Recording Studio Issue

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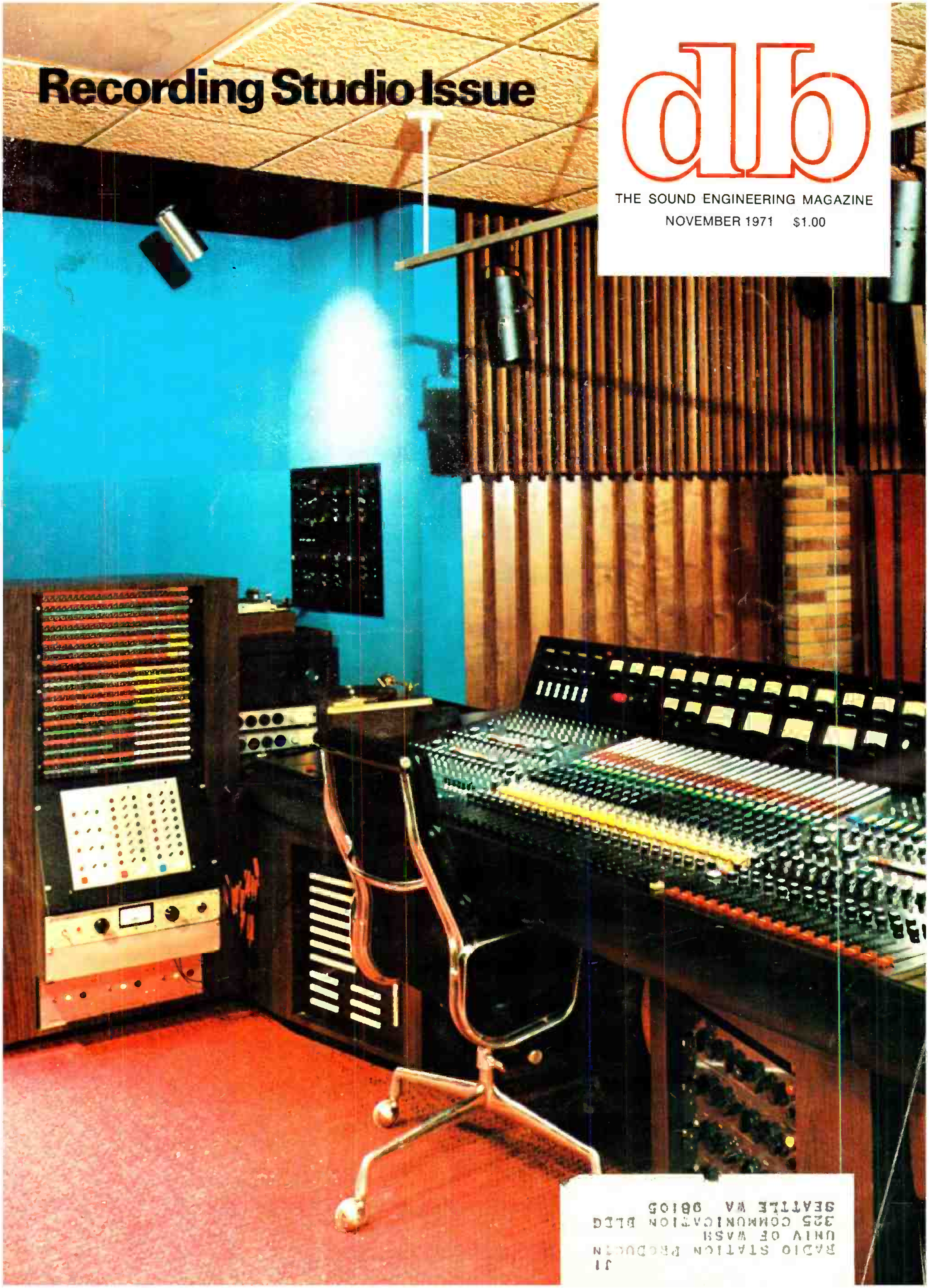
THE SOUND ENGINEERING MAGAZINE

NOVEMBER 1971 $1.00



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COMING NEXT MONTH

• Robert Ehle returns again to our pages witn another article of worth on the subject of electronic music—something every audio engineer wants to know more about. The subject this time—selecting optimum equipment for live performance of electronic music.

Koss Electronics recently moved to enlarged quarters in their home city of Milwaukee. A **db** VISITS story will show how headphones get made and what procedures are used to check each to assure performance as claimed.

Our camera got quite a workout at the most recent Audio Engineering Society exhibition held in New York. The proof sheets indicate that there will be a lot to see in our display of new equipment seen at the show. We even secured some pictures of the shape of some tape machines to come in 1972.

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

ABOUT THE COVER

• The scene is at Ultrasonic Studios in Hempstead, L. I., New York, and we're grateful to owner Bill Stahl for the color shot. A story on Ultrasonic is on page 25 in this issue which has been entirely devoted to the independent recording studio.

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George Alexandrovich

THE AUDIO ENGINEER'S HANDBOOK

Gainshifting in Two-Way Communications (cont.)

● In last month's column we discussed the principle of gain shifting. This time we shall look into the circuits involved. In order to change the gain up or down, two basic circuits are needed: expander and compressor. The nature of a gainshifter in the communication circuits is such that it requires that the expander and the compressor be closely matched not only in the amount of gain change but also dynamically. Dynamic matching means that the rate of change of gain in both circuits shall be the same at all times, in order to achieve highest circuit efficiency, and loudest reproduce levels without acoustical feedback.

With today's technology, it is possible to achieve gain shifting by various means: fet circuits, ldr circuits, variolosser diode circuits, pulse width modulation control circuits, as well as several other less practical approaches. Since most of my experience has been with ldr circuits I shall discuss a system designed around photo-sensitive devices. By merely substituting other variable gain circuits in place of ldr's would not change the principle or operation of the system.

FIGURE 1 shows a basic expander circuit. It consists of a resistive pad having resistor R1 as a series element and R2 in shunt. Both resistors are chosen so that pad represents insertion loss equal to the amount of expansion desired. Without LDR1 in the circuit loss produced by the pad can be 15 dB. From this follows that R1+R2/R2 = 5.6. Solving the equation for R1 gives us R1 = 4.6R2. In the value of R2 include the parallel impedance (or input resistance) of the amplifier or of the circuit that follows. If you select R2 to be let us say 2.2 kohms and the input impedance of the following stage is 100 kohms disregard the effect of the load. In this case, R1 will be 10.12 kohms or for practical purpose 10 kohms. Now we connect the ldr across the R1. When not illuminated, resistance of the cell is in megohm range, when fully illuminated (10-50 ft. candles) resistance drops to 50-100 ohms, depending on the cell. When this happens, ratio of the pad approaches unity and the 15 dB loss is eliminated; gain of the circuit increases by 15 dB and the effect of expansion is produced.

FIGURE 2 is a compressor circuit. The basic idea is the same, except that the pad ratio is kept small (close to unity) when the ldr is effectively out of the circuit. In this case resistor R1 acts as a limiting resistor protecting the amplifier from overload during full compression—and also determines the amount of compression, considering that the ldr goes down in resistance only to 50-100 ohms. In the compressor circuit, R2 comprises the resistance of the load as well. The goal in designing a compressor which should produce 15 dB of compression is to change the pad ratio by a

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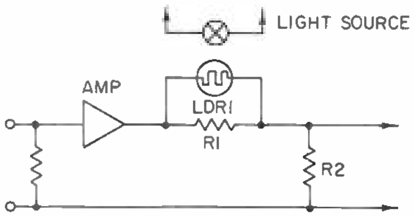


Figure 1. An expander circuit.

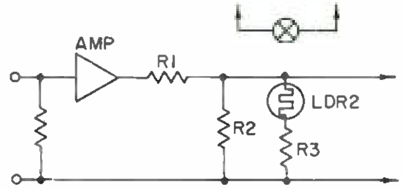


Figure 2. A compressor circuit.

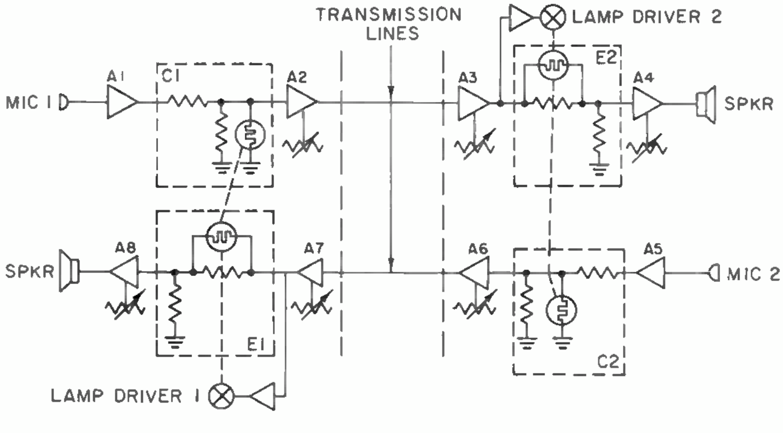
factor of 5.6. Since ldr's vary in their sensitivity and the light sources may produce various degrees of illumination (as a function of light-ldr distance) resistor R3 is introduced to offset variations in sensitivity of the cells. If we make this resistor (R3) 470 ohms, then the lowest shunt resistance we can expect would be R of ldr + R3, or 50 + 470 = 520 ohms. If we select R1 to be 2.2 kohms again then from the calculations performed for the expander, 4.6R2 would represent total resistance of the shunt circuit during full compression. Substituting 520 ohms for the value of R2 will give us 2.39 kohms. Since we have selected 2.2 k for R1 we have to either increase it to 2.4 k or decrease the value of R3 to 420 ohms. These calculations disregard the load impedance of the stage that follows the circuit. If this impedance is very high it *can* be disregarded. If it is small then it should enter into calculations as a part of the shunt. In this case, value of R1 would have to be increased to provide for sufficient amount of compression. Both circuits seem to be fairly simple and easy to make work. But we shouldn't forget that both expander and compressor have to be dynamically balanced. This requires careful selection of the cells and resistor values of the pads. We should also consider the fact that there is photon inertia of the cell which causes slow change in resistance of the cell when illumination is removed—in contrast to fast change when illumination is applied. Matching of both circuits requires some experimental work and juggling of the resistor values.

One more thing about gain switching before we look into the circuit of the complete system. If we substitute relays instead of ldr's the system will also operate, but switching action will be too obvious and harsh. Switching transients will trigger the system and cause a lot of extra work to isolate them. In order to soften the action of the gain-shifting circuits slopes of the expander and compressor should be similar, and preferably not higher than 1:4 and 4:1 respectively.

FIGURE 3 represents a complete two-station system diagram. In last month's column, signal flow in such a system was described. Now is the time to bring up some details for discussion. First—some readers may wonder why A3 is needed. The explanation is that a good number of lines present quite a substantial loss to a signal (sometimes as high as 40 dB), especially equalized lines obtained from the telephone company. Also, isolation of the circuit by an amplifier is to our advantage. Lamp driver 1 affects the operation of expander 1 and compressor 1 while driver 2 affects expander 2 and compressor 2.

Let us analyze the action of the gain shifter circuits. As the signal enters mic 1 it travels toward speaker 2. Before being amplified by power amp A4, it triggers driver 2 which sets both expander 2 and compressor 2 into operation. Gain of the mic 1 speaker 2 line increases by 15 dB while mic 2-speaker 1 gain drops by the same amount. Acoustical pickup

Figure 3. A complete two-station system.



of the reproduced signal by mic 2 is fed into the return leg of the system, but because of the compressor action, it is 15 dB lower and not capable to trigger driver 1 into action.

Let us assume that the threshold of the lamp driver circuits is set so that signal can increase another 15 dB into mic 1 before it will be strong enough in the return leg to trigger driver 1. But suppose the signal triggers driver 1, then compressor 1 will start to also operate and reduce the mic 1 level. This, in effect, constitutes the overload protection quality of the circuit. This condition may exist if someone approaches the mic and starts talking in an abnormally loud voice (an angry boss).

Another fail-safe feature of the circuit is that if one of the light sources fails, the circuit simply doesn't provide extra loud levels—but communications are not completely interrupted. This is the instance where it becomes advantageous to keep gainshifting to a minimum by applying acoustical treatment to the rooms and using directional transducers.

If fail-safe operation is of prime importance, two identical systems can be operated side by side—providing not only more reliable operation but also a stereo effect. Lamp drivers at both locations have to be synchronized otherwise gain changes in one half of the stereo system would upset the gain balance in the other half.

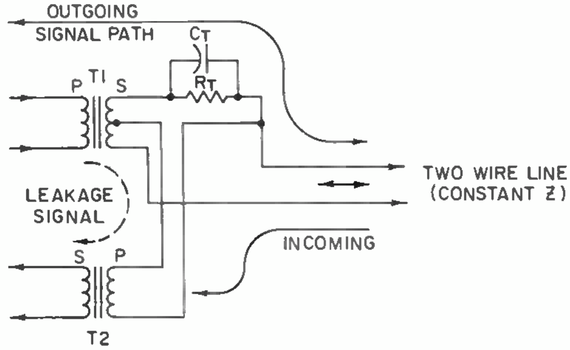


Figure 4. Conversion of a four-wire system to two wires using a balanced bridge hybrid. Rt and Ct tune the bridge for minimum leakage.

If the system is to be operating between two distant locations, individual lines for outgoing and incoming signals can be too costly. In this case the balanced bridge hybrid circuit shown in FIGURE 4 should be used. Two transformers, one with a center-tap secondary would cut transmission line cost in half. Also the circuit can be made switchable to a single line in a two line system if one line fails (it can happen—just ask Ma Bell).

One of the requirements is that the lines rented be permanent because the bridge on each side of the line has to be balanced to the impedance of the line, since every time the line is changed hybrids on each side of the line have to be rebalanced. The main purpose of balancing the hybrid is to cut the leakage currents to a minimum. A well-balanced bridge can provide outgoing/incoming circuit isolation up to 40 dB.

In order to balance the circuit properly it has to be done at several frequencies. Long telephone lines have large d.c. resistance, inductance, and capacitance. In order to balance the bridge resistor Rt and condenser Ct have to be trimmed to match the line impedance. Ct adjusts the balance at high frequencies while Rt adjusts it at low frequencies.

Another advantage of using a hybrid is that several stations can be connected across the common line. Then several people can hold conversation among themselves just as if they were all together in one room—yet they may be hundreds of miles apart from each other. In order to mix all these lines, a special mixing network would be required, since with the addition of every station the common bus impedance is lowered, thereby detuning hybrids of all incoming lines. What this mixing network has to accomplish is to maintain the common bus impedance, regardless of the number of stations participating or switched in.

The principle of gain shifting has found wide application in the communications field within the past decade. The system described in this column was designed and manufactured strictly for the communications field as an antifeedback device, but the principle of gain adjustment according to the level and frequency has also been applied in devices designed to reduce noise and distortion. One of them is the well-known Dolby system. Another system which emerged recently is the Philips noise-reduction system which uses expansion to raise the level of the program and reduce noise when the audio signal is absent and background noise becomes apparent. Intricacies of this system were revealed by Philips at the AES convention just past. Gain-riding circuits can be found not only in audio but in video circuits, r.f. circuits and almost any branch of electronics. ■

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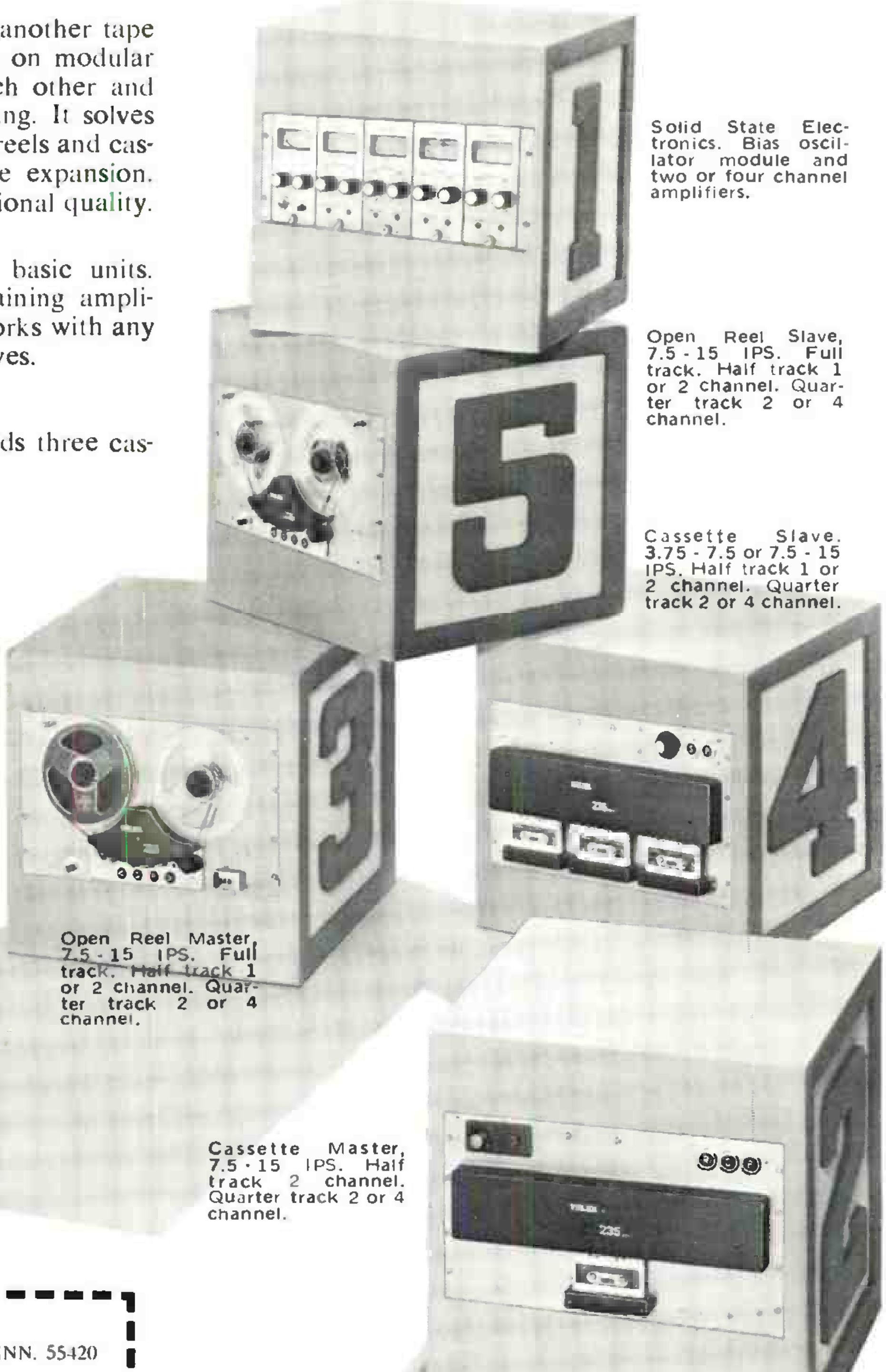

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John M. Woram

THE SYNC TRACK

More On Four

● Remember when an A-B switch had only two positions? Most of them still do in fact. Even on a rather involved 16-track recording console, you either listen to the console output or the tape.

Now, along comes quadraphonics (or whatever you call it), with its encoders, decoders, matrices, phase shifters, and such. An A-B switch at once becomes a lot more complicated. Just think of all the things you now want to monitor. (Maybe *want* is a poor choice.) Anyway, there's;

1. The discrete four channel output of the console.
2. That output, encoded down to two tracks.
3. The encoded output, decoded back to four channels.
4. The encoded master tape.
5. The encoded master tape, played back through a decoder.

And, if you're also going to be making discrete four-channel tapes too, you will want to be able to tape monitor them, without benefit of any encoder/decoder systems.

The A-B-C-D-E switching system should permit you to easily A-B between any two conditions, without having to pass through intermediate conditions. For example, at first you will want to compare the discrete four-channel console output (1) with an encoded/decoded combination (3). Once you have established this, you will want to verify that the program sounds presentable in its encoded form (2). Then, as you begin making the encoded master tape, you will want to listen to it, either in its encoded or decoded format (4 or 5).

The necessary switching isn't really that complex, although we can make it seem so by first drawing a truth table listing all the possible combinations. In the table, a *1* indicates the appropriate switch is on, a *0* indicates that it is off.

Condition	Console Out	Tape	In	Out	Encode	Decode	In/Out & Decode	Encode/ Disabled
1	1	0	when monitoring console out, these positions are irrelevant				0	0
2	0	1	1	0	1	0	0	0
3	0	1	1	0	0	1	0	0
4	0	1	0	1	1	0	0	0
5	0	1	0	1	0	1	0	0
6	0	1	0	0	0	0	0	1
	Switch 1		Switch 2		Switch 3		Switch 4	

TRUTH TABLE FOR MONITOR SWITCHING SYSTEM

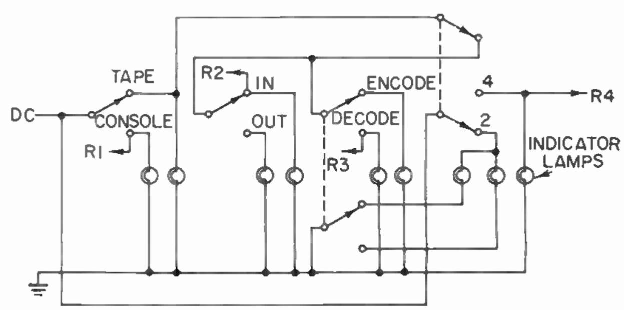


Figure 1. A remote relay switching system.

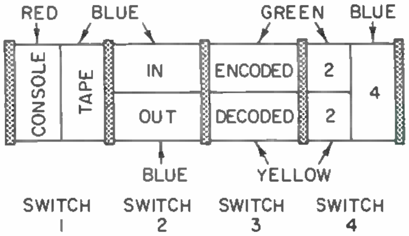


Figure 2. The physical layout of an indicator-switch system.

From the truth table, we see that all possible conditions can be met with four on-off switches. The first will switch between *console output* and *tape*. Once we have selected *tape*, the second switch will let us monitor the tape *input* or tape *output*. (Remember that tape input is no longer the same as console output, since the tape input is preceded by the encoder). Switch three enables us to monitor either the *encoded* or the *decoded program*, and the fourth switch gives us the output of a discrete four channel tape, if this is required.

It might be easier to wade through the switching system by starting with a look at the physical appearance of the switches themselves. In this case (FIGURE 1) they are Switchcraft alternate action switches. Depressing the first switch gives us *console out*. In this condition, the positions of the next two switches are irrelevant, therefore regardless of their positions, their indicator lamps are off. Depressing this first switch again gives us *tape*, and the indicator lamps in the second and third switches, come on, showing their conditions. We may now select tape *in* or *out* on switch two, and in either case, the *encoded* or *decoded* program on switch three.

The fourth switch disables switches two and three, transforming switch one into a simple A-B switch between *console out* and, in this case, the output of a discrete four-channel tape machine. You might even label this switch *discrete/indiscrete*, rather than 4/2. When this switch is in the 2 position, the indicator lamps are further controlled by switch three, so that only the legend *2* immediately to the right of the appropriate *encoded* or *decoded* legend is illuminated.

FIGURE 2 shows the wiring of the four switches. FIGURE 3 shows the actual wiring of the monitor switching system. The four inputs to the encoder are patched into the *console out* jacks. This does not lift the outputs from the console, consequently a discrete four-channel program is still fed to the inputs of the four-track recorder, if this is required ($IV_{1,2,3,4}$). The two outputs from the encoder should be patched into the inputs to the two-track recorder. (II in). This action does lift the regular console outputs from the two-track machine.

Relay 4 selects the output of either the four- or the two-track machine. Selecting the four-track machine automatically turns off relays 2 and 3, therefore all four outputs of the four-track machine appear at the *tape* position of relay 1, transforming it into a simple A-B switch. The blue legend *4* appears on switch four. all other lamps are extinguished, except for the appropriate function on switch one, and we can tape monitor a discrete four-channel program.

By selecting the two-track machine, switches two and three are re-activated, and are illuminated according to their mode. Once *tape* has been selected on switch one, the operator may monitor tape *in* or tape *out* by depressing switch two, and may listen to either mode in its *encoded* or *decoded* format via switch three.

Note the location of the two decoder inputs and the four outputs. The lines that are lifted by the action of patching in the decoded outputs might be eliminated, since they will be used rarely, if ever. ■

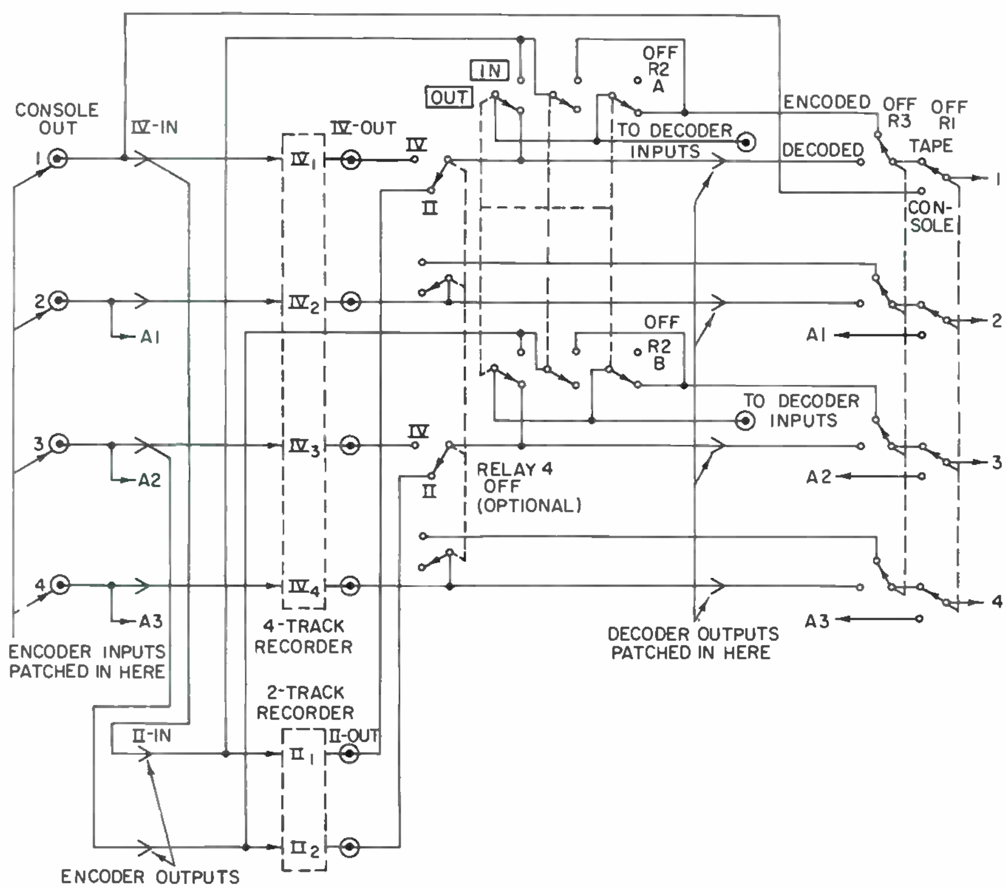
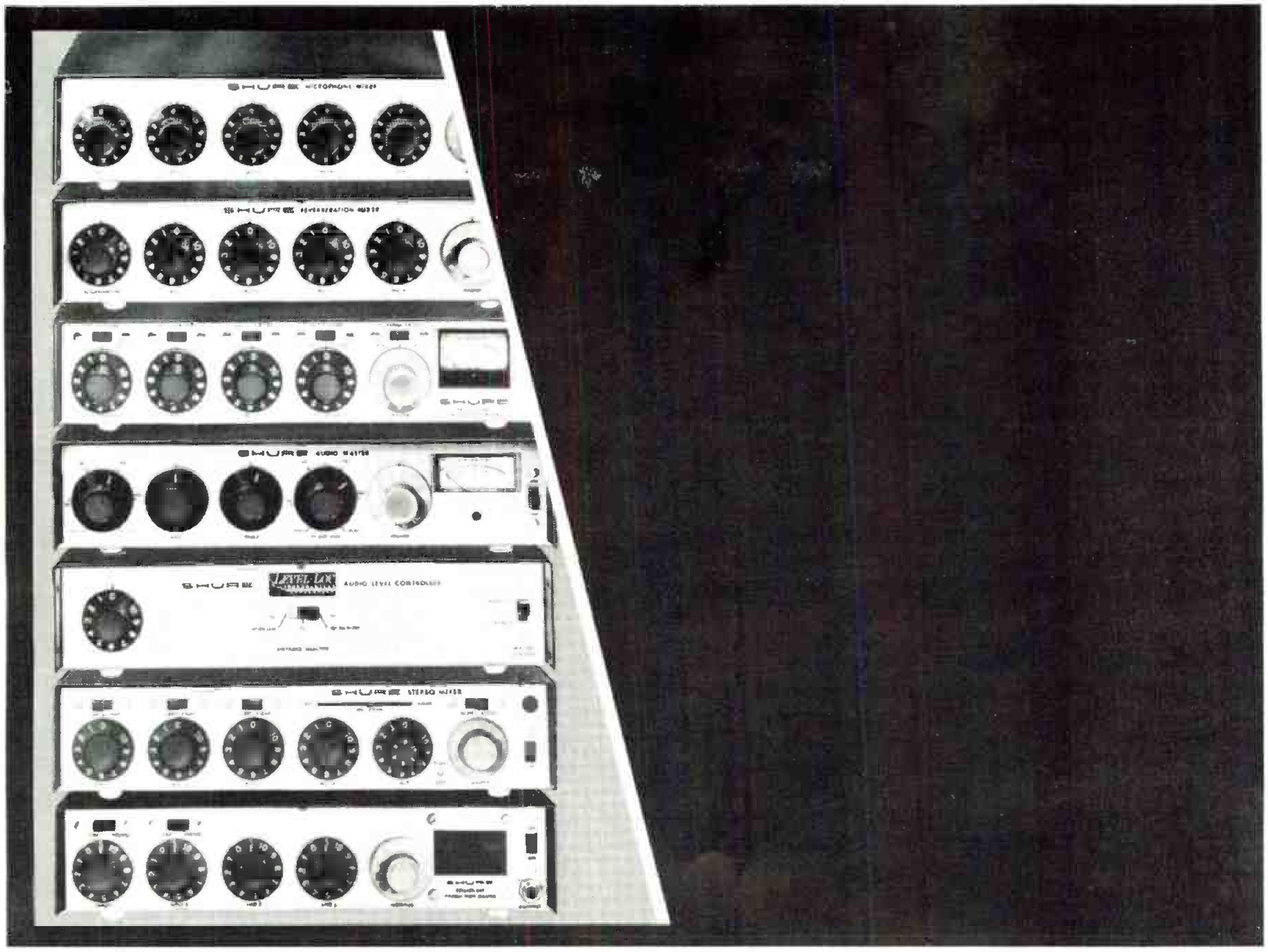


Figure 3. The monitor switching system for a four-channel mixing room. A non-lifting patch point is shown as ○ and a lifting patch point is >.



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Norman H. Crowhurst

THEORY AND PRACTICE

● So far, every issue of this column has related either to electronics or to transducers of the type used for microphones and loudspeakers. There is another type of transducer of which many are used in audio, and which unfortunately gets very inadequate mention in most electronics or audio courses. In consequence, many audio engineers are quite inadequately informed on the subject. I refer to motors.

One is apt to think other people (at least those with professional training) know what we learned during our own training and I have had several occasions to realize that this is not so. When I received my technical education, there were no electronics courses. as such, and audio had not been heard of at all. So the way by which my vintage arrived was by taking the old "heavy" electrical courses, and much later specializing in the "light" stuff, that eventually became electronics.

Generally speaking, I would say that the change in approach is an improvement: the old heavy courses were that in more than one sense; on the other hand, an electronics or audio man can sometimes benefit by knowing a little more about motors than the simple fact that volts and current go in and turning comes out!

Of course, most do know a little more than this. They know, for example, that an animal called a hysteresis-synchronous has some advantages for some particular jobs. But beyond that, their knowledge gets a little vague. Undoubtedly the curriculum of people who ultimately become motor designers has changed a lot since I was in school but, as they say, the essentials have not changed. Mostly, available materials have changed perspective, or emphasis.

In our days, we started learning about series and shunt wound motors and generators, which means that the field was obtained by means of a coil connected in a series or shunt, respectively, with the rotating armature. Today, few small motors possess a field winding at all, because the newer permanent magnet materials have made it much more feasible to use permanent-magnet fields.

So the simplest motor to understand is probably the d.c. one that has a permanent-magnet field, with an armature connected to the d.c. supply by means of a commutator, that keeps changing connections to the armature winding as the latter rotates.

Such a machine also works as a dynamo, or generator and thinking of it first this way helps understand its function as a motor. If you turn the armature by mechanical force, the voltage (the text-books call it EMF, or electro-motive force) generated is strictly proportional to the rpm at which it is turned.

When a voltage is applied to the machine, so it works as a motor, the current that flows is due to the difference betwen the applied voltage and that generated by the motor's turning. Current in the armature is the direct cause of mechanical torque. So if the motor is turned artifically at a speed to generate the same voltage as that applied, no current will flow, and

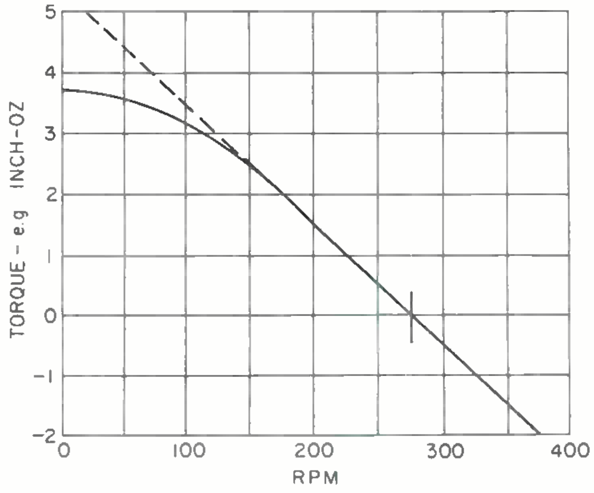

Fig. 1. Torque/speed curve for a permanent-magnet d.c. motor. The negative torque region represents a hold-back effect when the motor is mechanically driven faster than the mechanical balance point, when it really acts as a generator.

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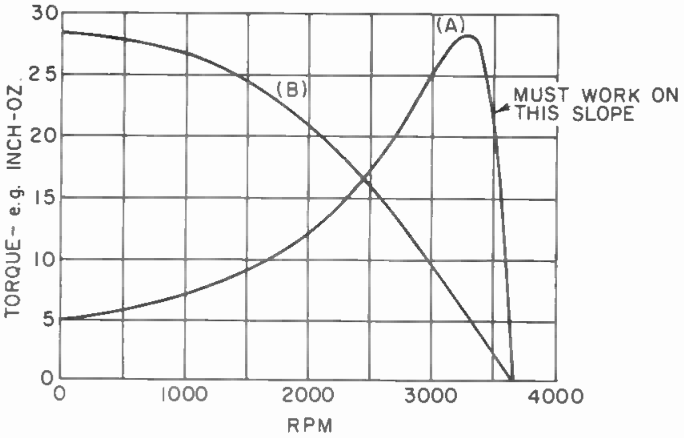
Circle 20 on Reader Service Card

Fig. 2. Two possible torque/speed curves of an a.c. induction motor: (A) Where the rotor reactance is 10 times rotor resistance; (B) where rotor resistance is equal to rotor reactance. Each Is at supply frequency.



there will be no torque: the motor will just float.

As the speed of rotation falls below this floating speed, more current flows, depending on the drop in self-generated voltage below applied voltage, and the motor's armature resistance. Thus, for a given applied voltage, the speed/torque curve of a d.c., permanent-magnet motor would look like FIGURE 1. The straight, dashed line is an ideal characteristic. In practice, the high current at low speeds somewhat offsets the permanent magnet's field, so the solid curve is a typical practical characteristic.

A motor needs some torque to make it turn, to overcome friction, and some more to do whatever work it is called upon for, which is why the motor was needed in the first place. If it is used in a tape recorder, then its work is to move the tape. So the motor's speed drops just enough to draw sufficient current to produce the total required torque.

Now suppose that supply voltage changes. The no-torque speed will change in direct proportion to the voltage. If 3 volts would produce the equivalent of 4.2 inches per second tape speed with zero torque (and thus no tape to move) and 3.75 inches per second when actually moving tape, dropping the voltage to 2.5 volts would drop the no-torque speed from 4.2 in/sec to $2.5/3 \times 4.2 = 3.5$ in/sec, which would drop about the same amount (not percentage), to about 3.05 in/sec when actually moving tape.

What this says is that, to use a d.c. motor for constant speed, the d.c. voltage needs quite precise controlling.

Motors that use a.c. bring in a whole new set of theory and facts. The earliest a.c. electrical machines were synchronous: they used a d.c., or permanent-magnet (except that in those days, good permanent magnets were difficult to come by) field, and supplied the armature with a.c. direct, without a commutator to keep switching it.

Although such machines did not need a commutator, they did need some means, usually slip-rings, to get current into and out of the rotating windings. And slip rings need not much less maintenance, because of sparking, than do commutators and their brushes. So the step that brought in a whole new range of a.c. motors was the advent of the induction motor. This combines the function of a transformer and motor in the same machine.

The rotor, or armature is built very like that of an earlier type motor, except that it does not use either commutator or slip rings for making external connections to the winding on the rotating core. Instead the winding is completed on the rotating assembly so that voltages induced in the rotor windings, by inducing currents in the stator windings, are accompanied by currents in the rotor.

These currents in the rotor then react with the field of the stator to produce rotational torque like any other motor. To cut short on the theory and get to the practical relationships, speed of rotation is basically fixed by frequency: if the rotor turned at the equivalent of synchronous speed, no currents would flow in it—and there would be no torque either.

So torque in an induction motor, like that in the d.c. motor, depends on it turning at less than this no-torque speed. On the d.c. motor, the speed is determined by voltage (along with magnetic field and number of turns in the windings.) On the a.c. motor, speed is determined by frequency and the number of poles produced by the stator windings. In each, the existence of torque depends on the motor running below this speed.

But the way in which torque produced by an induction motor varies as speed drops varies according to characteristics of the rotor windings. The amount by which speed falls below synchronous, or no-torque speed, is

Here's what 8 FM station engineers said about the Bang & Olufsen SP-12 cartridge:

WVCG/WYOR Coral Gables, Fla.
...this excellent cartridge is ideally suited for professional applications. SP-12 would be a good choice for the new quad-4 channel-stereo discs.

KBUC San Antonio, Texas
The cartridge is without a doubt the "Rolls-Royce" of the broadcasting industry!

KRBE Houston, Texas
Low's and hi's came through very impressively over entire audio range. The SP-12 is an excellent cartridge surpassing both the Shure V-15 and the Stanton 681EE in all respects in my tests.

WKJF-FM Pittsburgh, Pa.
Tracking, so far, has been excellent. SP-12 has been used "on air" 7 hours a day since received and not stuck or skipped yet.

WEMP Milwaukee, Wis.
We appreciate the wide-range response without the harsh "edge" that so many cartridges add to the sound.

KDIG La Jolla, Calif.
An excellent cartridge, none better on the market today.

KBAY San Jose, Calif.
Up 'til now the Shure V-15 type II has been our favorite for critical listening. After installing the B & O cartridge in the shell the Shure cartridge was in, we've left it there. It sounds great!
Exceptionally clean, undistorted, pure sound. One London Phase Four recording in particular has always broken up during a highly modulated passage, we assumed the record was over-modulated, until we played it using the B & O cartridge.

KMND Mesa, Ariz.
If there could be any comment at all, it would have to be that the cartridge seemed to display a very smooth and pleasing sound, a very flat and very clean, clear and brilliant response. The separation is very good and both channels are quite consistent on response.

Write for a report of FM Station Engineer Evaluation

SP-12 Cartridge
$69.95

Bang & Olufsen of America, Inc.

525 East Montrose Ave., Wood Dale, Illinois • In Canada: Musimart Ltd.

Circle 26 on Reader Service Card

called *slip* and it is given in percentage. Thus a 2-pole motor, for 60 Hz, will have a no-torque speed of 3600 rpm. That is zero slip. If the motor runs at 10 per cent slip, that is 90 per cent of no-torque speed, or 3240 rpm.

A good husky winding, of lowest possible resistance, will have more reactance than resistance, at the working frequency (60 Hz). If the resistance of the rotor winding is one tenth of its reactance, maximum torque will occur at one tenth slip, or 90 per cent of synchronous speed. This is the bottom of the safe working range.

If speed on load drops to this maximum torque speed, the motor will stall, because the torque at all lower speeds is less than at this point. The only way such a motor will continue to run and drive its load, is to keep it running above the maximum torque speed (FIGURE 2).

The advantage of a motor with a low-resistance rotor is that it develops a relatively high torque at a speed not much below synchronous. This means that its speed will not vary much with the mechanical load applied to it, unless it is loaded hard enough to make it stall.

The disadvantage is that it must be loaded lightly enough so that it can start with the low standing-start torque, or else it must be started without the load on, and have the load connected (*e.g.* by a mechanical clutch) after the motor has run up to speed.

Most commercially-built induction motors have this kind of characteristic. But they can also be built to have a maximum starting torque. This is done by making the winding resistance equal to its reactance at the supply frequency. The simplest way to achieve this is to use a much more "skinny" winding than the other variety, with a more husky core, except that it has some air gaps in its periphery to limit inductance. That's the motor designer's art, so we won't get into details.

A motor built this way has maximum starting torque, which trails off to nothing by synchronous speed. Its speed constancy is poor, because the least load change will vary it. But it is a feasible, low-cost way to provide fairly low-torque at variable speed, with a good start-up torque, which could be used for the take-up spool of a tape recorder. True it will not provide constant take-up tension, throughout the radius variation at which the tape feeds onto the spool, but it could come closer to that than a slipping-belt drive.

That's about all we have space for now. We will pursue the matter of motors and drives next time. ■

ARNOLD SCHWARTZ

THE FEEDBACK LOOP

● Last month I discussed the generation of intermodulation distortion by a square function, and the generation of third harmonics by a cube function. In these discussions I did not say anything about the gain of each of these functions. We can relate the gain of the basic linear function to the gain of the distorting functions. Any audio device, be it electrical, acoustical, or mechanical, can be represented by the generalized block diagram shown in FIGURE 1. Here we have the input of each of the functions fed by the same signal, and the signal output is the combined outputs of all the functions. Harmonic generation is an infinite series but we will only go up to the cube generator, which for most purposes will tell us all we want to know. Each function has a coefficient. We will assign the linear function the coefficient $k_1=1$. The coefficients of the square and cube generators are k_2 and k_3. We can now catalog four systems.

- an ideal device where both k_2 and k_3 are zero.
- a device with even order distortion where the distortion generated is directly proportional to the value of k_2
- a device with only odd order distortion where the distortion is directly proportional to the value of k_3
- a device with even and odd order distortion where the distortion is proportional to the rms value of k_2 and k_3.

Things can get even more complicated when the coefficients are not constant, as assumed above, but are functions of frequency and other variables.

We can work out a hypothetical system which contains a linear function where $k_1=1$, and a square generator with $k_2=0.1$. That is, the gain of the square generator is one tenth that of the linear function. If the input is sin ωt, then the output is

$$k_1 \sin \omega t + k_2 \frac{(\cos 2\ \omega t + 1)}{2}$$

Substituting the values for k_1 and k_2, and ignoring the d-c component for this and subsequent discussions, we find that the output is

$$\sin \omega t - 0.05 \cos 2\ \omega t.$$

This device then has 5 per cent harmonic distortion. If we used a system with both second and third harmonic distortion, the total distortion would be the rms values of the combined output of both harmonic generators.

Virtually all devices generate some distortion and various approaches are

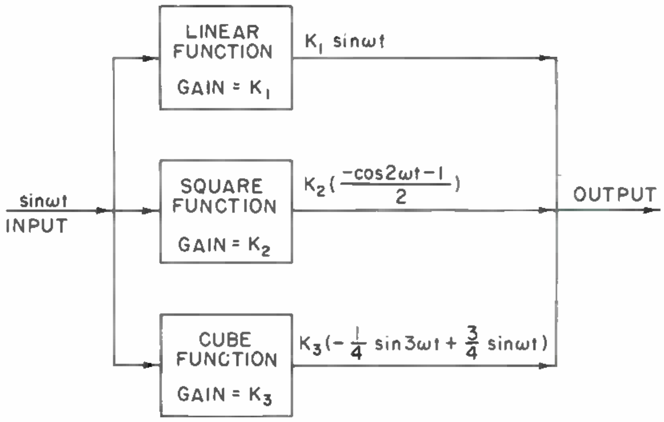


Figure 1. A generalized audio device.

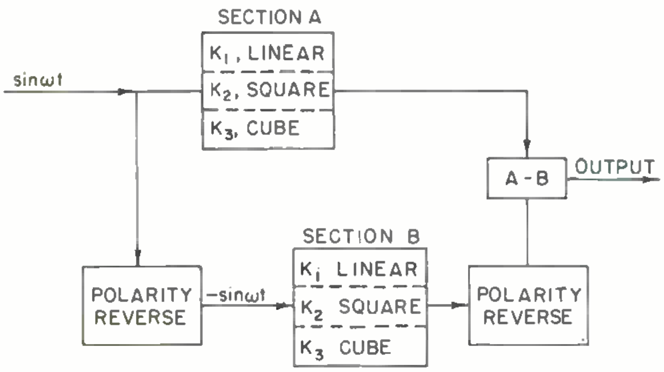


Figure 2. A typical push-pull stage.

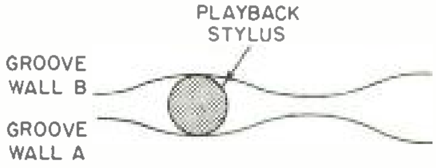


Figure 4. A single-ended mechanical system, vertical disc recording.

used to reduce this distortion when a linear system is the objective. One of these methods is the use of push-pull. A push-pull device can be represented (see FIGURE 2) by two identical stages, A and B, fed by the same signal but with the polarity reversed to one of the stages. Let us assume that each stage by itself generates both second and third order distortion. If stage A is fed the in-phase signal, sin ωt, then the output of this stage will be

$$K_1 \sin \omega t - \tfrac{1}{2} k_2 \cos 2\omega t - \tfrac{1}{4} k_3 \sin 3\omega t + \tfrac{3}{4} k_3 \sin \omega t$$

If stage B is fed the same signal as A but with the polarity reversed at the input to B, that is, $-\sin \omega t$ then the output of stage B would be

$$-k_1 \sin \omega t \tfrac{1}{2} k_2 \cos 2\omega t + \tfrac{1}{4} k_3 \sin 3\omega t - \tfrac{3}{4} k_3 \sin \omega t$$

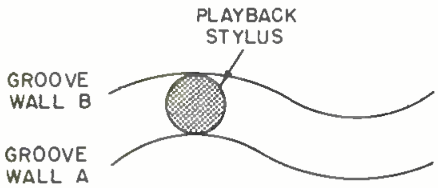
As expected, the fundamental of B with the k_1 coefficient and the third harmonic have a phase reversal with respect to the output of A, yet the second harmonic of B is still *in-phase* with the second harmonic of A. The output polarity of a square generator is independent of the input polarity, and stems from the fact that $(X)(X) = (-X)(-X) = X^2$. Or, to put it in another way, $-\sin^2 \omega t =$

$$\frac{-\cos 2\omega t + 1}{2} = \sin^2 \omega t$$

Therefore, regardless of the polarity at the inputs of A and B, the second harmonics will be in-phase. Having derived the outputs of each individual section of the push-pull stage, we then reverse the polarity of section B output and combine it with the output of A. In other words, we perform the operation A minus B.

$$A - B = (k_1 \sin \omega t - \tfrac{1}{2} k_2 \cos 2\omega t - \tfrac{1}{4} k_3 \sin 3\omega t + \tfrac{3}{4} k_3 \sin \omega t) - (-k_1 \sin \omega t - \tfrac{1}{2} k_2 \cos 2\omega t + \tfrac{1}{4} k_3 \sin 3\omega t - \tfrac{3}{4} k_3 \sin \omega t) = 2 k_1 \sin \omega t - \tfrac{1}{2} \sin 3\omega t + \frac{3}{2} k_3 \sin \omega t$$

Figure 3. A push-pull mechanical system in lateral disc recording.



We note that the fundamental and third harmonic components add, while the products of the square functions are cancelled, and we arrive at the well known result that a push-pull state eliminates second harmonic distortion.

The design of many electrical, acoustical and mechanical devices make use of this push-pull principal to eliminate second harmonic distortion. It is interesting to note that in disc recording lateral modulation corresponds to a mechanical push-pull stage; stereophonic and vertical recordings are single-ended systems and do have second order distortion. FIGURE 3 shows a lateral recording. We will trace this groove with a stereophonic cartridge and a playback stylus is shown in the groove. The stylus is in contact with groove wall A at a convex section of the modulation and we will assign a positive polarity to the signal induced in the A section of the cartridge. At the same instant the stylus is in contact with a convex segment of groove B, and we can assign a negative polarity to the signal induced in the B section of the cartridge. The outputs of each section of the cartridge contain harmonics with the same relative polarities as described in our push-pull stage. If the two sections of the cartridge are connected for lateral modulation the B output is subtracted from the A output so that fundamentals and third harmonics add, while second harmonics cancel. If we have a vertical recording (see FIGURE 4) the input to each section are in-phase, that is the concavities and convexities of the groove walls coincide. If we try to subtract the outputs we will find that the second harmonics and the fundamentals will cancel.

Using the "function generator" approach to distortion problems can provide fresh insight. It is (for example) possible to answer with some precision the frequently debated question of the relative magnitudes of harmonic and intermodulation distortion for a given device. ■

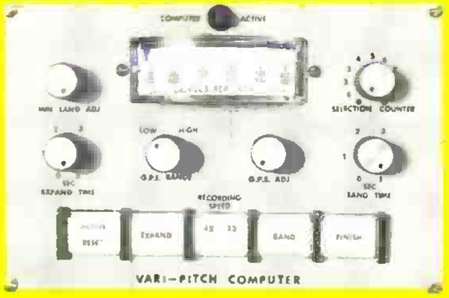
NEW PRODUCTS AND SERVICES

SIXTEEN-TRACK RECORDER

● Model JH-16 designates a new 15-30 in/sec speed studio machine that uses a full logic system for tape motion, one and two-inch tape capability, quick-change heads and guides. A servo system assures constant tape tension, the three heads are adjustable for height, zenith, and azimuth. Tape lifter and head shield come into play automatically. All critical componentry is on plug-in circuit boards, equalizers are plug in, and screwdriver adjust access is made for tape tension, idle null, fast forward and rewind speed, reproduce, sync, and record level control, and erase, bias, and equalization trimmers.
Mfr: MCI
Price: $16,500
Circle 55 on Reader Service Card

DISC MASTERING COMPUTER

● An American-made computer for disc mastering variable pitch control is now offered. In a matter of hours, variable pitch operation can be added to any Scully lathe with this unit. Accurate control and a linear readout from 50-1000 grooves per inch is possible at all turntable speeds. Pre- and post-echo expansion as well as banding and finishing are completely automatic. The unit can be over-ridden for manual operation if desired.
Mfr: Capps & Co.
Circle 54 on Reader Service Card



VANDAL-PROOF SPEAKER

● A new re-entrant horn loudspeaker that is almost immune to vandal attacks is now available. The APF-15 speaker is designed to completely recess into either wall or ceiling. The unit can also be flange-mounted on a panel or, surface-mounted in a protective enclosure. The 3-7/16-inch deep APF-15 is a high efficiency re-entrant type loudspeaker that both fits directly inside a 4-inch deep interior or exterior wall and flange-mounts with ease to any standard size baffle for 6- or 8-inch diameter speakers. A second version of the unit, the APF-15T, includes a built-in line matching transformer and is 5-3/16-inches deep. Both the APF-15 and APF-15T are completely weatherproof and architecturally harmonizing. They produce a sound level of 121 decibels and, are designed for maximum intelligibility and projection of voice and time or alarm signals. The units are rated 15 watts at full range continuous power.
Mfr: Atlas Sound
Circle 53 on Reader Service Card

new literature

● McMartin Industries has a completely revised and updated catalog of engineered sound systems showing their equipment. *Circle 60 on Reader Service Card.*

● B & K's short form catalog describes the firm's full line of precision transducers and instrumentation for sensing, measuring, and analyzing all aspects of sound, noise, and vibration. *Circle 61 on Reader Service Card.*

● Two brochures are newly offered by Ampex. Brochure A-554 describes the CD-200 high speed cassette-to-cassette duplicator system and brochure A-555 describes the AD-15 professional duplicator system which copies all major 150 mil and quarter-inch formats. *Circle 62 on Reader Service Card.*

● A cross-referencing guide and catalog to HEP semiconductor replacements is available from Motorola. Included are 1N, 2N, 3N, JEDEC, manufacturers' regular, and special house numbers, with particular emphasis on Japanese types. *Circle 63 on Reader Service Card.*

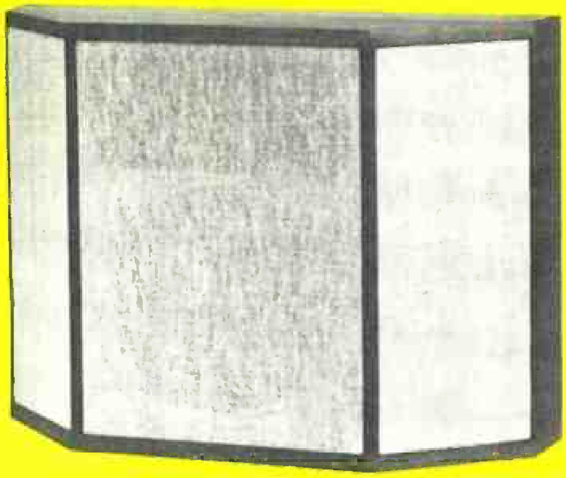
● Indicator lights, light-emitting diodes, and incandescent lamps are detailed in a catalog newly issued by General Illumination. *Circle 64 on Reader Service Card.*

● A "Primer of Plant Noise Measurement and Hearing Testing" is available from General Radio. *Circle 65 on Reader Service Card.*

● Pulse generators are described in a brochure available from Hewlett-Packard. A selection guide is also included. *Circle 66 on Reader Service Card.*

● The Delta-Tau model 101 digital audio signal delay unit is the subject of a four-color, six-page brochure. Applications as well as specs are given in Gotham Audio's release. *Circle 67 on Reader Service Card.*

STUDIO MONITOR



● The AR-LST is the first AR speaker specifically designed as a studio monitor. It utilizes the proven drivers used in this company's AR-3a but uses them in multiplicity to provide both power handling increases and improvements in dispersion. One woofer is used, a total of four mid-range domes and four high-frequency domes complement it. The woofer and two high-frequency domes face forward. Each of the angled side panels contain two mid-range and one high-frequency unit. A switchable autotransformer permits the choice of six acoustical curves ranging from acoustically flat output to various positions of boost or attenuation of lows and highs. The control switch will be placed on the front panel for production models. Efficiency is low, high power amplifiers are required for high output but the fused system will provide high s.p.l. averages. Power handling specifications for which the fuse is set are 1000 watts for 2 seconds, 64 watts for 30 seconds, and 23 watts for long term average. Efficiency is 0.8 per cent. Weight is 90 lbs. Finish will be black wood, but walnut will also be available.
Mfr: Acoustic Research, Inc.
Circle 52 on Reader Service Card

● A Dolby illustration in the September New Products and Services may possibly have been misleading. What was shown, and is repeated above is a new testing device for 360-series Noise Reduction Processors. The tester will accept a 360-series card for direct plug in and will, by means of two rotary switches, test all the parameters of the card. In addition, the tester also plugs into the 360-series chassis to test it for its functions. When the tests, which take but a few moments, are complete, you know that the complete system is good, or you know in exactly which area a difficulty lies.
Mfr: Dolby Labs.
Circle 50 on Reader Service Card.

Independent Recording Studios—A db Forum

Another in our continuing series of discussion forums. This one brings together owners and operators of recording studios who sat around a large table and talked about their experiences and operations.

DON PLUNKETT of Harvey Radio, New York City, recently played host at the new Harvey Audio-Video Center on Madison Avenue to a group of recording engineers. Participating were:

Malcolm Addey	TeleGeneral Recording Studio
Bob Bach	Publisher, **db Magazine**
Sid Feldman	Mastertone Recording
Steve Katz	Sound Exchange
Ed Kramer	Electric Lady
Bob Lifton	Regent Sound
Walter Sear	Sear Electronic Prod. Co.
Larry Zide	Editor, **db Magazine**

Around the table at Harvey Radio.

Clockwise from the extreme left, John Woram, Sid Feldman, Bob Lifton, Walter Sear, Malcolm Addey is obscured by Harvey Radio host Don Plunkett, while Ed Kramer has his back to the camera.

The conversation went for hours, and covered everything from speaker preference to studio rates. The typed transcript is almost book length and the editors have found it difficult—if not impossible—to accurately determine just who said what. To do so would require weeks of research and tape monitoring, and would probably make for duller reading anyway. Accordingly, these pages are more a summary of what was said, rather than a word-for-word repetition of the proceedings.

More often than not, the casual record buyer thinks of recording studios in terms of major labels recording grand opera in some European capital. Indeed, the average hi-fi type magazines rarely mention anything except the goings-on of these big record companies. However, much of the recording work in this country—and in Europe too—is done at independent studios.

But, speaking of recording in Europe, why do so many companies prefer travelling abroad whenever a big recording project comes up? Most of the participants felt that musicians' fees were reason enough to cross the Atlantic. A typical case was a client who was producing a series of educational records encouraging students to study musical instruments in high school. Since the records were to be given away, he requested a lower rate, and when the musicians' union refused, he went to England, had a great vacation, completed the job, and saved himself more than $10,000.

Left to right, the back of Ed Kramer, front of Sid Feldman and Bob Lifton, and side of Don Plunkett.

In addition to European competition, and the generally poor condition of the economy, it was pointed out just how much elaborate equipment the independent studio operator needs in order to keep up with the competition. If the studio down the block has sixteen-track facilities, with Dolby units, EMT's, and all the other little goodies, you'd better have them too if you plan to compete. Obviously, competition costs money, some of which must be reflected in higher studio rates.

This brings up the other side of the coin. For a self-contained group, an album can cost a fortune in studio costs. For less money, the group may be able to buy a used multi-track tape recorder and a bare-minimum console, which may be nothing more than a resistive combining network. But, they can bring it all home to their pad, loft, or basement, and spend the next six months fooling around until they finally get something worth bringing into the city to mix down. Unless they're quite proficient, it will probably sound wretched, but does that matter? Let's face it, a lot of the current hits certainly didn't make it on good engineering. In fact, some of our panelists were on last year's NARAS committee to select the best engineered records. Some of the entrees were so bad they were *funny*. A very few were superbly engineered. Interestingly enough, the better engineering showed up on albums by Neil Diamond, Elton John, Blood Sweat and Tears, and Simon and Garfunkel. In no case was the committee able to find a record that contained excellent engineering but bad musicianship. Yet we all know that good engineers have often worked with not-so-good musicians (and by all means, the reverse has also been the case). So, perhaps engineering cannot, or should not, be judged independently of musical content.

Maybe there should be another meeting held at sometime to determine just what good engineering is anyway. In any case, it's not what comes out of most people's basements, and the independent studio cannot consider the group with its own equipment as his competition.

Nor does he have to concern himself much with the studios attached to some large record label. Most of these are run by executive types with little or no understanding of the peculiarities of the recording studio, and their facilities reveal this. These days, a studio that looks, and behaves, like an insurance company is just nobody's competition. Most independent operators have always understood this; most large outfits never will.

STUDIO RATES

Most studios have a graduated rate card, with a considerable price differential between mono and sixteen-track recording. Although this certainly seems reasonable at first glance, it does encourage the prospective client to try to think small. There may be little point in charging more for sixteen- than eight-track sessions, since chances are, the same machine will be used. The studio makes its money by the hour, and there are no additional costs involved in sixteen-track work. So, why not make it a little easier for the customer to do a sixteen-track session? By giving him eight more tracks, he'll probably wind up spending more time with you anyway. And even if he doesn't, you're not out anything.

For the one room studio, a significantly lower rate for four-track work can actually put a strain on the operation, since tying up the studio at a lower rate prevents it from being rented at a more profitable figure.

RATE CUTTING

Some studios are trying to bring in business by drastically

Sid Feldman and a smiling Bob Lifton.

Over the shoulder of John Woram we see Walter Sear, Malcolm Addey, and Don Plunkett.

cutting their rates. Although these days that's certainly understandable, most of our participants were in favor of sticking to a published rate schedule, less some reasonable discount for quantity booking. There seems to be little point in competing with cut-rate studio costs unless that's the kind of service you intend to give.

However, if you are going to charge a respectable rate, you've got to be prepared to give the customer first-class, *personal service*. This may include anything from free coffee to a friendly telephone operator when he calls a month later to fight about his bill.

Again, the independent studios often show the way. With the sophisticated equipment in general use today, most studios can produce good-to-excellent engineering (assuming a competant staff, of course). The distinguishing characteristic of the successful studio is often its pleasant atmosphere—both physical and psychological. An ambience that encourages creative work often means more than an improved signal-to-noise ratio. Once the clients feel *their* success depends on your studio, *you* can count

John Woram (left) and Steve Katz (right).

Ed Kramer makes a point while John Woram listens.

yourself a success.

THE STATE OF THE (RECORDING) ART

There was some talk about the excellent recordings made before the introduction of the first multi-track tape recorder. If we now need sixteen tracks to create a hit, how come some of those old "two trackers" sound so good?

Since the top-100 business is so dependent on youthful tastes, it's often the case that the hit makers, whether in the control room or the studio, are just too young to have been around in the two-track days. Suggesting that the strings (or brass, or chorus, or what have you) be recorded in classical stereo on two tracks (no less or no more) brings terror to their hearts. They insist on, either all strings on one track (and then maybe double them or, first violins on one track, seconds on another, violas on a third and celli on a fourth track. Either way—from the point of view of good sound—you lose.

Multi-track mono is no substitute for good stereo, but if you have never heard good stereo, you may not be aware of what you are missing. Many engineers and producers have never heard a legitimate classical-type orchestra. Their sole musical experience is with rock groups, and their only exposure to strings or brass is what they have heard over control-room speakers on sweetening sessions. Their product shows it. It's the phenomenen, certainly not unique in the recording industry, of the craftsman misusing his tools. We've certainly all seen old furniture that has already outlasted more modern pieces. The older items, whether tables or tapes, were produced with care by artists who were the masters of their tools. Some newer products have been slapped together by artisans who have neither the time, inclination, and/or knowledge to do better work. If you've been raised on formica and chrome, hand-rubbed finishes may be beyond your experience. If you cut your teeth on a sixteen track head, you may not know what you're missing.

Of course, the demands of a particular recording session may require you to apparently mis-use your equipment. As the panelists pointed out earlier, musicians' time is expensive, and musical decisions often take time. So, if these decisions can *really* be made later (we'll fix it in the mix), time and money can be saved. If the end product is to be a spot commercial or an a.m. radio type single only, there may not be much point in seeking audio perfection. That's one of the facts of life with which we all have to live. However, a little knowledge of earlier recording techniques can certainly do the engineer no harm, and for quality album productions it can be a positive asset.

TRAINING THE ENGINEER

Where does a recording engineer get his education? Some schools offer an occasional seminar in recording arts, and there are a few private organizations offering a variety of courses aimed at the would-be engineer. Yet there is no industry-wide standard for qualifying as a recording engineer. Nor perhaps should there be. Unlike many other professions, the qualifications for a successful career in recording are nebulous at best. Some engineers hold advanced degrees, while others have difficulty with Ohm's law. Some are accomplished musicians, still others can't read music. Within our panel, there was a divergence of opinion on which prerequisites a prospective recording engineer should have. One chief engineer may require that all his engineers be proficient in some musical instrument, while another may stress a strong technical background. Yet some successful engineers have neither. Depending on your point of view, it is either fortunate or not so fortunate that successful studio engineering is largely a function of on-the-job training. Like swimming lessons, there is only so much you can learn without getting your feet wet.

THE BUSINESS OF RECORDING

It was universally agreed by this group that business is not in a serious decline, nor has it been. But what has happened is that cash seems to have vanished. Payment schedules are becoming far worse than they have ever been. Accounts receivable are a universal problem and what is amazing is how many of the delinquent accounts belong to what might be considered prime firms. It was seriously suggested that a percentage fine be attached to delinquent accounts to spur them on (but apparently none of our group is doing this now).

The use of credit cards by clients has been instituted by at least one studio (not represented in our group). Master-Charge is used. Although the bank creates a limit on the amount any one card can charge (usually $500 or so) several cards held by respective group members can be ganged to pay a bill. It does cut out the problem of delinquency to the studio, at least by the credit card users.

No doubt about it, our group agrees that the independent recording business is a good one to be in. ■

db Visits—Ultrasonic Recording Studios

ELSEWHERE in this issue, a panel of recording engineers discuss the phenomenon of the independent recording studio. These studios are found throughout the country, and range in size from expanded broom closets to large multi-studio complexes. Usually, the independent studio depends entirely on custom business for its success, since more often than not, it does not have its own label.

The 1971 Billboard Directory of Recording Studios contains a seemingly endless listing of studios throughout the country. The pictures illustrating these pages were all taken at an independent studio in Hempstead, Long Island.

Hempstead, Long Island? In case you've never been there, Hempstead is not exactly the recording center of the universe. In fact, it's a good hour away from New York City, which may be a little off-center itself these days.

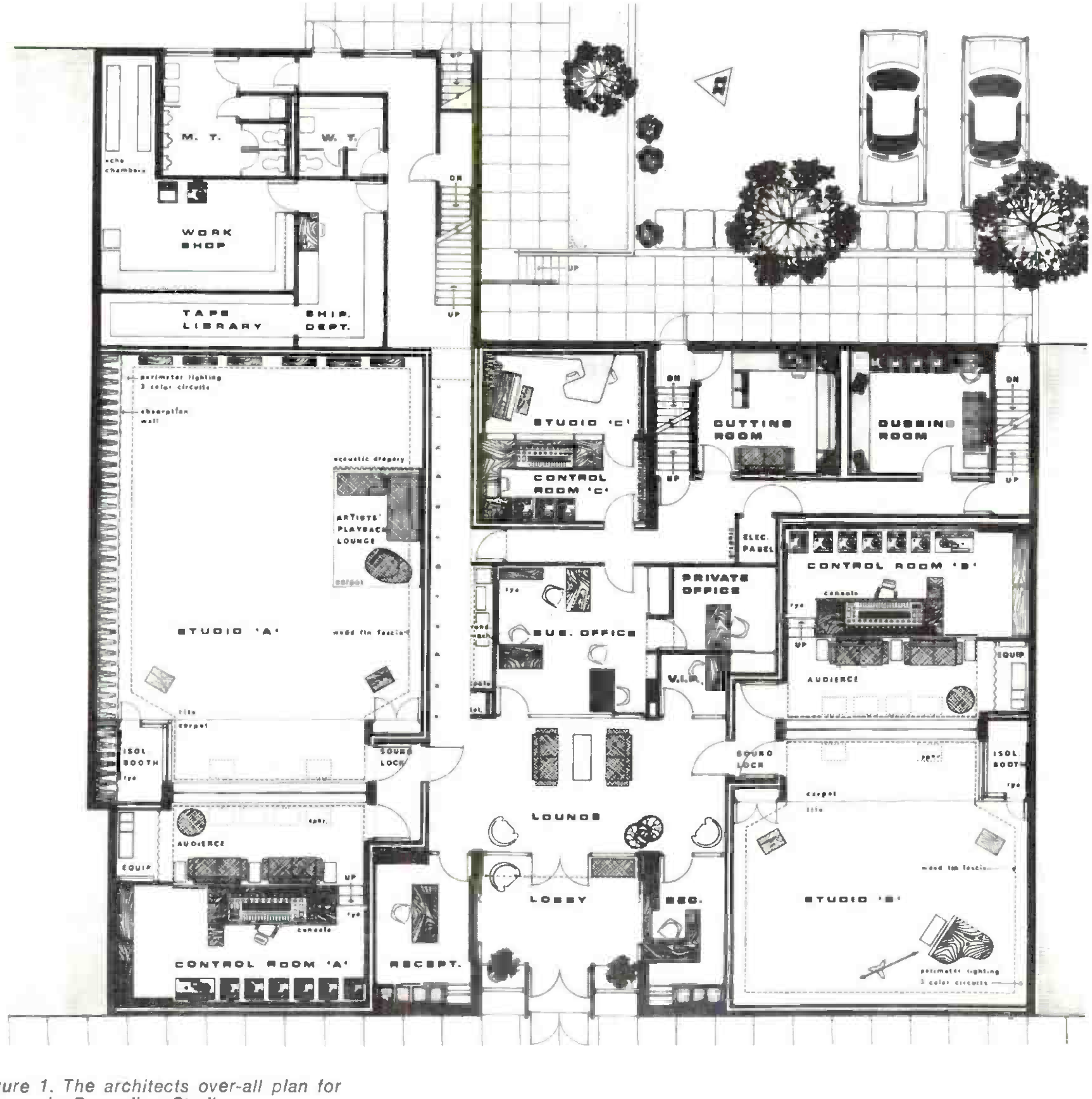


Figure 1. The architects over-all plan for Ultrasonic Recording Studios.

To find out how such an impressive facility could spring up in such an unlikely location, **db** recently visited Ultrasonic Recording Studios in Hempstead to chat with its owner. Bill Stahl.

Some years ago, Bill started out with a few microphones and a tape recorder, recording whatever passed through Hempstead. Eventually, he had a fairly successful operation going, and when Scully announced an eight-track machine. Stahl bought one: Serial Number 1.

At about this time, the self-contained rock group was emerging as a major force in the recording world. Any one of these groups might book a studio for weeks at a time, which in a metropolitan area was (and is) expensive. Not only studio rates, but hotel accommodations, parking fees, and meals contributed to the expense.

Eventually groups discovered their way out of the city, and into suburban studios, such as Hempstead's Ultrasonic. Here, the rates were lower, you could park nearby without having to float a loan, and lodgings were a little more reasonable. Among others, the Vanilla Fudge recorded their *Iron Butterfly* album at Ultrasonic. And, with Fun City being what it is, many studio side men enjoy spending the day away from the smog and the muggings. Furthermore, since some commuting studio musicians live nearby, Ultrasonic may be even more convenient for them than midtown Manhattan.

Earlier this year, Ultrasonic moved from its original location to its new home at 100 North Franklin Street. At this moment, Studio A is completed, to be followed shortly by Studio C, and later on by Studio B. Studio B's control room will be identical to that in Studio A, so there will be no adjustments necessary in moving from one studio to another. Studio C will be quite a bit smaller, and is intended primarily for educational and documentary work, as well as small demo sessions.

The console in Studio A was built by Herman Bear's Audio & Electronic Consulting Services of Butler, New Jersey. It is a full sixteen track board, with 26 inputs and sixteen echo lines.

Yes—sixteen echo lines, each of which feeds its own spring type unit to supply instant echo to any track, or to the monitor system. When higher quality is required, EMT's are readily available, and future expansion plans include the construction of natural reverberation rooms in the basement.

Like other studios, there is, of course, a window between the control room and the studio. However, unlike most studios, the window is seven feet tall! Visitors seated on the plush control room couches enjoy an unobstructed view of the studio, and musicians have the feeling of being in closer touch with their producer and engineer. The isolation booth also features floor-to-ceiling windows, for better visual communication with both studio and control room.

Ultrasonic's architect is James T. Pepper of Edwards and Malone, Garden City, N.Y.

Figure 2. Come through the doors from outside into this lovely reception area.

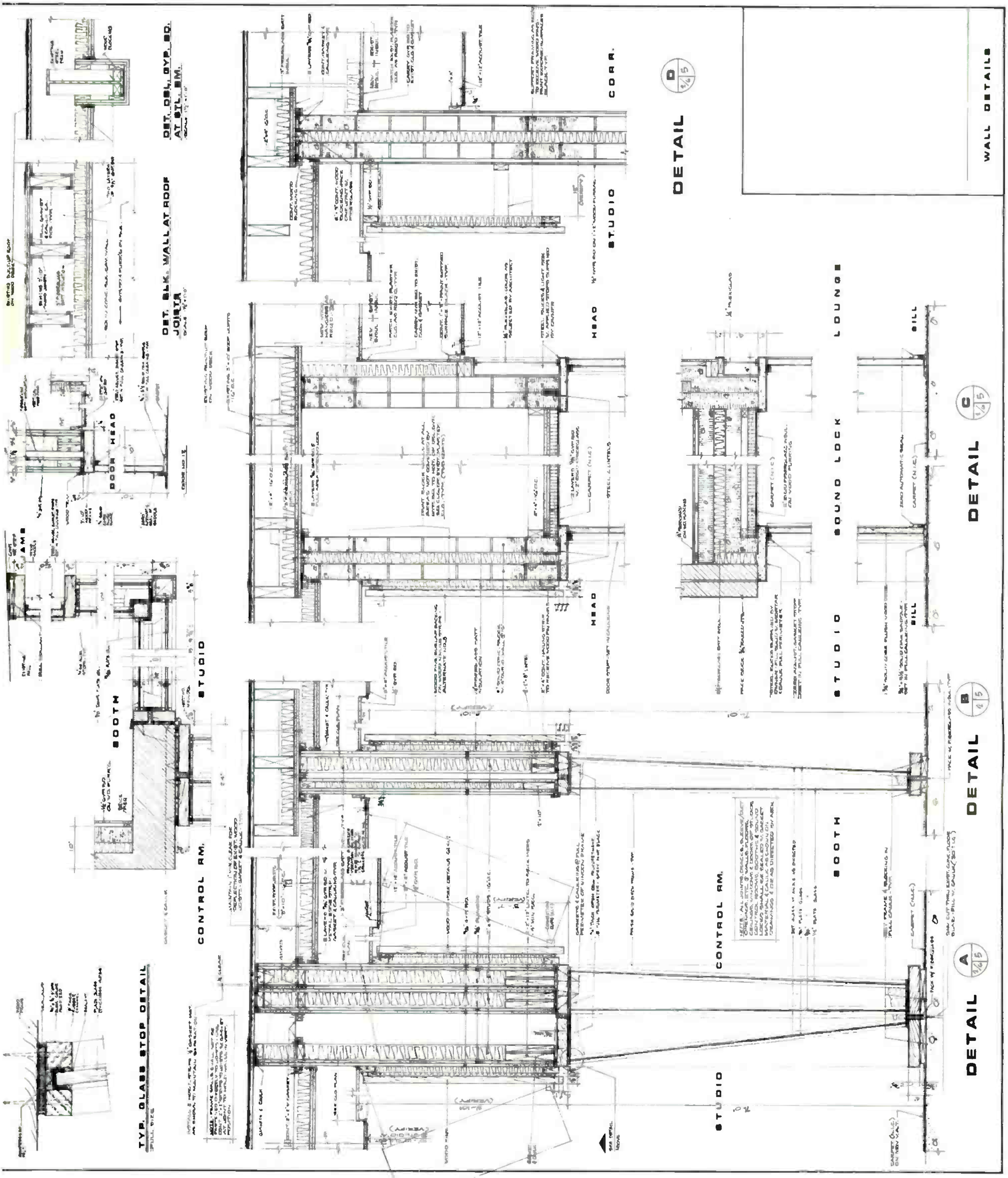
Figure 3. An inner lounge has been created for talent and guests to relax within. Entrance to all the studios adjoin this area.

Figure 4. The main control room's custom-built board is behind a panoramic view into studio A.

Figure 5. Ultrasonic started with Scully machines and has continued with them. The machines are directly behind the console.

Figure 6. The huge studio A does not constrict talent and the large glass areas into master control and isolation areas help.

Figure 7. It all had to begin somewhere. Ultrasonic in its earlier days (in another place) presented a less uniform equipment impression. Do you recognize everything?



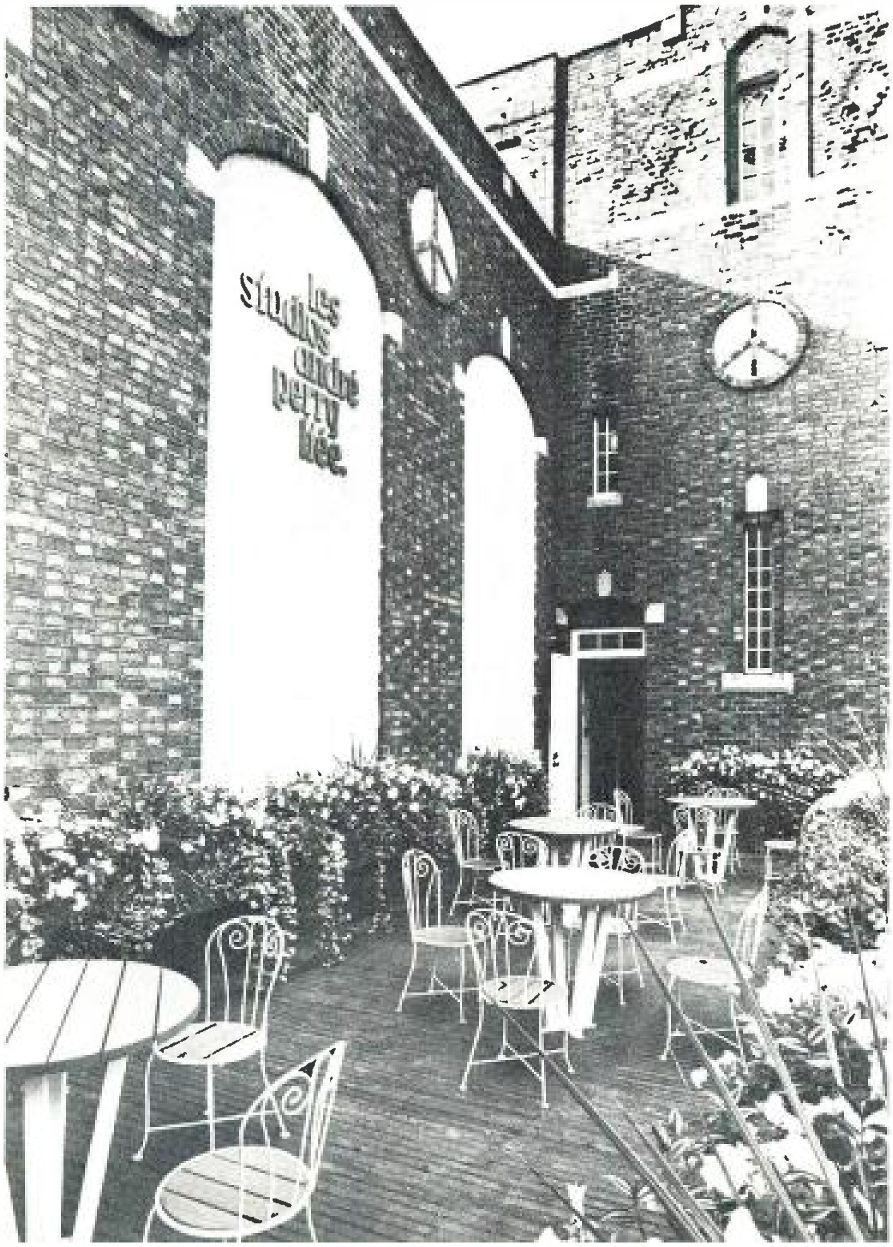
Details of the inner wall construction of Ultrasonic Studios.

db Visits—Les Studios André Perry Ltée

CHURCHES seem to be a very desirable location for any one in the audio field. Media Sound on New York's busy 57th St. is beautifully housed in what was formerly a church. WBAI, after much searching for a new studio center, finally found new quarters in an ex-church on East 62 St., also in New York City. Both Media Sound and WBAI had to do extensive alterations to make the premises suitable for their requirements, but both are more than happy with the results. There is something about a church that challenges the imagination—the possibilities are great and the basic structure is usually much better than anything that could be built today.

One of the latest to buy a vacant church for this purpose is André Perry Ltée. in Montreal, Canada. Located in the former Church of all Nations on Amherst Square, it is in the heart of the French area of downtown Montreal. Much of the church's interior had to be stripped

Figure 1. The original grim lines of the old church have been considerably softened by ingenious touches of flowers and terrace furniture.



because of the poor acoustics, but as much as possible of the building's flavor has been retained. The doors, for instance, are the original heavy, dark wood doors with stained glass inserts. A viewing room window overlooking the main studio carries the shape of one of the arches that used to frame the pulpit. The original light fixtures (an antique collector's dream) hang from massive beams in the main studio and even the little signs that say "Studio A," or "Terrace" are carved wood with old English lettering. One of the big stained glass windows (unfortunately all the others had to be covered for acoustic reasons) sits in a corner of master control. You get the feeling that somebody "up there" is keeping an eye on you!

Aside from the studios and the mix down rooms, etc., Perry has taken over the third floor, that was formerly the minister's living quarters. With much love (and cash) he has made an extremely charming apartment. He also makes excellent cappucino coffee and doesn't need much prompting to serve his guests.

What makes this studio of particular interest is that it is jammed full with some of the most sophisticated gear in our industry. To start there is a pair of Ampex MM-1000's with an interlocking system that allows thirty-two track operation. Facilities are, of course, available for sixteen-, eight- or four-track recording of anything from a sixty piece orchestra to a radio spot. Incidentally, the entire studio is Ampex equipped.

The console is the automated model 2000 by Olive Electro Dynamic and includes an automated remix programmer. This permits the operator to automatically record all console functions and keep them stored on the original master so that the engineer can work on subsequent remixes with an unusual degree of freedom. He can manually modify any track as desired and again have this adjustment memorized without disturbing any other console function.

Figure 2. A view of the control room with the Dolbys on the right the stained-glass window in the center and the studio seen thru the window at left.

Figure 3. Another view of the studio control room. The Olive console and Ampex machines certainly dominate the room.

Figure 4. The remix room is decorated in an unusual manner. Note the ARP synsthesizer in the far corner.

Figure 5. A view of the main studio shows the wall treatment covering the original stained glass windows and indicating the size of this huge room.

Closed circuit t.v. is used to replace projectors for film sound tracks and can also be used for other recording purposes as required. Then there is an ARP synthesizer, a multi-channel group of Dolby units, an EMT chamber, a full complement of Kepex units, and a grand piano and a Mason & Hamlin church harmonium with two keyboards and pedals. JBL monitors are used throughout and AKG, Neumann, EV and Beyer mics are found in great abundance.

Perry has recorded some of the well known names in the music world such as Charles Aznavour, Mireille Mathieu and John Lennon whose *Give Peace a Chance* was recorded by Perry in a Montreal hotel room long before the studio was ready for operation.

With the growth of Montreal as a cultural center Perry looks forward to increasing business both locally and from elsewhere. He estimates that within six months about 40 per cent of his business will come from outside Canada due, in a great part, to his impressive facilities.

db Visits—Whitney Recording Studios

IN A NEAT small building located in Glendale near Los Angeles can be found Whitney Recording Studio, Inc. It's not a new building, but inside can be found a thoroughly modern establishment.

It all began in 1955 when the building was begun from the ground up with plans which were popular at the time. Studio A began life as an organ studio with a large four-manual Robert Morton Pipe Organ (34 ranks of pipes) installed. It's still in use.

According to owners Lorin J. Whitney and Aimee C. Whitney and chief engineer Frank Kejmar the studio was leased to the Walt Disney Music Company for two years beginning in 1956 and many of the Disney albums released at the time were made here. When an offer by Disney to buy out the studio was refused, Whitney began to rent out space to commercial and religious organizations. That's the primary business today. There are now two studios in use.

Studio A control is today equipped with a Rupert Neve console equipped with 24 complete input channels and two submasters making a total of 36 mic input capability. The console is set up with four echo send channels with eq—with a maximum of eight echo send available by using the four cue outputs. There are eight echo returns that may be switched to any or all of the sixteen output mixing busses and independently assigned to the stereo mixdown channels with panpots.

The console came with a complete set of spare amplifier cards and modules and fader. Installation a bit over a year ago took twelve hours, most of which was unpacking time.

Lorin Whitney told us that since using the Neve console for over a year now he has not had to make any modifications to accommodate the present state of the art. It is already set up for quad recording and remixing.

Also within the control room are a 3M sixteen-track recorder, Scully eight-track, and Ampex four-, two-, and full-track machines. There are two stereo live acoustic echo

Figure 1. Studio A master control. The Neve console looks into the studio and permits all corners to be seen. At the extreme left, the sixteen track 3M and eight-track Scully are visible.

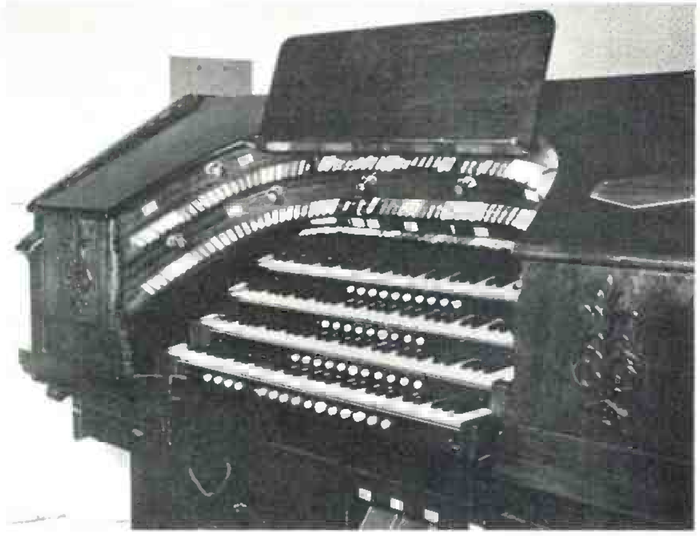


Figure 2. If you want glorious pipe organ sound, Whitney can give it to you with this four-manual keyboard located in Studio A.

Figure 3. Twelve open reel Ampex slaves can turn out a lot of per-hour copies. Not shown are the master machine and the Pentagon cassette duplicating equipment, also located in this room.

chambers and three EMT stereo plates. Dolby and Kepex equipment is used.

Studio A itself is a 45- by 35-foot room with a 14-foot ceiling. It is dominated by the huge organ at one end. But there are also a Steinway B grand, a celeste, and a Hammond organ with Leslie speakers.

Studio B is smaller and has its own control room equipped with a twenty-input Electrodyne console with an eight bus output. This studio has its own Hammond and Steinway B.

A separate mastering room has a Neumann computer-controlled disc mastering lathe with the SX 68 cutter and VB-66 solid-state driving package. Dolby noise reduction units are used.

Whitney Studios also has a complete tape duplicating facility. This includes Ampex high-speed master equipment that drives up to twelve slaves used to make multiple copies. In addition, Pentagon cassette dubbing equipment is used to duplicate cassettes for educational customers.

We only partly convey the attractiveness of the Whitney setup. Located near enough to the central Los Angeles business areas, it offers the conveniences of suburban location with the practicality of big-city nearness to talent. ■

Martin Dickstein

SOUND WITH IMAGES

Video Tape Recorders

● As anyone involved in some way with audio is aware, a tape machine made by one manufacturer is not the same as one made by another, but at least there is some similarity, and a tape made on one machine can be played on anyone else's similar type machine.

In video, this has not been so. There are 3 widths of tape used, 2-inch, 1-inch and ½-inch. The widest tape is generally used for color and for broadcast applications because it is capable of higher band width (frequency response) than the others. The 1-inch is used in industry, education, and in semi-professional applications where highest quality is not obligatory. The narrowest tape is used, generally in schools, field coverage (outside of a permanent location) where the equipment for wider tapes is too cumbersome, and in rough shooting where speed and flexibility with battery operation are essential. So far so good, but it is not that simple.

Video recording, which, incidentally, uses the same general principle of recording as audio, is relatively new, having started in the middle of the 1950's when the first machines came out for broadcast use only. Originally, each unit may have cost in the neighborhood of $40-70,000. Today, with the introduction of color and additional features, a unit may cost closer to $125.000. Professional units which have been traded in for more up-to-date machines are still available for $20,000 or more depending on age, features and capabilities on an "as is" basis (purchaser to make his own arrangements for shipping from present location).

Since broadcast video recorders had to meet previously set standards for picture quality, resolution, color, technical compatibility with broadcast transmitting and receiving equipment, artistic capability to compete with live presentations, etc., all machines for this application were made according to these standards. The width is 2-inches to permit the recording of the broad bandwidth required for broadcast color.

In time, viedo recorders were made for consumer markets and for home use with the price now down below $900. Tape was made in the 1-inch and ½-inch widths, and most recently a machine was offered to the consumer (school, business, etc.) using ¼-inch wide tape. Where good quality is required (but not broadcast) the 1-inch is used. A sacrifice in resolution would permit the narrower tape to be used. For each width, the manufacturers found a way to achieve the quality they wished and thought the market would buy, but each system was unique unto itself.

In order to achieve the high frequency capability required for video recording, a high relative speed between the tape and the head had to be accomplished. The relatively slow 30 in/sec. for audio professional work would not suffice when the bandwidth had to be well over 2 MHz as compared with audio's top of about 20 kHz.

Basically, there are three ways to arrive at a high relative speed between the tape and the head. One method would require that the head be rotated at high speed and the tape could then move past it rather slowly. Another means would be to move the tape very rapidly with the head revolving rather slowly. The third way would be to achieve the relative speed by a compromise in both.

The first method is used to achieve the resolution and picture quality required by t.v. broadcasting. A quad-head (four separate heads on the same rotating assembly) are spun at 14,400 r.p.m. The 2-inch tape moves at 15 in/sec. and the video information is recorded almost perpendicularly across the tape width. This transverse method permits the recording of color detail on the whole width of the tape. except for the audio and sync tracks which are also put on, and clean editing.

The second method would require a tape speed, for fairly good quality, of about 160 in/sec. and a special tape handling assembly would then also be required. This longitudinal method has not become very popular at all. The last method was the one adopted for home and industrial, as well as educational, application. Quality requirements were met satisfactorily and the cost was moderate, ranging from about $795 to $4,000 depending on features and capability.

To achieve the sufficiently high relative speed between the tape and the head (sometimes called the video writing speed), a revolving drum with either one or two heads is used. Speed of rotation is in the neighborhood of 3600 r.p.m. and the horizontal velocity of the tape ranges from 6.5 to 12 in/sec. (One manufacturer uses a speed just over 11 in/sec.; another is at 9.6; still another is at 7.8; another is at 7.5; and yet another is just under 7 in/sec.) The combination of speeds help to determine the "frequency response" and the resolution of the machine, but since there is no standardization, each maker is free to choose a feasible combination resulting in satisfactory operation.

One general restriction is that the tape can not run as it does in an audio machine but must be wrapped around the rotating drum in a manner similar to the Greek letter Omega (Ω). To accomplish this as much as possible the machines are made with one reel (usually the take up) slightly higher than the other and in some cases it is above the supply reel. As the tape makes its pass around the revolving head, the path taken by the head across the tape is in the shape of a long sweeping diagonal line. This helical scan method covers almost the entire width of the tape, whether it is 1-, ½-, or ¼-inch leaving only the space required by one or two audio tracks (again depending on the maker and the model) and the sync control track, along with the guard bands which separate the two tracks that are on the same edge of the tape and the outside of the tracks from the edge of the tape itself. The location of the audio tracks on the tape, whether on top or on bottom, varies between manufacturers.

One thing that is common to all 1-inch and under video machines, however, is that the audio and control heads are stationary, but they are not necessarily put at the same location by each of the makers. Positioning depends on where on the tape the signal will go. Other similarities and differences might include the output provided by the units. Some may have outputs from modulators which permit feeding directly to a non-used channel on the standard t.v. set while others can feed only to monitors or "jeeped" t.v. sets.

In some instances, machines made by the same manufacturer can dub to and from each other without any problem, while for some other manufacturers this is either not possible at all or only between certain models. Across the country, facilities have been built up specifically for the purpose of dubbing from one maker's models to any other maker's units.

Editing, that is, physically cutting the tape and splicing cleanly, is an impossibility in helical scan machines. Since the frame is actually recorded in a very long diagonal sweep, the cut would have to follow the line accurately right down the "groove" for a clean cut, but even if the cut were made in the clear between images, there would still be roll over. Editing used to be done on the 2-inch transverse machines, but now almost all work is done by switching automatically by preset computer settings between *A*, *B*, *C*, . . . rolls of tape. These cuts are made cleanly.

The 2-inch tape systems have been made according to set standards since it began. There has been no standardization in the 1- or ½-inch formats until this year. Now the ½-inch format has been set up by Sony, Philips, and others and it looks as if all makers of the ½-inch tape machines will conform in a short time to this EIAJ specification. Tapes made on any machine within this format will be playable on any other unit which conforms, just as audio.

However, there is still no standardization in the 1-inch medium. It is, therefore, essential that this fact be taken into account when recommending video equipment, especially recorders, to a client. Is it necessary to match other systems in the organization? Is overseas operation a factor? Do tapes get sent out throughout the country? Is there any other machine in the company and is dubbing necessary, or can one tape be played on other machines? Is 1-inch needed or is ½-inch sufficient? Will there be editing? Will slow speed and/or stop action, which is available on some machines but not others, be necessary for the intended application of the recording system. Consider that at present, the wider the tape the higher the resolution—but is higher resolution necessary in this particular installation? Also, remember there is compatibility within a manufacturer's line, but not between manufacturers.

One more precaution. In cleaning heads on an audio machine, it might be as simple as using a cue-tip and head cleaner. As the heads are stationary, this is easy. However, on a video machine, the head is spinning at very high speed and it is very small and projects a very short, but sharp, distance. In a careless moment, the cotton can catch the head and leave a thread, or worse, damage the head —a possibly costly mistake. Keep your head clean, but make sure you keep it working well. Keep your head. ■

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PEOPLE, PLACES, HAPPENINGS

• **Morley Kahn** has been appointed vice president, manager of U.S. operations for **Dolby Laboratories.** Headquartered in New York City, he will have over-all responsibility for the sale of Dolby A professional noise reduction equipment, liaison with existing and potential Dolby B circuit licensees as well as promotional coordination with the London, England office. He comes to Dolby Labs from **Dynaco, Inc.** of Philadelphia where he was sales manager.

• A series of clinics have been established by the special applications products group of **Superscope. Elliott Davis,** product manager for Sony products for Superscope heads the division which has been especially created to handle the microphone and tape recorder units utilized by professional people in broadcasting, recording, sound reinforcement, etc. The clinics, headed by **Fred Dellar** will provide complete technical information on the products to those attending the clinics. The first dates are being set in the Los Angeles area, home base for Superscope. Plans are underway to provide this service to all dealers wishing to participate and a full schedule is planned for the coming months.

• Appointment of **Neil R. Vander Dussen** as division vice president, broadcast systems, in the **RCA communications systems division** (Camden) has been announced by **Andrew F. Inglis,** division v-p and general manager. In his new capacity Mr. Vander Dussen will be responsible for RCA's radio-t.v. broadcast equipment business, including sales, product management, engineering and support activities. He was manager of studio equipment engineering and product management, broadcast systems, for the year preceding his promotion.

• Purchase of the manufacturing and sales rights to a line of audio tape recorder test equipment has been announced by the **Mincom division** of **3M Company.** The rights were acquired from **Data Measurements Corp.,** of Palo Alto, California. The purchase also included an inventory and rights to continue to use for a limited period the tradmarks **DMC** and **Micom.**

• Two educational courses will soon be offered by the **Institute of Audio Research** in New York City. Designed for those interested in professional recording careers, these courses have developed a successful reputation for the training of mixing and recording engineers with most of their graduates currently employed in the field. On January 10th they will begin a course of ten-week's duration entitled **Studio Technology and Practice** which covers most important aspects of advanced recording technology.

On January 17th they will offer a more advanced course, **Audio Systems Design.** This will be a three-and one-half week seminar that will teach the best means of utilizing available components. It will also focus on application design for establishing proper operation parameters of the chosen components.

For details on registration dates, fees, etc., write the **Institute of Audio Research, 156 Fifth Avenue, New York, N. Y. 10010.**

• A touring bus has been sent out by **Lowell Manufacturing** to promote to the trade their line of sound products. The 24-foot travelling show room will serve to bring the Saint Louis, Mo. company to its distributors around the country. The first trip, now under way, has embarked on a month-long tour of the south-eastern states. We assume that other directions will be taken in the future. The drivers are key company home-office staff personnel. They will travel in relative comfort since the bus is equipped as a home on wheels with shower, wash basin, lavatory, refrigerator, stove, air conditioning, a sound system, mobile telephone, water supply, and heating system.

• **Arthur H. Hausman** has been elected to the newly-created position of chief operating officer of **Ampex Corporation,** it was announced by **William E. Roberts,** chairman and chief executive officer. The appointment was approved by the Ampex board of directors and announced at the company's annual shareholders meeting. The new top echelon of the company goes like this: Mr. Roberts continues as president, chairman, and chief executive officer. **John P. Buchan** and Mr. Hausman will now share the chief executive officer responsibility with him. Decisions requiring top officer action can be handled by any one of the three.

• **Tonus, Inc.,** manufacturers of the **ARP Synthesizer** line has taken on a new company name and logo. The logo is shown, and the name, appropriately enough, will be ARP Instruments, a Division of Tonus, Inc. The Soloist a compact synthesizer for amateur and performing musicians is the first product to bear the new logo. The logo was designed by **Margaret Shepherd, Friendly Ink Studios.**

attention overseas readers

The slow delivery of each month's issue to overseas addresses often results in the return of reader service cards that have passed the date of their expiry. As the processing computer is trained to reject such cards, overseas readers wanting information are not always receiving it.

You should check the expiry date on the reader service card. If the date is close, and you must allow the time for mail service back to the address on the card, we can only urge that air mail be used.

The new Revox A77 Mk III.

It's still not perfect.

Nothing is.

But the new A77 Mark III is certainly the best recorder Revox has ever made. And that's saying something.

The Mark III is an improved version of our critically acclaimed A77. The recorder that The Stereophile magazine (1-71) described as, "Unquestionably the best tape recorder we have ever tested . . ."

And that judgement is as true now as it was then.

However, at Revox we've never been content to rest on our laurels. We thought we should make the best even better.

But in bringing out a new model, we didn't discard all of the time tested features and superior performance that distinguished the original A77.

Instead, we made only those changes which would meaningfully improve performance and reliability.

Not a radical transformation, but a program of rational development.

As a result, you have to examine the new A77 Mark III rather closely before you see any external differences at all.

On the other hand, from the moment you start to use the new Revox, you'll begin to appreciate the changes we've made inside.

For example, we've designed a new oscillator circuit for greater efficiency and lower distortion. Modified and strengthened the self-adjusting braking system. Devised a new hardening process to reduce capstan wear. Improved tape handling and spooling. And made a number of other changes. A total of eighteen . . . some major, some minor.

All in all, we haven't created a revolution.

We've just done what we set out to do . . . that is carry the art and science of tape recording a few steps closer to perfection.

And, in the process, we've given you eighteen more reasons why . . .

REVOX
delivers what all the rest only promise.

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