3. Using two complete systems, such as stereo, enables the difficult middle zone to be covered.

respective amplifiers in identical phase. This means that the sound radiated by each track on the same side of the auditorium will be in phase.

A further improvement can be achieved, for wider coverage of the stage area, by using three or more systems (FIGURE 4). The essential feature is that each microphone be positioned on a null between its out-of-phase loudspeakers.

Perhaps you still feel a little uneasy about this whole thing. It contradicts the principles you may have adhered to rigidly for years in putting together such installations, maybe. So let us pursue the possibilities a little further. In each instance, we have assumed the speakers are pressure radiators (the waves from the back of the diaphragms are not utilized) and that the microphones are also pressure type (omnidirectional) or at least partially so (cardioid).

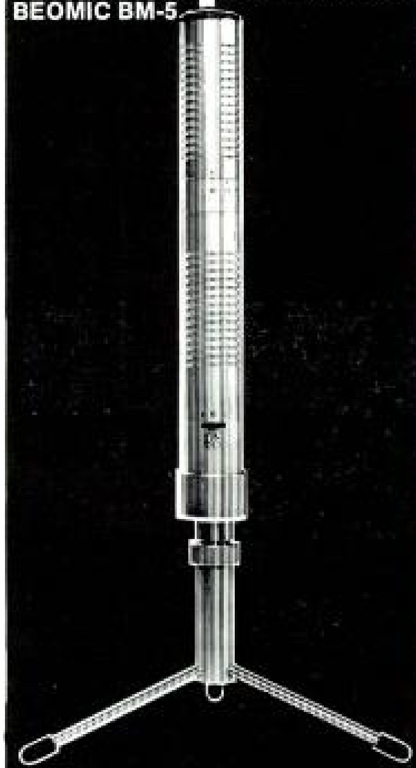
Figure 4. A further improvement, using three (or more) systems, with each microphone at the null point of its own speaker system.



If the microphones and/or speakers are essentially velocity devices, the picture changes somewhat. With pressure devices, the only relevant quantity about the sound wave at a point is its pressure and timing: if the pressure and timing of two component waves are equal and opposite for pressure, at identical instants in time, then null occurs. But with velocity devices, wave motion at a point has effect, too.

In loudspeakers, this can work by having the wave from the back of the same unit affect the direction of particle motion due to the wave from the front. However, usually the microphone will be sufficiently far enough from the speakers so that this effect will not be important. But it may affect the equality of pressure at points where the timing is identical, or *vice versa*.

In a microphone, a bidirectional has a direction of null, which could be used with a single speaker (FIGURE 5). Provided the path from speaker to mircrophone is direct, this will work as well as the idea just described, when the microphone is oriented so the speaker is on its dead spot. But if a person's head, for example, obstructs the direct path partially, so



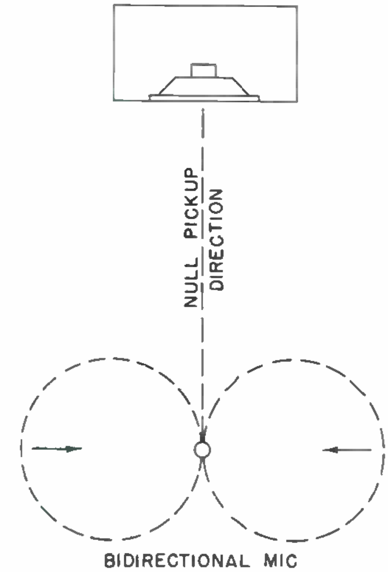


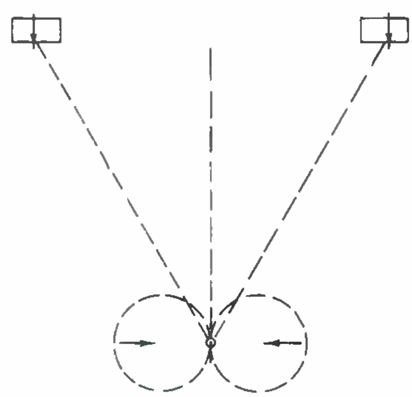
Figure 5. A bidirectional microphone can (in theory) provide a null effect from one loudspeaker.

the angle of arrival of the direct wave is changed, the null can be spoiled. Such an arrangement can be sensitive to movement of people in the microphone area.

Similarly, the crossways microphone can be used with two speakers, where these are connected in conventional *in-phase* (FIGURE 6). Here, the cancellation depends on the sound reaching the frontal lobes of the microphone at the same time, and in the same vector intensity. This vector intensity depends not only on the intensity of the arriving wave, but on its angle of arrival. Obviously this arrangement will be somewhat more sensitive to the movement of heads in the vicinity of the mic. But the idea has been made to work. Rotating the mic can achieve considerable gain in the amount of amplification that can be used.

This, of course, is the criterion of the success of each of the systems described. This is one method by which each system can be used additively, in over-all result, except for those narrow areas where one system is ineffective. Each microphone should be placed, relative to the speakers that handle its amplified sound, without the others working.

Figure 6. A bidirectional microphone can (in theory) provide a null effect with two loudspeakers operating in phase, but the situation is more than critical than with pressure microphones.



Now, when each has been thus set without the others turned up, each system will have its own level of operation, and effective service area. Most of the service areas of the individual systems will overlap in combined coverage. Thus when they are all turned on, to a safe sound level (one at which acoustic feedback does not occur) the sound level at most individual auditor's positions will be cumulative.

The extent to which nulling enables individual systems in the set to be turned up, depends on the reverberation characteristics of the auditorium. Nulling can cancel the pickup of only the direct sound waves, or of waves travelling by the most direct paths. No systematic cancellation of reverberant sound is possible.

It may be possible to cancel the pickup of a particular frequency at which standing waves build up, by placing the microphone at a null point in the standing wave pattern. But this will only work for that particular frequency and that particular pattern. Use of a sharp frequency-rejection filter, that eliminated just that frequency from the amplification, would be just about as effective.

For those who have worked with rejection filters, that last remark may put the rest in perspective. In some buildings, where there is one horrible peaking frequency, such a filter can do a lot. In most half-way good buildings, it does not affect much improvement (although *Acousta-Voice* response tailoring may).

Similarly, cancellation of the direct wave by the systems described will always be good. If this is not much help, it is because a bad reverberant condition runs direct-wave feedback a close second. Then choice of a microphone position that finds a null in the standing wave pattern for that frequency, as well as for the direct-wave feedback (which could involve a lot of cut and try) may help more. Or the use of rejection filtering (in each channel) may do the same thing, essentially.

So far, our discussion of microphone placement has concentrated on reinforcement uses, which pose their own kind of problems. But choice and placement of microphones can also have a profound effect in studio use, where acoustic feedback does not complicate matters. More of that later. ■

Martin Dickstein

SOUND WITH IMAGES

The A.N.A. Television Workshop

● One of the most recent meetings whose agenda was devoted to talks and discussions on cable t.v. and video cassettes took place at the end of May at the Hotel Plaza in New York when the Association of National Advertisers held its Workshop on Television Advertising.

The Association has a membership which includes individuals in, or associated with the advertising industry and the world's largest insurance companies, advertising agencies, aluminum companies, photography equipment manufacturers, cosmetic and soap makers, food companies, pharmaceutical houses, soda bottlers, etc., etc., etc. The purpose of this semi-annual meeting was to bring their members and guests up to date on the developments in the fields of c.a.t.v. and video playback devices with emphasis on the possibilities of these media for the advertiser. The session lasted two days and included talks by experts from ad agencies, t.v. broadcasting, program production, audio/visual and t.v. system designing and a Commissioner of the F.C.C. Subjects ranged from surveys of the changing audience and their segmentation to rules and regulations of the television industry, from an analysis of the different video systems to studies of future advertising media. About 150 people attended each of the sessions and then were able to question a panel of some of the speakers.

Although the overall subject was *The Segmented Viewing Public of the 70's—And How To Reach Them*, several of the speakers dealt with video devices and their future for the advertiser. Brief excerpts of some of the remarks will be of interest to those in the audio-visual field who are observing the current scene and looking for trends of the future. Although these segments are taken out of context, there is no intent here to editorialize in any way nor is any personal opinion expressed or intended except the meaning of the speaker himself. The excerpts are in the order of the program and will deal primarily with c.a.t.v. and/or video devices.

Under the title *CATV—Is It An Advertising Medium?*, Dr. George Simko, senior v.p. of Benton & Bowles Advertising Agency, looked at the future of c.a.t.v. this way:

"Certainly, I am aware of c.a.t.v.'s ability to improve television reception. That's basic. "I'm also aware that the ultimate capability of c.a.t.v. to provide two-way communication can have many benefits for the consumer:

"... he could know what his bank balance is instantaneously.

"... he could use it to achieve a home burglar alarm system connected to the police station.

"... he could have his water, electric, and light meters read electronically.

"and these are but a small sample of the ultimate possibilities.

"I know too that we can look beyond this to the point when c.a.t.v. could provide hard copy in the home, making newspaper facsimiles possible and enabling the transmittal of correspondence electronically, thus bypassing the U.S. mails."

Mr. Robert J. Nissen, senior television specialist of Hubert Wilke Inc., Communications Facilities Consultants, spoke on *The Video Systems—A Survey and Comparative Analysis*. Following a slide presentation in which the various video devices were compared, Mr. Nissen discussed areas of Cost, of both the devices and the raw stock, requirements for reliability, simplicity of operation, quality of picture and sound and internal system standardization. He then expressed a few personal comments on the present state of the devices being built or proposed.

"EVR was the first out of the starting gate. But as any confirmed horse race bettor will tell you, the first horse to break out of the stall is not necessarily the first to cross the finishing wire. EVR has been plagued by technical problems during the past six months. Many competent observers who have followed the various public and non-public demonstrations of EVR agree that EVR has not shown consistent demonstrable quality. Both CBS and Motorola are painfully aware of the problems and are working nights to solve them. Unlike the other manufacturers who are in the prototype stages, the EVR shake-down cruise is underway. I'm sure that

Figure 1. Panels were held that enhanced the information transfer of the meetings.

they're probably feeling about as comfortable right now as the first early Christian to walk into the Coliseum.

"With regard to magnetic tape systems, Sony appears to have the lead at this time. Not only has Sony demonstrated a functional and high quality (albeit, expensive) unit but they have also assembled a high-powered international consortium for standardization.

"While the Ampex Instavideo unit has shown decent quality in prototype demonstrations, Ampex has not, as yet, convinced other manufacturers of the viability of the Ampex format. Ironically, Ampex is using the Japanese EIA type 1 standard; a standard which Sony instigated some years ago; while Sony has chosen to formulate an entirely new ¾-inch format.

"Avco Cartrivision, with its own unique format, has a tough row to hoe. Their go-it-alone approach will require a large amount of economic staying power and an inordinate amount of patience on the part of stockholders.

"The Philips VCR system, with yet another format, has not to this date been demonstrated in the United States. In typical Philips fashion they are taking their time in research and development in the hope of duplicating the success they achieved in making their *audio* cassette the industry standard. We should be hearing from Philips within the next several months.

In the videodisc field, Teldec has achieved perhaps the most impressive technological breakthrough with demonstrated quality. The low cost of the playback device, coupled with the very low cost of the plastic disc in large quantities, gives the videodisc the lead in the potential mass consumer area at this time. The videodisc finally opens the door to the often heralded electronic publishing. Just as a book publisher would not consider printing a book with a Xerox machine, neither can an electronic publisher seriously consider cracking a mass market with a low replication rate device and a high unit cost for the storage medium. The video disc is the closest comparison to the printed book on the horizon today. On the other hand, the video disc has little function to play in the low volume distribution business.

"With respect to the 8-mm color image film systems, there is to date little substantive information to properly evaluate their standing. But there is no question that giants like Eastman Kodak, with their expertise in, and commitment to, color film, are hard at work investigating film to television translator devices.

"RCA demonstrated a laboratory prototype of the holographic SelectaVision process in the fall of 1969. Since then little has been heard from the RCA camp with the exception of numerous public announcements of software commitments. There has been persistant conjecture that development of the holographic SelectaVision process has been shelved. I was told last week by RCA that this is not true; that the development of holography is continuing but that RCA is also investigating all other types of systems (with the exception of film systems which their original research had ruled out). They have announced as late as April 26 that they are investigating the magnetic approach. With the traditional RCA association with the mass market, it would not be at all surprising that they are vitally interested also in the video-disc approach." In his concluding remarks, Mr. Nissen said: "I see two basic types of systems emerging to serve two, quite different functions. The first type of system is applicable for users who require low volume distribution. This market primarily an institutional one, is setting its sights on education, business, and industry. The magnetic tape device with its ability to record and to produce video cassettes at low volume and low relative cost appears to offer the most advantages.

"The second market, that for the mass consumer, requires high volume

Figure 2. F.C.C. Commissioner Wells addresses a packed audience at one of the sessions.

production at low delivered cost per unit. At the moment the videodisc would appear to have the edge in this market."

In a talk entitled *Audience Segmentation: A Problem—And An Opportunity*, Mr. E. P. Genock, director of broadcast advertising, Eastman Kodak Company, and chairman, A.N.A. television advertising committee said: "The trends are visible—but the implications for advertising are not so clear. From this advertiser's point of view it would seem that there is a sharp distinction between cable t.v. and cassettes—yet both will have opportunities and challenges for advertising. There appears to be much less of a distinction between cable t.v. and existing over-the-air television. It's a matter of degree mainly of quality but *adds* completion for the viewer's attention, rather than reaches the self-selected specialized audience-to-be for cassettes."

Turning his attention to the advertising message, Mr. Genock said: "It is true that too much time and perhaps too much attention has been focused in the press and broadcast trade magazines, on the hardware covering all the projection and electronic systems involved in all these new developments. The key to their market success however, and especially in their interest and appeal to advertisers — will be in the quantity and quality of program software. Software or suitable program material will need to be available (and available *simultaneously*) with the installation of any particular piece of hardware equipment, and to cover the wide range of entertainment, information, education, news, or sports.

"*Television In The '80s—But First, a Word From the '70s* was the title of the talk given by Mr. Don Durgin, president of the NBC television network. He spoke about the ups and downs of t.v. and advertising in the last few years and then discussed the effect of c.a.t.v. and cassettes on tv.

"Regarding new technology, NBC

does not believe that any of network television's prospects in the '70s are threatened by the developments we've been hearing about, and certainly not by cable and cassettes. Their structures, purposes, and markets are not those of commercial television. Their economic realities gear them for specialized services, not mass medium circulation. And I should remark that we view their potential with an open mind, for NBC itself owns and operates five c.a.t.v. systems, and our parent, RCA Corporation, is deeply involved in cassette hardware development with Selectavision, as well as software.

"Cable television has been slow in progress. Over the last five years the television home increase has been nearly double the gain in cable homes, and today's 4.5 million cable-connected homes represents only 8 per cent of all television homes. Actually, cable in 1971 is running a half-million subscribers behind our projections, and at this pace we forecast 14 million cable subscribers and a t.v. home penetration of 20 per cent by 1980."

On the subject of cassettes, Mr. Durgin said: "Video cassettes are interesting but equally blue sky at this point. A study by the Arthur D. Little Company recently projected cassette hardware and software as a 500-million dollar business in this country by 1975. That's pretty fast stepping, considering the fact that it is unlikely any home system will be on the market before some time in 1972, at the earliest.

"NBC does not expect video cassettes to have much effect on broadcast television viewing patterns. Their greatest appeal—like the phonograph record—will be to allow personal selection at any time by buying or renting recorded material.

"But again, this is a specialized, personalized, and expensive service that is at the opposite pole from a mass medium—and even at this, a significant number of people will not acquire video-players within the next five years and probably not within this decade.

"I understand there's a thriving overseas business in something called Sexcassettes, but I'm sure other software can be found for American home playback—at prices expected to range from 10 to 30 dollars a half hour, or one-time rentals at 3 to 5 dollars. As for advertising via home cassettes, you might first want to reevaluate matchbook covers and skywriting."

Commissioner Robert Wells of the Federal Communications Commission discussed the regulations imposed, requested, and rejected on t.v. broadcasting—as well as the advertising on television. He also brought cable television into his remarks.

"We have heard many predictions about the future of cable television and promises of its performance as a major medium. I am sure that many of the predictions will be borne out. But I think that at his point that it is difficult to predict the precise form of c.a.t.v. advertising. "Cable t.v. will provide unique opportunities for the highly specialized advertiser who simply finds it uneconomical to purchase time now on programs of mass appeal. For example, such specialized services as medical equipment could be advertised on programs directed specifically to doctors, thus giving these advertisers the benefits of television advertising which they have not had before.

"Geographical selectivity of audiences should be enhanced by c.a.t.v. permitting advertising to be directed to specific groups of viewers. With two-way communication by c.a.t.v. we may begin to come full circle and again approach the face to face method of marketing — an expensive, but effective means of selling."

As part of the courtesy extended by the A.N.A., passes were provided for visitors so that they could attend an exhibit of audio-visual equipment sponsored by the American Society for Training and Development. This meeting will be covered in a subsequent report. ■

(*Letters, from page 2*)

Perhaps this information was incorrect, or perhaps this meant the method that would be built into the future units.

In my recent discussions with the U.S. representatives, I was given some new information that I would like to pass on. Under present development for possible demonstration along with the color model during late summer or in the early fall, was a "sleeve"-like device which would hold enough discs to permit continuous play for periods of 2 to 10 hours with only a one second pause during the record change cycle.

With this type of device under development Teldec wants to emphasize that they are strongly in the home market and not necessarily primarily in the industrial or institutional markets as had been indicated by some writers (not me) in the past.

Should there be further developments, I hope to be able to keep you up-to-date.

Martin Dickstein

classified

Classified advertising is an excellent and low-cost way to place your products and services before the audio professional. If you are a prospective employer seeking skilled help or an employee seeking a change you will find that the classified pages of **db** reach the people you want. Special low rates apply for this service.

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Operations/Recording Engineer
United States Marine Band
Recording Laboratory
Washington, D.C.

The United States Marine Band is anticipating an opening in its Recording Laboratory staff for an operations/recording engineer.

The position requires familiarity with recording studio equipment and techniques. Backgrounds in studio engineering, production, and music are advantageous but not required. Either a degree or equivalent experience in the field is required.

Selection will be made through a personal interview with the Chief Engineer and one or more of the Directors. Interviews are by appointment, Monday through Friday, from 9:00 a.m. to 3:00 p.m. at the Marine Band Recording Laboratory. Any expenses incurred, transportation, lodging, etc., will be the responsibility of the interviewee.

When interviews for the vacancy have been completed, the applicant selected will be enlisted and promoted to the rank of Staff Sergeant (E6) and transferred to Washington, D.C. at government expense.

Resumes and enquiries may be addressed to:

Geoffrey M. Langdon
Chief Engineer, Recording Laboratory
U.S. Marine Band
8th & Eye Streets, S.E.
Washington, D.C. 20390
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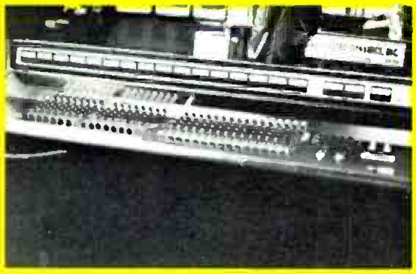
NEW PRODUCTS AND SERVICES

As PROMISED last month, several additional items from the West Coast AES Convention appear. These include six consoles, plus other items. If you wish specific information from any of the respective manufacturers detailing the product shown, simply circle the appropriate reader service number on the card bound into this issue.

Audio Designs RC-1616 offers a full sixteen output channels for $39,000. *Circle 50 on Reader Service Card.*

Automated Processes has a large patch bay in their 20-in, 16-out console. *Circle 51 on Reader Service Card.*

DuKane showed their equipment in a custom console designed for hotel use. *Circle 52 on Reader Service Card.*



Room for expansion in **Electrodyne's** console, which as shown is 16 in and out. *Circle 53 on Reader Service Card.*

In subdued grey color, a **Neve** console offers more than 20 in and 16 out. *Circle 55 on Reader Service Card.*

Countryman Associates offers a small phase shifter control, model 967. *Circle 56 on Reader Service Card.*

Langevin AM-301, EQ 308, and AM 307 equipment in an 8-channel control console. *Circle 54 on Reader Service Card.*

For mixdown use, 2-channels of record and play in a twin-capstan **Gauss** recorder. *Circle 57 on Reader Service Card.*

Westrex RA1700 solid-state disc recording equipment for disc recording systems. *Circle 58 on Reader Service Card.*

EXTENDED RANGE dBm METER

• Model 81 is an extended range meter that offers true r.m.s. response on a single scale, extending from —70 to +10 dBm. Designed as a portable, battery operated test instrument to measure audio system noise and dynamic range, the unit offers accuracy of ± 1 dB at 0 dBm, accuracy of ±1.5 dB from —60 to +10 dBm, and ±2.5 dB accuracy at —70 dB Frequency response is 20-20,000 Hz from —40 to +10 dBm, reducing to a high of 15,000 Hz at —60 dBm and 7500 Hz at —70 dBm.

Mfr: dbx, Inc.
Price $189.00
Circle 62 on Reader Service Card

MONITOR MODULE

• The MM-8 is a monitor module for use in 8-track recording consoles. As part of the company's series 8 line, it accomplishes the following functions: talkback, slating, studio monitor level, control room monitor level, bus/play monitoring of up to 4 recorders, as well as other important monitor control features. Use of the unit eliminates the requirement to come back through the console when doing overdub or sync recording, thus freeing the channels normally used for recorder return.

Mfr: Gately Electronics
Circle 61 on Reader Service Card

HIGH SPEED CASSETTE DUPLICATOR

• A new high-speed cassette copier duplicates the contents of a master cassette once every 2½ minutes. The copier resembles an attache case and can copy from one to fifty cassettes. Model 521 can duplicate a 30-minute cassette every 2½ minutes including recycling. It is also able to duplicate 60 and 90 minute cassettes from a cassette tray which holds up to 50 standard cassette tapes. The cassette-to-cassette copier features a built-in high speed rewind. After the copy cycle, it automatically rewinds the tape so it is ready to be played from the beginning. The unit has wide-band electronics in its record and playback amplifiers, an 800,000 Hz bias oscillator and mixer, and all-silicon power supply mounted on mil quality circuit boards. The portable model weights 35 lbs. and is 18 x 14 x 5 inches. Head life is rated at more than 2000 hours; duplicating speed is 15 in./sec.

Mfr: MCA Technology
Circle 73 on Reader Service Card

POWER AMPLIFIER

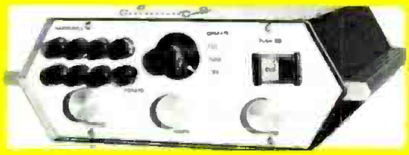
• This British-made amplifier line will soon be available in this country. Model TPA-100 delivers 100 watts continuous power into 15 ohms, and 120 watts continuous into 8-ohm loads. Total harmonic distortion is stated to be less than 0.1 per cent at full power, over most of the frequency band. The output is class B and direct coupled. Dissipation limiting circuits are used to protect the amplifier from output mismatches and short circuits. Recovery from such condition is virtually instantaneous, with no thermal resets or fuse replacements necessary. Other specs include: —90 dB s/n referenced against full power and a 600-ohm source: input impedance of 10 k ohms unbalanced (balanced input versions can be supplied); operating temperature range is —25°C to +50°C; full power frequency response is 20-20,000 Hz +0, —0.5 dB; and input sensitivity is 0.775 V for full output.

Mfr: H. H. Electronic
Circle 64 on Reader Service Card

TAPE LOCATOR

● A counter locator is now available for 3M eight- and sixteen-track machines. The Selectake is used during a recording session to automatically search the tape and to locate previously logged takes. The unit will stop the tape at the preselected location within ±2 counts of the readout counter. It can be overridden manually. Four digital display tubes indicate recorder tape position. Controls include the *preselector* which sets the location of a predetermined tape position on the recorder; a *count enable* which allows the operator to maintain a registered count during such modes as editing; and a *search-stop enable* which inhibits automatic search operation.
Mfr: 3M Company
Price: $895.00
Circle 71 on Reader Service Card

AUDIO PRODUCTION TOOL



● The HERN is a low cost, automatic music synthesizer which can be quickly programmed for station i.d.'s commercials, and tags. It can be used to produce a series of sixteen notes. Each note can be tuned over a three-octave range. After tuning, the entire melody can be adjusted over an additional three-octave range. Tremolo, and/or vibrato can be added in varying amounts. The harmonic content can be varied from thin reedy to heavy bass. There is a built-in cue speaker and earphone jack. A noiseless switch converts the unit from a tuning mode to on line operation with variable output to +8 dBm at 600 ohms.
Mfr: Television Equipment Associates
Circle 60 on Reader Service Card

NOISE MONITORING SYSTEM

● Model 141B is a portable outdoor microphone system designed for community or industrial outdoor noise monitoring, vehicle noise studies, or aircraft noise certifications. The system transmits measured data to a distant station for recording and analysis. The internal nicad battery pack will operate from 15 to 150 hours without the need for recharging, depending on operating conditions. Miles of low-cost cable can be used for transmismission of data, with gain controlled remotely. Four different models are available to give a choice of weighting characteristics to meet the application requirements.
Mfr: B & K Instruments, Inc.
Circle 69 on Reader Service Card

Model 141B portable microphone system

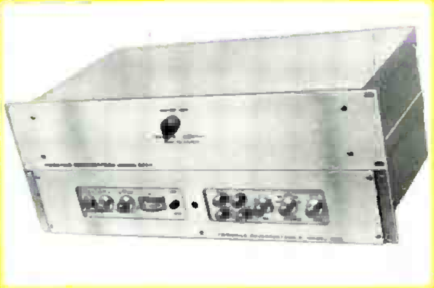
TURNTABLE PREAMP

● These self-powered compact units are available in stereo or mono and will provide 0 dBm into 600 ohms. Headroom is available to +15 dBm. RIAA/NAB equalization is built into these self-powered units. A front-panel switch permits the RIAA curve to be varied at the high end by plus 5 dB or minus 5 dB. Standard cartridge inputs permit the use of conventional 47 k ohm type cartridges. The mono unit combines the two stereo outputs of the cartridge for mono use, while the stereo model offers separate outputs. Both may be terminated into 600 or 150 ohms. Output levels may be adjusted for console inputs, and in the stereo version, balanced against each other.
Mfr: Gray Research and Development Co.
Circle 66 on Reader Service Card

DYNAMIC MIC

● M-67N designates a shock-resistant dynamic that contains a rubber-suspended cartridge to minimize body noises. Any climatic condition is suitable for the mic's use. The pattern is cardioid even at extremely low frequencies and is thus ideally suited to on-the-spot recording. Frequency response is 40-18,000 Hz; output is 500 ohms (200 ohms on request). The M-67N is ideally suited to reportorial, solo singer, and portable tape recorder use. Cannon connection is included.
Mfr: Beyer (ReVox Corp.)
Price: $95.00
Circle 72 on Reader Service Card

COMPACT REVERBETRON



• This latest version of the model 659 Reverbetron is dubbed the model 659A. It is identical or better in performance to the older model except that it now contains a lock mechanism for portability. Including the mechanism, the 659A is 19-in. wide, 9-in. deep. and 7-in. high. Three types of reverb control are offered: dry, premix 1, and premix 2. A selector permits short, medium, and long decay times. The signal-to-noise ratio has been improved by 10 dB over the previous model. Input levels from —30 dBm can be accepted. Outputs up to +18 dBm are provided. Inputs and outputs are transformer isolated for 600 or 150 ohms. All signals are metered.
Mfr: Fairchild Sound Equip. Corp.
Circle 67 on Reader Service Card

LOW TOXICITY HEADCLEANER

• Fluorodex is a newly-developed chemical formulation composed of fluorocarbons that has been designed specifically for the cleaning of all forms of magnetic heads—including video and computer heads. It can also be used to clean motion-picture film, negatives, etc. The safety of the solution is important as it is both non-inflammible and low in toxicity. It will not attack plastics. All traces of grease, silicones, and hydrocarbon oils will be washed away. The chemical is available in 4-oz. plastic bottles and in larger containers.
Mfr: Avedex, Inc.
Circle 63 on Reader Service Card

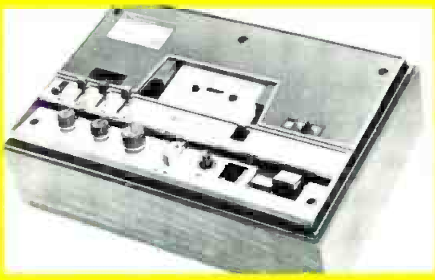
FM DIGITAL TUNER

• Nixie long-life indicators are used to identify the exact station frequency for any of the available 100 f.m. channels. The readout is crystal controlled which offers the same degree of accuracy as required for the operation of the transmitter. The all solid-state tuner also features a 3-inch rectangular 'scope that graphically displays multipath distortion, center of channel tuning, relative signal strength, and audio display of mono and stereo signals. The i.f. filter is a 14-pole Butterworth-type toroid phase-linear circuit.
Mfr: Scientific Audio Electronics
Price: $950.00
Circle 68 on Reader Service Card

LINE AMPLIFIERS

• A new series of audio line and loop amplifiers is covered by the designation 180 series. Output from 0 dBm 600-Ohm line is 16 watts continuous into 8 ohms. Both 12 V d.c. and 115 V a.c. models are available. The illustration is the model 185 for use in remote broadcasting, and is inexpensive enough to leave in locations.
Mfr: PDMC
Price: (illustrated unit) $59.50
Circle 70 on Reader Service Card

DOLBY CASSETTE RECORDER



• A quality heavy-duty cassette transport is combined with special electronics incorporating Dolby-B play and record characteristics to provide low-noise cassette performance. In addition, switchable record equalization for standard or Crolyn tape formulations, is provided. A single record meter provides integrated or individual channel stereo information for level setting. At the conclusion of a cassette's play, a solenoid disengages the transport mechanism completely. With an accessory mic preamplifier, the Model 201 recorder is capable of making high-quality stereo on-location recordings. The accessory preamp (mic preamps are not in the cassette unit) will accept balanced or unbalanced mics, and is powered from the deck itself.
Mfr: Advent Corp.
Price: deck—$280.00; mic preamp—$20.00
Circle 65 on Reader Service Card

Walter Jung

A Differential Bridging Amplifier

There are active alternatives to transformers. The author investigates one and tells you how it is to be built. A parts list is included.

A COMMON AUDIO SYSTEM PROBLEM is ground potential difference between remote and local pieces of equipment. Traditionally this very real problem has been dealt with quite effectively by balanced-line transmission with input and output transformers at both ends of a signal line to convert the single-ended signals to double-ended ones and *vice versa*. This practice has been standard since the earliest days of radio. Invariably, amplifiers have had an input transformer (balanced line to single-ended input stage), and an output transformer (single-ended or double-ended stage to balanced line). The transformers serve as isolation elements between the preceding and succeeding stages, allowing signal transmission with large differences in ground potentials between various pieces of gear.

Recently, attention has been focused on alternative methods of accomplishing the electronic equivalent of transformer action.[1,2] Unquestionably this movement can bear significant gains in quality improvement of audio processing circuitry. There are those that may yet scoff at such an innocent device as a passive transformer contributing distortion of measurable magnitude. In past years when *circuit* performance did not get much below distortion figures of 1 per cent or so, this attitude may have been justifiable. But nowadays you'd have to build a transformer with distortion levels down to 0.001 per cent to be an order of magnitude better than some consoles. And the winding techniques, quality of iron and type of shielding used in such a transformer is by no means cheap. Now, assuming that you could build or buy such a device, compare what an equivalent amount of coin of the realm will get you in the way of pure circuitry.

REQUIREMENTS

To idealize for a moment, let's see what this electronic transformer simulator would have to do in an input stage to satisfy isolation requirements. First, it should be sensi-

Walter Jung is a frequent contributor to **db**.

. . . having gotten our differential signal through the first stage and rejected the common-mode signal, the rest is fairly smooth sailing.

tive only to differential input signals, that is the audio voltages appearing *across* a balanced pair at normal line levels. It should amplify this desired signal with a minimum of distortion and response degradation. At the same time it should reject all voltages appearing between this pair and ground. This voltage is common mode, caused by the difference in chassis potentials. We'd like to reject this signal with a ratio of about 70 dB with respect to our desired signal. What this means is that the desired differential signal can ride up and down atop a 60 Hz hum component, and as long as the hum is common to both input lines it will be rejected—exactly as a transformer! Ideally the magnitude of the allowable common mode voltage would be very high, preferably unlimited. In the case of a transformer it is limited only by insulation breakdown potential. But since a practical amplifier will have voltage-sensitive components in it, we'll have to factor this requirement down to a reasonable limit which can be handled with a transistor stage, 15 volts peak-to-peak or so. In a practical situation we're not talking about isolating the 117-volt line, only potentials of the same order as the desired signal.

Aside from these major objectives, we can also assign some secondary ones. We like the amplifier to be bridging so we don't load a 600-ohm line, this requires a high impedance input. We also like this input to be a.-c. coupled to remove any restrictions on d.-c. line potentials. Now, having stated our objectives we can talk about how they can be accomplished.

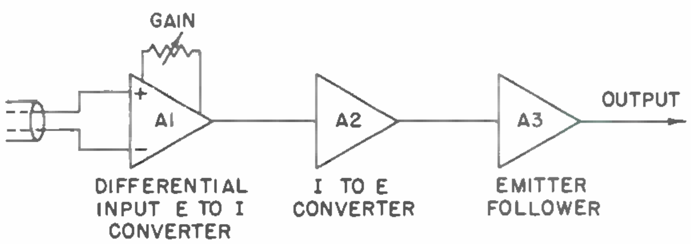
CONCEPT OF ELECTRONIC APPROACH

The theory behind this approach is shown in block diagram form by FIGURE 1. The push-pull signal is introduced at the input of amplifier A1. This amplifier has an input impedance sufficiently high that it does not load the line appreciably, so it can be termed bridging. It is also a differential amplifier, which means it will respond to end-to-end or push-pull signals, but reject the in-phase or common-mode signals such as noise and hum. At the same time, it converts the differential voltage signal into an equivalent current signal (more on the "why" of this particular trick later) and passes it to the next stage, A2.

A2 reconverts the current signal into a voltage signal which is now referenced to ground, or single ended. This signal is buffered to a low impedance level by emitter follower A3, and after a 600-ohm source termination, appears as the output signal.

The design of this amplifier is such that it converts the push-pull input signal into a corresponding single-ended output level. A floating +4 dBm input signal appears as a single ended +4 dBm output. The input stage is configurated for maximum rejection of common mode signals, while passing differential signals to the output with unity gain.

Figure 1. The concept of a differential bridging amplifier.



CIRCUIT DESCRIPTION

Now turning to FIGURE 2, let's look inside an example of this type of amplifier to see what makes it tick.

The input signal is applied to Q1 and Q2 via C1 and C2, d.-c. blocking capacitors. Q1 and Q2 form a differential pair, although it may not be obvious at first glance. A pair of constant-current sources (Q3-Q4) are used to feed the emitters of Q1 and Q2 with separate d.-c. current paths. Both Q3 and Q4 provide high (many megohms) a.-c. output impedance over a large dynamic range of signal swing. Now, if we momentarily remove R11 from the circuit let's see what Q3 and Q4 do for us in terms of common-mode rejection. With R11 out of the circuit and ignoring Q6 for a moment, the gain of Q2 (for common mode signals) is very low since it is proportional to the ratio of the collector load to the effective emitter impedance. Since in this case the emitter impedance is very high due to the collector impedance of Q4, this input signal cannot change the current flowing in Q2. The same reasoning applies to Q1 due to an equivalent effect of Q3.

Now if we connect R11 between the emitters of Q1 and Q2, let's see what happens. With a differential signal the base of Q1 will be going up as Q2 goes down (and *vice-versa*). Since the emitters of both transistors will follow their bases, the current in R11 must change, as the potential across it is changing. A current change in R9 means that current must be going in or out of Q1 and/or Q2. Current going in or out of Q2 means its collector current is changing, so this means it is amplifying. This is how the Q1-Q2 pair responds to differential inputs.

Now, if we go back a moment, we can see what common-mode signals on the bases of Q1 and Q2 accomplish. A common-mode signal on both inputs means the emitters of Q1 and Q2 will be going up and down *equally*. If they do, so will both ends of R11. Then if this is true, R11 will not pass any current due to the common-mode signals. If there is no current variation in R11, Q2-Q6 does not experience any current change. So as a result, the Q1-Q2 pair does not amplify common mode signals. The effective-

So the logical next step would be to try a Darlington pair to raise the net current gain.

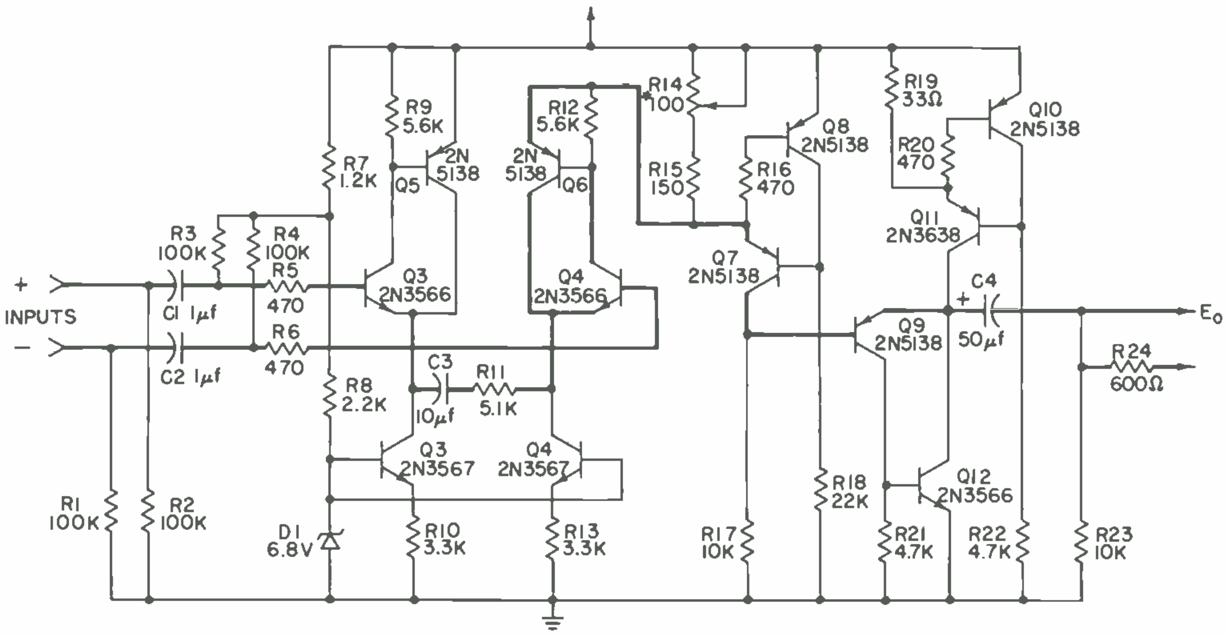


*Figure 2. A schematic of the described differential bridging amplifier. Signal path is denoted by the heavy lines. *Trim R14 for symmetrical clipping at the output.*

Table 1. Performance specs of Figure 2.

Gain: Ratio of R17 to R11—with values shown +6 dB at direct output, 0 dB behind 600 ohms. R11 may be remoted for 2 wire control of gain. Note low impedance level of control lines for R11. Gain may be raised up to +40 dB (with corresponding decrease in maximum input level).

Maximum Output Level: +22 dBm into 600 ohms with 24-volt supply.

Maximum Input Level:

1. Differential—equal to output peak to peak swing minus voltage gain. With +22 dBm output, 11 volts peak to peak.
2. Common Mode —15 volts peak to peak, both inputs to circuit common.

Distortion: At levels up to +22 dBm and gains up to 40 dBm THD distortion 1 ≦ 0.15 per cent or less. At lower gains (6 dB) distortion becomes difficult to resolve with present test setup (residual 0.05 per cent).

Frequency Response: Response variations within audio range are quite low (see Figure 5) due to direct coupling of amplifier. Lower —3 dB point of circuit is 5 Hz.

Noise: Output noise is 1 mV peak to peak of "white" components. Rejection of 60 or 120 Hz ripple on power supply line is 26 dB referred to the output.

Common Mode Rejection: 60 db or better with equal voltages at both inputs with levels up to 15 V peak to peak.

Output Impedance: Zo emitter of Q9, 0.5 ohm.

Input Impedance: Differential, 100 k common mode, 50 k per side.

... we should clearly be able to see the transformer similarity.

ness of this rejection is as good as the match in the signals, and with an equal input will be between 60 and 70 dB.

At this point one might ask the reason for Q5 and Q6. The reason is not singular, but rather a number of quite good ones, and they apply equally well to both sides (Q1-Q5 and Q2-Q6).

The primary function of this input stage is a highly linear *voltage* to *current* converter. Differential voltages at either input terminal should be translated to a corresponding current in R11. To do this, Q1 and Q2 must buffer the input voltage and present a low source and/or sink impedance. Q1 must be a voltage source and Q2 a current sink so the current in R11 will be truly proportional to applied voltage. If a simple emitter follower were used, emitter impedance would be

$$\frac{26}{\text{Ic in mA}}, \quad \text{or } \frac{26}{2 \text{ mA}}, \quad 13 \text{ ohms.}$$

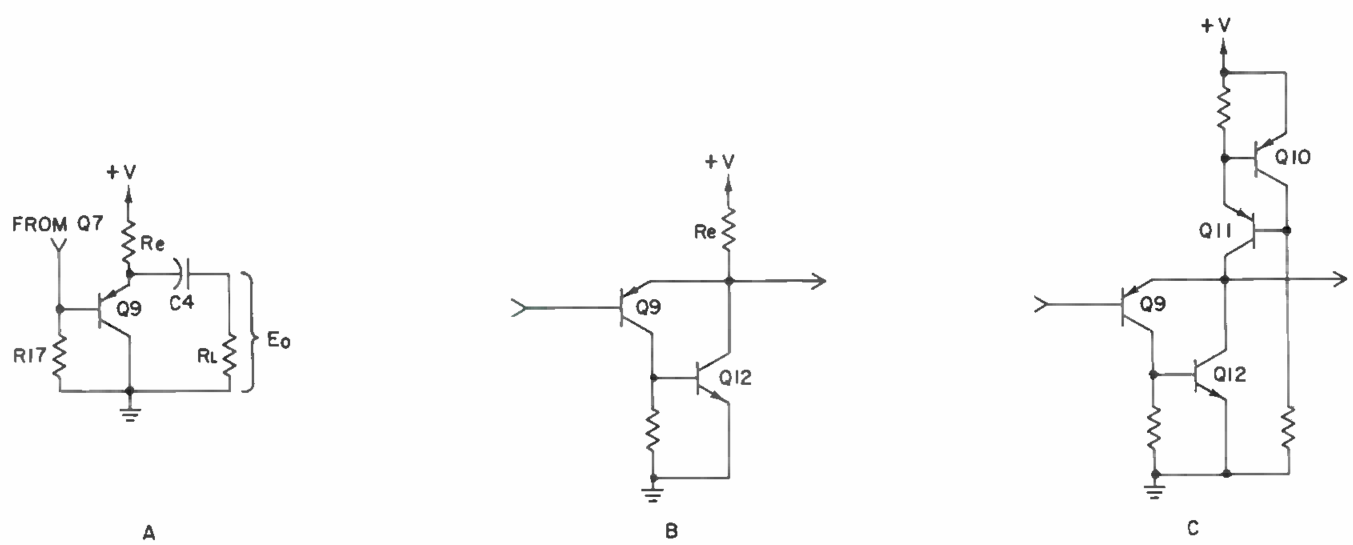
The compound connection reduces this to less than an ohm, reduces distortion to the vanishing point, and reduces input current required for Q1-Q2 to negligible proportions. So, although this extra transistor pair is not essential for the basic function, it improves performance to the degree where there is no measureable distortion contribution from this stage.

Now having gotten our differential signal through the first stage and rejected the common-mode signal, the rest is fairly smooth sailing. It was mentioned previously that the input stage was a voltage to current converter. Part of this can be appreciated because of the discussion just passed on Q2's output current changes. However the dynamic currents at Q2's collector aren't converted directly to a voltage as in a normal load, but are passed on to a current to voltage converter, Q5. The reason behind this extra stage is to maximize the dynamic input range of Q2. It is desired that Q2 be able to swing high amplitudes from base to ground, so as to handle large common-mode and signal voltages simultaneously. If a conventional collector load were used in Q2's output, it would develop voltage swings, and Q2 would saturate with much lower positive going input levels. So by using a low impedance load such as Q7, voltage swing at the collector of Q2 is eliminated allowing larger amplitude at the base of Q2, thus improving input dynamic capability. The output signal that would normally be developed at Q2's collector is then transferred to Q7's collector load and there it develops the output voltage.

The Q7-Q8 combination is another example of a local feedback configuration, in this case connected to regulate Q7's emitter current constant. A similar reasoning also applies as to the degree of performance. With no feedback Q7's emitter impedance might be about 25 ohms (Ic = 1mA). Feedback reduces it to less than an ohm, and makes it an effective current sink. The signal current injected by Q2-Q6 bucks this d.-c. feedback and Q7's collector current obtains this signal by current transfer, developing a voltage across R17. Other advantages of this stage are its ability to swing nearly the full supply voltage (less only Q7-Q8 Vbe) and inherent rejection of supply ripple.

The voltage across R17 is the single-ended output, and needs to be buffered down to a low impedance to drive a 600-ohm line. However, a seemingly simple gain of one power stage is not all so simple when the concurrent objectives of high level output (≧20 V p-p), very low distortion (0.05 per cent) and minimized reflected loading to R17. This latter feature is important because the circuits' voltage gain is determined by the ratio of R17 to R11 (the current in them is the same, so the ratio of

Figure 3. (A) A simple emitter follower output stage; (B) The evolution into a unity gain feedback pair; and (C) further evolution with the current source loading by Q11 replacing Re.



Frequency response is limited only by the input and output coupling capacitors as the amplifier is entirely d.-c. coupled . . .

voltages is the ratio of resistances). Any variation in R17's value by load reflections is a gain variation, so this is obviously undesirable.

The apparently complicated (but yet relatively inexpensive) output stage of Q9-Q12 can be evolutionized as follows. A first step approach to problem would be a simple PNP emitter follower such as Q9 of 3A. If we assume a mean beta of 100 for Q9, a 600-ohm load would reflect as 60k, hardly high enough to be negligible loading across R17. This is without even considering Re, which would approximately halve this impedance as it would be about 1k in d.-c. value. What is even worse is the non-linear effect of dynamic changes in base currents as Q9 swings between minimum and maximum currents. So the logical next step would be to try a Darlington pair to raise the net current gain, but there is an even better choice. If all we're adding is one transistor, why not another complimentary feedback pair connected as in FIGURE 3(B)? Here we have the current gain multiplication of a Darlington without its disadvantages. This configuration is also a true feedback circuit with input output comparison taking place at Q9's base-emitter junction. And with high-gain devices for Q9-Q12, the equivalent beta will be well above 10,000. An additional advantage is that it's Vce Sat is a diode drop lower than the Darlington, allowing more power output before clipping.

From the standpoint of maximizing power output, we reach the final evolutionary step of FIGURE 3(C). Here the d.-c. load resistor Re is replaced by Q10-Q11, Why? Consider what value Re would have to be to deliver a +20 dBm signal into 600 ohms. This is about 20 volts p-p so with a 24-volt supply it quickly becomes impossible. Even with a higher supply, say 30 volts, the standing current in Q9-Q12 becomes unreasonably large. The solution to this is to use current source biasing to feed the Q9-Q12 amplifier. This is Q10-Q11 of FIGURE 3(C), a current regulator pair similar to Q7-Q8, but set up in this case to supply 20 mA from Q11's collector. Now Q9 and Q12 can swing in a positive direction right up to the point where Q11 saturates, or slightly less than 2 Vbe's below the +24-volt supply line. So with this output stage we can indeed swing 22 volts p-p into 600 ohms with a 24-volt supply and the output stage still has a reasonably small static dissipation, allowing low-cost epoxy transistors to be used. A not insignificant virtue is the fact that it is entirely class A-Q9 and Q12 conduct for the entire duration of the signal waveform, eliminating the characteristic dead zone of a class B stage and its attendant distortion. So now we have done a more reasonable job of buffering the R17 signal in a high-fidelity fashion. It may be a bit more complex, but yet it is inexpensive and the performance justifies the extra parts.

Now, if we go back and compare this circuit with our original objectives. we should clearly be able to see the transformer similarity. The 2 inputs to Q1 and Q2 correspond to the ends of the transformer winding and the circuit responds to the potential between these two terminals, amplifies it and delivers a single-ended replica at the output. R1 and R2 provides a common-mode return and charging path for C1 and C2. An in-phase input on the plus input develops an in phase output, the reverse is true for the minus input.

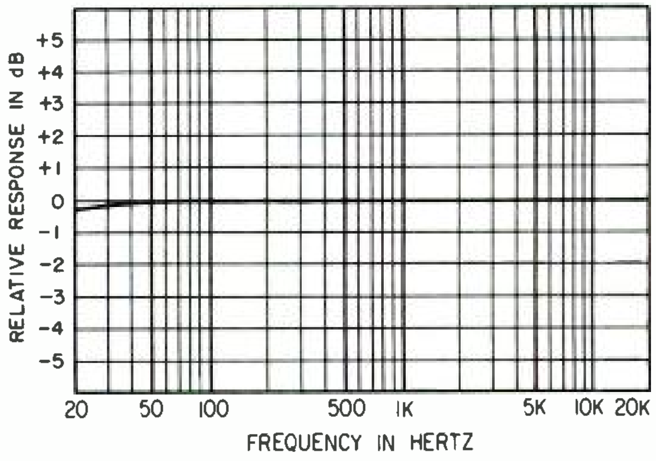
Differential input impedance is essentially R3 and R4 in parallel with R1 and R2, or 100k. R11 is multiplied by the Hfe of Q1-Q2 and is sufficiently high so as not to be a determining factor. Common-mode input impedance is 50 k per side or 25 k if taken in parallel. These impedances should be high enough so as not to upset the level of a 600-ohm line. Voltage gain of the circuit is +6 db if taken directly from the emitter of Q9, being the ratio of R17 to R11. Lowering R11 will raise the differential gain, as more dynamic current will be produced for a given input voltage. Common-mode rejections remains the same, but the rejection *ratio* will be *raised* as it is proportional to gain.

The output impedance at Q9's emitter is less than one ohm, so a 600-ohm source resistance will give a 600-ohm source impedance almost solely determined by this resistance (amplifier Zo $\leq$ 0.1 per cent of total resistance). This also means the +20 dBm output capability will drop to +14 dBm if 600 ohm matching is desired.

Frequency response is limited only by the input and output coupling capacitors as the amplifier proper is entirely d.-c. coupled with the exception of the C3-R11 path. C3 is not absolutely necessary for circuit operation, but is used here to eliminate possible differential d.-c. due to imperfect Q1-Q2 matching (more on an ideal solution to this particular problem in a moment). Response of the amplifier circuit is shown by FIGURE 4, taken at a +22 dBm level and a gain of 6 dB (R9 = 5.1k).

For those who may want to build a circuit of this type and try their hand at transformer elimination, a parts list with sources for the semiconductors and pricing information for small quantities appears. Although the circuit does have a total of twelve transistors in it, they are all plastic types, and inexpensive ones at that. Performance specs are listed in TABLE 1.

Figure 4. The relative frequency response at 6 db gain, +22 dBm level, of the circuit shown in Figure 2.



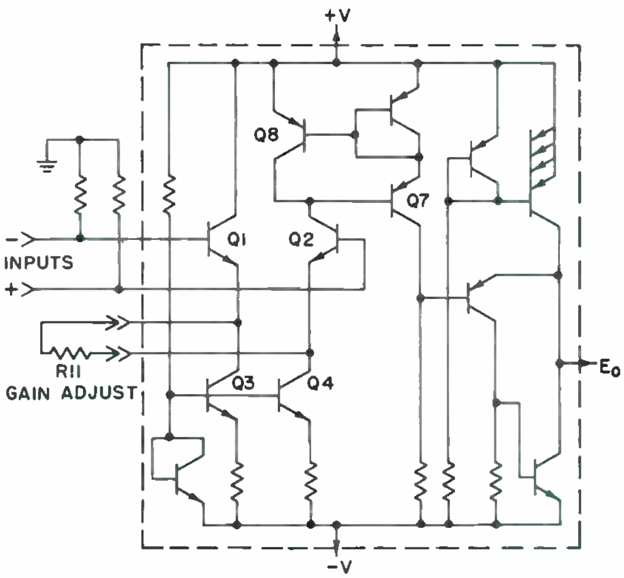


Figure 5. A hypothetical integrated circuit model of a differential bridging amplifier.

BLUE SKIES DEPARTMENT

I'll have to confess to a more than normal intrigue with this circuit concept, so much so that I'm going to stick my neck out and invite comment on its potentialities as an audio building block. There are a few basic facts about this circuit configuration which could allow it to be readily adapted to a monolithic i.-c. design. I've even been so bold to sketch out a rough translation of what an i.-c. schematic looks like. FIGURE 5.

Recalling the previous comments on the d.-c. coupled property; this is one point essential to an i.-c. design. But within a monolithic circuit all transistors match up extremely well, so the gain set resistor (R11) can be directly connected between Q1 and Q2. These points can be brought out for user-selected gain changes. Q3 and Q4 serve the same functions of current feeds for Q1-Q2, but in this circuit they can be made to operate much more closely to the negative supply by referencing to a forward diode drop rather than a large (and therefore wasteful) zener voltage. This enhances common-mode input swing, as Q1 and Q2 can now swing down nearly to the —V supply line and still operate linearly. Although Q1 and Q2 are shown as a simple unbuffered pair, they can easily be a Darlington or other compound stage as extra transistors cost no more in an i.-c.

Parts List for Figure 2

Item	*Description*	*Quantity*	*Price*
R1-R4	Resistor, 100K ± 5 per cent	4 x $.10	$0.40
R5, R6, R16, R20	Resistor, 470Ω ± 5 per cent	4 x $.10	$0.40
R7	Resistor, 1.2K ± 5 per cent	1 x $.10	$0.10
R8	Resistor, 2.2K ± 5 per cent	1 x $.10	$0.10
R10, R13	Resistor, 3.3K ± 5 per cent	2 x $.10	$0.20
R9, R12	Resistor, 5.6K ± 5 per cent	2 x $.10	$0.20
R11	Resistor, 5.1K ± 5 per cent	1 x $.10	$0.10
R14	Resistor, 100Ω trimmer, IRC-CTS 201 R101B		$0.39
R15	Resistor, 100Ω ± 5 per cent	1 x $.10	$0.10
R17, R23	Resistor, 10K ± 5 per cent	2 x $.10	$0.20
R21, R22	Resistor, 4.7K ± 5 per cent	2 x $.10	$0.20
R18	Resistor, 22K ± 5 per cent	1 x $.10	$0.10
R19	Resistor, 33Ω ± 5 per cent	1 x $.10	$0.10
		Resistor subtotal	$2.59
C1, C2	Capacitor, 1μ F 75v, polyester film (Sprague Orange Drop)	2 x $.69	$1.38
C3	Capacitor, 10μ F, 35v, electrolytic (Mallory M7A)	1 x $.36	$0.36
C4	Capacitor, 50μ F, 25v, electrolytic (Mallory, M7A)	1 x $.40	$0.40
		Capacitor subtotal	$2.14
Q1, Q2, Q12	Transistor, npn, 2N3566 (Fairchild, National)	3 x $.65	$1.95
Q3, Q4	Transistor, npn, 2N3567 (Fairchild, National)	2 x $.60	$1.20
Q5, Q10	Transistor, pnp, 2N5138 (Fairchild, National)	6 x $.19	$1.14
Q11	Transistor, pnp, 2N3638 (Fairchild, National)	1 x $.46	$0.46
D1	Diode, zener, 6.8 V, 1N5235 or equivalent (Motorola)	1 x $.67	$0.67
	Semiconductor subtotal		$5.42
	TOTAL		$10.15

The output current of Q2 feeds a local feedback stage consisting of Q7-Q8 and the diode-connected transistor in Q7's emitter leg. Using this trick with matched transistors, Q7 will conduct exactly the same current as Q2*. This "current folding" via matched transistors is a natural one for i.-c's, and is one of the basic reasons why the i.-c. approach is being suggested as the ultimate realization of this circuit technique.

The output of Q7 constitutes the signal current, as in FIGURE 2. It develops the output voltage across a similar load resistor, and is buffered by a class A stage and fed to the outside world.

If symmetrical supply voltages are used, both input and output can be directly coupled, in a manner similar to op-amp techniques. Standard supplies of ±15 volts would allow about 28 V p-p into a 600-ohm load, a power level which should be within the dissipation capabilities of a TO-5 package. An i.-c. design can have a lot of other factors going for it also. Common-mode rejection is excellent in today's i.-c.'s rejection ratios of 80-90 dB being quite common. And from a design standpoint all of the transistors can be optimized for their function. For instance, it might not be unreasonable at all to design the input stage for good equivalent input noise and use this amplifier on a microphone output This is an area where monolithic technology specialists can really perform a service, the refinement of this basic circuit concept towards potential mass duplication. To justify their interest, they need a demonstration of market existence. But if audio technology and the i.-c. revolution are to ever really get together, it will have to be on common ground. I recall George Alexandrovich's comments in his column some months back when he discussed images of audio processing circuits on a chip. Who knows, we may be closer to that goal if we can interest some western monolithic wizards and get them attuned to our special audio needs. I wonder if the ears of National, Fairchild, Motorola Signetics, and RCA are listening? ■

*See G. R. Wilson, *A Monolithic Junction FET-NPN Operational Amplifier*. Proceedings of 1968 International Solid-State Circuits Conference.

REFERENCES

1 William G. Dilley, *An Integral Active Isolation Transformer/Audio Amplifier*, AES Preprint No. 566

2 Allan P. Smith, *Console Transformer Elimination*, **db** March 1970, p. 18

RICHARD SCHULZE

The Fairchild 641 Revisited

The author wrote the enclosed as a letter to our Publisher. It has been reproduced (edited slightly) as an article because of the wide interests it may stir.

MANY THANKS for Bob Bach's sensitive and penetrating eulogy of the late Sherman M. Fairchild as it appeared in the March issue. Bob's major thesis that the productions of Fairchild's r & d teams were generally at least a generation too advanced for their time brought keenly to mind the plight of those (including this writer) who desperately depend upon keeping various of these productions alive until the rest of the world is ready for them.

In the present case, the production in question is the Fairchild 641 stereo disc cutting system, introduced in 1958 but, like so many other Fairchild products, finally withdrawn as an item "unprofitable to produce." (sic!) Almost the entire U.S. recording industry has standardized on the far inferior Westrex cutters, while overseas producers vacillate among a small group of not-good-but-not-bad-either European cutting systems.

Perhaps the passing of Sherman Fairchild is a fit time once again to raise the cudgels for the 641, in hopes that the revival of at least one of his pet projects while it is still ahead of the prevailing state of the art might find acceptance as the fittest memorial to a probing mind like Fairchild's.

A quick review of what makes the 641 great begins with a description of what a stereo groove is. On one wall appear the modulations of the left channel, while the right channel information is engraved in the other wall of the groove. The phasing arrangement is such that an instantaneous displacement of given polarity in the left channel which tends to make the groove shallower is matched by a corresponding displacement in the right channel which tends to make the groove deeper. It is part of the logic of this convention that the vector sum of the information in the left and right channels can be expressed as the lateral resultant of FIGURE 1.

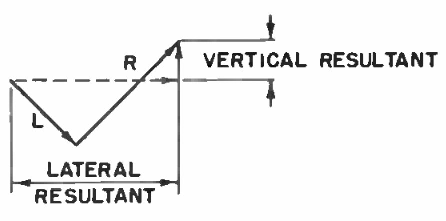
What, then, does the vertical resultant represent? Here we have a blind spot which has kept scientists from thinking clearly about stereo grooves. First of all, few of us have taken the time to reason out the simple proposition that, if L is the left channel and R is the right channel, and if the lateral resultant is their vectorial sum, then the lateral resultant contains *all of the music*. That is, it is a

The kiss of death to the Fairchild 641 was its "compatibility."

mathematically complete mono mix. Therefore, we know what the vertical resultant is *not*. It is *not* a contributor to the music heard from two stereo speakers. Rather, then, the vertical resultant has to be a *program* signal. Thus tipped off, we can now by a simple process of vector analysis satisfy ourselves that the only function of the vertical travel of a pickup stylus is to *program* the *distribution* of the total musical sound between the two speakers.

In conventional stereo cutting as universally practiced today, this distribution process of the total musical signal into the two channels is busily carried on throughout the entire range of audio frequencies in spite of the fact that below middle C or so there is no directional effect in music. We sense the location of a double-bass or a bassoon by the direction from which we hear its *overtones*, not its fundamentals. Therefore, since bass frequencies are generally at higher energy levels, we often go on for sustained periods straining one speaker to its performance limits while the other is loafing along, and, more importantly, we keep cartridges pointlessly straining themselves over low-frequency hills and dales which nobody can hear. Thus, we keep the cartridge mechanism from staying as well as possible within the limits of its best performance capabilities while needlessly increasing stylus wear. Fairchild's engineers knew (or at least sensed) this in 1957 when plans for the 641 were laid. Therefore, it was decreed that the 641 cutting system was to be based on a *vertical-lateral cutter*. It therefore became possible to provide means to switch in a vertical roll-off at the bass end. No more pointless vertical meanderings below 250 Hz. A

Figure 1. The vector sum of the left and right channels can be expressed as the lateral resultant.



Richard Schulze is with Philharmonic Standard Corp. in Concord, Massachusetts.

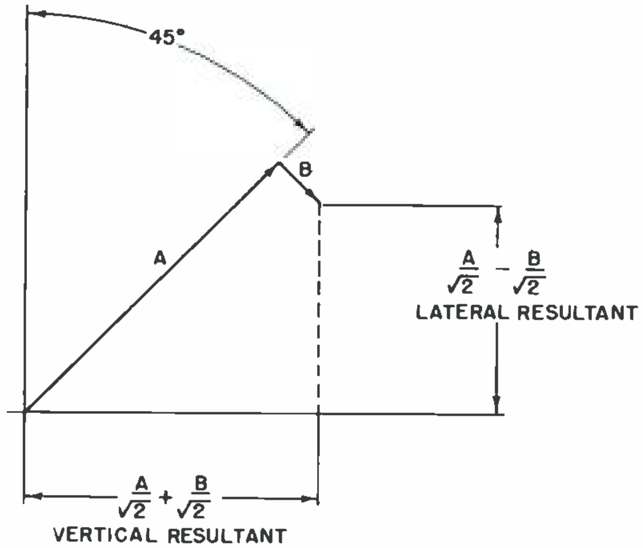


Figure 2.

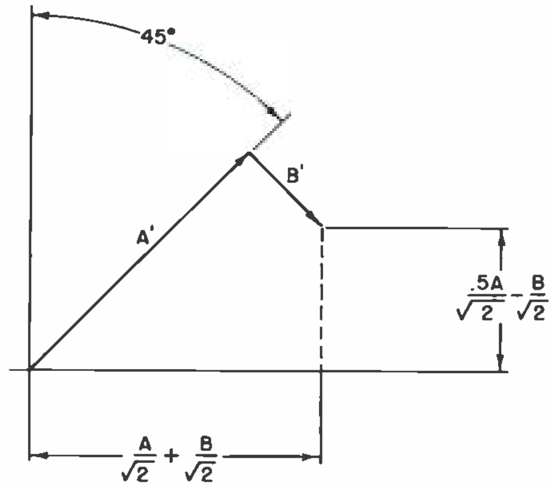


Figure 3.

new clarity and definition of stereo sound became possible because all cartridges became allowed to reduce their average stylus displacement and thus stay in a range of motion where they sounded best.

There are, of course, other things which make the 641 superior to all of its competitors. First and foremost, the unique r.f. proximity feedback system, which imposes zero load on the armature. Second, there is the logical, compact geometric structure of the cutterhead, with the armature well placed in the gap of a massive magnetic structure and the cutting stylus mounted directly in the tip of the armature—no push-rods, torsion bars, or other filmsy structures, no endless chase after secondary resonances of secondary resonances. Finally, the electronic circuitry, though dating from tube days, would be difficult to improve upon from the standpoint of noise levels, distortion, response, etc., but for anyone who thinks he *could* improve upon it, the 641 would lend itself well to "transistorization."

The kiss of death to the Fairchild 641 was its "compatibility." A stereo record with vertical rolloff in the bass frequencies could also be used with excellent results in a mono playback system. There is a perverse type of purism that crops up from time to time in the audio fraternity that says, in essence: "No device that does *two* things can do *either* thing as well as a device that has been tailored strictly to the requirements of doing only *one* of the two things." In this case, nobody stopped to realize that the 641's ability to do two things was an accidental by-product of exactly such an effort to tailor the device strictly to what were the *real* requirements of maximum stereo performance (as opposed to what many people hastily *assumed* were the requirements of maximum stereo performance). Thus, an atmosphere of vague suspicion developed in the professional community which ultimately led to the failure of the 641 to be accepted, as it should have been, as the standard of the industry.

Imagine, then, the plight of a handful of independent producers of LP classical and specialty albums who depend upon the 641 to maintain a reputation for excellent stereo performance but who find one studio after another taking out its Fairchild cutter and replacing it with inferior systems.

Therefore, in memory of Sherman Fairchild, is it not fitting to ask the audio fraternity to re-evaluate the 641 cutter, and perhaps get a band-wagon rolling that'll eventually catapult the disc cutting trade out of the '50's and into the '70's? ■

Vector Analysis of Vertical Rolloff

A = Vector representation of signal in channel A (left) instantaneous displacement.
B = Vector representation of signal in channel B (right) instantaneous displacement. See FIGURE 2.

Suppose A to represent a frequency below 200 Hz and B to represent a frequency above 200 Hz. If that portion of the vertical resultant which lies below 200 Hz be cut in half, the vector representation changes as in FIGURE 3.

$$\frac{A'}{\sqrt{2}} + \frac{B'}{\sqrt{2}} = \frac{A}{\sqrt{2}} + \frac{B}{\sqrt{2}}$$

$$\frac{A'}{\sqrt{2}} - \frac{B'}{\sqrt{2}} = \frac{0.5A}{\sqrt{2}} - \frac{B}{\sqrt{2}}$$

$$A' + B' = A + B$$

$$A' - B' = 0.5A\text{-}B$$

$$2A' = 1.5A$$

$$A' = \tfrac{3}{4}A$$

$$2B' = 0.5A + 2B$$

$$B' = \tfrac{1}{4}A + B$$

SUMMARY

Twenty-five per cent of signal A (whose frequency lies below 200 Hz) has been caused to eminate from the right speaker, while 75 per cent remains at the left. All of signal B (whose frequency lies above 200 Hz) remains in the right channel.

The sound of the ear remains the same insofar as stereo distribution is concerned.

The work is better divided between the two speakers.

The pickup cartridge is working within its best operating range.

N.B! There is no energy loss in the music—only a redistribution of the total energy between the two speakers.

db Visits-- Ampex Corporation

WHEN YOU SAY you have visited Ampex Corporation, you must specify which buildings are being discussed. Professional products all come from a 401 Broadway address in Redwood City, California. But this is not where they all are made. Redwood City is the corporate headquarters and also the center for research and development and some manufacturing. You can be sure that the MM-1000 you own was sired at this address, but it may have been made elsewhere possibly in a Colorado Springs plant that Ampex owns). Our peripatetic camera, this time wielded by Steve Katz of the Sound Exchange Studios in New York, visited 401 Broadway and recorded some scenes of the work done there. We wish to thank Ed Dowling of Ampex for his assistance in this project.

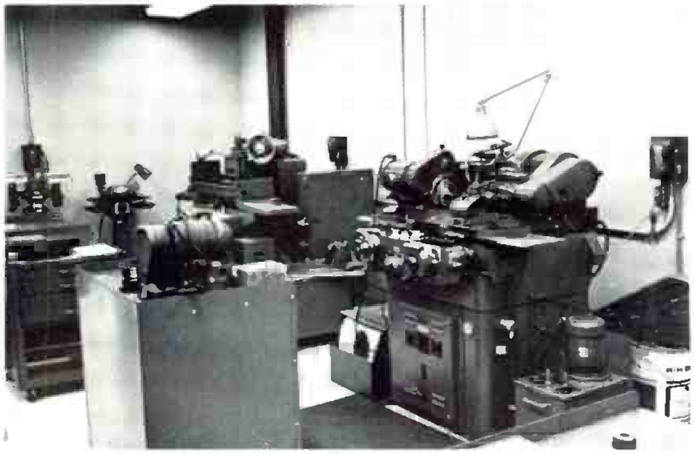
An engineering model of the Ampex ABR recorder.

An MM-1000 has its Auditec checked by engineer Ben Oniki.

Special d.c. capstan motors used in the ABR stand ready for inspection.

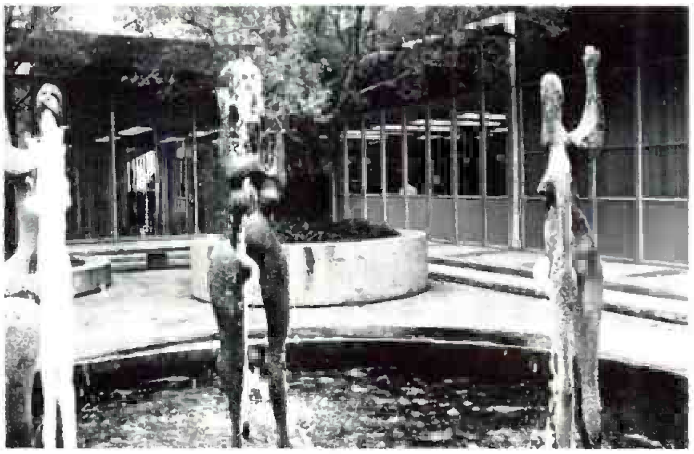
Circuits being checked by engineer Lou Catalona.

Ed Dowling looks over the reel module of the ABR system.



This machine shop has an ability to custom-make new or specialized parts that may someday go into mass production.

The drafting room is where ideas are transferred to plans.



401 Broadway is attractive and conducive to creative work.

Robert C. Ehle

The Technique of Electronic Music

This is the conclusion to the article begun last month that space limitation prevented from appearing.

FREQUENCY VARIATION

In the generation and manipulation of electronically produced sounds, it is often a simple matter to produce one pitch to a certain specification yet very difficult to produce all desired pitches to the same specification.

Two methods are in use to overcome this problem. As both involve special installations of complex equipment, it is very possible that a studio would be able to provide only one of the two. Both methods will be described in the following paragraphs.

TAPE METHOD

Assume that a composer has created a certain tone on tape. This tone is complex, perhaps, and his plans call for several hundred more tones of different pitches but with the same overtone and formant patterns as the original. The classic way of producing these pitches is with a tape recorder equipped with variable speed. Assuming that two recorders are available, one with two speeds and the other with a plus or minus 50 per cent variation of speed, any mutation of the original pitch is possible within the limit of a few re-recordings of the material.

It is a well-known fact that if a recording is speeded up, the playing time is reduced and vice versa. An additional device, which may be added to the variable-speed tape recorder in order to maintain the same playing time with variation of speed, is the rotating head. This device is actually four heads on one rotating wheel. The four gaps on the heads go past the tape in such a way that only one gap contacts the tape at a time.

In order to extend the playing time of the tape, the heads rotate in the opposite direction to the tape; therefore, small sections of the tape are repeated. Since the head is moving in an opposite direction to the tape, the pitch is actually raised. However, it is brought back to the desired pitch by reducing the over-all tape speed.

It should be clear that with a variable speed tape recorder and a rotating head it is possible to: raise the pitch and keep the playing time constant; lower the pitch and maintain the playing time; speed up or slow down the playing time while keeping the pitch constant; and alter both the pitch and the playing time in any desired relationship.

The most important point to keep in mind when comparing this method with the one to be described next is that, with this method, all pitches are altered proportionately so that the intervals (and therefore, the harmony) are maintained over the entire range of pitch variation.

SINGLE-SIDEBAND METHOD

The second method in use for the shifting of a pitch or tone to new frequencies is the single-sideband, frequency-shifting technique. Although the details of the process are too complex for this article, the procedure may be briefly described as follows:

If a pitch is modulated by a supersonic frequency, the result is two sidebands which are the mathematical sum and difference of the original two frequencies. Now, if the original supersonic frequency and one of the sidebands is filtered out, the original signal, by a process of demodulation can be recreated. Demodulation occurs by re-inserting the supersonic frequency (called the carrier); but, if a frequency which differs from the original is inserted, the resulting audio signal will differ from the original audio signal by the number of Hz that the second carrier differs from the first. The reason that one of the sidebands and the original carrier must be filtered is that, if this is not done, the original pitch plus the shifted pitch will be the output result.

This single-sideband, suppressed-carrier, modulator-demodulator, (s.s.b.) as it is called, produces two results which are different from those of the tape recorder pitch shifting system. In the first place, time is completely unaltered by the s.s.b. system and there is absolutely no way of changing the length of a pitch or the playing time of a composition with this system.

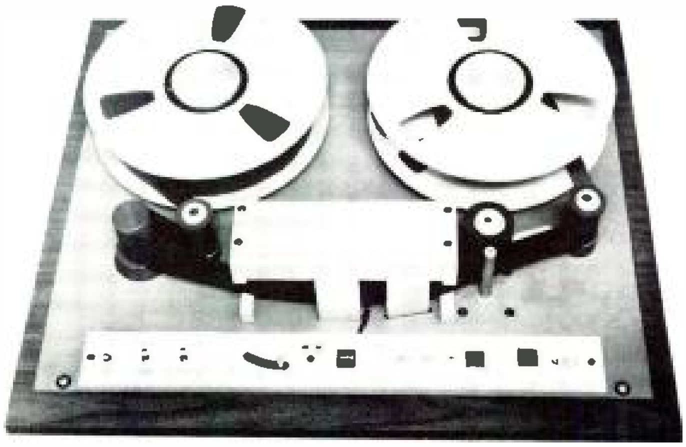
Secondly, and very importantly, the s.s.b. system maintains the absolute difference in Hz between any pair of frequencies which are fed into it. This means that the relative difference in ratios is lost. Thus a tone with a complex overtone structure will be completely changed when it is shifted. Two notes which have a certain interval will have their interval changed, and the total harmony. which depends on the ratios which make up the various intervals, will be completely altered.

Although the relative differences of the pitches or overtones are lost, the absolute difference is maintained. If two frequencies happen to differ by 100 Hz then this same difference is preserved and the two frequencies may emerge at any two frequencies which differ by 100 Hz (say, 8,765 and 8,865 Hz), but the interval between them will be greatly changed.

The reader might ask, "What happens to frequencies that have gone below zero Hz?" The answer is that they start to rise on the other side of zero; that is they sound the same, but their phase is reversed. This reversal of phase is not usually of any audible significance, but another consequence of this operation is significant. If two frequencies are fed into the s.s.b. shifter and moved more than the number of hertz in the higher frequency in a downward direction, both frequencies will appear with their own frequency difference, but the higher will become the lower. In other words, the pair has been inverted. If we should feed more than two frequencies into the unit, the entire set will be inverted. We can extend this principle by feeding in a fundamental with its overtones. This phenomenon, never heard in nature, is thus unique to electronic music.

The two methods of shifting pitch which have just been discussed are similar in that they produce the same result if a simple sine tone is all that is fed in; however, the results with complex tones are quite different. Actually, it is not absolutely necessary to have either machine since any desired tone complex can be constructed for every desired pitch and with every desired overtone complexity. In the last analysis. these machines serve primarily as time savers.[4] ■

[4] A device which is not commercially available, called the Multitrack, has been designed by Hugh LeCaine of the National Research Council of Canada. This device has a long capstan and heads for up to ten reels of tape or ten tape loops at one time. The speed of the captan is servo controlled and may be played by means of a keyboard so that any continuous loop of tape which has a certain waveform on it may be played at any tape speed by means of the keyboard, which may actually be tuned to any desired scale or type of intonation.



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WANTED: MIXER/MUSICIAN. Commercial production company. Heavy electronics not required. Must be good mixer, post mixer, editor. Operator must be fast, musical, agreeable, and greedy. Knowledge of sweetening, vocal OD, eight track equipment, EG, all required. Age open. Write, do not phone. Send resume to **Tom Loy, TM Productions, Inc., 3103 Routh Street, Dallas, Texas 75201.**

PEOPLE, PLACES, HAPPENINGS

Sakellarios

• In a change of executive command at **Melcor Electronics Corp. Nicholas Sakellarios** has been appointed general manager of the company and a vice president of the parent **Newton Electronic Systems, Inc.** In the announcement by Newton president **I. M. Cummings,** it was noted that **Aldo A. Bussi** has resigned as president of Melcor and a v.p. of Newton due to a difference of opinion between Mr. Bussi and the Newton board regarding the operation of Melcor.

• An announcement by **Warren B. Syer,** publisher of **High Fidelity Magazine** and **Stereo Quarterly** details the appointment of **Norman Eisenberg** as editor in chief of a newly-formed international division which encompasses Stereo (Quarterly) in its U.S. and European editions. He also becomes executive editor of High Fidelity of which **Leonard Marcus** is editor in chief. This is a move upward from Eisenberg's titles as editor of the U.S. edition of stereo and as audio/video editor of High Fidelity Magazine. Moving into this last position is **Robert Long** who has been with the publication as associate editor.

• **Synthesis,** the electronic music quarterly, has published their second issue and their first full-size issue. Full size is hardly the way to describe this most unusual publication. It is in the format of a Sunday newspaper in that there are several distinct sections, each devoted to a particular electronic music topic. In this issue you will find a very complete and detailed description of the music department at the University of California at San Diego, a veritable text book on the current synthesizers (more as a set of instruction books), part one of the History of Electronic Music plus other sections concerned with the field. Aside from the fact that it is unorthodox in its format, it is evidently the result of a labor of love by its writers and editors. If you have not yet seen a copy we suggest you write to **Synthesis** at **1315 Fourth St. S.E., Minneapolis, Minn. 55414.**

• As we go to press, we learn that **David Klepper, Jerry Marshall,** and **Larry King,** all formerly with **Bolt Beranek & Newman's** New York office have resigned to form their own consulting company. The firm name is **Klepper, Marshall and King Associates, Ltd.** and will surely be known as **KMK** for short. They will specialize in architechural acoustics including room acoustics, sound-system design, noise control, and sound isolation. Offices are located at 475 Fifth Avenue in N.Y.C. (telephone (212) 683-1093).

Marantz and Bozak

• Two pioneers in the high-fidelity sound industry have united their experience and talents as **Saul Marantz** joins **Rudy Bozak** as vice president, marketing and product for the **R. T. Bozak Manufacturing Company.** The Bozak firm, established in 1949 is known for its speakers and speaker systems. Saul Marantz founded the **Marantz Company** in 1954 to design and produce advanced audio electronics. The Marantz Company was ultimately purchased by **Superscope, Inc.** in 1964, with Mr. Marantz continuing as president until his resignation at the end of 1967.

• **Barney Rigney, Jr.** has joined **Gauss Electrophysics** as director of marketing of the recently formed loudspeaker division. He comes to Gauss, a **MCA Technology Company,** from past positions with the **Auriema International Group,** a marketer in the electronics field, and as a vice president of **James B. Lansing Sound.**

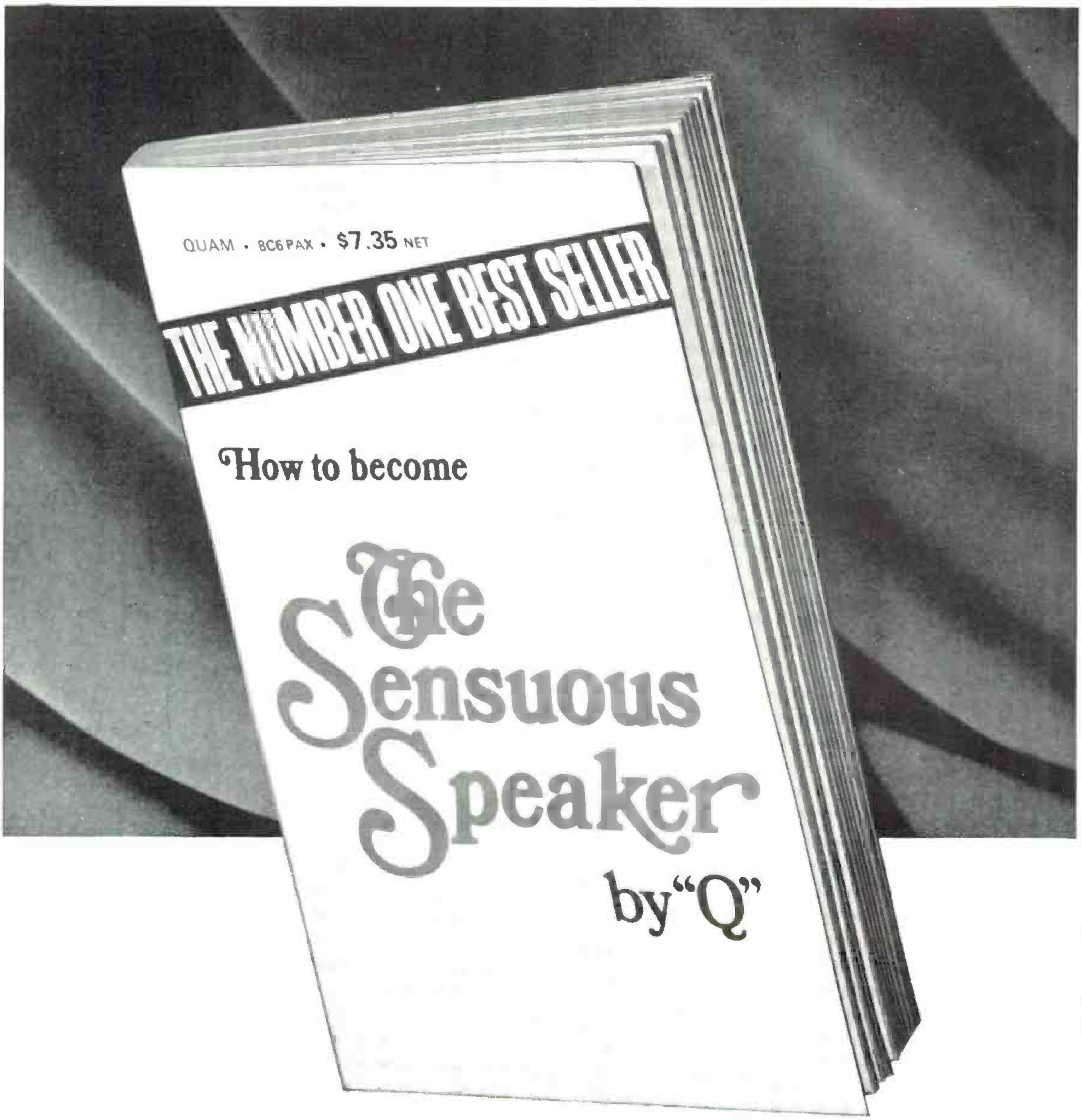
• In a move upward, **Earl J. Peterman** has been named vice president and general manager of the **Metrotech division** of **Dictaphone Corporation.** He comes to this position as one of the founders of Metrotech in 1962 where his last title was as vice president of engineering.

• Two separate announcements, one from **Dolby Laboratories** London office and the other from **Signetics** confirm that the latter firm is well on the way to the development of the Dolby-B (consumer) circuitry contained within a microcircuit system. Signetics will develop and produce the Dolby system in the form of a monolithic semiconductor integrated circuit. After a brief period of exclusive commercial rights to the integrated version of the circuit, Signetics will make all technical information available to the entire integrated circuit industry. The information and materials are expected to become available to Dolby licensees early in 1972.

• **Louis J. Kleinklaus** has retired as chief engineer of **WQXR** and **WQXR-FM,** the radio stations of **The New Times,** after thirty years of service. He has overseen the development of WQXR to a 50-kilowatt Class 1b facility at 1560 kHz, and WQXR-FM to become the first station to feed the pioneering f.m. master antenna atop the Empire State Building. Mr. Kleinklaus is a senior member of the **Society of Broadcast Engineers,** a member of the **Audio Engineering Society,** and a veteran member of the **Society of Wireless Pioneers. Doc Masoomian** has been appointed as WQXR's new chief engineer.

• In a joint announcement by **Electro-Voice, Inc.** president **Lawrence LeKashman** and **Peter Scheiber,** president of **Audiodata Company,** it is said that the two have reached an agreement in principle to cooperate in the area of four-channel matrixing systems for broadcasting, recording, and home-entertainment equipment. The companies have pooled their efforts in seeking encoding standards in the industry based on the E-V system. The agreement will also include co-patent protection and probably manufacture of equipment using developments from both firms.

• An announcement from **Thomas Schillinger,** president of **Sennheiser Electronic Corp.** of New York details that the firm has been named sole U.S. distributor for **SEAS,** the Norway-based Scandinavian manufacturer of speakers and speaker systems. The SEAS line is broad in scope with a range from raw speakers for general and specialized use, to finished sound reinforcement and high-fidelity speakers, to crossover networks for two and three way systems.



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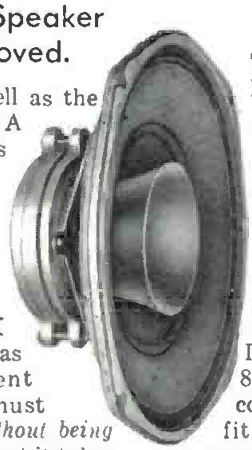

But few manage it as well as the Quam Model 8C6PAX. A jillion of these speakers have already been installed in factories, offices, restaurants, and other locations. What's the secret of success? It's the Sensuous Sound!

The Quam 8C6PAX *knows* that music often has to compete with inherent situational sounds. It must manage to be *audible without being obtrusive*. It has to have what it takes.

What Does It Take?

To be the Sensuous Speaker, you have to be well-engineered and well-manufactured.

Do you have a 6 oz. ceramic magnet? Get one! And get a dual cone, too. A frequency response of 50—20,000 Hz. will also help you, the way it has the 8C6PAX.

Fitting In

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