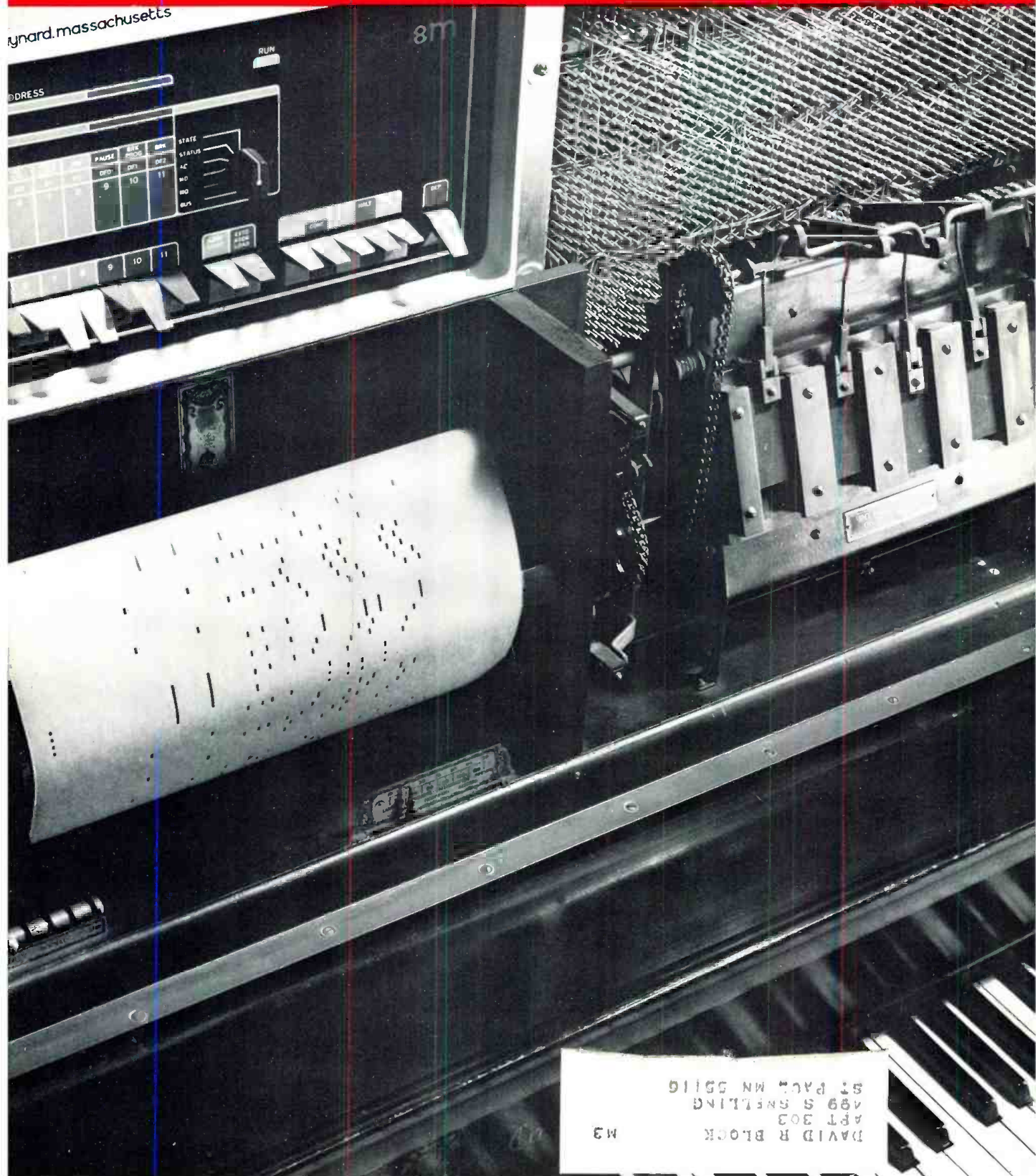


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THE SOUND ENGINEERING MAGAZINE

APRIL 1972 \$1.00

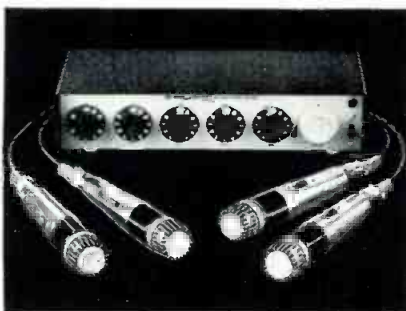
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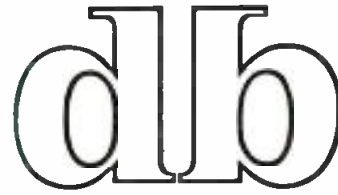
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ABOUT THE COVER

● Can a computer perform? Our cover is designed to point out the nearness of computer technology to the professional audio industry. And we thank Digital Equipment Corporation of Maynard, Mass. for their creative photography. We also suggest that you read Walter Jung's incisive article beginning on page 24.



THE SOUND ENGINEERING MAGAZINE

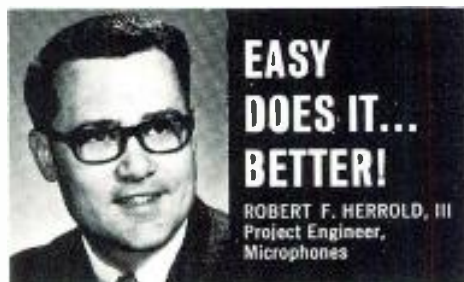
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In past columns in this series we reported on a novel concept for improved distant sound stage pickup that involves locating the microphone quite close to the floor. Further experiments by a number of engineers have fully proven the validity of the idea.

Briefly, the technique is designed to eliminate pickup of out-of-phase sound reflected from the floor which degrades level, frequency response, and gain before feedback. However, to work properly, the microphone head must be within 1/4-inch of the floor surfaces, yet isolated from it to reduce mechanical noise.

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letters

REVISITING THE 641 REVISITED

Falsehoods appearing in technical journals are often relatively harmless. However, when I see one that may mislead enough important readers as to cause a retreat in the state of the art, then I feel compelled to set the record straight.

In THE FAIRCHILD 641 REVISITED in the July, 1971 issue, Richard Schulze states that "... below middle C or so there is no directional effect in music." A little later in the article he asserts, "... we keep cartridges pointlessly straining themselves over low-frequency hills and dales which nobody can hear." Still later, he says, "It therefore became possible to provide means to switch in a verticle roll-off at the bass end. No more pointless vertical meanderings below 250 Hz."

In a letter to the Editor in the January, 1972 issue, Mr. Schulze again states several times that the effect of rolling off the bass in the difference signal (presumably at around 250 Hz) is undetectable.

Well, boys, it just ain't so. Anyone can prove this to himself by means of a simple listening test, unless there's something wrong with his hearing. However, there is really no need to make such a test, as the literature provides ample expert testimony regarding the audible effects of such meddling.

No less than three prestigious institutions independently conducted careful tests on this very subject over a decade ago, and reported their results in the *Journal of the Audio Engineering Society*. Donald S. McCoy of RCA Laboratories concluded, in part, "... it appears that all audio-frequency components (certainly those in the range 100 cps to 10 kcps) contribute to the localization of the sound by the human observer..."¹ Harvey and Schroeder of Bell Telephone Laboratories stated, "In setting commercial standards for two-channel stereophonic transmission, it is recommended that a channel separation of at least 20 dB should be maintained from 100 cps to 8 kc to preserve the spatial resemblance of the original program material."² Beaubien and Moore of General Electric Company concluded,

"Tests employing actual program material . . . showed the extreme lower frequencies to have equal or superior directional content to the higher frequencies . . . Test results and consideration for future developments suggest adoption of full frequency stereophonic systems."³

On the basis of these papers and my own listening tests, I would say that any recording engineer who purposely reduces separation at any frequency above 100 Hz is doing a dis-service to the public, the art, the industry, his company and himself.

Peter W. Tappan
Bolt Beranek and Newman, Inc.
Downers Grove, Illinois

¹ D.S. McCoy, "Distortion of Auditory Perspective Produced by Interchannel Mixing at High and Low Frequencies," *J. Audio Eng. Soc.* 9, pp. 13-18, Jan. 1961.

² F. K. Harvey and M. R. Schroeder, "Subjective Evaluation of Factors Affecting Two-Channel Stereophony," *J. Audio Eng. Soc.* 9, pp. 19-28, Jan. 1961.

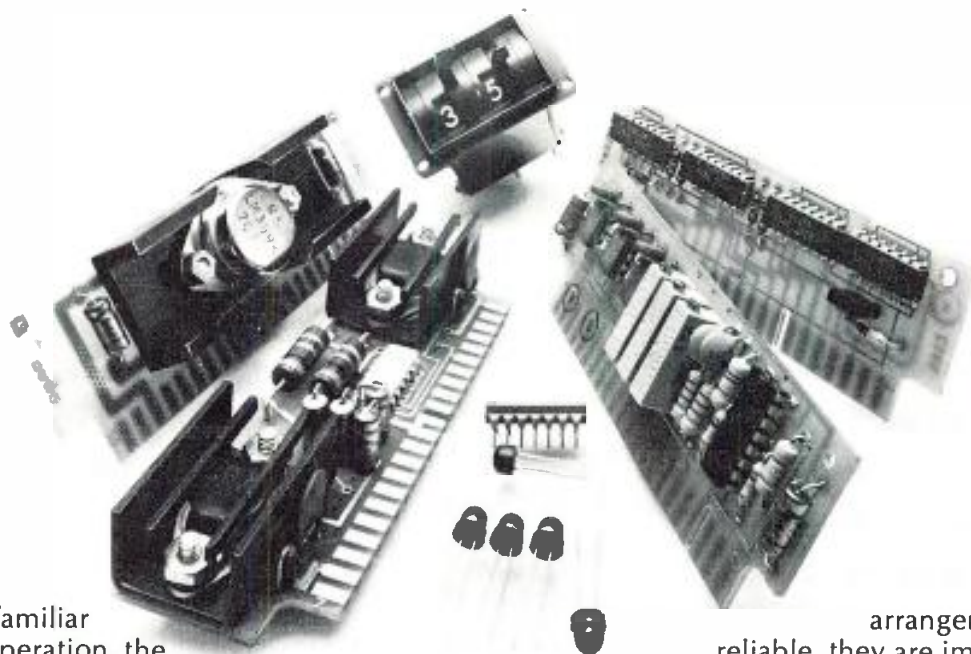
³ W. H. Beaubien and H. B. Moore, "Perception of the Stereophonic Effect as a Function of Frequency," *J. Audio Eng. Soc.* 8, pp. 76-86, Apr. 1960.

The Editor:

I didn't pay too much attention to Richard Schulze's article on the Fairchild 641 when that article appeared in the July issue. However, when Richard Orban's highly critical letter concerning that article appeared in the September issue I started to take notice. There's nothing like a good controversy to stir up one's interest! So it was that I re-read the original article and looked forward to seeing a rebuttal by Mr. Schulze. When the latter finally appeared, in the letters column in January issue, I was disappointed to see that it didn't really meet the principal point made by Mr. Orban.

For what seems to be most basically at issue between the two gentlemen doesn't really have much to do with the 641. Rather, it appears to re-

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late to the principles determining the level of sound perceived by the listener to a given program transmitted on two channels. The question arises in connection with diminishing the difference between the left and right signals in the region of bass response; *i.e.* more evenly apportioning the program between the two channels. In his article Mr. Schulze proceeds from the basic premise that if reapportioning is done so that the vector sum of the left and right signals (as represented by the lateral signal) is not disturbed, then the sensation of loudness experienced by an ideally situated listener will not be disturbed. (That is, though the reapportioning be done at selected frequencies there will be no resultant disturbance of the frequency response.)

It was this basic premise that Mr. Orban rose to challenge. It is the opinion of the latter that you have to maintain constant the total sound power in the room, which he takes to be represented by the sum of the squares of the respective signal strengths. He points out that in the particular example given by Mr. Schulze there would be a net loss, in the total power thus figured, by virtue of the reallocation of power between the channels.

To make Mr. Orban's point clear, let us here use a more extreme example: Suppose that all of a given program is being reproduced by the left channel and we wish to redistribute the task of reproduction so that it is equally shared by both channels. According to Mr. Schulze's way of thinking, the way to accomplish this would simply be to cut the signal fed to the left channel by half and to drive the right channel with an equal and in-phase signal. But then if one figures power, each channel, having half the signal, would be developing one-fourth the power. Total power: half of what it was initially. You can't get something for nothing; how, then, Mr. Orban would ask, can you expect to maintain the same loudness? This was the point that Mr. Schulze's rebuttal completely failed to deal with.

In the meantime, Mr. Orban's way of handling the same problem of program redistribution would be to assign 0.707, not 0.5, of the original signal to each channel. At least that is the way it would have to be done in order to meet the requirements of his Eq. 5. And he claims to have designed apparatus which would do just that—equalize the response in left and right channels (at given frequencies) and still keep the *sum of the powers* (as reckoned via signal strength) constant.

So there, as it would appear to the reader at least, is the outline of the

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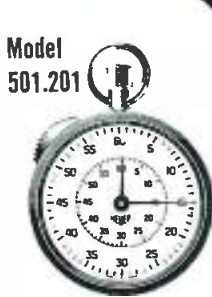
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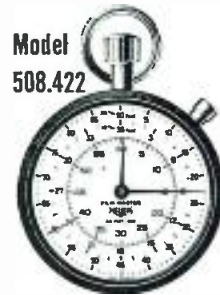
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conflicting views. So who is right and who is wrong? To tackle this question let us take a critical look at Mr. Orban's position. Since the latter has been so intemperate as to allege that most engineers are tricked by their intuition, and that Mr. Schulze's article is "nonsense," perhaps he won't mind. Reproduced herewith is Eq. 5, which is the culmination of the analysis which begins in the early part of Mr. Orban's letter:

$$LL^* + RR^* = \frac{1}{2}(SS^* + DD^*) \quad (5)$$

The most important thing to be noted in connection with this equation is that the left side of it represents, to Mr. Orban, "what we hear when we listen in stereo." (There can be no misunderstanding him on this point; in context he makes it abundantly clear.) In other words, the assumption is that if the sum of the two terms on the left side is not disturbed, then neither is the apparent loudness perceived by the listener. The purpose of the analysis is to express this given-in-advance sum in terms of the variables on the right side of the equation in order to study the effect of the latter on the former.

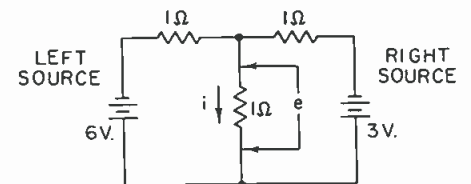
Meanwhile, later in the letter (near the bottom of the middle column on p. 29, as printed) it is acknowledged that the phase of the two signals with respect to each other has to be preserved. So, as a starter, one can ask, "Just where in Eq. 5 does it say this?" The equation says only, just as Mr. Orban contends verbally, that the sum of two powers must be preserved. But there's no way to make a vector addition of two variables each representing power. Power (at least power of the type you get from multiplying a vector times its conjugate) is a scalar quantity, not a vector. You can't even make an algebraic addition of two powers, because neither is allowed to have a negative value. So what you're left with is an arithmetic addition that takes no account whatsoever of phase. The signals as they emanate respectively from the left and right loudspeakers can be in phase, out of phase, or anything in between; the sum of the powers will not be disturbed. And if it isn't disturbed, neither will be, according to Mr. Orban's theory, "what it is we hear." But that all has to be wrong. Otherwise, why do we go to all the trouble of preserving proper polarities?

(Incidentally, one notes in passing that Mr. Orban's computations indicate to him that the sum and difference signals may respectively have any phase without affecting "what we hear." The trouble with mathematical analysis is that its findings are only as valid as the postulates on which they are based. If Mr. Orban's premises, in

their mathematical form, allow the left and right signals to have any phase whatsoever, is it any wonder that he finds that the sum and difference signals may also have that same privilege? Yet, he proclaims such finding "a very powerful result." Under the circumstances, this would seem to be a slight exaggeration, particularly since it's the only result he could have expected.)

The next searching question to be asked is this: "Just how does the hearing mechanism, or the air in the listening room, make an addition like that required by the left side of Eq. 5? Can Mr. Orban suggest even so much as an analogous mechanism which would do the trick?" This is a tougher question to deal with than might first appear, because time-varying information is involved. The brain can do wonderful things, but it can't unscramble scrambled eggs. If it is to make a judgment of the sum of two powers it has to have the two signals separately and respectively rendered into power form, e.g., already translated into heat. But at that point the time-varying information is irretrievably gone. If, on the other hand, the time-varying information is read out before the transformation to power is made, then what you are getting is the power of the sum, not the sum of the powers

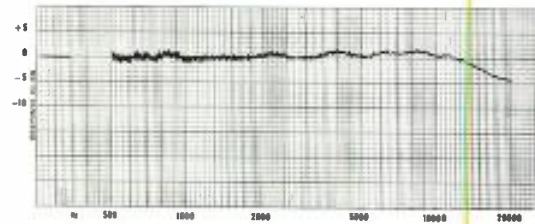
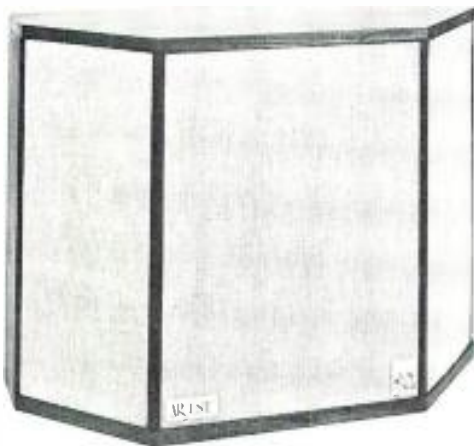
But that's all academic. The fact is that the information has to be transmitted by the air before the brain can get at it. Here, the information from both channels is present simultaneously. One has to face the fact that in a given increment of air there cannot be two net particle velocities nor two distinguishable sound pressures. What this means in a mathematical sense may be clarified by just a simple example couched in electrical terms:



For simplicity the sources in the illustration are shown as d.c. They can be representative of a.c. sources if they are taken to represent the situation at a given instant in time. Internal resistances are assumed to be zero. Then the solutions for the voltage across, the current through, and the power in the central resistor may be tackled by the method of superposition. (One assumes that each source, in turn, is the only one, and adds the results.) This leads to:

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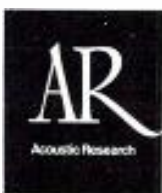
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$$e = 2V - 1V = 1V \quad (1)$$

$$i = 2A - 1A = 1A \quad (2)$$

$$P = 4W + 1W = 5W \quad (3)$$

Eq. 3 above corresponds with Orban's Eq. 5 and embodies his "sum of the powers" concept. The only trouble with it is that it is dead wrong! Although Eqs. 1 and 2 are correct, power itself cannot be figured in this fashion (not even when sources are in phase). The actual power in the resistor is 1W, not 5W, representing a considerable error. The moral is that so long as voltages and currents respectively superpose there is no way for two powers to be summed up, for after superposition there is actually only *one* power involved, not two. To translate into acoustical terms you need only have sound pressures and particle velocities which superpose.

So it appears that the "sum of the powers" concept is a complete fallacy. This is a conclusion so inescapable that not even a veritable blizzard of mathematics is going to obscure it.

However, it is admittedly not a fallacy that you can't get something for nothing. How, accordingly, does one account for the disparities in power seemingly shown by such examples as that in the third paragraph of the present letters? The answer is that such disparities disappear when certain unwarranted assumptions are discarded. One of these unwarranted assumptions is that the total acoustic power output is necessarily representative of the power through the air adjacent the listener's ear. Another is that the square of the signal strength in a given channel is necessarily representative of the acoustic power output from that channel.

What the first of these assumptions overlooks is the possibility of directivity of the radiation pattern from the loudspeakers. Such directivity can always be observed in reproduction of the same signal by two loudspeakers whenever said speakers are separated by an appreciable fraction of a wavelength (and when, of course, the room is at least dead enough so that program information is not lost). Under these conditions a listener favored by directivity can obviously find his loudness undisturbed although the total power through the room is undiminished. It should be carefully noted that it is not through some miraculous coincidence that the improved directivity, when two speakers are brought into play in place of one, happens to be just the right amount to preserve the loudness. Rather, the preservation of the loudness is due to the law of acoustic superposition, which says that the sound pressure at any given point in space is the vector sum of the sound pressures which would

exist at that point due to each of the sources taken separately. (For the ideally situated listener the sound pressures from two speakers fed the same program are in phase at all frequencies. So one can strike out "vector" in the law just stated.) Meanwhile, the directivity effect, in turn, is also due to a law—the very same one! Consequently, the effects *have* to balance.

But what about those frequencies so low that the speakers are only a tiny fraction of a wavelength apart, function together as a point source, and radiate in all directions so that there can be no conservation of power by virtue of directivity? In the latter case, to meet the shortage in the given example, one would have to have some extra power coming from somewhere. And come it does. To illustrate from whence, let us assume the simple situation wherein cone velocity is proportional to signal voltage at a given frequency. This will be substantially the case whenever the speaker is reactance controlled and/or its mechanical and electrical damping is high. Then author Schulze's intuition about displacement being proportional to signal will hold for any one given frequency. Surely, one pint from each of two effectively adjacent speakers will amount to the same thing as the original quart from one speaker. Who could argue with that?

But that still doesn't answer the question as to where the extra power comes from. The answer lies in the fact that in the specified situation the acoustic output will be quite independent of the amplifier output and will vary directly as the air loading does. If the air loading doubles, so does the acoustic output and the amplifier scarcely knows the difference. What happens is that power formerly wasted is turned into acoustic energy. Loudspeaker efficiency may go, say, from 1 per cent to 2 per cent.

In the example at hand, the extra air loading comes from the fact that the actuation of the extra speaker—same program, phase and velocity—in effect sets up a virtual wall between units which cuts the solid angle into which each radiates by half. Half the angle means twice the former radiation resistance for each unit. Thus everything balances out in the long run and there is no something for nothing after all!

The sum-of-the-powers doctrine is an insidious one which sometimes raises its ugly head in a direrent context, namely, the design of crossover networks. It is the humble hope of the undersigned that the considerations here presented will help lay it to rest once and for all.

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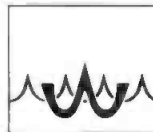


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Norman H. Crowhurst

THEORY AND PRACTICE

● In the January issue, a letter from a reader commended Bob Ehle on his articles about *TECHNIQUE OF ELECTRONIC MUSIC*, last June and July, but suggested that Mr. Ehle is confused about *tremolo* and *vibrato*. If Bob is confused, so are a lot of other people. But I believe, when the facts are examined a little more closely, it was the critiquer who was confused.

Bob Ehle's article, as one would expect from its title, discussed the generation of musical effects electronically, which is a whole new ball game since the advent of the music synthesizer. Before that, all the electronics had to do was amplify the music generated in the same old ways it has been for centuries.

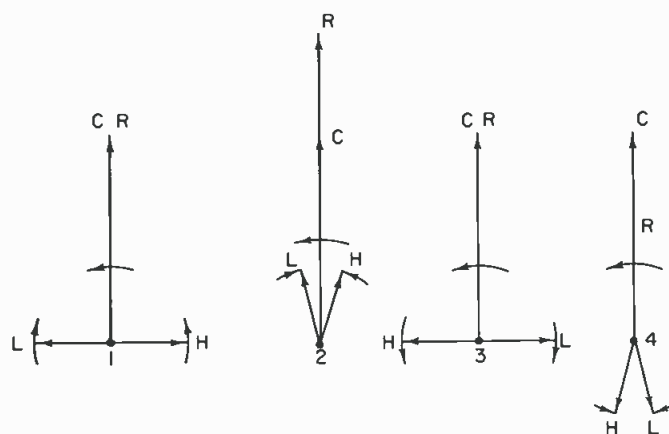
Having written several books on electronic organs and the features of electronic music, whether as adjuncts to traditional instruments, such as guitar, accordion, etc., or as complete electronic synthesizer systems, I have run into this confusion before. So I decided to resolve the confusion in my own mind at least. And there prove to be several reasons for the confusion.

Vectors for amplitude and frequency modulations as discussed by the author.

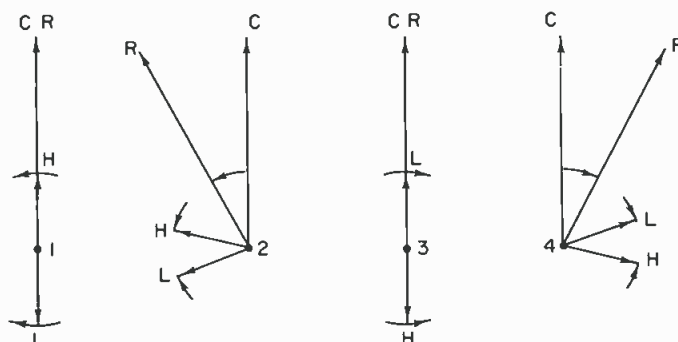
First I found that, as generally accepted definitions, tremolo applies to a rhythmic fluctuation in intensity, while vibrato applies to a similar rhythmic fluctuation in pitch, which is precisely the way Bob Ehle defined the distinction in his article. So our critiquer, Mr. Haskett, has evidently adopted a different set of definitions about these effects.

But it is not really that simple, as I found in my earlier investigation into the matter. If you talk to musicians, who know pitch and intensity, but not frequency and dB's, they will refer to vibrato and tremolo in terms of the way different musical instruments achieve one or the other effect. So the audio man naturally tries to reason out whether amplitude or frequency is modulated by the action that produces the effect.

There is the shaking of the hand of the violin player, causing the finger to roll on the string, naturally varies the pitch, by minutely fluctuating the active length of vibrating string and/or its tension. Then there are wind instruments where the player's stimulation of the note varies by use of his mouth. That, we would deduce, varies



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the intensity. Or if the instrument uses a mute, and the player waves the mute back and forth rhythmically, that would vary intensity too, wouldn't it?

Then we come to the methods of producing one or other effect in organs, either mechanical or electrical. This gets a little closer to the cases about which Bob was writing. The old harmoniums that were around when I was a young man used a rotating vane in the sound box, that interfered with the egress of sound, somewhat like the cornet player mute, I would assume.

But then we get to the newer Leslie speaker that has been used for years with electronic organs, with variations from the original designed. In this, the loudspeaker is rotated so the sound source actually moves as it is emitting sound. By our studies of Doppler effect, we are pretty sure that this fluctuates pitch or frequency are we not?

And so it goes on. Back in those days, a wise man who was in the business of making amplifiers for musical instruments told me he thought that in musical instruments neither amplitude nor frequency modulation occurred as a pure entity, without the other. If intensity fluctuates, then frequency fluctuates a little with it. If frequency fluctuates, then intensity fluctuates a little with it.

That was what turned on my mathematical thinking process. What really is the difference between amplitude and frequency modulation? While in one sense, this is the same as the use of those terms in radio transmission, in another sense it is not. The advantage of frequency modulation in the hundred megahertz range is that, by using a deviation ratio considerable higher than one, a greater channel width is used, thus improving the inherent signal/noise ratio of the system.

The modulation we are discussing occurs at about 5 or 6 hertz, is of very slight degree, usually, and modulates whatever musical tone frequency it is applied to. But in the sense that a modulated wave can be analyzed into a carrier, which in this case is the central musical tone, before tremolo or vibrato is applied to it, and sidebands, one above and one below.

If you could find an extremely narrow filter, less than a hertz wide, through which to pass the modulated wave, you would strip off the side bands, and the central frequency would be left as a steady tone. The warble, be it in amplitude or frequency, is only conveyed by the presence of the sidebands, one 5 or 6 hertz below and the other 5 or 6 hertz above the central musical tone frequency.

So let us examine the mathematical

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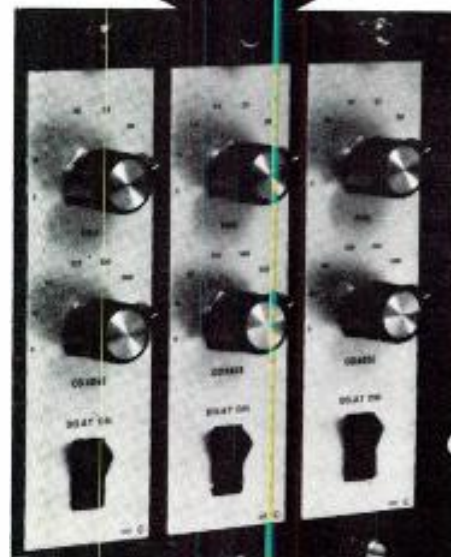
The old man would have been proud.

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mechanism by which the sidebands modulate the resultant wave. Vectors show this best. We draw a constant vector which we label C, to represent the central frequency. Then we draw two smaller vectors that rotate relative to C, to represent the sidebands. The vector convention is rotation anti-clockwise. So a sideband vector that rotates clockwise relative to the carrier vector represents a slower absolute rotation, and thus a lower sideband frequency, while one that rotates anti-clockwise relatively is the higher sideband vector.

For amplitude modulation, when both sideband vectors are momentarily at right angles to the carrier and antiphase to one another, the resultant is the same as the carrier. As the lower one and higher one both approach in-phase with the carrier, the resultant becomes longer, but is still in phase with the carrier.

As the sideband vectors continue their relative rotation, they again become antiphase, mutually at right angles to the carrier, and the resultant is the same as the carrier again. Finally, as their relative rotation continues, the sidebands become antiphase to the carrier and thus decrease the resultant. The resultant remains in phase with the carrier, but fluctuates in amplitude.

For frequency or phase modulation, we start with one sideband in phase with the carrier, one antiphase with it. As they rotate in opposite directions, relatively, they will coincide with one another at a position at right angles to the carrier and thus, vectorially added to it, will advance (or retard) the phase of the resultant.

As the sideband vectors continue to rotate, they will come to inphase and antiphase oppositely from the start, when the resultant is again in phase with the carrier. And finally they will coincide again at right angles to the carrier in the opposite direction, resulting in a retarded (or advanced) resultant.

Thus when the sidebands are in this phase relationship, the resultant swings back and forth in its phase relationship to the carrier. In position 1, the resultant is swinging back toward position 2 (advanced) thus representing a slightly higher frequency. In position 2 (or slightly after that shown, to be precise) the resultant is momentarily at steady phase relationship to the carrier and thus has the same frequency. In position 3, the resultant is moving back from position 2 to position 4, and thus represents a lower frequency than the carrier. After position 4, the movement continues back toward position 1.

In an electrical circuit, where com-

ponents of different frequencies can be analyzed in time relationship, this explains the two forms of modulation explicitly. But notice that, even in this condition, each form contains vectors for the same group of frequencies. The only difference is in the relative phases of the two sidebands. If these get changed by any means, what started as amplitude modulation can finish as frequency modulation, or *vice versa*, or any stage in between.

So my musical friend had a mathematical reason for being right, although he may not have known it.

The possibility of producing relative phase shifts of 90 degrees within a span of 5 or 6 hertz at a mid-range (musical) frequency, in an electrical circuit is somewhat remote. It would be very difficult to achieve intentionally, and very unlikely to happen accidentally. But what can happen to the acoustic wave is something else. Reflections, recombinations can produce all kinds of new phase relationships between frequencies this close together. Thus, what may appear as amplitude modulation at one spot may turn into frequency modulation a few feet away, or *vice versa*.

Can you tell the difference by listening? Are you sure you can? This gives you food for thought, doesn't it? ■

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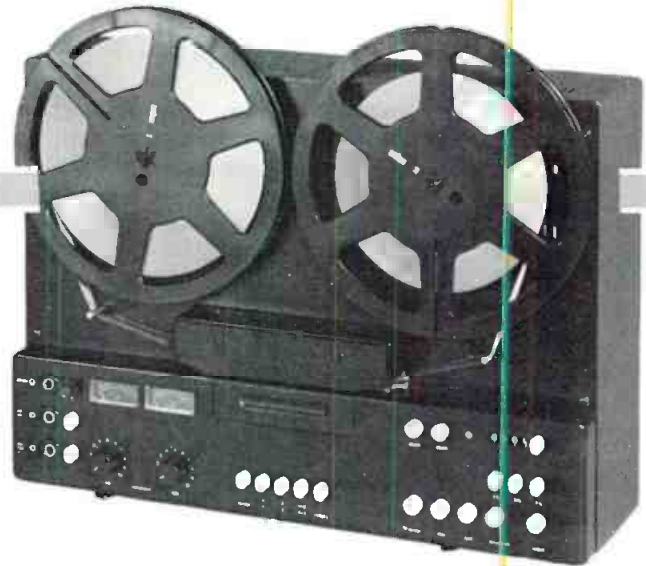
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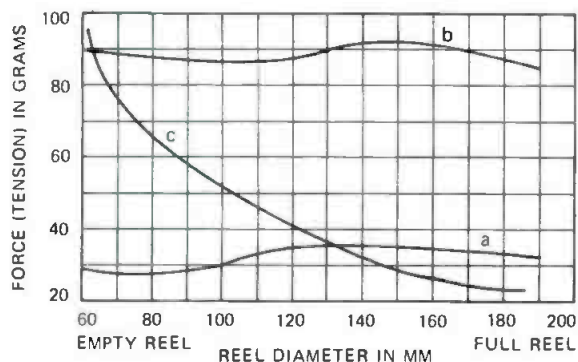
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Introducing the Braun TG-1000

BRAUN, a world-wide name synonymous with highest quality has recently made its Model TG-1000 tape recorder available in the United States. Its unusual design and meticulous detail plus its high order of reliability make it of great interest to recording studios, broadcasters, schools, background music applications — in short to many areas of professional use.



The TG-1000 features a three motor transport which is the smoothest on the market. The unique transport electronically regulates current to the torque motors, thus achieving extremely low tape tension variations. In fact, there is just about zero tape tension at the capstan. And the capstan itself acts as a metering device, neither pulling nor pushing the tape across the heads as in most machines. Tape tension remains constant for both large and small hub reels and tension does not vary more than 10 grams from a full to empty reel. Thus, there is no undue head wear from the high torque on an empty reel and no poor head contact often found with full reels. The graph shows



tape tension for the TG-1000 in the play mode (curve 'a') and fast mode (either forward to rewind) (curve 'b'). Note that in either mode, the tension does not vary more than 5 grams. Curve 'c' shows typical playback tension for another quality deck of comparable price. Note that there is poor head contact when the supply reel is full and excessive head wear when the reel is nearly empty.

The high performance of the Braun transport allows use of the thinnest tapes with complete safety, even in the high-speed wind and rewind operations. And high speed (3300 ft. in 90 sec.) is so smooth, the wound reel looks like it has been played at 7 1/2 ips. The only other machines that can achieve this performance are computer tape transports (\$10,000 and up) and audio decks that use very large (3 inches plus) capstans.

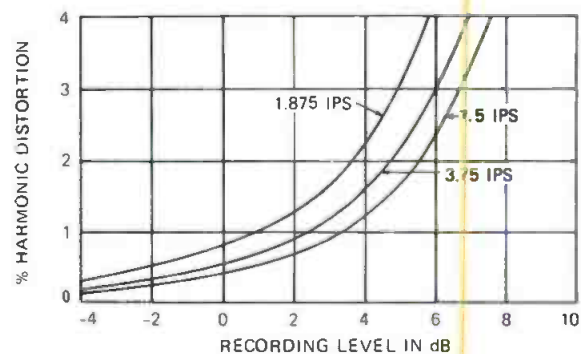
There are "sound" benefits from this transport system also. The most important is the virtual elimination of distortion caused by tape oscillation and scrape flutter. For example, tape oscillation and flutter on the Braun

is better than 20dB below that of the other very popular and otherwise excellent recorder in the same price range. This has been a serious problem for the professional recordist.

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The TG-1000's sophistication does not end with the transport. Its electronics are unsurpassed. The graph shows the distortion curves for three speeds. Harmonic



distortion is below 0.4% at 0 VU at 7 1/2 ips. It does not reach the standard 3% harmonic distortion level until about + 7dB. Signal to noise is very conservatively rated at 60dB by DIN standards. And record-to-playback frequency response is almost unbelievable ± 0.5 dB from 20Hz to 23kHz.

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John M. Woram

THE SYNC TRACK

● Last month's SYNC TRACK column was omitted—the reason, as some knew was that I was laid up with a slipped disc. Some astute readers have already noted the remarkable coincidence between the dates of my “illness”, and the recent Presidential visit to China.

Although it is true enough that I had some slight trouble with my back, the complete story is more or less as follows.

As part of its continuing policy of service to the readership, *db* strives to keep them informed—especially at this time of the year—of things and events somewhat beyond the narrow confines of the audio/video industry. In this age of intense specialization, the serious professional often finds little time to read beyond the journals of his trade. Realizing this, it is well within the format of a magazine of integrity to probe beyond the frontiers of its usual format.

You've probably guessed what this is leading up to—not a back injury at all, but a secret trip across the Pacific and back to bring our readers a view of current events abroad, and as a bonus, a quick look at recording techniques hitherto unmentioned in American scientific publications.

THE NEED FOR SECRECY

Some time ago, the Administration was noted giving itself a pat on the back because it had been able to wisk a high level advisor in and out of assorted countries almost undetected. If inconspicuousness is a measure of success, the *db* excursion must be considered an unqualified triumph, since even at this date, no one on either side of the Pacific Ocean will admit to having seen me within thousands of miles of the official entourage.

While, abroad, I had the opportunity to chat briefly with a key figure in this international confrontation. Since *db* has no wish to compromise the best efforts of our government, its editors have (wisely, I think) asked me not to identify the principal in the following conversation, which consisted of a few timely questions by your reporter.

Q. Tell Me, Mr. P——, what made you decide to come here in the first place?

A. Well, let me make this perfectly clear. I want to be re-elected in the worst way. And I mean that sincerely.

I am, of course, always sincere. Anyway, my p.r. people thought that a trip abroad would be very good for my image, and would show that I'm concerned.

Q. Concerned about what?

A. I'm not really sure about that. I think it's got something to do with Southeast Asia. You know, we're spending a lot of the taxpayer's money trying to blow it up, and I guess if I come over and let everyone know we're doing it for their own good, they'll all vote for me. We need the Asian vote you know.

Q. Well, if you're looking for votes, why not just say, look folks, I'd like to be re-elected, and save the time and expense of this trip?

A. Boy, you are naïve. Look, we've spent a lot of time and money developing a great line of b— . . . let's call it a highly sophisticated official language. In diplomacy, what we say and what we mean are never the same thing. The voters know this and they're grateful to us. But that doesn't mean they'd sit still for the truth. If I come out and say I want to be re-elected, the average voter will think I want out. Things are pretty tough back home, and if I lose this job, I don't know what I'll do.

Q. I can't help wondering why you're telling me all this, if it's against official policy to let the people know what's really going on?

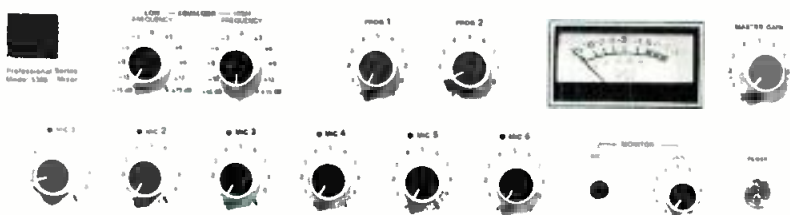
A. Because it doesn't really matter. My agents have told me that no one reads your column anyway. And besides, I just wanted to see what it would feel like to do a little straight talking. You mustn't take that personally. You will vote for me won't you? Please?

(In the interests of national security, the rest of this interview has been deleted by the editor).

After the interview, I made my way out to the Anti-Imperialist Recording Studio on the outskirts of the city. As I arrived, technicians were preparing the studio for a session with a popular local group, the Grateful Red. The group was in town to record a new album. Although the charts were written by several different musicians, all the lyrics were taken from the collected works of Chairman Mao, and included such hits as: *We've Only Just Begun* (our new tractor fac-

(continued on page 39)

Our new mixer goes to the greatest extremes.



Our new JBL 5306 Mixer/Preamplifier is a solid-state wonder. Two program channels and six microphone inputs. And with each microphone channel capable of taking an input signal of 500 millivolts.

That's a lot of input, even by rock group standards.

Another thing about the 5306 is that it's practically goof-proof. Each mic channel has a peak light that flashes before its preamp circuit begins to overload (after all, there's a limit to the extremes that even the 5306 will go). You'll have plenty of time to ride gain. This is the big advantage of the 5306; reducing the gain allows you to accept greater input levels without overloading the mixer. Mic channels can take signals up to *ten times higher* (-2dBm) than most other mixers. And with the mixing circuit controlled by the

Master Gain, your 5306 can handle anything a group of artists can create.

The 5306 is a *complete* mixer. It comes with everything for microphone use: mic receptacles, input transformers, VU meters, line output transformer... everything. You don't have to spend money mixing and matching components. You might want to plug in our 5308 Expander, though. It will give you a

total of 14 mic channels for a lot less than the cost of another mixer. Other options include plug-in program input transformers and phono input amplifiers for program channels.

There's a lot more to be said about our new 5306. Specs written under actual field test conditions, not just in the lab, tell you how the 5306 performs in an actual application. After all, that's where you intend to use it. And that's where our new 5306 will go to greater extremes of performance than any other mixer will.

Professional Equipment Division, James B. Lansing Sound, Inc., 3249 Casitas Avenue, Los Angeles, California 90039. A subsidiary of the Jervis Corporation.

Gentlemen:

Tell me more about your new JBL 5306 Mixer/Preamplifier and the wide range of extremes it will go to in my application.



Name _____

Address _____

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Application _____

Circle 20 on Reader Service Card

NEW PRODUCTS AND SERVICES

12-VOLT AMPLIFIER

● Model PA50 is a miniature 12 volt d.c. mobile amplifier that can operate as a general purpose public-address amplifier, or by the flick of a switch convert to a high intensity speech amplifier with an equivalent acoustical output power over 10 times its normal 50 watt rating. Housed in a die-cast aluminum case and built of top quality materials, the unit is stated to be extremely rugged. Output power is rated at 50 watts square wave, 35 watts continuous at 14 V d.c. Power can vary from 8 to 15 volts. Output impedance is 1-4 ohms or 4-16 ohms. Inputs are available for hi impedance mic, low impedance mic, aux. Signal to noise is 90 dB in mic and 96 dB in aux.

Mfr: Soundpower

Price: \$119.95

Circle 51 on Reader Service Card.



TAPE REELS



● Aluminum tape reels in seven-inch size are now available. Five permanently yanodized colors are provided for coding purposes. The colors are: silver, gold, black, blue, and orange. Reels are available directly or through local distributors.

Mfr: Studio Reel Co.

Price: \$3.50 each

Circle 56 on Reader Service Card.

VARIABLE-SPEED TABLES

● Complete turntable systems that feature variable turntable speed and a quality arm are included in the features of the Lenco L-75. In addition to the four standard preset speeds of 16 $\frac{2}{3}$, 33 $\frac{1}{3}$, 45, and 78, any speed between 30 and 86 rev/min are easily set. The turntable assembly is mounted on isolation suspension springs. The tonearm comes with adjustability for low-force tracking cartridges, and anti-skating compensation. A damped arm cue lever is provided.

Mfr: Lenco (Benjamin Electronics)

Price: \$99.50 with base; cover: \$11.95.

Circle 57 on Reader Service Card.

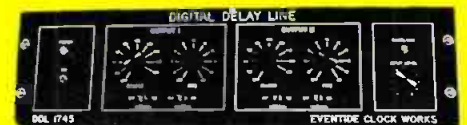


DIGITAL DELAY

● This unit features two outputs; 200 milliseconds delay is independently variable for each output in 2 millisecond steps. Frequency response of the system is 20 Hz to 15 kHz, signal to noise ratio is better than 62 dB. The system can be expanded at any time to a total of 800 ms. and an unlimited number of outputs.

Mfr: Eventide Clock Works

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\$49900
WIRED

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Circle 21 on Reader Service Card

A Note from the Publisher

We are gratified to offer a very unusual and extremely worthwhile new service to our readers; a service that is a means of achieving a goal we've had from our very beginning.

We stated in our initial editorial in November 1967:

"In a field as broad as professional audio has become, the dissemination of information necessary to the improvement of performance becomes vital. However, with the exception of the highly respected professional societies, no one has yet come forth to provide such service. **db's** emphasis, therefore will be to complement the theoretical orientation of existing publications with a focus on practical new concepts.

"Our purpose is to establish an intra-industry dialogue—an exchange of ideas—with immediate relevance to everyday applications."

Starting this month, we are offering **db** readers a way to achieve this interchange of ideas that is simple and efficient—a way to build on the ideas in our articles with other involved readers—without the time and expense of travel. It is called **db TeleSessions**—group telephone conferences held in connection with selected **db** articles. You will be able to dial into one or more hour-long, freewheeling discussions in connection with an article you find especially provocative. You can exchange experiences and ideas with a small group of other readers as concerned and involved with that area as you are.

A key ingredient in these **TeleSessions** is the other readers who participate. You will find that each of them is involved and experienced in activities where success often depends on empirical results. This is a chance for you to learn from other experiences instead of from expensive trial and error.

Before launching this joint project with **TeleSession Company** (which has run over 700 sessions), we reviewed the results of prior sessions. Participants were from very different job levels and functions. They found the **TeleSessions** not only stimulating, but a low-cost form of consulting that gave immediate answers.

On the inside of the back cover, you will find a complete description of the way **TeleSessions** work, including the ways in which they are different from conference calls and how *you* can participate.

For example, after reading this month's article **AUTOMATING THE AUDIO CONTROL FUNCTION**, you can discuss ideas with other readers who are affected by these developments. Your session might explore the ways to use this technology in your particular field, or it might focus upon an exchange of ideas and information about new marketing problems, or how this technique can be adapted to specific needs.

On the other hand, readers most interested in building their own consoles or mixers will be dialing into the **TeleSession** based on ideas within the article **A STEREO CONSOLE YOU CAN BUILD**.

We have invited the authors as well as other experts to join our readers in **TeleSessions** and become involved in the discussions. These are just a few examples of the content of your **db TeleSessions**, for of course the actual direction of each discussion depends on the unique questions and contributions each participant offers.

We will select one or more articles or columns from each issue in the coming months to be the basis for **TeleSessions**.

We urge you participate in one or both of these electronic meetings.

Robert Bach
Publisher

42nd AES Convention

On the facing page you will find an up-to-the minute map of the AES convention that is being held in Los Angeles.

THE EXHIBITS

Dates: *May 2 to May 5*

Place: *Los Angeles Hilton Hotel*

Exhibition Hours:

Tuesday—*1 to 9 p.m.*

Wednesday—*1 to 9 p.m.*

Thursday—*11 a.m. to 5 p.m.*

Friday—*11 a.m. to 5 p.m.*

Banquet: *Thursday, May 4th.*

Cocktails: *7:00 Los Angeles Room*

Dinner: *8:00 Golden State Room*

THE PAPERS

Tuesday, May 2nd

9:30 Magnetic Recording and Reproduction

Golden State Room

9:30 Audio Instrumentation and Measurement

Los Angeles Room

2:00 Disc Recording and Reproduction

Golden State Room

Wednesday, May 3rd

9:30 Sound Reinforcement

Golden State Room

2:00 Quadriphonics

Golden State Room

Thursday, May 4th

9:30 Acoustical Noise Control

Los Angeles Room

9:30 Audio in Broadcasting

Golden State Room

2:00 Digital Techniques

Golden State Room

Friday, May 5th

9:30 Electronic Circuitry and Signal Processing

Golden State Room

2:00 Transducers

Los Angeles Room

7:30 Recording Studio Workshop

Golden State Room

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| 4. Equalizers | 19. Oscillators — 25 Hz | 34. Timing Circuits |
| 5. Phono Preamps | 20. Filters 25 Hz | 35. Switching Matrices |
| 6. Tape Preamps | 21. Distribution Amps | 36. Power Amplifiers |
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| 12. Auto-Tens® | 27. Bipolar Supplies | 42. Custom Consoles |
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SOUND EQUIPMENT CORP.

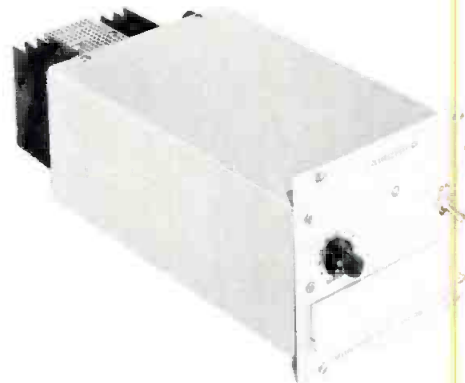
ENGINEERING DATA

MONITOR/POWER AMPLIFIERS,
10 & 70 watt RMS, Models 610 & 870

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Model 610



Model 870

These meticulously engineered, manufactured and tested solid state power/monitor amplifiers are specifically designed for high reliability use in the broadcast, recording and professional sound reinforcement fields, and no cost or effort is spared to achieve near-perfection for these purposes.

- Extremely low distortion
- Excellent transient response
- Flat frequency response
- Output circuit protection against overload, open and short circuits
- Compact design and rack mounting for minimum space requirement
- Self-contained power supply
- Low Noise
- Transformerless output
- Bridging input

Both 610 and 870 amplifier circuits consist of four directly coupled stages of amplification, phase inversion and driving. DC feedback loops stabilize the operating point over the wide range of operating temperatures with no degradation in performance of the unit.

Amplifier load is connected directly to the output transistors through barrier strip terminals at the rear where input connections are also located.

Model 610

In this unit the gain control on the input accommodates levels from -10 dbm (.25 bridging) and higher for full output. Minimum level of .25 V is required to produce 10 watts rms power into an 8-ohm load or 6½ watts into a 16-ohm load.

Output stage is Class AB circuit with maximum current flowing through the transistor being .4 amps, and idling current 20 ma.

Instantaneous overload protection is obtained through current limiting transistors in the driving circuit of each half of the output stage. As current through either of the output transistors exceeds preset value (clipping point), output stages are clamped down, driving the output stages into non-conductive state.

Model 870

The unit's balanced power supply eliminates the need for bulky and deterioration-prone coupling elements such as transformers and electrolytics. With the exception of output transistors and power supply, unit is housed on plug-in card, allowing instant access to any critical component for purposes of inspection, maintenance or repair.

Signal of .8 volts across the input produces 70 watts across the load. The amplifier will operate at any source with impedances up to 100,000 ohms. Output impedance is only a small fraction of recommended load impedance so that damping factor of the output is extremely high and, with average load, exceeds 20.

SPECIFICATIONS

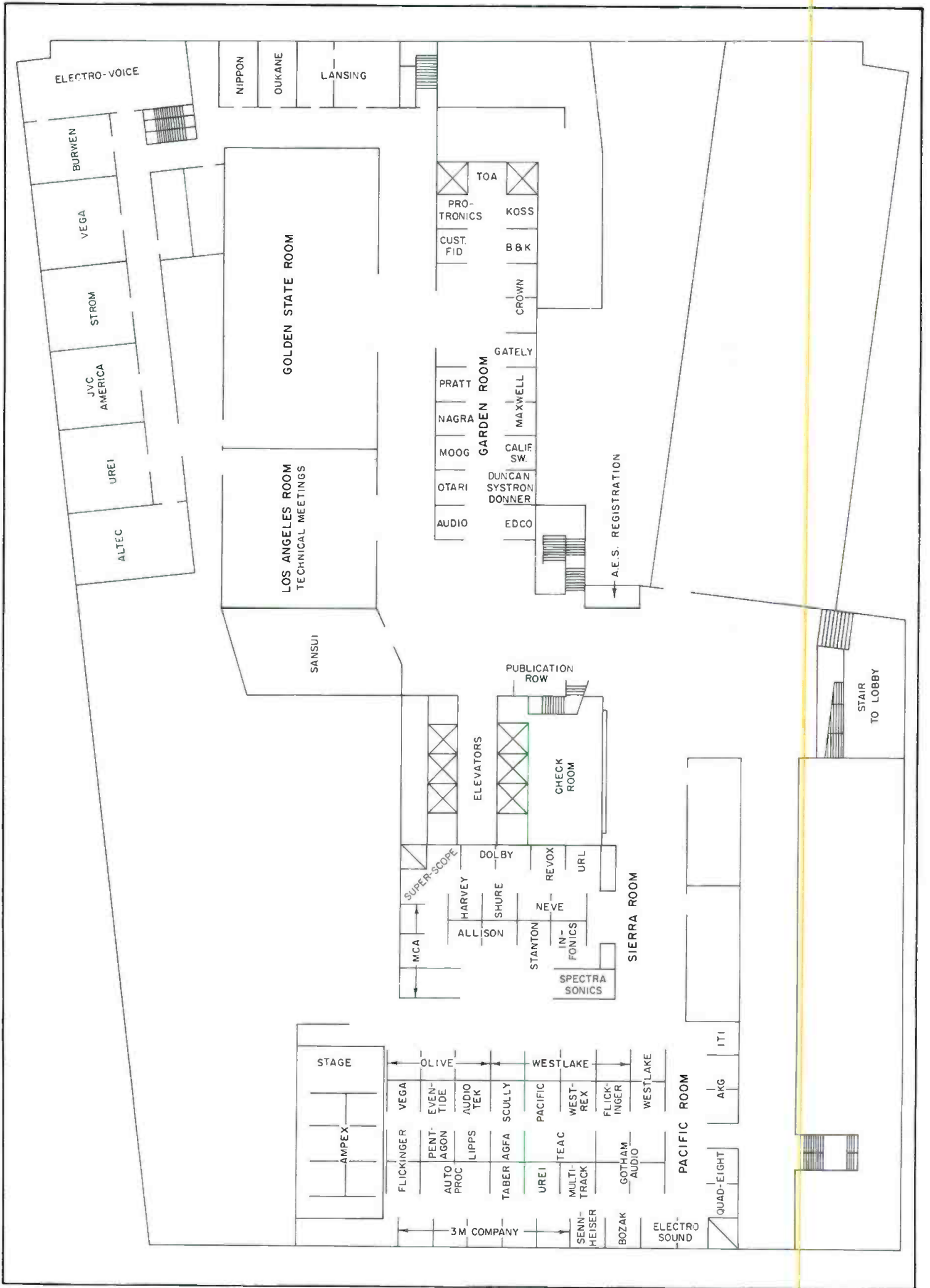
<u>Model No.</u>	<u>610</u>	<u>870</u>
Power output, watts rms into 8 ohm load	10.0	70.0
Power output, watts rms into 16 ohm load	6.5	35.0
Peak power output, watts	+15.0	+100.0
Frequency response, 20 Hz to 20 kHz, db.	- 1.0	- 0.5
THD, at full power, %	0.4	0.4
THD, typical, %	0.2	0.2
Noise, below rated output, db	-86.0	- 85.0
Input impedance, bridging, K ohms	10.0	100.0
Output impedance, ohm	0.5	0.4
Input level, min. for max. output, db	-10.0	0.0
Damping factor	16.0	20.0
Power requirement, 117 VAC 60 Hz, amps max.	0.3	2.0
Suggested load impedance, ohms	8.0	8.0

MECHANICAL SPECIFICATIONS

<u>Model No.</u>	<u>610</u>	<u>870</u>
On/Off Switch	Yes	Yes
Input Gain Control	Yes	Yes
Weight, lbs.	4½	13½
Dimensions, height "	5½	5½
width "	3	6
depth "	10	10
Rack Mount frame	#662RM	#662RM
No. of units mountable in one #662RM	5	2



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Automating the Audio Control Function

This is the first of a series that will explore the applications of automation and digital electronics and its value to the audio professional.

WE HAVE ALL BEEN WITNESS to the many opportunities for superlative performance integrated-circuit technology has opened up in the area of audio signal processing. One such example is the wealth of material written both in this publication and others on applications of ic op-amps for audio use. Mixers, line drivers, preamps, equalizers; many standard audio processing functions can be handled quite well by ic op-amps. And many firms are rolling out modules which do just that with superlative results. But in this particular area the main attribute of the ic op-amp is its performance for the application in relation to its price. These applications were all possible before the age of the one dollar ic op-amp but didn't see widespread usage because of the prohibitive cost of the amplifier that it took to do the job. However, now that prices have dropped the circuit designer can no longer afford to overlook the usage of op-amps. But then, this is really but one aspect of the ic picture, and not really one we're going to talk of in this article.

Instead, consider things which previously could not be done at all, or only "half done". Here what we refer to is the situation where you can get the job done alright, but the hardware you are forced to use has other hangups.

Polite engineering terminology for describing this dilemma refers to the shortcomings as "trade-offs". To illustrate further, take a case in point—switching audio signals by electrical control. Simple you say. Use a relay—if you don't care about contact bounce, and 1 millisecond closure time is fast enough. And you have enough coil power handy to hold it in. Suppose you can't stand any bounce or contact chatter. Try an ldr for smooth switching, if 10 milliseconds is fast enough. (Hmm . . . solve one problem and introduce another!) Still, it takes power to make light the thing understands though—lamps? led's?

Suppose I go solid state and use an fet? . . . Maybe this is it; a voltage controlled resistor I can drive right from a flip-flop and turn my audio on and off. Well, I can't drive it directly from a flip-flop, I need another transistor to shift the gate minus. But it sure switches fast—1 microsecond, and it doesn't bounce.

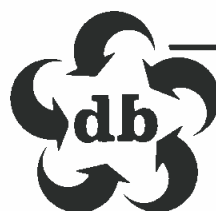
Oh—now you say you want to switch 2 signals. Easy, I'll just add another fet. Uh-oh; not so easy—I need another driver for the 2nd fet!

Now if any of this sounds at all familiar to you, maybe you'll be receptive to a look at a new approach to switching audio signals via digital control. New in that it is a different twist on a basic circuit element which has been around for some time, and timely also in that it is an avenue to sophisticated automated control techniques. It uses the monolithic balanced modulator—but not as a balanced modulator, as a digitally controlled dpdt audio switch. And this one will do some things the others won't—it has gain, it can invert the signal and it gives you a second output signal which is the complement of the control state for free. It's all solid state so its nice and compact, draws little power for control or biasing and should last indefinitely. And it won't cost you an arm and a leg either—about a buck and some change for the first one you buy just to see if I'm lying.

The chip which can do all of this is an MC1596/1496¹ (See TABLE A for alternate source equivalents.) used in a somewhat different fashion from its original intent. The details of its conversion are quite interesting²

References

1. Data Sheet for MC1596/MC1496 Balanced Modulator-Demodulator *Motorola Semiconductor Products*, August, 1970.
2. Walter G. Jung, *The Monolithic Balanced Modulator as a Versatile Audio Switching Element* presented at the 41st Audio Engineering Society Convention Oct. 8, 1971. AES preprint #816.



TeleSessions

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

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And in all that time we've built up quite a family.

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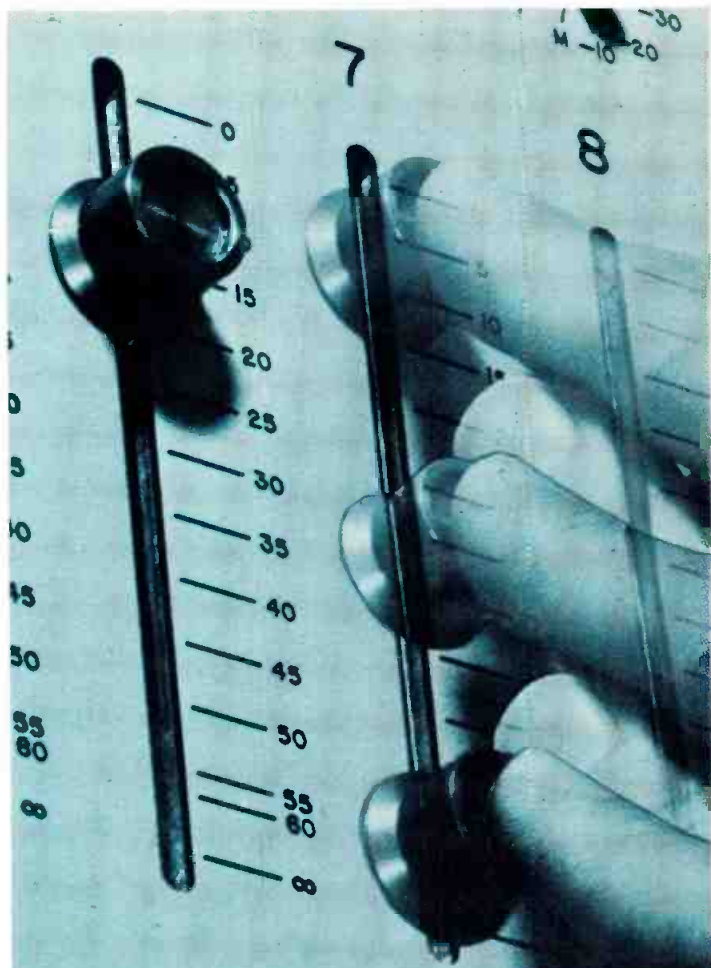
Which, if you are at all interested in better equipment, is something you should send for. Revox Corporation, 155 Michael Drive, Syosset, N.Y. 11791.



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Manufacturer	Part Number
Motorola	MC1496/MC1596
Fairchild	* μ A796C/ μ A796
Signetics	N5596/S5596
Silicon General	SG1496/SG1596
Lithic Systems	LS1496/LS1596

*TO-100 only

Table A. Device manufacturers and part numbers.

More Positive Control Input C + (as shown) C -	Output @:	
	O ₁	O ₂
	Ch A	Ch B
	Ch B	Ch A

Table 1. Control logic sense.

and illustrate how cunningly innocent-looking devices can harbor widespread potential. Let's look now at how this potential can be tapped for audio switching applications.

FIGURE 1 is a diagram of a balanced modulator chip connected for conventional operation. There are two inputs to the device, Ex and Ey. Ex is applied to cross-coupled differential pairs Q1-Q4. These transistors receive emitter currents from transistors Q5-Q6 which are driven by signal Ey. The differential input Ey modulates the static current I in Q5 and Q6 and generates two equal and out of phase currents I + Iy and I - Iy as shown. The bias currents I flowing in Q5 and Q6 are generated by matched current sources Q7-Q8 which duplicate the current set in D1 by the bias set resistor R bias.

Operation of the device is four quadrant with regard to signals Ex and Ey, and this fact may be verified by examining the signal flow and relative polarities appearing at the output. The output will always be the product of Ex and Ey with the correct sign.

Now if you examine the process which provides this sign reversal capability some interesting by-products may be discovered. If you regard the signal output at RL1 with the signal polarities shown, you will note it will consist of the current from transistor Q5, or I + Iy. In this case we are speaking of a high amplitude of Ex so RL1 will receive only current from Q1-Q5 and none from Q3-Q6. But watch what happens if you reverse the polarity of Ex—Q3 and Q6 now feed RL1 the current I - Iy. So the relative polarity of Ex can control which of the two collector currents of Q5 and Q6 will appear at RL1. You will also note that the complementary state of control will exist at the RL2 output; that is if the Q5 output is appearing at RL1, RL2 is receiving Q6's output. As the control state of Ex changes these outputs interchange. So we now have an electronically controllable (via the Ex control input) dpdt switch which can shift two signal currents Ic Q5 and Ic Q6 back and forth between outputs RL1 and RL2. This is more clearly shown by FIGURE 2(A), a model of the circuit configuration. Since the currents of Q5 and Q6 are still related in this hookup, the obvious next step is to remove the interdependence of the collector currents. If we can separate these two signals entirely we will then have the capability of controlling two separate input signals by Ex, and be able to toggle either one to a desired output.

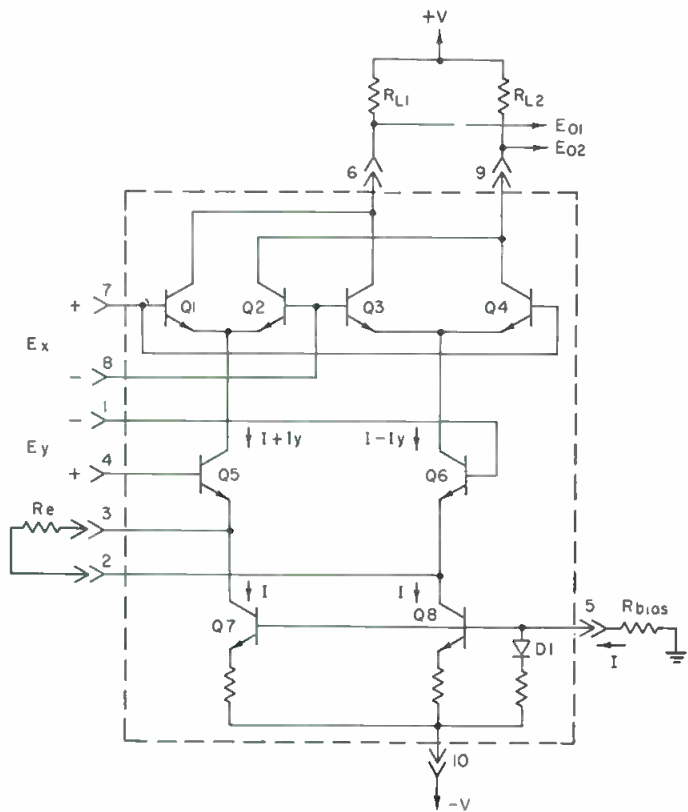


Figure 1. A typical monolithic balanced modulator.

The separation is easily accomplished by removing the differentially cross-connected R_e and introducing new resistances R_{Ea} and R_{Eb} from Q_5 and Q_6 emitters to signal ground. As shown in FIGURE 2(B), there is now no cross coupling between Q_5 and Q_6 because these resistances are returned to ground. You'll also note the high impedance provided by Q_7 and Q_8 prevents any a.c. signal flow through these paths. Essentially, Q_5 and Q_6 have been converted into a pair of single ended gain stages. The switching structure of Q_1 - Q_4 is identical, the big difference lies in the signals which are applied to the Q_1 - Q_4 dpdt switch. In FIGURE 2(B) we have developed the same basic ic hardware into a useful general purpose switching tool. It remains new to put the thing to work for us.

To both simplify and clarify things as we begin to apply our new switching device we'll need to define a few things and state some operating ground rules. We can reduce the relatively complicated schematic of FIGURE 1 to its switching symbolic equivalent in FIGURE 3. Here we have reduced the chip down to its bare essentials for application as a dpdt switch. You'll find the descriptions and abbreviations of FIGURE 3 self explanatory. A truth table of control logic given in TABLE 1, and TABLE 2

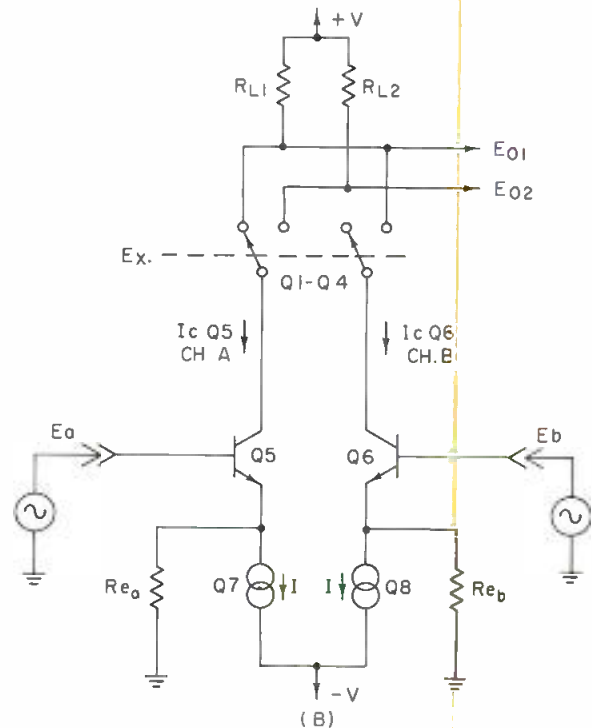
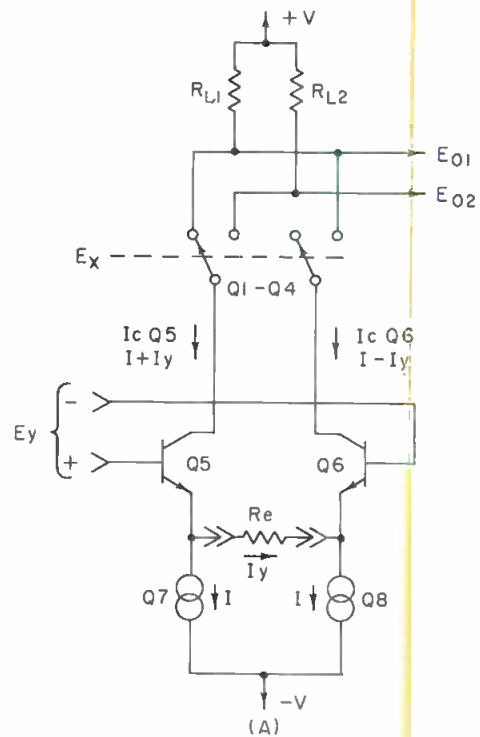


Figure 2. (A) A model of a balanced modulator showing the switching mode. (B) The evolution of a balanced modulator onto a programmable dpdt audio switch.

Table 2. Symbol abbreviations and pin numbers.

Abbreviation	Description	Pin numbers for	
		TO-100 (10 pin can)	TO-116 (14 pin DIP)
Ab	Channel A Base	4	4
Ae	Channel A emitter	3	3
Bb	Channel B base	1	1
Be	Channel B emitter	2	2
C +	Control Input +	7	8
C -	Control Input -	8	10
O ₁	Output 1	6	6
O ₂	Output 2	9	12
Is	Current Set	5	5
-V	Negative Supply	10	14

ANNOUNCING: AN INSIDE LOOK AT CZECH FILMMAKING.

**All the Bright Young Men and Women:
A Personal History of the Czech Cinema
by Josef Skvorecky**

The "bright young men and women" referred to in the title of this new book are the filmmakers of the Czech New Wave of the sixties. Josef Skvorecky was associated with most of the important directors of this period (including Nemec, Schorm, Forman, Passer and Chytilova) and the largest section of the book is devoted to their work. However, the work of earlier filmmakers is not ignored, for *All the Bright Young Men and Women* traces the entire history of the Czech cinema from its earliest days to the post-invasion seventies.

Josef Skvorecky is "one of Europe's leading novelists". He is also an essayist, translator and screenwriter, whose screenplays have been filmed by Evald Schorm and Jiri Menzel among others. *The Cowards*, Skvorecky's first novel to be translated into English, was published by Grove Press in the United States and by Gollanz and Penguin in Britain. He is presently teaching at the University of Toronto.

All the Bright Young Men and Women is published jointly by the film magazine TAKE ONE and by Peter Martin Associates. Its 280 pages include more than 100 illustrations, a comprehensive index, and a chronological listing of the most important Czech films and their directors.

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shows symbol abbreviations and pin numbers for the two currently available ic packages. We'll use these symbols and abbreviations in all subsequent application discussions. As far as ground rules go, we'll be limited to the ratings of the device as far as biasing voltages and currents go. Chip quiescent current is set by programming a current into the I_s terminal. The $-V$ terminal will be the most negative point of the entire circuit. Ab, Ac, Bb and Be will be more positive than $-V$, but less positive than C+ and C-. Normally these pins will be at or close to ground potential. C+ and C- will be close to one another in relative potential, and one of the two will always be more positive than Ab and Bb. O1 and O2 will always be more positive than C+ or C-, whichever is more positive. All of these restrictions may be easily understood if you go back and regard FIGURE 1 in terms of bias requirements.

BIASING THE SWITCH

Now to start off the applications discussion let's develop a basic switching stage using the principles above.

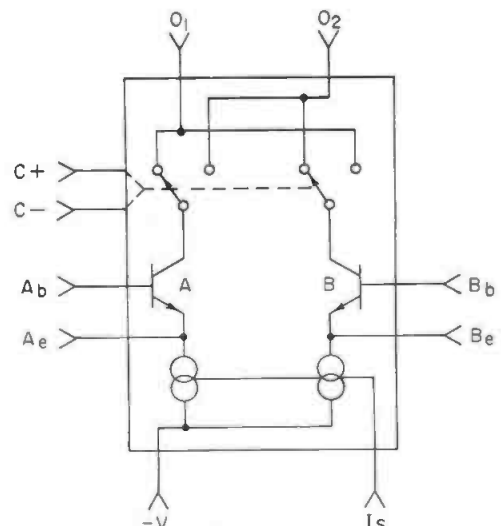
First of all, we select supply voltages to be used. The 1596 will operate very well from the popular dual 15 volt supplies such as we are used to for op-amp systems. So this is a natural selection, and it simplifies the input biasing at Ab and Bb as is shown in FIGURE 4. Next select an operating current. 10 mA is the chip's rated maximum, but we need not go this high. One mA is adequate for audio frequencies and it will also keep the dissipation down. Chip current is set by the $-V$ supply (-15 volts in this case) and the resistor from I_s to ground. At 1 mA the internal network (see FIGURE 1) will drop about 1.2 volts ($0.7 V_{be} + 0.5$ volts across 500 ohms) so the R_{bias} resistor will be

$$R = \frac{15 - 1.2}{1 \text{ mA}} = 13.8K.$$

Using the closest 10 per cent value of 15 k will yield a current of slightly under 1 mA (about 0.9 mA). This current will flow continuously in RL1 and RL2 and for maximum undistorted swing we should select RL1 and RL2 to drop the correct voltage for symmetrical clipping. The upper limit is $+15$ V and the lower limit is approximately equal to the highest level applied to C- or C+. With 5 volt control logic this will be about 3.5 volts. The max p-p output is $15 - 3.5 = 11.5$ volts. DC center of this is

$$\frac{11.5}{2} = 5.75 \text{ volts.}$$

Figure 3. Symbolic representation of a balanced modulator digitally programmable switch (dps).



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One of the most compelling reasons for buying a Revox is the sounds it doesn't make.

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Listening to tapes on the new Revox/Dolby B is a revelatory experience. Tape hiss is virtually non-existent. The music seems to emerge from a background of velvety silence. And at 3-3/4 i.p.s. the absence of extraneous noise is truly startling.

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

Revox delivers what all the rest only promise.



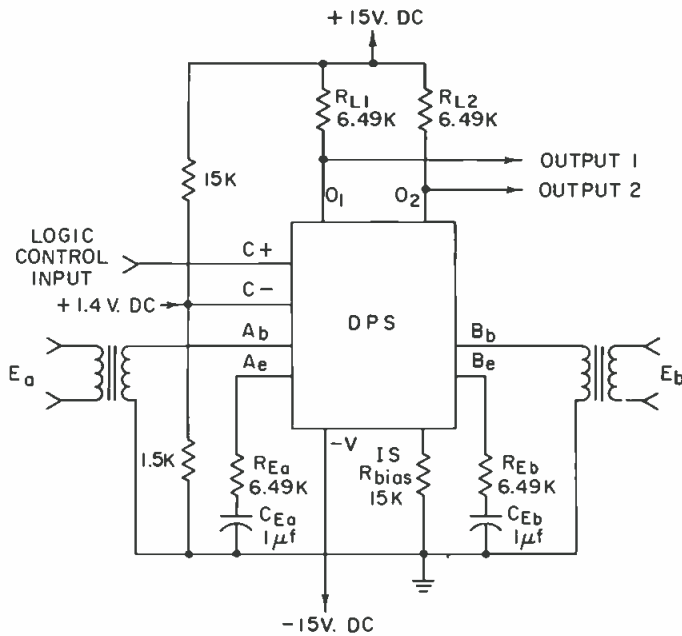


Figure 4. The complete circuit described in the text.

So R_{L1} and R_{L2} should drop 5.75 volts at 0.9 mA this makes their value

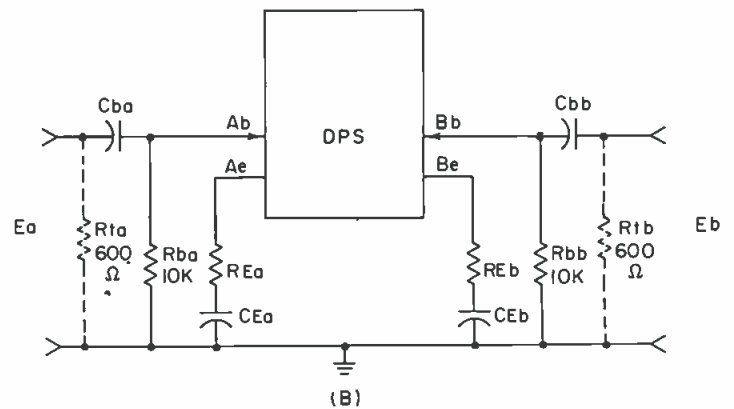
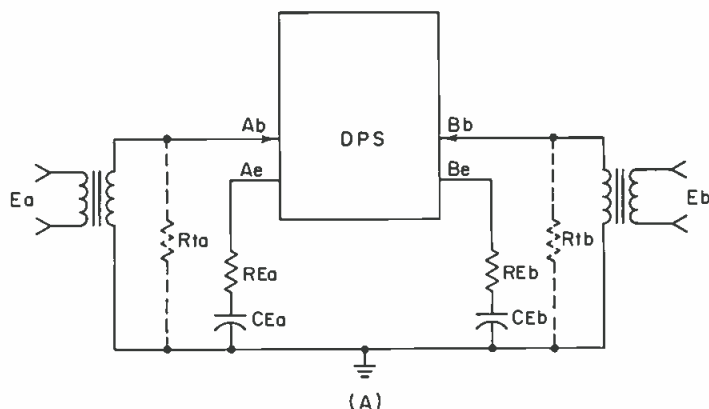
$$R = \frac{5.75 \text{ v}}{0.9 \text{ mA}} = 6.4 \text{ k.}$$

This is not a standard value, but the 1 per cent value of 6.49 k is close and is recommended for gain stability.

So now we have set the output dynamic range by defining the operating current and selecting R_{L1} and R_{L2} . The gain of the A or B channel in their respective *on* states is determined by the ratio of R_{L1}/R_E where R_E is either R_{Ea} or R_{Eb} as the case may be. Thus for a unity gain $R_{L1} = R_E$. This is the most simple mode of operation, and may be realized with the values as shown in FIGURE 4. Lower 3 dB rolloff point will be where the reactance of $C_{Ea} = R_{Ea}$; the values shown give a corner of about 20 Hz.

Switching between the channels is accomplished by the signal applied to C+ in conjunction with the 1.4 volt d.c. bias on C-. This bias is selected to be compatible with 5 volt TTL logic so a *one* level (higher than 1.4 volts) selects Ch A at O1 and a *zero* level (lower than 1.4 volts) selects Ch B at O1. This is in accordance with the control sense TABLE 1.

Figure 5. (A) A common emitter signal input bridging, transformer coupled; (B) the same, rc coupled.



COMMON EMITTER INPUTS

FIGURE 5 shows two input bias options which can be used with the common emitter mode. Since the input impedance of this mode is high ($\beta \times R_E$) it is a natural one for bridging applications. The variations most easy to implement is the transformer coupled version of 5A. 5B is an rc coupled variation. Either of these may be operated with a termination resistor such as R_{ta} or R_{tb} in shunt if this is desired.

The common emitter stage is very familiar to us from its usage in discrete transistor circuitry and the same principles apply here. The stage is an inverting one, and it has a relatively high input impedance. Voltage gain is basically the ratio of R_L to R_E , and you may raise gain by lowering R_E , or lower gain by raising R_E . In both cases R_L remains constant. The stage has a limited input dynamic range because of the biasing restrictions of the C+ and C- circuit nodes. This is because the logic potentials applied to these points necessitate signal swings at Ab or Bb lower than about +1.5 volts to preserve low distortion operation and good signal isolation.

COMMON BASE INPUTS

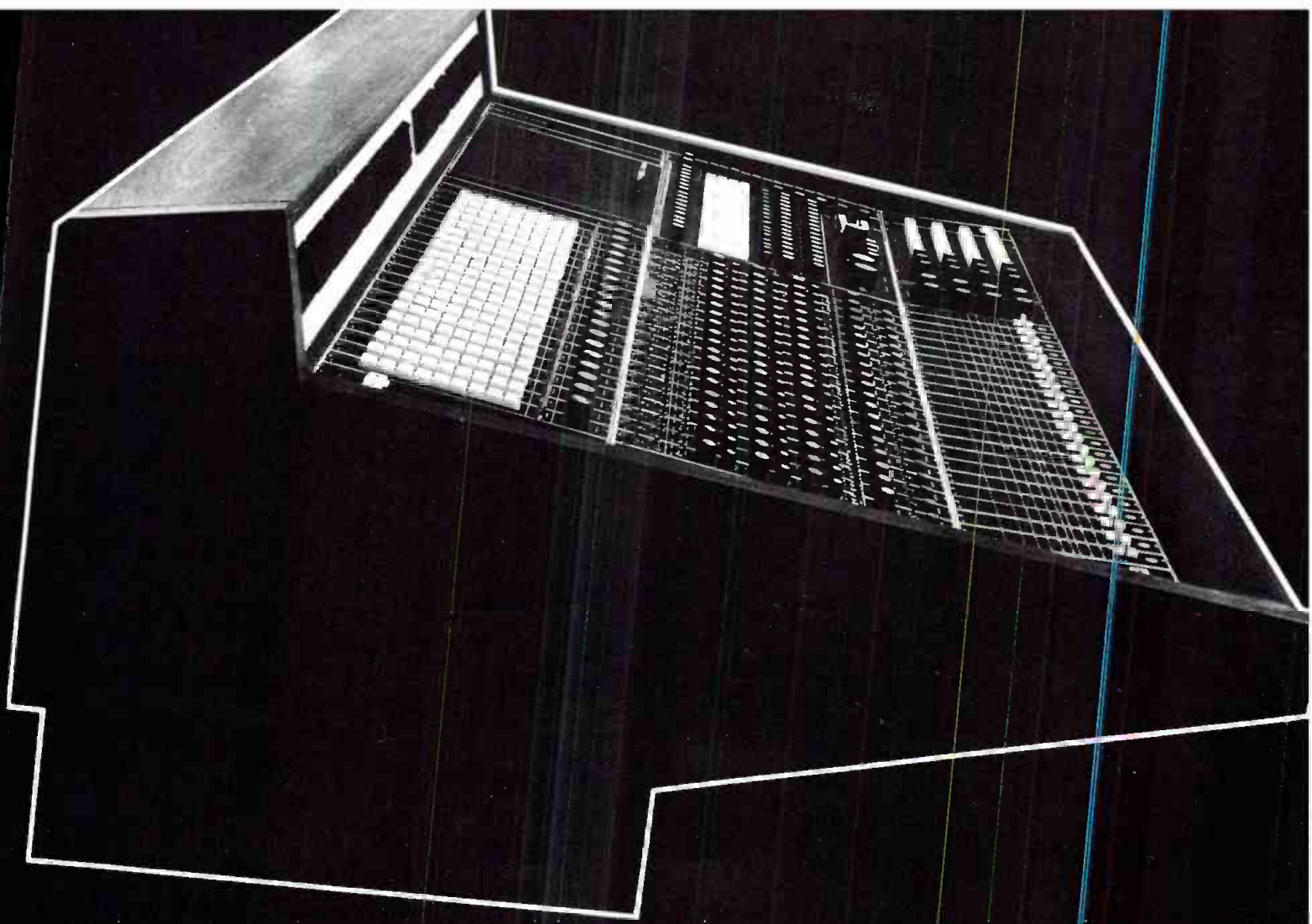
The common base input is implemented by grounding Ae and Be through series input resistors R_{Ea} and R_{Eb} . This type of stage has a low impedance input, and does not invert the signal phase. The input impedance is essentially the value of the resistor selected for R_E , since in most cases this resistor will be large compared to the internal emitter impedance which is

$$\frac{26}{I_E \text{ mA}}$$

For unity gain operation this stage can be termed *bridging* if impedances on the order of 5 k or greater are a sufficiently light load for a signal line.

Options of operation are available in this configuration also, as shown in FIGURE 6. The simplest would be a transformer input such as 6(A). Note that this must be rc coupled to Ae and Be to prevent shorting the 0.7 volt V_{be} . This type of input stage may also be simultaneously used for a summing stage by taking advantage of the naturally low Z_{in} of a transistor junction. In 6(B) a number of Ch A signals may be simultaneously summed and then be switched as a single composite signal. As with op-amp summers, this has the advantage of high level (and good s/n) summing and low cross coupling.

The dynamic range of the common base input stage may be tailored to whatever input level is available by selecting R_E to scale the input current appropriately. The



n e w: SPECTRA SONICS announces an all new audio control console — now in full production. The Model 1020-8/16 offers the ultimate in electronic performance and functional capability, and is available for shipment to your studio today. Among the completely new features of this 20 input — 8/16 output console, are 3 range equalizers with 15 separate frequencies, and an integral 16 channel monitor console that includes echo facilities. A detailed brochure of the advanced functions and performance is available upon request.

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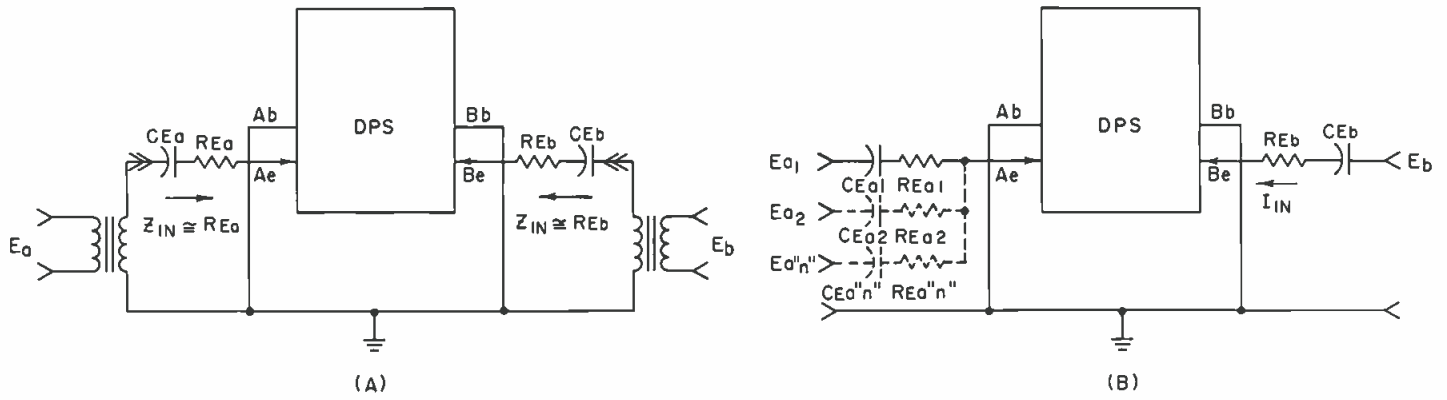


Figure 6. (A) A common base signal input transformer coupled and (B) rc coupled, A channel with mixing option.

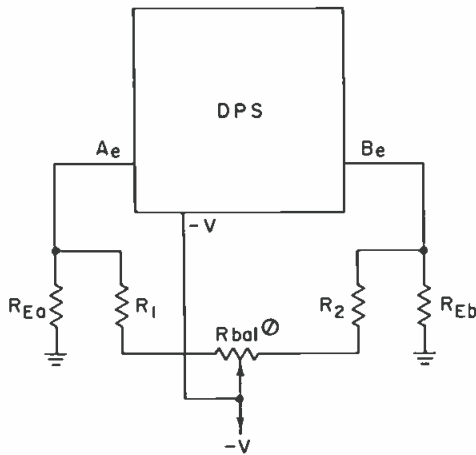
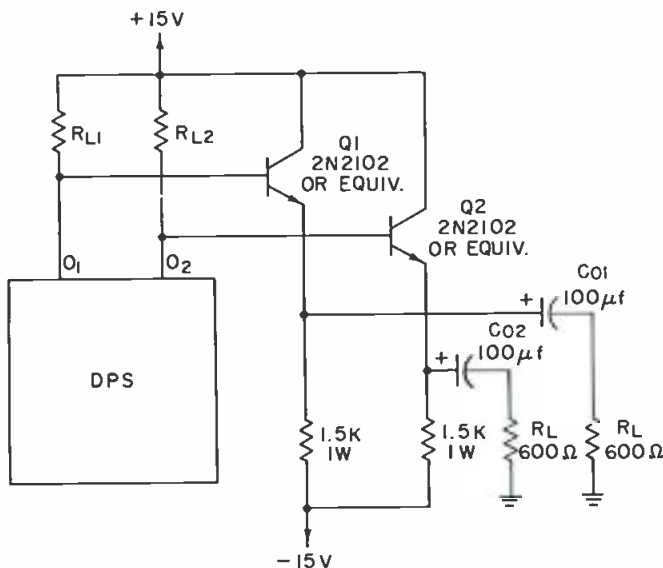


Figure 7. A thump null circuit, applicable to either CE or CB input operation. Note: Let d.c. in R1-Rbal and R2-Rbal equal 10 per cent of Is. Adjust Rbal for zero thump in output.

Figure 8. The output interface, a.c. coupled.



stage of figure four for instance with an I_{in} of 1 mA and R_E of 6.4 k would handle input levels of 6.4 volts p-p. Larger voltages are handled easily by raising R_E to keep $I_{in} < I_E$ where I_E is the d.c. current in the A and B channels. In this manner this switching stage can be set up to handle +20 dBm line levels with no problems whatsoever.

SWITCHING TRANSIENT SUPPRESSION

One tremendous benefit of the balanced modulator switching mechanism is its natural suppression of control switching transients. This is brought about by the usage of monolithically matched current sources for generating the bias current of the amplification channels. In FIGURE 1, these current sources are Q7 and Q8, externally programmable by I_s . Typical monolithic accuracy provides a matching of 1 to 2 per cent of full scale; that is, if I_s is nominally 1.00 mA, the match will be within 10 or 20 μ A. Using the device "as is" will result in a switching transient of this order when switching from Ch A to Ch B or *vice versa*. For applications where this degree of transient suppression is adequate, utilization of the device need not be complicated further. However for optimum transient suppression and reliable guarantee of channel bias current matching the device should be externally nulled.

A simple technique to provide a current null is a differential bleeder network such as R1-R2-Rbal of FIGURE 7. The network provides additional d.c. paths from Ae and Be to negative supply, allowing the total emitter currents of Q5 and Q6 to be precisely matched by adjustment of Rbal. The technique works for any input configuration.

OUTPUT SIGNAL FROM THE SWITCH

Since the signal output at either O1 or O2 is of relatively high impedance, being equal to the value of RL1 or RL2, it should be buffered to prevent loss of gain and/or gain errors due to loading effects. The most simple and direct method is to use a class A emitter follower such as Q1 or Q2 in FIGURE 8. These are then a.c. coupled through Co1 and Co2 into the external 600-ohm loads.

For a dual output circuit using both O1 and O2, two buffers will be required as is shown in the figure. Many applications however will require only one output, either O1 or O2. In this case only a single buffer need be used, and the unused opposite output can be connected directly to +V.

Thus far we have discussed the basic concept of the digitally programmable switch and its basic input/output considerations. However, this is only the beginning. In future installments we'll go into practical circuit applications of the device and show how it can be used to solve problems both old and new through innovative marriage of audio signal handling and digital control. ■

When you buy MCI's new JH-416 mixing console—priced at a phenomenal \$19,500 for the 16-track model—you'll have enough money left over to buy our JH-16 recorder (\$16,500) ... and still be paying less than what you'd expect for a comparable mixing console alone. Expandable to 24 tracks (total: \$25,100), the JH-416

makes possible a complete studio package of heavy hardware at unheard-of savings. And to save even *more*, consider starting out with an 8-track version of the JH-416 (\$13,900), which you can build on later. We'll match our mixer—its specifications and functions—with any competitive model, even the \$40,000-and-up jobs. For example, each input module

of the JH-416 features: illuminated straight-line fader · four-knob equalizer · individual track / quad monitor assign with pan and level control · two cue feeds · two echo feeds · solo/pre-view · 16-track, plus direct bus assignment · overdub switching · sub master on each bus · plus much, much more for much, much less.

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ALLISON RESEARCH

Introduces the Voltage Controlled KEEL BOAT

Once upon a time, in the industrial forest, there lived a boy named Paul, a boy named Wayne, a boy named Randy and a girl named Allison. They were all searching for something. What they were looking for can't be held in the hand because it is a feeling about life and doing what makes one happy... people to love, a kind of work that is so natural that you sometimes forget it is work, and other stuff like that.

In the year 1963, Paul found Allison, in 1970 Wayne found Paul and Allison and in 1972 Randy found Wayne and Paul and Allison. Wayne wanted to be a flag pole, Randy wanted to be an Edsel repairman, Paul wanted to be a keel boat operator in the Los Angeles River, and Allison wanted to someday be the world's oldest living drum majorette. With aspirations like these, there was but one thing to do... start an electronics company.

First, they needed a name. "Let's call it Paul Research," said Paul. "Randy Research," said Randy. "Wayne Research," said Wayne. Then from a distance came a voice as dainty as the cry of a wounded bull moose, "We will call it Allison Research or I'll cry and if crying doesn't work, I'll try something else." Knowing full well that they didn't stand a chance and that she could out nag the finest naggers in the world.... they agreed to her suggestion.

Now they had a name, next a product was necessary. Paul said, "I'll invent a KEPEX, it will expand my keel boat operation," Wayne said, "I'll build a GAIN BRAIN, it will give me limitless flag pole ability." Randy said "I'll build a voltage controlled amplifier (VCA-1) and install one in every Edsel that I repair." Allison said, "Has anyone seen my baton?"

With people to love, a company, a company name and products to sell, everyone at the enchanted Allison Research workshop was happy. The elves create products that they feel are needed in recording land and hope the people on the planet can groove on them. (By the way, we are looking for our new distributor to be opening on Mars soon, it will be called SPACED OUT ELECTRONICS)

Remember children, Allison Research is not interested in the hard sell or scratching and kicking our way to the top. However, if you happen to be in need of electronic audio equipment, run do not walk to our nearest distributor and ask for our products by name. KEPEX, GAIN BRAIN, VCA-1 and VCA-1PC. Remember, we buy in volume and pass the saving on to you.



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Circle 30 on Reader Service Card

A Stereo Console You Can Build

If you have been afraid up to now to build a stereo console to put in that auxiliary control room or, carry to fancier field trips, read this.

DO YOU HAVE YOUR new console all picked out? What does it have to do? Bring all those inputs together, permit you to cue them, and send them out? And you don't have a thousand dollars or more to spend?

Here's a dandy little unit that can mix up to ten input signals together like a recording studio or a radio station; can cue up a program source without disturbing the one that's playing; can equalize both the mixer and the monitor systems separately and independently; has an independent and versatile stereo headphone system, and much more. There are microphone preamplifiers built in, pan pots for special effects, vu-type meters for visual level indication and several unique features. Let's talk about the console in terms of the various systems of which it is composed.

There are five basic systems: the mixer; the selector; the cue system; the monitor system; the headphone system. FIGURE 1 shows the interrelationships among these systems. Although the prototype described here was designed and constructed for a specific installation and purpose it illustrates only one form the console might take. By tailoring the basic recipe of each system to your own purposes you can create an ultimate audio control center.

THE MIXER.

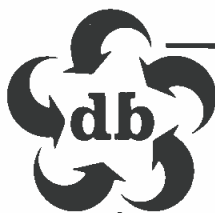
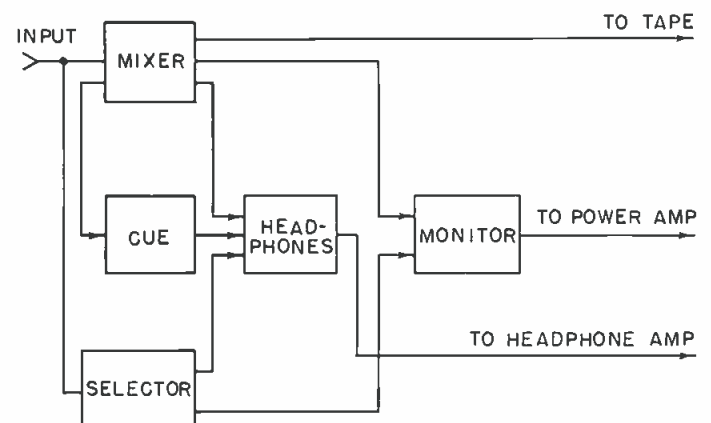
Our prototype's mixer system has four stereo inputs and two mono inputs. Each stereo input has a ganged dual fader and a stereo-mono switch. Flipping this switch to mono joins the left and right sides of a stereo input together. Each mono input has a pan pot, making it possible

to place a mono input signal virtually anywhere between extreme left and right, or to make the sound appear to move back and forth across the speakers. From the input faders the signals pass through separate left and right mixing networks and sub-master controls to a ganged stereo master control, and then into the mixer's amplifiers. Stereo equalizers (bass and treble controls) on the front panel influence *only* the mixer's program.

Some of the mixer's faders have more than one function. While stereo faders 1 through 3 are fed only by their respective RCA jacks on the rear panel, stereo fader 4 can be fed either from its rear panel jacks or from auxiliary front panel jacks, the choice being made by a switch between the latter. Mono faders 5 and 6, like fader 4, can (individually) be fed from either of two sets of inputs, both on the front panel. One set, the two miniature phone jacks, accommodate microphones and are connected through trimmer pots to two mic preamplifiers built into the console. The other set, the RCA jacks on the front marked 5 and 6, accept the usual higher-level signals. The switch between these RCA jacks makes the choice.

This dual-purpose design allows a convenient means of making temporary connections to the console without dragging it out from the wall and fumbling blindly about in a maze of cables. Suppose, for example, that a friend brings over his stereo cassette machine and either wishes to hear it through your audio system or wants to dub off something onto one of your tape machines. Simple. Just plug the cassette machine into fader 4's front auxiliary jacks, flip the switch and you're in business. The same holds true for mono faders 5 and 6.

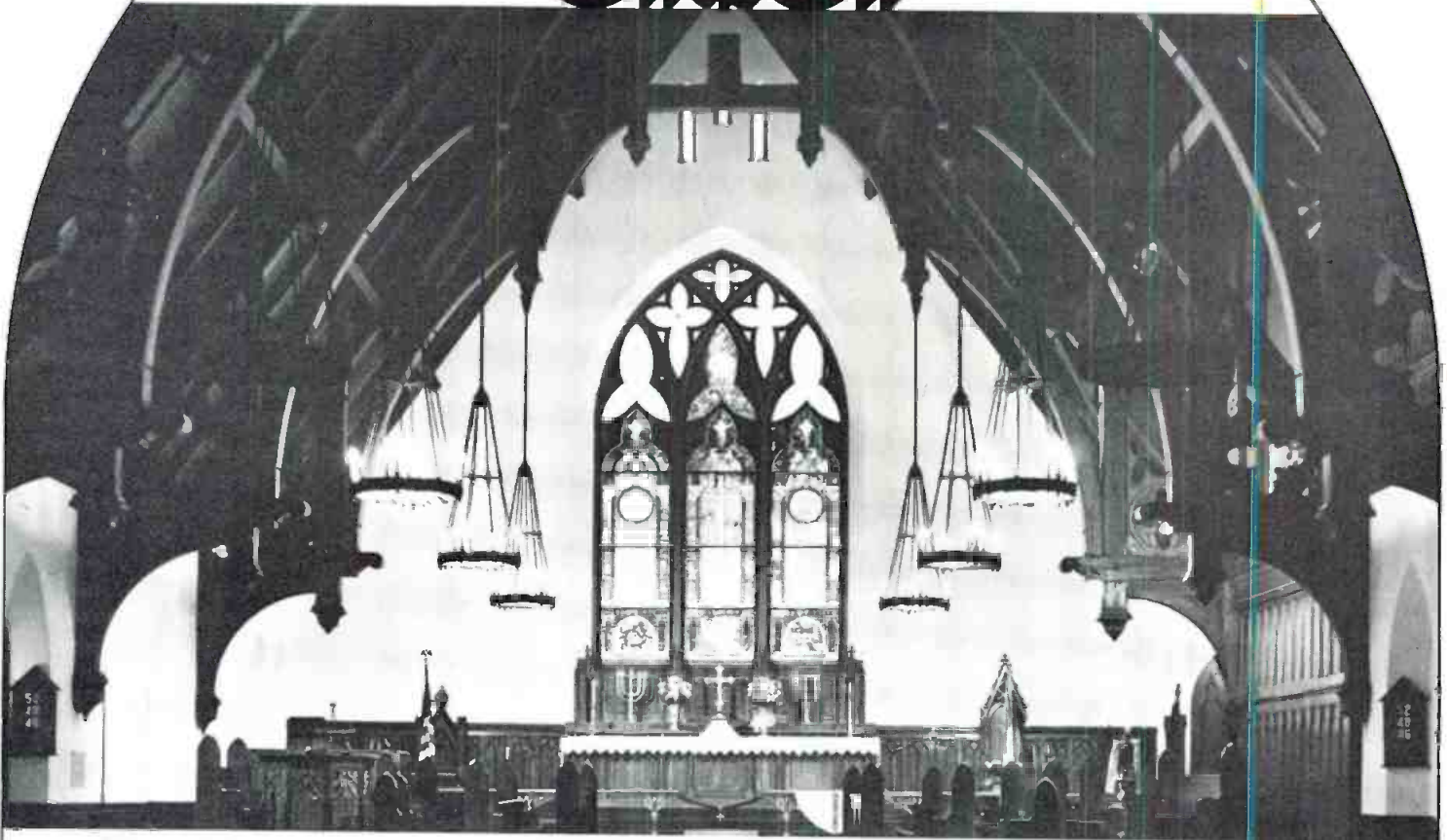
Figure 1. The Interrelationships of the systems in the console.



db TeleSessions

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HERESY IN THE CHURCH



Most of the congregation of Holy Cross Episcopal Church in Shreveport, Louisiana, thought the Rector had just started speaking louder. At the pulpit, where there was a microphone, his voice sounded exactly the same as it did at the altar, where there was no microphone. Just louder. There was no difference in voice quality. When told that the new P.A. system was installed, some members were disappointed. It "didn't sound like a P.A. system."

What they did not know was that a new "Heresy" had been introduced into the church. Mounted on a beam thirty feet above the altar, it works unobtrusively, reinforcing the spoken word. And it does this with such naturalness that no one realizes it is there. Yet even the people on the back row understand clearly everything that is said.

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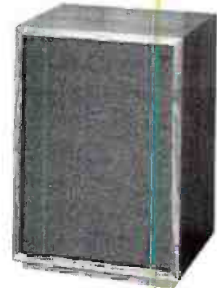
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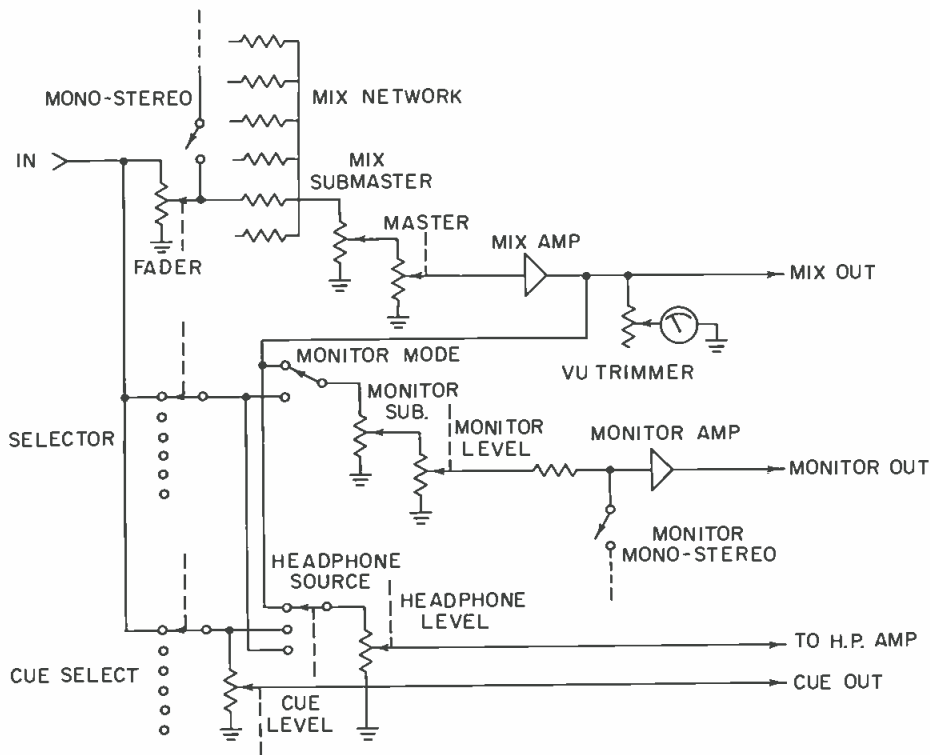


Figure 2. The basic console logic. One channel is shown. The mix resistors are 220 k and all pots are 250 k.

Bridged across the mixer's stereo outputs are two v-u-type meters which give a visual indication of signal levels.

THE SELECTOR.

The mixer's purpose is mixing input signals together. The selector, then, is for simply listening to one at a time or comparing the mixer's output to a tape being made of it. The inputs to the selector switch itself are taken from the four stereo faders (selector position 1 equals fader 1, etc.), the tuner jacks on the rear panel and the auxiliary RCA jacks for fader 4. In other words:

- Selector position 1 equals fader 1
- Selector position 2 equals fader 2
- Selector position 3 equals fader 3
- Selector position 4 equals fader 4
- Selector position 5 equals Tuner
- Selector position 6 equals Front Aux. Jacks for fader 4

Remember, however, that these assignments can be anything you want them to be, and that these shown here are for a specific installation.

THE CUE SYSTEM.

The mixer is uniquely useful for many things, among these the production of custom music programs on tape. With the mixer it's easy to create segues. To accomplish this it is necessary to locate the starting note of the second song before the first song comes to an end and do this without allowing the sounds of this search to reach the tape. This is the function of the cue system, to listen to whatever is connected to a particular fader without turning that fader up. The system consists of a six-position rotary switch which connects the headphone systems to any desired set of input connectors. The cue system, like the headphone system, is stereo. In the prototype's cue system there is an additional potentiometer through which the output of the rotary cue selector is delivered to special RCA jacks on the rear panel. This is for special effects, such as external reverberation (echo).

THE MONITOR SYSTEM.

Monitor refers to what is delivered to the power amplifiers and speakers. The monitor system consists of the monitor mode switch, the monitor level controls and the monitor equalizers. The monitor mode switch connects the system to either the mixer or the selector. To control the levels to the power amplifiers there are two single sub-controls on the rear panel and a ganged stereo level control on the front. The individual left and right controls on the rear allow setting volume levels to suit an uneven room or uneven power amplifiers, and the front control is used for routine over-all level changes. The equalizers (bass and treble) for the monitor system are on the rear panel, intended to be set and left alone. These equalizers permit matching the monitor system to any room characteristics or individual taste.

THE HEADPHONE SYSTEM.

Actually another stereo monitor system, without equalizers, the headphone system is much more than a couple of phone jacks glued onto last year's front panel. There is a separate stereo headphone level control, a headphone source selector, and two stereo jacks on the front. The selector gives the system the ability to listen to the mixer, the cue system or the selector in the phones. Although the prototype utilized external power amplifiers to drive the headphones suitable amplifiers could easily be built right in. More about this a little further on.

It is quite possible and simple to have one program going through the mixer to a tape recorder, another through the selector to the speakers and a third in the headphone system via the cue system. Talk about versatility!

MISCELLANEOUS FEATURES.

In the lower right-hand corner of the front panel are two RCA jacks marked *mix*. These are parallel with the jacks on the rear called *to tape 1*, and *to tape 2*. All are fed by the outputs of the mixer. The pair on the front perform

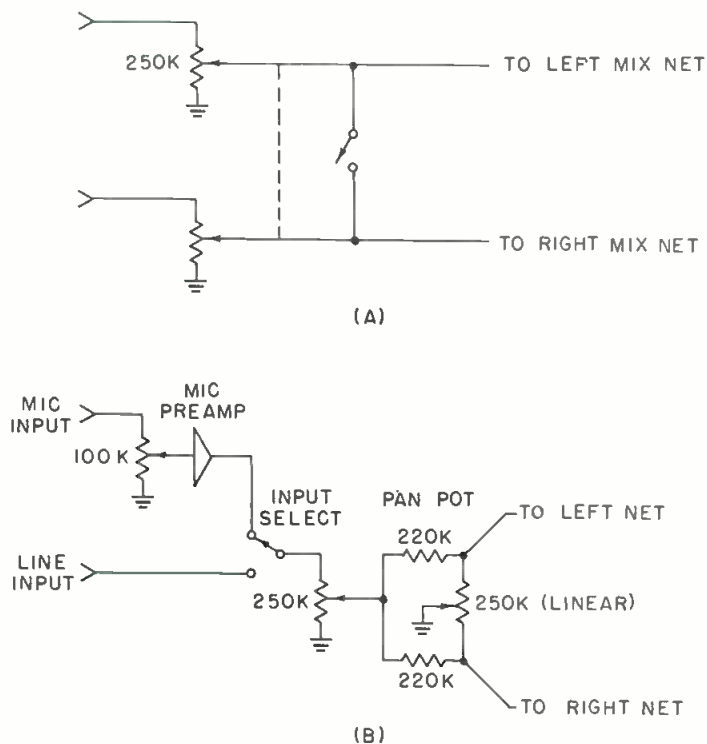


Figure 3. Details of a typical stereo input (A) and a mono input (B).

a very convenient service, rarely found on commercial preamps. Suppose a friend brings over his tape recorder to make a copy of one of your custom music programs. Instead of dragging everything out from the wall to connect it to your system merely run cables from the mix jacks on the front of the console to the line inputs of your friend's machine. Simple. Also on the rear panel are two a.c. receptacles, both controlled by the console's on-off switch.

CONSTRUCTION.

The prototype, again, illustrates but one form the console could take. Built into a standard and readily available aluminum case, it is more of an example of how to make new uses of existing circuitry rather than an exercise in circuit design. The amplifiers are all contained on four printed circuit boards that formed the heart of a unit previously featured in *Popular Electronics* (*Build the FET Preamp*, by Dan Meyer, April 1969). In all, then, there are four low-level preamplifiers and four high-level preamplifiers. Two of the low-level preamps serve as the mic preamps for live recordings. The other two are not used in the prototype, but could be RIAA magnetic phono preamps, NAB tape head preamps, or anything the builder can think of. Two of the high-level preamps are the mixer amplifiers and the other two function as the monitor amplifiers. The associated tone controls become the mixer and monitor equalizers.

In putting the console together there are a few standard construction practices that should be observed. Neatness will pay off, even if it takes a little longer. Always use shielded cable for all low-level connections such as microphone inputs and inputs to the mixer amplifiers. Position the power supply transformer as far from low-level lines as possible to minimize the possibility of hum. Plan out ahead of time as much wiring as possible to eliminate rats-nests and tangles. Use of color-coded wires makes things easier and neater, too.

Begin by performing all machine work on the aluminum.

First, taking care to prevent scratching the panel surfaces. Next, install all connectors and switching and potentiometers. You will find it easy to wire these if this is done before proceeding with construction. Now finish assembly by installing the prewired amplifiers and the power supply.

CONNECTIONS.

Most of the connections are normally made at the rear panel. Left to right across the rear they are:

Cue—auxiliary outputs from cue level control.

Monitor—outputs of monitor system, to be connected to power amps.

To Tape 1—outputs of the mixer.

To Tape 2—outputs of the mixer.

Headphone Amps—connect to inputs of external headphone amplifiers.

Tuner—connects tuner to position 5 of selector.

Fr Tape 2—input to fader 4

Fr Tape 1—input to fader 3

Phono 2—input to fader 2 (external RIAA pre-amp).

Phono 1—input to fader 1 (external RIAA pre-amp).

L&R Phone Jacks—these connect the outputs of the external headphone amps to the front headphone jacks.

ADJUSTING AND FIRING IT UP.

Very few adjustments need to be made, and the only equipment necessary for precision adjustment is a signal generator and an a.c. vtvm, or some other form of measurement. Feed a mid-range frequency signal to one of the stereo faders and flip the switch to mono. Set both submasters and master controls to maximum and open the fader until a full-scale reading is obtained on the meters of the console. With the a.c. vtvm check to see that the output level of the right mixer channel matches that of the left. Use the output trimmers on the pc boards to make any adjustments. Now adjust the meter trimmers so that the two meters read the same as well. Now, once the meters of your tape recorder are adjusted to follow those of the console, you need not look at them again. Everything you need to watch is right in front of you on the front panel of the console.

VARIATIONS.

As mentioned earlier it would be easy to build the headphone amplifiers into the console cabinet itself. The *Li'l Tiger*, also previously featured in *Popular Electronics*, makes an ideal amplifier choice. It is a clean, stable circuit and brings with it an ideal power supply for the entire console.

A patchboard would be another very professional improvement. Consisting of jacks representing every useful input and output connection within the console, the patchboard allows the console to virtually be re-wired to perform any audio task imaginable. The board can take the form of individual miniature phone jacks or one of the vector computer-type units can be used.

More elaborate equalization can be employed, being inserted somewhere in the mixing circuit, or even in the monitor circuit. The graphic stereo equalizer described in *Popular Electronics* (*Assemble A Frequency Equalizer*, by George Meyerle, October 1970.) is an excellent example of maximum performance with minimum expense.

Other add-on goodies could include speech compressors, built-in RIAA magnetic phono preamps, an alignment oscillator, echo adapters—the list is endless. Experimentation and practice will yield countless hours of enjoyment on a highly professional level. ■

db Visits— Westlake Audio

NOT TOO LONG AGO, we journeyed out to sunny southern California taking our cameras with us. Westlake Audio had invited us to the gala party that marked the commencement of their operation at 6311 Wilshire Boulevard, right in Los Angeles.

Westlake is a complex operation. They are a distributor of professional audio products, a manufacturer of speaker systems and other items, and a complete turnkey operation that can take you from the ground up to a finished studio.

Most of the equipment they represent is on display at their offices. The equipment ranges from tape machines by MCI, 3M and Studer to consoles by Automated Processes, Flickinger, MCI, Oliver, Quad-Eight, and UREI. Monitor speakers sold include JBL systems and their own units (which are built with JBL drivers).

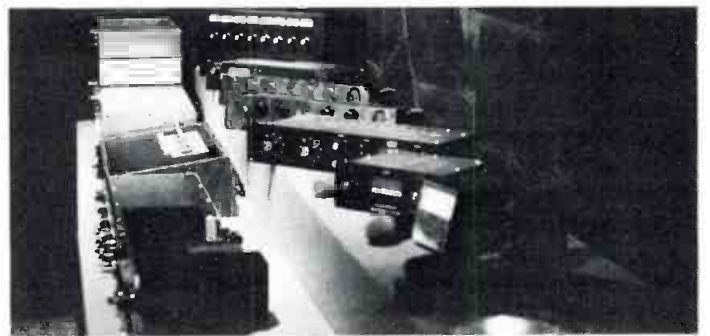
Westlake can also provide custom acoustical design and fabrication on equipment ranging from drum cages to complete studios.

A feature of the offices is a room set up to appear exactly as a control room. At the time we were there, a Flickinger console was installed. Inside the room, the total effect is exactly the feel of a control room, and we saw happy potential customers experimenting away with console and tape equipment.

Westlake is a nice place to visit.



A goodly crowd turned out for the gala opening party that Westlake threw.



Here's a portion of the equipment as it is displayed at Westlake. Other tables, and semi-booths contain microphones to consoles.



The ornate entrance to Westlake Audio's Wilshire Boulevard place.



A fish-eye lens view of Westlake's simulated control room. The Flickinger console is in operation. On the wall in front can be seen Westlake Audio Monitor speakers.

(continued from page 16)

tory), *Rainy Days and Sundays Always Bring Me Down* (to Hydroelectric Plant #3) and of course *Carry On* (the high productivity).

It is indeed true what they say about Oriental microphones—the farther away you put them, the more separation you get! As a consequence, studios here are very large, so that microphones can be placed at a great distance from the musicians.

Since multi-track tape recorders are looked upon as a tool of Yankee imperialists and their running dogs, they are unpopular here. Most recording is done on stereo machines, with one track used for all the music, and the other reserved for the relevant recorded thoughts of the Chairman. In the unlikely event that he has had no relevant thoughts, the track is left blank, out of respect.

A unique version of a time-delay machine is used on all sessions. Signals fed into the unit come out ahead of the original signal, rather than after it. Because of this feature, the signal may be studied by a Revolutionary Comparator, and if it is not judged ideologically compatible, the machine compresses the offending signal so that it is effectively masked by those sounds that are more politically suitable for the masses. Due to this technological breakthrough, song consorship is not the problem that it is back in the states. There is an (as yet) unconfirmed rumor that local officials are considering sending a machine to Washington, on memo.

In the control room, I was surprised to find that the engineers all preferred monitor levels far louder than anything I had experienced in our American rock studios. Noting my apparent discomfort, my hosts offered me a gift set of needles. During a break, they explained that by inserting the needles through the eardrums, many people had found relief from the painful sound levels. Since I had brought along no gifts with which to reciprocate, I declined the offer, and made an excuse to leave.

I arrived back in town just as the official party was making its way to the local Chinese restaurant. (Chinese restaurants seem to be very popular here, too.) Since the visit had not yet received extensive coverage in the local press, many citizens had the mistaken notion that the Americans had come here seeking permanent sanctuary. I was unsuccessful in convincing the people around me that we would all be leaving shortly, and as the dignitaries passed by, I overheard one local citizen mutter, "well, there goes the neighborhood."

Shortly before my departure, I had the good fortune to meet one of the local vip's. What with the language difficulties, I didn't get his full name, but apparently the English equivalent was Joseph N. Lee, or Lai. Trying to effect a casual atmosphere most of the Americans called him just plain old Joe.

Anyway, Joe seemed pleased with the visit and told me that as a gesture of good will, he was authorizing one of the local factories to begin immediate production of "Re-elect Richard" buttons for export to the States. In return he had apparently been promised exclusive Asian reprint rights for the Time-Life biography of Howard Hughes. He declined comment on the rumor that his government had been invited to purchase a substantial share of I.T.T. stocks at a favorable price.

While abroad, I contacted the Albanian Embassy to see if I could arrange a visit to that country's recording studios too. However, no one at the Embassy had heard of the United States, and so I was unable to convince them of the validity of my request. Consequently, a report on that country's recording studios will have to be indefinitely postponed. ■

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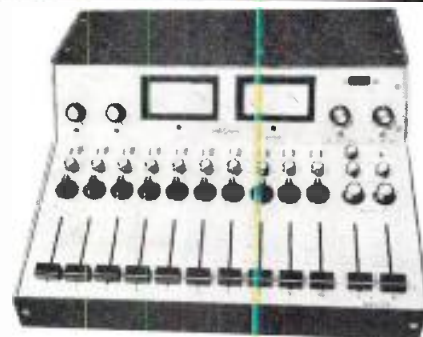
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PEOPLE, PLACES, HAPPENINGS

● The studios of **International Telecom, Incorporated** of Cockeysville, Md. were recently the scene of the charter meeting of the **Baltimore Audio Engineering Society**, a group formed to serve the interests and needs of audio professionals in the area. This is the newest group of the AES. A meeting is set for April 19th at 7:30 p.m. at the studio of **Flite III Recording**, 1130 East Cold Spring Lane. **Neil Muncy**, chairman of the Washington, D.C. AES chapter will be the speaker. The meeting will cover the scope, organization, and background of the AES. For further information on this chapter, contact **Walter Jung**, 1946 Pleasantville Road, Forest Hill, Md. 21050. His phone is (301) 877-1712.

● **RCA Records** has just announced that they will release discrete four-channel disc recordings beginning in May with an accelerated release program scheduled for the fall of this year. The system used is the one originated by **JVC**. **JVC** and **Panasonic** will be making the home hardware for the system. In the announcement by **Rocco Laginestra**, president of RCA Records, it was mentioned that the price of the new discs would be the same as present lp records. RCA claims to have a new material for the pressing of records that resists deterioration of the high-frequency signal (45 kHz) used as a carrier. It was noted that RCA stands ready to assist other record manufacturers in the new technology.

● **Dolby Laboratories** has announced their entry into the film noise reduction area. A new unit, the model 364 has been made available to permit projection systems to be converted to Dolby-A decoding of film tracks that are encoded by standard materials. **Rank Film Equipment** of Brentford, England has been appointed distributors of the 364 to theater exhibitors throughout the world except for the U.S. In this country, final plans for distribution were not announced.



● A new, 10,000 foot facility is now in operation by **Schafer Electronics Corp.** The facility in Santa Barbara Research Park, Goleta, California will be used for design and manufacturing, as well as engineering of the Schafer line of broadcast automation products.

● **Jensen Sound Laboratories** announces the resignation of **Karl Kramer**, commercial products manager. Mr. Kramer is well-known in the audio industry and had been with Jensen since 1935. He plans to continue limited activity as a consultant in the field of sound system product design and application.



● **Frank Karlov** has been appointed manager of the electromechanical development department for **Shure Bros., Inc.** Prior to joining Shure, he was manager of electrical engineering products for the **Profexray** division of **Liton Industries**.

● A broad patent covering high-speed in-cassette duplication equipment has been granted to **Infonics, Inc.** **Peter H. Stanton** president of the firm stated that U.S. Patent 3,620,476 contains twelve claims covering high-speed tape duplication onto cassettes loaded with blank tape.

● A number of special engineering courses will be offered by the University of Michigan's College of Engineering. Of interest to audio professionals are courses on **Integrated Circuits**, and **Advanced Electronic Instrumentation for Engineers**. The intensive courses which will be given for one and two week periods this summer will cover a great many engineering fields. For complete information write **The University of Michigan, College of Engineering, Chrysler Center North Campus, Ann Arbor 48105**.

● **JBL** the Los Angeles based manufacturer has established a Canadian distribution center under the name **James B. Lansing Sound Canada Ltd.** The operation will serve as warehouse and shipping center for all Canada. The firm's sales representatives for Canada will be **E. S. Gould Marketing Company Ltd.**



● Two promotions have been announced at **BASF Systems Inc.** **Heinz Kreuels**, formerly audio/video products manager is now that division's marketing manager. **Richard E. Dalessio** is the new product manager. Mr. Kreuels comes to BASF's U.S. offices from the parent company in Ludwigs-hafen, Germany. He has been with BASF for twenty years. Mr. Dalessio was formerly the assistant product manager of the audio/video product group and has been with BASF since 1970.



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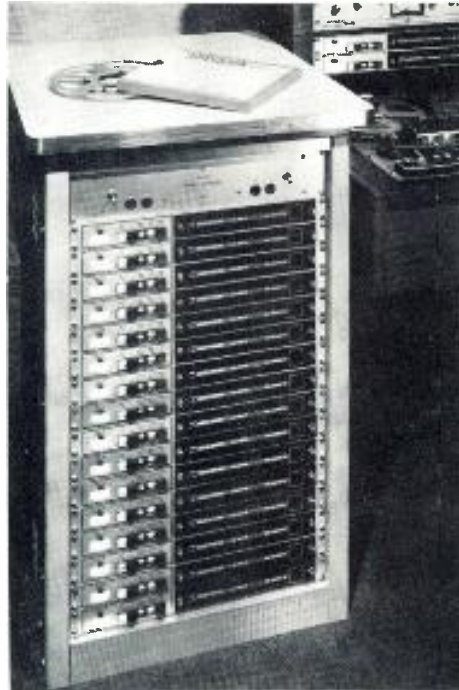
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