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THE SOUND ENGINEERING MAGAZINE

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"Unequivocally, this is by far the best text on microphones we've ever seen."— **Stereo**

"So well written that it can be clearly understood by a non-technical person; for the professional it will probably be one of the most-used books in his reference library."— **Journal of the SMPTE**

And the rave reviews go on and on. "At last...a decent book on microphones," said David Lane Josephson in *Audio*. "Excellent chapters on various aspects of microphones, which are discussed in great detail," said Werner Freitag in *The Journal of the AES.*

They're applauding **Microphones: Design and Application**, by Lou Burroughs, who has written this practical, non-theoretical reference manual for everyone involved in the application of microphones for tv, motion pictures, recording and sound reinforcement.

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Along with down-to-earth advice on trouble-free microphone applications, Lou Burroughs unfolds dozens of invaluable secrets learned during his more than three decades of achievement in the field. He solves the practical problems you meet in everyday situations, such as:

- When would you choose a cardioid, omni-directional, or bi-directional mic?
- How are omni-directional mics used for orchestral pickup?
- How does dirt in the microphone rob you of response?
- How do you space your microphones to bring out the best in each performer?

"The chapter headings give a clear idea of the down-to-earth contents of the book . . . each chapter contains advice, direction, suggestions and warnings couched in the clearest and most unambiguous language possible." *(Journal of the SMPTE.)* Here are all 26 chapters.

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Coming Next Month

● Microphones get close scrutiny in the July issue.

Robert Schulein has contributed an article on the present status of the electret microphone. Its come a long way and is truly a professional device now.

The Calrec Sound Field Microphone system is explained by E. Howard Smith. This system has been attracting a lot of favorable attention recently.

Microphone Preamplifier Noise is explored by Joseph W. Dorner. What do the laws of physics permit?

A directory of electret microphones is in the assembly stages.

In fact, there is so much that not only July, but August will be special issues on microphones and other transducers. All this is coming in **db, The Sound Engineering Magazine.**

About The Cover

● Nestled almost within the shadow of the mammoth Las Vegas Hilton, a handful of seemingly small antennae signal the nearby presence of broadcasting activity. For a closer look at these antennae and other broadcast items, see our coverage of the NAB show, beginning on page 40.

db
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db Letters

THE EDITOR:

I would like to call your attention to Patrick Finnegan's column in the March, 1978 issue of **db** Magazine entitled "Tape Recorder Measurements." On page 8 you state:

To adjust the bias for optimum, set up and record at 10 or 15 kHz tone on a blank tape. Observe the audio output of the playback unit while recording, and adjust the bias for peak audio output.

I sincerely hope that some editor misplaced your next sentence, which should read something to this effect: "Continue to increase the bias until the audio output level has dropped about 5-6 dB (at 7.5 in/sec)."

As anyone who works with tape recorders can tell you, the point of maximum audio output with this method will yield some rather poor results in actual operation. To my knowledge, all tape recorder manufacturers (as well as tape manufacturers) recommend a 5-6 dB drop in output above the peak (overbias) as being the proper operating point. At 15 in/sec this reduces to about 4 dB and at 3.75 it increases to about 7-8 dB.

GORDON S. CARTER
WFMT
Chicago, Ill.

Mr. Finnegan replies:

There was no omission on the part of the editors, nor error on my part. The way it is written is exactly the way I do it.

I have never heard of overbiasing to the point where the audio falls off as much as 8 dB! A small amount of overbiasing will help compensate for different tapes, but that is up to you. Our operations have 25 tape machines in daily operation. These represent four of the top broadcast recorder manufacturers' products; all recommend peak on the bias (at 1 kHz).

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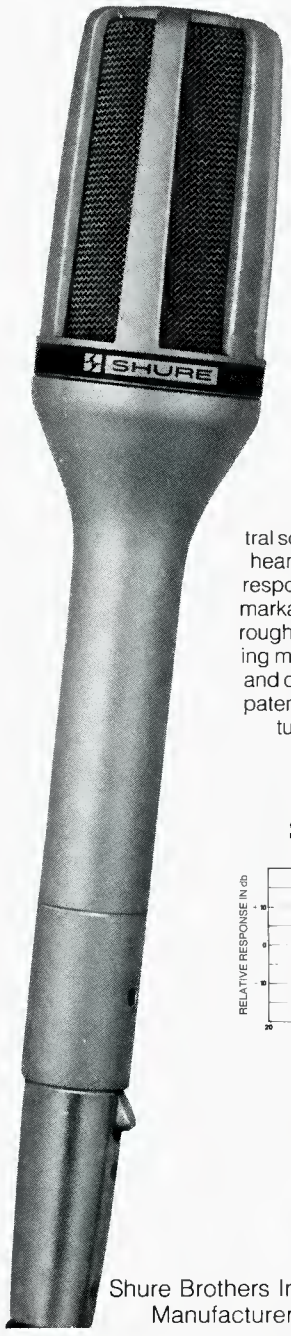

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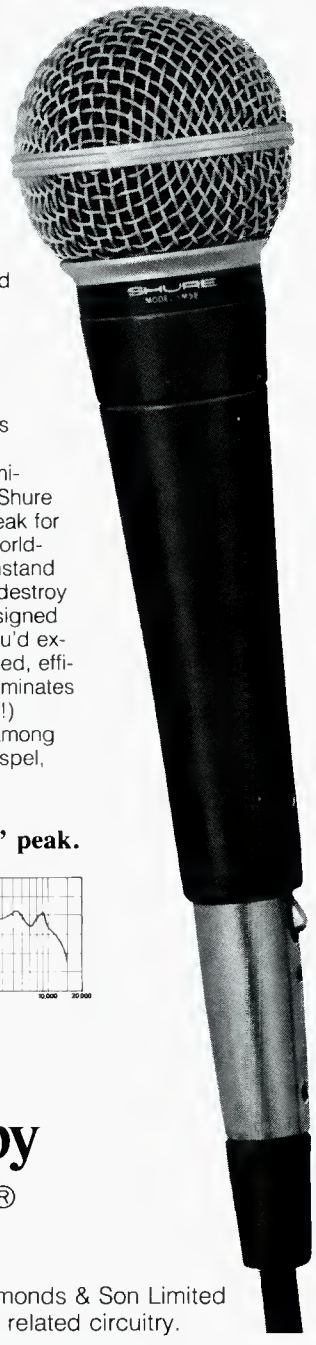
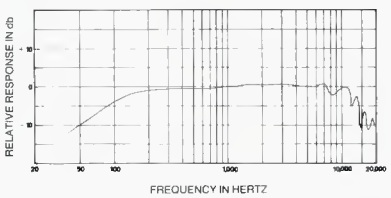
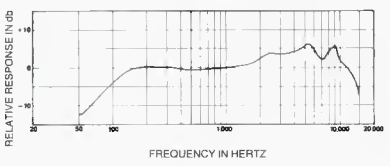


Some like it essentially flat...



...some like a "presence" peak.



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db Calendar

JUNE

9 **NRBA Sales Management Seminar.** Welsh Company, Tulsa, Okla. Contact: NRBA, Suite 500, 1705 De Sales St., N.W., Washington, D.C. 20036. (202) 466-2030.

9, 10 **Industrial Sales Workshop,** for manufacturers, distributors, representatives. Hartford Graduate Center, Hartford, Conn. Contact: Hank Lavin, Box 159, Cheshire, Conn. 06410. (203) 272-9121.

11-14 **Consumer Electronics Show.** Chicago, Conrad Hilton Hotel, McCormick Place, McCormick Inn. Contact: CES, 2001 Eye St. N.W., Washington, D.C. 20006. (202) 457-4919.

New York Management Seminars. Contact: Heidi E. Kaplan, 14NR, N.Y. Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

1, 2 **Unlocking Creativity.** NYU. Chicago.

5, 7 **Project Management for Engineers.** NYU. Houston, Texas.

8, 9 **The Federal Procurement Process.** U. of Chicago. Los Angeles.

12-14 **Management of New Technology Projects.** NYU. Chicago.

21-23 **Effective Communications for Engineers.** NYU. New York.

22-23 **Industrial Noise Control.** NYU. New York.

22-24 **Understanding Finance for Mfg. & Production Mgmt.** NYU. Chicago.

26-27 **Project Management.** U. of Pennsylvania. London, England.

21-23 **International Exhibition of Professional Recording Equipment.** Connaught Rooms, London, England. Contact: Assoc. of Professional Recording Studios, Att. Mr. E. L. Masek, 23 Chestnut Ave., Chorleywood, Hertfordshire WD3 4HA, England. (Rickmansworth 72907).

26-8/4 **Summer School, New England Conservatory of Music,** including an Electronic Music Workshop, with a portion for the secondary school music educator. Contact: Robert L. Annis, New England Conservatory of Music, 290 Huntington Ave., Boston, Mass. 02115. (617) 262-1120.

(continued)

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calendar (cont.)

JULY

2-30 **Montreux Music Encounter.** Jazz, Audio Engineering, Business seminar in the Swiss Alps. Contact: School of Music, University of Miami, P.O. Box 248165, Coral Gables, Fla. 33124.

10, 11, 12 **J.B.L. Seminar,** design and installation of sound reinforcement systems. Contact: Ms. Nina Stern, James B. Lansing Sound, Inc., 8500 Balboa Blvd. Northridge, Ca. 91329. (213) 893-8411.

12, 13 **NYU Seminar,** New Products: A Systematic Approach. New York. Contact: Heidi E. Kaplan, Dept. 14 NR, N.Y. Management Center, 360 Lexington Ave., NYC. 10017. (212) 953-7262.

17, 18 **NYU Seminar,** New Products. Toronto, Ontario. Contact: See above.

AUGUST

Management Seminars. Contact: Heidi E. Kaplan, Dept. 20 NR, N.Y. Management Center, 360 Lexington Ave., New York, N.Y. 10017. (212) 953-7262.

3-4 Foreign Market Entry Strategies. Wharton School, U. of Pennsylvania. Washington, D.C.

7-8 New Products: A Systematic Approach. New York University. Los Angeles.

14-15 The Effective Engineering Manager. New York University. Houston, Texas.

17-18 Unlocking Creativity. New York University. New York City.

13-17 **British Musical Instrument Trade Fair.** Bloomsbury Centre Hotel; Hotel Russell; Connaught Rooms, London. Contact: British Information Services, 845 Third Ave., New York, N.Y. 10022. (212) 752-8400.

11 **National Radio Broadcasters Association Management Seminar,** Welsh Company, Tulsa, Oklahoma. Contact: NRBA, Suite 500, 1705 De Sales St. N.W. Washington, D.C. 20036. (202) 466-2030.

14-16 **J. B. L. Sound Reinforcement Workshop,** Kansas City. Contact: Nina Stern, James B. Lansing Sound, Inc., 8500 Balboa Blvd., Northridge, Ca. 91329. (213) 893-8411.

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PATRICK S. FINNEGAN

db Broadcast Sound

Audio Matching Devices

• Audio units should have their input/output impedances matched correctly if the system is to operate properly and distribute the audio signal efficiently. Although most units incorporate matching ability within themselves, we often find ourselves in situations where this will not suffice and must resort to some external matching device. The two most common passive devices used for matching impedances are the transformer and the resistor pad. This month, we will discuss some of the aspects of these devices and their use.

IMPEDANCE MATCHING

An audio unit is designed to deliver a given signal level into a prescribed load impedance. But the unit can do this only if it has the correct signal level at its input terminals. The signal level which arrives at the unit's input is dependent to some degree upon the impedance the input presents as a load to the driving unit. So consequently, if we want the unit to operate in the manner for which it was designed, as well as to operate properly in our system, we must give due concern to both the input impedance of a unit and its load. It is important that every unit in the system be properly matched in impedance with the preceding and following unit—from the signal source to the output of the system.

Mismatching may occur at any place in the system when we install or replace units or make temporary patch-ups. The mismatch could occur around a single unit in that both its input and load impedances are incorrect, or it could be that the input impedance of a unit is wrong, presenting an incorrect load to the driver or to any impedance interface between two units in the system.

When the impedances are not matched properly, the audio units involved and the audio signal passing through them will be affected in some manner—depending upon the circumstances and the degree of mismatch.

Figure 1. Some important transformer formulas, all related to the turns ratio.

$$\frac{N_P}{N_S} = \text{TURNS RATIO}$$

$$\frac{N_P}{N_S} \begin{cases} = \dfrac{E_P}{E_S} \\ = \dfrac{I_S}{I_P} \\ = \sqrt{\dfrac{Z_P}{Z_S}} \end{cases}$$

N = NUMBER OF TURNS
P = PRIMARY
S = SECONDARY

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Some results of mismatch could be signal levels that are too high or too low at the point of mismatch, a unit operating outside its parameters and introducing noise or distortion, or the bandpass affected due to reactive elements in the mismatch point reacting to high audio frequencies differently than the low audio frequencies. Some circuits have a greater tolerance for some degree of mismatch without serious signal degradation, yet other circuits are more critical.

TRANSFORMERS

A very common device used for impedance matching is the transformer. This may be the conventional primary/secondary type, or it may be an auto-transformer; the conventional type is more common.

The number of turns on the primary, the number of secondary turns, and the coupling between the windings are what affect the impedance transformation. The transformer can be wound with the appropriate number of primary and secondary turns to suit the specific requirements. Those most commonly used for matching are designed around standard impedances.

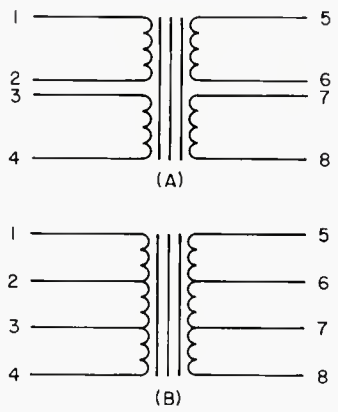

Figure 2. The styles of matching transformer windings. (A) shows separate windings, (B) continuous, but tapped, windings.

Matching transformers of the conventional type more commonly available have two different styles of windings. In one style, the primary has two separate sets of windings and the secondary has two sets of windings. These are brought out to terminals so that we can externally connect the windings in series or parallel combinations to select the impedance matching desired. The other style has a continuous winding on the primary and a continuous winding on the secondary, each with several taps that are brought out to terminals. With this style, we simply select the pairs of terminals assigned to the impedance value desired.

ADVANTAGES & DISADVANTAGES

The first advantage of the transformer is its ease of matching the impedance of two audio units by selection of the proper taps. But of course, the impedances we wish to match must be those for which the transformer is designed. This is no real problem since transformers can be obtained which are designed for the usual audio impedances.

The second advantage of the transformer for matching is that there is no direct connection between the two audio units except the magnetic coupling of the windings. This provides isolation in cases where ground loops or other differences could create hum or noise problems in the audio signal.

A well designed transformer is expensive; this could be a determining factor in its use in certain instances. Less expensive units are available, but there is a trade-off in quality. This may show up in a poor response curve and non-linear phase shift across the audio bandpass. In some applications however, such a transformer can be used successfully.

Besides transforming the impedances of the circuits, the signal voltages are also transformed to different values. There can be a one-to-one voltage transfer, or a step-up, or step-down voltage action according to the impedance transformation selected. This could be a disadvantage in some applications. But aside from this and the bandpass problem, a well designed transformer has an insertion loss of about ½ dB acros the audio bandpass.

RESISTOR PADS

The other most common device used for audio impedance matching is the resistor pad. These have the advantage of linear phase shift, and the cost is often less than the cost of a transformer—especially when we build our own pads. The main disadvantage of the resistor pad is its insertion loss, although in many cases the loss is as desirable a feature as the matching. Resistors consume power, so there will always be a loss much greater than when a transformer is used. The loss of signal level caused by the pad depends upon its construction and the impedance values we wish to match. We should point out that there are several different types of pads intended for different uses. The resistor ar-

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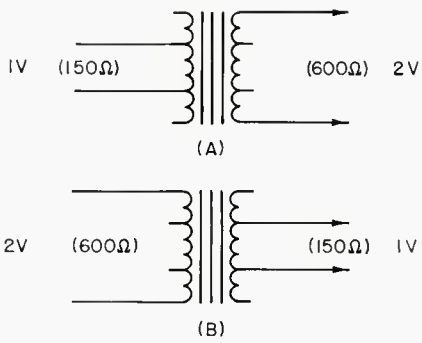

Figure 3. The voltage is transformed along with the impedance. In (A) there is a voltage step-up; in (B) there will be a voltage step-down.

rangements and values are different in each of these types. When matching is the primary feature desired, then use the *minimum loss* matching pad.

Resistor pads can be used in either balanced or unbalanced circuits. The positioning of the resistors is different in these two applications. When minimum loss matching is the desired function, then the "L" pad or the "U" pad should be used. The "L" pad is for unbalanced circuits, the "U" pad for balanced circuits. But if loss is the main feature besides matching, then the "T" or the "H" pads are more common.

BUILDING PADS

Formulas can be found in many textbooks and reference books to help you compute the values for different pads and loss values. You will often find charts for loss pads in equipment catalogs in which the values have already been worked out for you. In all these cases, the resistor values are for the unbalanced pad. In the majority of broadcast applications, balanced circuits are used so a balanced pad should be used. It is a simple matter to convert an unbalanced pad to a balanced pad. Go ahead and determine the resistor values required for the unbalanced pad. Simply divide the value of the resistor in the series arm in half and place half the resistance value on each side of the balanced circuit. Assume, for example, you want to convert the "L" pad to a "U" pad. The series arm resistor value in this case calculates out to 470 ohms. To make the "U" pad, divide this value in half, which results in a value of 235 ohms. Place 235 ohms in each series arm of the pad. The shunt resistor remains the same value.

Once you begin computing resistor values for pads, it soon becomes obvious that the odd values required do not match up with standard resistor

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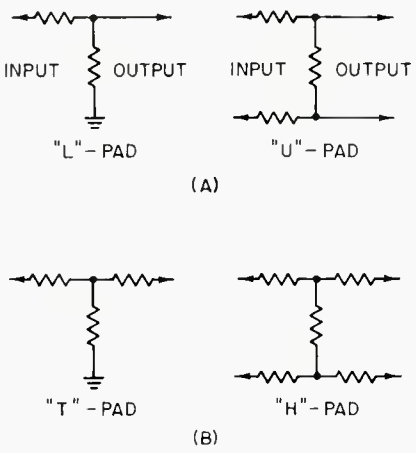

Figure 4. Use minimum loss pads for matching only, others for matching and loss. (A) shows the unbalanced and balanced minimum loss matching pad. (B) illustrates typical loss pads.

values you find in the resistor stock. Use the standard values which are the closest to the calculated values (series some values if necessary), but match the values on both sides of the circuit. The practical effect of the pad you have constructed is that the calculated loss will be off a few dB's and the match will not be quite as good. But for many applications, these pads are entirely acceptable. In some situations where the loss value and the match requirements are more critical, use the commercial precision pad.

SIGNAL LEVELS

Matching impedances between two audio units provides the most efficient transfer of signal between the two units. But when we use an external matching device, there will be some signal loss—from the insertion loss, or the transformation loss. The insertion loss of the resistor pad is greater than that of the transformer because the resistors consumer power. The transformation loss is caused by the impedance change and the resulting voltages. Taking these two factors into consideration, the application often dictates what type of matching device can be used.

Since the resistor pad produces the greatest loss, a circuit which is marginal in terms of signal levels, or signal to noise ratio, may require use of the transformer. Although resistor pads can be used to match balanced/unbalanced circuits, they aren't as effective as the transformer. In some cases of noise or hum problems, only the transformer will work effectively. The pad maintains direct connection between the two circuits and can't balance out the noise as well as the transformer with its complete isolation.

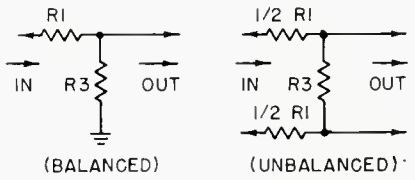

Figure 5. To convert an unbalanced pad to a balanced pad, place one-half of the required series resistance of the unbalanced pad in each side of the balanced pad.

But on the other hand, loss, as well as matching, may be a predominant feature. For example, you may desire to couple a 600 ohm program line with its +8 dB signal level into a 50 ohm microphone preamplifier. Not only do you want to match the impedances in this case, you also want to introduce a serious signal level loss. In some cases, you may need to use a bridging transformer for its matching, loss, and circuit isolation, plus a pad for additional loss.

POWER

In most of the impedance matching situations, we deal with signal power that is in the milliwatt regions or lower. But when working with loudspeakers or similar applications, we deal also with signal power. So consequently, the matching transformers or resistor devices must have adequate power rating for the anticipated power in the circuit.

Higher power requires larger transformers than do low power circuits. In speaker applications, the wire in the windings must be of a larger diameter to safely carry the higher currents involved. Resistive controls will also be larger so as to dissipate the greater heat developed. Ignoring the power in the circuit and the wattage rating of the components, will soon result in finding those under-rated components burned up.

RECAP

To effect the proper impedance match among units of the system and distribute the signal efficiently, we must often resort to external impedance matching devices. Transformers and resistor pads are most often used. Each type has its advantage or disadvantage, according to the particular application. When dealing with audio power circuits, be careful to use components of adequate power rating. ■

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NORMAN S. CROWHURST

db Theory & Practice

A Loudspeaker Substitute

● Several columns this year have addressed the problem of producing authentic reproduction in various environments. From these discussions, it became evident that what is an ideal loudspeaker system (whether mono, stereo or quad) in one environment may sound quite awful somewhere else.

We also showed how sometimes it is possible to use features of the environment to help get the desired authenticity, rather than having it fight you. In earlier columns, I have discussed size versus efficiency and frequency range, both low and high. By now, regular readers of this column should know that, in audio as well as in every other walk of life, you never get something for nothing.

Changing the subject, in these days of inflation many entrepreneurs have made profitable business out of getting rid of the middle man. Now, before you think this column is going to plunge into an economic discussion, have you ever considered that in the context of audio, a loudspeaker is, in a sense, "the middle man?"

The Rolen Star audio transducer. It weighs two pounds.
(Photo courtesy Golden Sound.)

Perhaps, like me, you have been as unaware of the effect of the middle man as is the average housewife shopping at the corner grocery store. All she sees is the price tag put there by the local proprietor. All you hear is the sound put out by the loudspeaker in the room where you hear it.

Any loudspeaker designer will know what I am talking about—the problem of matching a moving diaphragm to a radiating acoustic wave, in air. Because of the mis-match between the mass of the moving parts and the air that conveys the sound across the room to your ears, a loudspeaker is not at best a very efficient device. For an input of 10 electrical watts, some 1 or 2 acoustic watts into the room represents a high-efficiency loudspeaker.

A large proportion of this excites the environment into whatever response it makes, while a very small proportion eventually reaches your ears to convey its desired impression to your brain. As we say, that represents the high-efficiency speaker. Most of the modern compacts require 50 or 100 watts to get the same effect. Electrical watts, that is.

The electrical watts are what you pay, the microwatts or milliwatts that activate your ears are what you get for the "money." What you pay gets shared between the loudspeaker's inefficiency in converting electrical energy into acoustic waves and the environment, which is something about which you cannot really do anything except maybe to go into another room.

Looking at it that way, the loudspeaker is the middle man. If you could just get the electrical energy straight to the environment, you would save much of that loss due to the loudspeaker's inefficiency. In case you think that is very bright of me, I must not take the credit. A new product was called to my attention, invented by a man who lives only fifteen miles from where I live and who has it patented.

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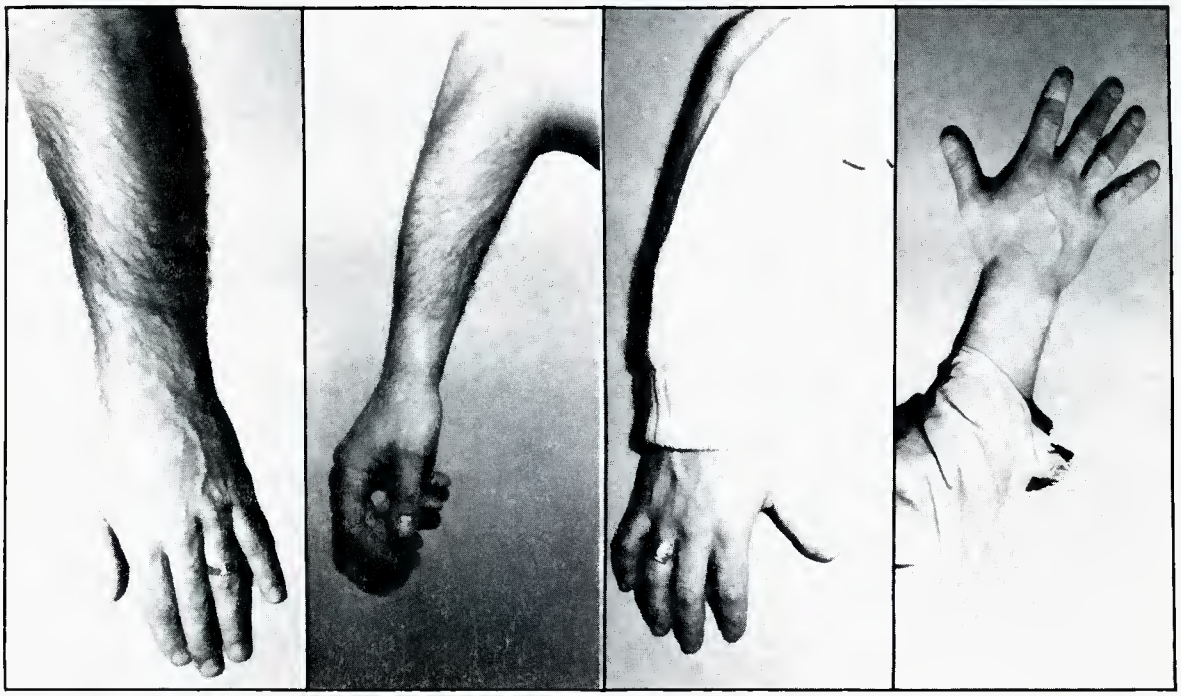

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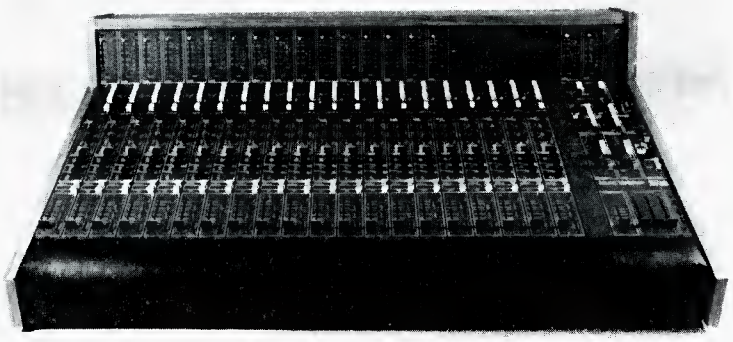

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theory and practice (cont.)

ROLEN STAR TRANSDUCER

It is marketed under the name *Rolen Star Audio Transducer,* put out by Golden Sound, 783 Cessna Street, Independence, Oregon 97351, to whom you should write for the usual commercial information about how to get one or more. I am sure it represents a breakthrough in the realm of sound reproduction, so what I want to talk about here is how what it does, or can do, relates to things with which we are more familiar.

It is another of those many theory or practice questions that this column has gone into in the little over ten years it has been running. The loudspeaker designer has been working with one part of this theory and practice most of his life. He spends time computing the theory to find a way of getting a response that is plus or minus however few dB he can achieve, between, say, 20 and 20,000 hertz. Then he builds the speaker and tests it in an anechoic room, or chamber.

He knows very well that he cannot run these tests in any ordinary room because the environment will completely louse up his response, with standing waves and all kinds of other effects. But he wants to be sure that the acoustic wave that he releases into that environment is as perfect as he can make it, for each environment to affect in its own particular way.

After he has gone through all this, either he, or someone else, is going to judge its performance in a quite subjective way, by listening to it in a variety of actual room environments. But any attempt to measure the overall effect will show that his nice perfect loudspeaker is not doing so well, technically, in that environment.

The only thing that makes all that effort seem worth while is that a loudspeaker which measures good in an anechoic chamber compared with one that sounds poor in there will usually sound better somewhere else, too. But any loudspeaker designer is fully aware that this is far from being the whole story. And perhaps we should mention the fact that many people buy on a basis of specifications rather than using their ears.

Also, there are government agencies and consumer testing facilities who insist on the tests and specifications being accurate, even if anyone really in the know realizes that those tests and specifications do not really mean much when it comes to judging how the system performs under given circumstances.

ENVIRONMENT CONDITIONS CONSCIOUSNESS

As I have also pointed out before, whatever room we are in conditions our consciousness before we even turn the audio system on. We may not realize it because we have been doing it all our lives. But a result of this fact is that if we put on a recording of a performance in Carnegie Hall, we do not expect to find ourselves transported to Carnegie Hall but to hear an authentic reproduction of such a performance in the environment in which we are actually present.

We do not think about it, but if we speak with our eyes shut outdoors or in any of a variety of rooms, the sound of our own voices or of other familiar sounds coming back to us tells us where we are: outdoors, or in what kind of room. Just because we put on a recording made in Carnegie Hall does not take away that consciousness. We are still listening to it in our own environment. So, though we may not realize it, that is what we expect to hear.

But at the same time, we do want the environment to interfere as little as possible. We do want to hear that performance, not the rattling of china in the china cabinet, for example.

The environment will not go away, whatever we listen to, because it surrounds us. But we do like it if the loudspeaker can perform a disappearing trick, so we are not conscious of its presence, only of the sound it brings to us.

SOLID TRANSDUCER

This is where the solid transducer does what the loudspeaker has great difficulty doing. First, because it is designed to move solid materials, requiring more thrust for given velocity, matching is much easier, and efficiency is up, compared with any loudspeaker. A much higher percentage of the electrical watts is converted in vibrational watts on the surface of the environment used to radiate it as sound.

Using conventional loudspeakers, we usually have to kind of work around the environment. This method uses it instead. The transducer itself can be designed to have a flat response, from 20 to 20,000 hertz, with little problem. What introduces deviations in the frequency response will be the paneling or other surface used to radiate the sound.

The theorists will probably reject the whole idea as impractical for this reason. Let me remind them that these features of the environment are there, resonating, reflecting, transmitting, just

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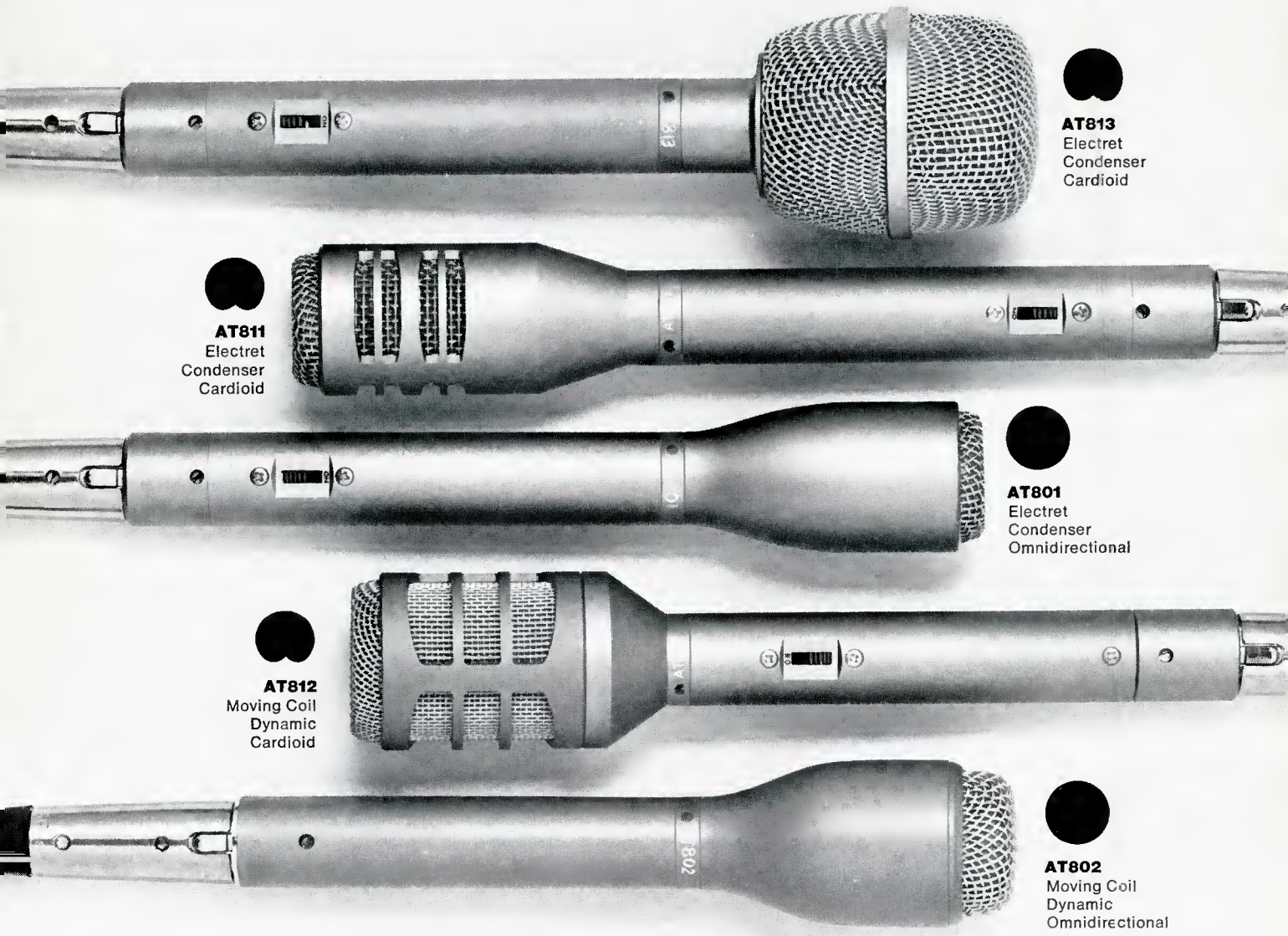

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as frequency-selectively, when you use a loudspeaker in the same room.

When you use a loudspeaker, care in placement is necessary. All too often the position eventually chosen is determined by how it looks as furniture rather than how it sounds best. The transducer looks rather like a thermostat. Many rooms have at least one of these, and few people pay much attention to it unless it needs adjusting for their physical comfort. The rest of the time they forget it is there.

The placement of the transducer depends on using the environmental feature that will work to its best advantage—paneling, ceiling, floor, doors, windows, tables, or whatever. The whole surface of the item on which the device is mounted becomes a radiator; the illusion is that the sound comes through that whole surface. Acoustically, the surface is no longer there!

Using this method to best advantage will require some theory-and-practice type of accommodation to a whole new technique, at which we can only hint in what is left of this column. It opens up whole new challenges.

The mechanical thrust, transduced from the electrical input, is applied between the surface to which it is mounted, and its own two-pound mass. Thus as a basic concept it is extremely simple, although some technical details which are the subject of patents covering it had to be resolved. It is completely sealed, which makes it more attractive than the conventional loudspeaker in environments where the atmosphere might be corrosive, for example.

PRACTICAL SUGGESTIONS

Here are a few suggestions that have been effective. In the small condominium-type living room, finding places for four quadriphonic speakers can pose problems that are easily resolved when any surface in the right vicinity can be used as a sound radiator. If one position where you want a radiator happens to be a plate glass window, fine—the transducer converts a plate glass window into a very good radiator.

Even a door, perhaps with a relatively small window in it, can become a radiator by mounting the transducer on the glass. The window makes an excellent "tweeter," while the rest of the door handles the low frequency range. In this case, the mounting of the glass in the door must be tight to avoid rattles.

Paneling, or sheet rock, can be driven by mounting a transducer at a position chosen, equidistant between studs, and at a vertical position that is not precisely mid-way between floor and ceiling, but a little off-center in this direction. A little experimenting can optimize this.

Don't forget the possibility of floor or ceiling. The transducer can be mounted on the underside of the floor, or subflooring, or on the top side of the ceiling. The ceiling is a particularly good place, if you want to achieve a real sense of "invisible source," with good quality sound that provides stereo of either the 2-channel or quad variety.

When exploring, you can just press the transducer against the surface and move the point of contact around, to find the best spot. In doing this, you need to realize that the firm mounting will give considerable improvement over a pressed contact. Pressing limits amplitude range, while lack of pressure allows a large amplitude to rattle, both of which are overcome when you make the permanent installation. ■

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MARTIN DICKSTEIN

BACK TO BASICS

• Recently there has been a movement back to the basics of *almost* everything. Soaps, cereals, sprays, detergents, bread, cigarettes, etc. Advertisements boast of the return to basic concepts, such as without additives, without aroma, without—you name it. The a/v business seems to be going the other way. Everything plays up the fact that more and more complexity has been included in the latest models. There are more buttons and dials, more functions, more of whatever the simpler models had and more additional capabilities. It's gotten to the point where the audience simply expects something more than just the basic presentation, and most presenters feel the need to comply with these demands. They no longer even give a thought in passing as to whether there is any real need for increased activity on the screen. They don't seem to question whether the material they are presenting is enhanced by a multi-projector, multi-image showing. And, in some instances, permanent installations of audio-visual equipment have been designed and set up for such complexity, eliminating (or, at least, seriously curtailing) the possibility of putting on a simple show. One such incident which occurred a few weeks ago might illustrate the situation.

As a consultant to a large advertising agency, I was asked to sit in on a meeting of executives to help prepare the material to be presented to a new and very large client. After a rundown of the approach to be taken in the presentation, the topics to be discussed, and the means for presenting the material, there was a need to decide on the media to be used. This was the first time such a presentation was to be given by this agency to the top executives of the client company and I was asked to survey the meeting room.

THE MEETING ROOM

The room had a huge rear screen setup with two slide projectors with dissolves on each side for side-by-side images with super slides, and a 16mm film projector in the center. All the slide projectors had RP lenses to avoid the necessity for reversing the slides. There was a rack behind the screen containing a tape deck, mixer and amplifier, and alongside the rack there was a console on a table to operate the equipment in the rack. Controlling the projectors was a console in the conference room set up on a pedestal next to a large oval table. The controls on the panel worked the lights, the screen-hiding drapes, and the film and slide projectors, and allowed adjustment on the sound level. The left and right slide units were also set up for random access with a pre-show memory for punching in the next slide to be shown while the previous image was still on the screen. The system required two men to operate it, one behind the screen to change drums and cue up tapes, and another at the operating console in the conference room.

Several things were left out, however. We were told that because the film projector was furnished with a Xenon light source and could not be turned off and on again quickly once a film was shown, all film pieces had to be spliced together because there was no way the first film could be taken off to put the second one on without spilling light on the screen. We were also told that the total film reel had to have 8 to 10 seconds of black leader between segments wherever the film had to be stopped. The reason given was that sometimes the projector failed to stop when the button was first pushed on the console "due to a build-up of static electricity from the carpeting in the room." Even though the light on the console indicated the projector had stopped, the man behind the scene had to indicate to the console operator whenever the projector kept running and required another push on the button. (This situation was rather awkward because if the film projector did stop the first time, there were about 7 seconds of nothing after the cue for the next film, making for a rather slow moving show.)

NO MONITORING SYSTEM

Another omission was a monitoring system so the man behind the screen could hear what was going on in the conference room. All communication had to take place between the two operators by phone, with both men using buttons to signal each other and a handset to converse. The man in the room had to be sure his whisper was inaudible to the executives sitting next to him so as not to disturb them, but loud enough for the man behind the screen to hear plainly enough to avoid the need for repetition—there might not be time for that.

There was a microphone on the lectern located off to one side of the screen, but this was for use only in recording the speaker at the podium. (It was learned during the survey that a recording could be monitored behind the screen but that in order to pick up the speaker's voice it required a special setup not normally used and they were reluctant to hook up for that.) There was no voice reinforcement in the system because the "acoustics in the room were perfect."

One more consideration which must have been considered but was shrugged off was that the person at the podium was so far to one side that he (or she) could not read the slides on the far side of the screen. The light fall-off in rear screen projection made it impossible for the speaker to work off the screen rather than from a script, except for images on the lectern side of

the screen; these were darned hard to read, too, but not impossible.

MARKED SCRIPT

The final requirement for all presenters was to provide the operator of the console with a precisely marked script indicating each slide change, each tape start and stop, each film start and stop, each light cue for room illumination, etc. The alternative was to have someone from the presenting team sit next to the console operator to give him hand or verbal cues as required for a smooth showing. (As for the slides themselves, they could be brought to the meeting accurately marked in sequence in slide boxes with enough time for the operators to set up the drums for the dissolve operation. "This way the presenter does not have to worry about alternating the slides in two drums. It will be done for him." A good and thoughtful consideration, but if the presenter is rehearsing back at the ranch prior to show time, it seems hazardous to remove the slides from the drums to have them reset at the site.

Meanwhile, back at the ad agency, pre-show decisions were continuing. After the report back on the survey, the decision was still made that all slides would be shown single-image even on one side of the screen (toward the podium). A call to the client's operating supervisor to relay this information caused great upset. We were told that operating the system in that manner was not feasible because the console operator would have to remember to punch up alternate, not sequential, slides in order to bypass the dissolve. However, they did say they would try to set up a single projector near the center of the screen with a remote control at the lectern just for this presentation. ("No one else ever did this before.") Due to the wide angle of projection from the 16mm lens, it was necessary to place the single slide projector away from dead center to allow for drum changes, but this was considered acceptable to the agency.

D-DAY

The day of the presentation finally arrived, the material was brought to the site, and slides and film and tape were set up for testing before the meeting. The slides had been reversed (the center slide projector did not have an RP lens), and the film and tape levels set. I sat next to the console operator to guide him since there were no scripts for several of the presenters, who always work ad-lib from notes. Since the presenters themselves activated the slide movement, the operator was cued only for lights, tape, and film. The showing went smoothly and was well received. The agency felt that the material to be presented did not need elaborate systems, but that a simple approach would work best. They were right.

Comments from the executives in the audience proved the point that simplicity was a novelty and very effective as long as the material was good, and the presenters were also good. The system that insists on complexity had been bypassed, but this did not hurt either the presentation or the audience. Comments from the technical staff were more like "all other presentations take advantage of the system so why couldn't you?" Maybe because it was not necessary to use complexity to get the points across effectively. Ah, for the simple life—and back to basics. Not to take away from dissolve or side-by-side images, mind you, but at least don't make it hard to put on an easy show. Use the fancier stuff when you think it's necessary, not as a MUST. ■

"FOR THE FIRST TIME RECORD PEOPLE AND MOVIE PEOPLE HAVE REALLY PULLED IT TOGETHER."

Quincy Jones

It's not surprising that Quincy Jones sometimes feels like he was born in a studio. He's performed on, composed for, or produced over a thousand albums. Right now he's finishing his first musical, Sidney Lumet's version of The Wizard of Oz, The Wiz, starring Diana Ross.

While Quincy is one Jones that's impossible to keep up with, we were able to catch him briefly to find out his views on the current recording scene, his latest work, and "Scotch" 250 Mastering Tape.

The only thing Dizzy Gillespie, Andy Williams, Peggy Lee, and Ringo Starr have in common is that they've all worked with you. How can you work in so many musical styles?

"I don't get hung up in any bags. When I was studying in Paris, a teacher told me once, there were only twelve notes, so you should find out what everybody's done with them, because they're the same twelve notes that Palestrina was scuffling with. So I can live with the best of all different areas. I like that, you know. The menu is broad, man—eat everything."

There are a lot of movie scores that have turned into some pretty hot albums lately, Saturday Night Fever, for example...

"You know why I think it's happening? It's just a guess... for the first time record people and film people are basically the same people and they've really pulled it together.

"Of all the films I did, the thing that bugged me the most was that we'd be in the studio and the music would boom down at you, and when you got to the theatre it was almost like a rumor, all the bottom end and the top end falls off. Then Dolby came along and they got *A Star is Born, Star Wars, Close Encounters,* and *Saturday Night Fever.*

"Those are successful record-wise because for the first time people actually hear the music in the track, really hear it. We've got a new kind of sound system now with Dolby. Emotionally it hits you from a place you're not even aware of."

Is it technically harder to achieve what you want in a musical as opposed to doing a score for a dramatic film?

"Oh yeah, in *The Wiz* we've got choral things that go up to 80 and 120 voices, so to get a good lip sync we decided to use just two voices for guide tracks, almost like a Polaroid. After their mouths are moving in the right way, then we sit down and put the sweetening on the dance and singing numbers."

So the music is composed simultaneously with the filming?

"They've been sending me out dailies on videotape from New York because the color really turns me on. You get it at 2 o'clock in the morning and look at the reel about ten times. You have to eat it. That's the best homework you can do for a film."

You're a big user of "Scotch" 250. Do you find that it has a clean sound? That's one of the things we've been selling the tape on.

"That's right.

"It's like with film stock, you know. When you've got 800 people out there on a set, I don't care what happens on that performance, if it isn't recorded on camera, it's all over. And it's the same in the recording studio; everything else is superfluous.

"No matter how great a song we get, or performance or balance or anything else, if that same thing isn't reproduced and captured on that tape, nothing we do means a thing.

"That's why we stay with 'Scotch'."

"SCOTCH" 250 MASTERING TAPE.

The tape the masters use.

3M COMPANY

db New Products & Services

CARTRIDGE STORAGE/RETRIEVAL

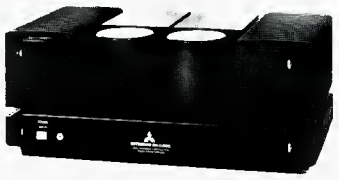
● Rapid access to 1024 cartridges, plus back-to-back program capability through the use of 1-20 playbacks is possible with the IK cylinder cartridge storage system. The system features unlimited segue, with complex formats easily controlled and adjusted. The system facilitates voice tracking and permits day/part mix.
Mfr: International Tapetronics Corp.
Circle 50 on Reader Service Card

MIXER/POWER AMP

● Delivering 150 watts rms continuous power output at a claimed less than one percent thd from 45 to 12,000 Hz, TCA-150 mixer/power amplifier has over 100 dB of gain. Active mixing is possible for nearly zero interaction between input controls. As input channels are added, there is constant preamplifier gain with minimal residual mixing-bus noise. With eight input channels, each has its own slide level control and a continuous-action 0-30 dB input attenuator is provided for all microphone inputs. A linear-action master gain control adjusts the output levels of all channels simultaneously. Four inputs are equipped with high-quality transformers for low-impedance balanced microphones. One is convertible to a 600-ohm balanced line. Solid state, the TCA 150 incorporates integrated circuits and silicon transistors. Dimensions: 19 x 14 x 5½ in. Weight: 37 lbs.
Mfr: Lear Siegler, Inc.
Circle 51 on Reader Service Card

POWER AMPLIFIERS

● Better than 80 dB interchannel separation is promised in DA-A15DC (150 watts-per-channel) and DA-A10DC (100 watts) power amplifiers with dual monaural direct coupling. Either amplifier can be docked, by attaching units to the aluminum handles of the amplifiers, to the line's two pramps, the tuner-preamp, or the power level meter. Linking cables complete the electrical interconnections. Elimination of crosstalk and improvement of channel separation of 30 dB or more is claimed. THD for the A15DC is 0.005 per cent at 75 watts per channel and for the A10DC, 0.005 per cent at 50 watts per channel. Both units have a frequency response of ± 0.1 dB from 20 Hz to 20 kHz.
Mfr: Mitsubishi (Melco Sales)
Price: DA-A15DC, $630. DA-A10DC, $430.
Circle 52 on Reader Service Card



ULTRA-MINIATURE MICS

● Hands-off tiny electret condenser AT803S and AT805S mics with omnidirectional pickup patterns are accessorized with windscreens, battery, carrying case, lavalier neck cord, belt clip and tie clasp. Frequency response is 50-20,000 Hz; -57 dB sensitivity; -151 dB EIA sensitivity; 600 ohm impedance. The maximum input sound level is 130 dB and the signal-to-noise ratio is greater than 50 dB. The size of the AT803S is 0.4 in. diameter by 0.78 in. long, the AT805S a bit larger.
Mfr: Audio-Technica
Price: AT803S: $80.00. AT805S: $50.00.
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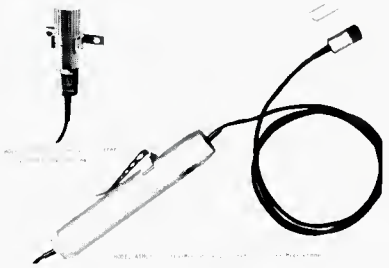
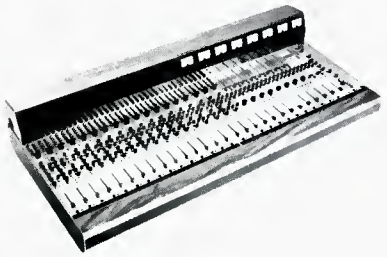


CONTROL MODULE

● Tonal compensation in the top and bottom octaves is one of the controls achieved by Control Module CM-1, a device that is inserted between the pre- and power amp, or tape monitor. The control is also able to effect a multi-step lateral tuning to widen or to narrow the breadth of stereo imaging. Mates with black box featureless preamps. Dimensions are 12 x 5 x 2 in.
Mfr: Harold Beveridge Inc.
Price: $300.00.
Circle 54 on Reader Service Card

LIVE MIXER



● On-site situations where extra long connecting cables would ordinarily be a problem are one type of consideration incorporated into the design of the Fleximix 8-input/dual output mixing console. The console comprises two standard 8-way mainframes joined electrically and mechanically, including input and output line balancing modules, which take the long cable headache into account. The system is modular; any module can be placed anywhere in the mainframe, creating expansion at any time from mono to 24-track with no pre-wiring necessary. There is a maximum of 10 mixed output groups (8 submasters and 2 main left-right masters) plus monitoring facilities up to 24 tracks. The mainframes can be mounted in flight-cases for transportation and the mixer has a self-contained power system.
Mfr: Trident
Circle 55 on Reader Service Card

CASSETTE DUPLICATOR

● A two-module duplicator has been consolidated into a single master/slave unit, Model 32S, a budget-designed cassette reproducer. The device operates on one button, producing, according to the manufacturer, 72 C-60 cassettes per hour. Internal mechanisms include synchronous motors, solid state digital logic using integrated circuits to command the two d.c. servo control motors to protect against damage to masters, and provision for automatic stop. There are also lighted push buttons, track select, and automatic rewind of the master.
Mfr: Pentagon Industries
Circle 56 on Reader Service Card

RECORDER SYNCHRONIZER

● A vtr may be synchronized to an audio recorder, or 16- and 8-track recorders can be expanded to 20 or 30 audio tracks through the use of Model TLS 2000 tape recorder synchronizing system. A SMPTE time code used as the electrical link between the units being synchronized is recorded on an audio or cue track. Equipment of any make can be used, as long as it has the ability to read the code. Applications include creating separate audio tracks for later editing; they can then be transferred back to the vtr to make the release. By using the TLS and converting one channel from each multitrack tape recorder to a cue track, an 8-track and a 16-track become a 22-track facility—a pair of 16-tracks becomes a 30-track recorder, etc.
Mfr: Studer Revox America
Circle 57 on Reader Service Card

STEREO MIXER

● Features of compact Clubman One-One M mixer include twin meters, a rumble filter, talkover switch, headphone output with level control, cross fade, three slide fader controlled inputs: microphone plus any two of phono 1, phono 2, line 1, and line 2. Dual output levels are provided. Construction of the portable unit includes plug-in i.c.'s, tantalytic caps, 5 per cent resistors and computer grade, double-sided p.c. boards.
Mfr: Meteor Light & Sound Co.
Price: $249.00.
Circle 58 on Reader Service Card

3-WAY LOUDSPEAKER

● Studio monitor L1030 loudspeaker is a three-way acoustic suspension system of moderate size. Full range performance is ensured by the combination of midrange and high-frequency drivers with a low frequency transducer. A seamless transition from driver to driver is achieved through the design of the dividing network. Frequency response is 20 Hz to 2500 Hz. Power handled is 100 watts continuous and 140 watts peak.

Mfr: Braun (Adcom)

Circle 59 on Reader Service Card

Circle 27 on Reader Service Card

SOUND REINFORCEMENT SPEAKERS

● Designed for either indoor or outdoor applications, Models 4662 (two-way) and 4663 (three-way) sound reinforcement loudspeaker systems produce 110 dB at 16.4 feet when driven at 125W continuous sine wave. A pair of systems can produce up to 6 dB more SPL than a single unit outdoors, delivering more indoors. 4662's frequency response is 40 Hz to 9 kHz, with 4663 capable of reaching 20 kHz. The systems contain a 15 in. loudspeaker (K 130) energized by a 12 pound Alnico V magnet and featuring a 4-in. edgewound aluminum ribbon voice coil. An exponential horn flare is designed for high efficiency above 90 Hz and is reflex-loaded for extended bass response, to 40 Hz. The systems also contain Model 2461 high frequency compression driver with a cast iron magnetic assembly and phenolic-impregnated linen diaphragm. The radial horn unit, Model 2345, produces a sound distribution pattern of 90 degrees horizontal and 40 degrees vertical. 3110 frequency dividing network provides 800 Hz crossover between the base and horn compression drivers. System 4663 contains an ultra-high frequency loudspeaker and a network for the high to ultra-high frequency transitions at 8 kHz.

Mfr: James B. Lansing Sound

Circle 60 on Reader Service Card

FUNCTION GENERATOR

● Audio test system Model 101 consists of two sine/square/triangle function generators, a pulse generator, a frequency counter and an a.c. voltmeter. The system will generate a frequency response plot on an X-Y recorder or 'scope. The time base generator has symmetrical or independent control of the positive and negative sides of the ramp, providing a duty cycle of 1 per cent to 99 per cent. The audio sweep generator provides manual frequency adjustment or log or linear sweep of 20 Hz to 20 kHz. The pulse generator frequency range is 0.002 Hz to 100 kHz and is adjusted independently of frequency, from 4 seconds to 40 nanoseconds. The a.c. voltmeter has full scale sensitivities from 1 mV to 250V. The frequency counter is 6 digit, 50 or 60 Hz line-triggered, and reads either internally or externally.

Mfr: Fidelity Sound

Price: $695.00.

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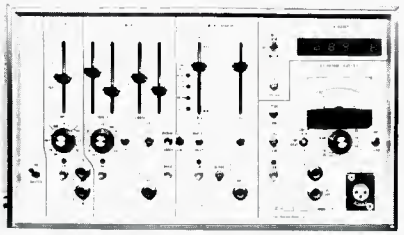
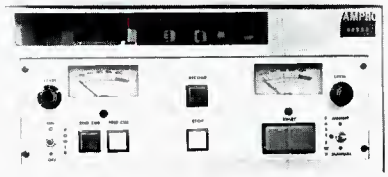


DIGITAL DELAY LINE

• A remote control card, using the IEEE standard interface to permit computer automation control and new effects has been introduced as an adjunct to Model 1745M digital delay line. The modular p.c. card plugs into an unused connector in the delay line and permits delay setting, and control of the "repeat" and "double" modes of operation. Two new features incorporated are automatic flanging and a method of vocal or instrumental "doubling," achieved by allowing a microcomputer to vary the delay of one or more of the delay line's output modules, done in a pseudo-random manner to simulate naturalness. The device uses the ANSI.IEEE 488/1975 interface bus—the manufacturer claims that adapting it to existing systems through the use of adapter boxes will be simple. It is already compatible with Hewlett-Packard and Commodore Pet computers.

Mfr: Eventide Clockworks
Price: $550.00.
Circle 62 on Reader Service Card

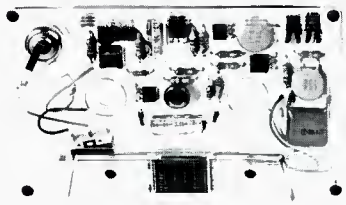
DIGITAL MESSAGE TIMER



• Available factory-installed on new equipment or as a retrofit kit for Ampro equipment, the Digital Message Timer is a five-digit l.e.d. display that reads out the cartridge elapsed playing time in minutes, seconds, and tenths. The total playing time from spot *Start* to *Finish* is stored in the display and continuous elapsed play time readout cues the on-air operator.

Mfr: Ampro Broadcasting, Inc.
Circle 65 on Reader Service Card

DEMAGNETIZER/CLEANER KIT



• Two maintenance products, a head demagnetizer and a head cleaner kit are designed to simplify tape head housekeeping. The demagnetizer, in a cassette format containing the necessary electronic circuitry, is powered with a drycell battery. You push the cassette into the set in the "play" mode and it whisks away magnetization; a red l.e.d. lets you know when the job is finished. Tucked into the head cleaning kit are such necessaries as mirror, brushes, pads, and cleaning liquid.

Mfr: TDK
Price: Demagnetizer: $20.00; Cleaning Kit: $6.00.
Circle 63 on Reader Service Card

CODED INDEXING

• Rapid surveillance of time coding of films and tapes, using everyday language, is possible with the SMPTE READ system. The program uses any 8080 based microcomputer to read time coded films and tapes. The display will handle up to eight sources simultaneously. Supplied on punched paper tape with a manual complete with source listing, the program is written in 8080 assembler. Included in the package is one pre-soldered tested interface module. Additional interface modules are sold separately.

Mfr: Conrac
Price: $49.00.
Circle 64 on Reader Service Card

db New Literature

THE STORY OF V-F.E.T.

Vertical Field Effect Transistors are explained in an illustrated, semi-technical booklet. Mfr: Sony Corp., Technical Publications Dept., 47-47 Van Dam St., Long Island City, N.Y. 11101.

SEMICONDUCTOR REPLACEMENT GUIDE

Cross-references of 1800 solid-state devices are covered in an eight-page supplement to the Master Replacement Guide. Mfr: GTE, 1 Stamford Forum, Stamford, Conn. 06904.

RECORD PROTECTOR

Suggested for record protection, a felt decorative material called Vymello is described in a booklet with swatches. Mfr: David Sloan Creations, Inc., Hook Creek Industrial Park, Building #10, Valley Stream, N.Y. 11581.

KIT-MANIA

It's kit time again with Heathkit's new catalog of practically everything broken down into "easy-to-assemble" parts. Mfr: Heath Company, Benton Harbor, Michigan 49022.

NORTHERN CALIFORNIA DIRECTORY

A free comprehensive directory covers over 100 recording studios and services in Northern California. Source: BAM Magazine, 5951 Canning St., Oakland, Ca. 94609.

FREQUENCY SYNTHESIZERS

This brochure details how Series 6000 synthesized signal generators function as frequency synthesizers as well as signal generators and spectrum analyzers through interchangeable plug-ins. Mfr: Dr. Ron Juels, Comtron/Adret, 200 E. Sunrise Highway, Freeport, N.Y. 11520.

DEMO TAPES

Free demo tapes of The Production Master, a commercial production library service derived from a survey of the popularity of various spot commercials, are available. Contact: Toby Arnold & Assoc., 4255 LBJ, Suite 156, 2 Summers Square, Dallas, Texas 75234.

PRIMARY COMMUNICATIONS EQUIPMENT

Five communications case histories of the use of microwave, carrier, data, and switching systems are detailed in a brochure. Source: Marin Communications Div., P.O. Box 490, 517 Marine View Ave., Belmont, Ca. 94002.

MAGNETIC SHIELDING

A four-page data sheet describes cable, wire, and conduit material. Mfr: Magnetic Shield Division, Perfection Mica Co., 740 N. Thomas Dr., Bensenville, Ill. 60106.

TEST INSTRUMENTS

An 8-page short form catalog covers and illustrates 36 testing devices. Mfr: VIZ Test Instruments Group, VIZ Mfg. Co., 335 E. Price St., Philadelphia, Pa. 19144.

REVERBERATION ROOMS

A very detailed description of a line of reverberation rooms includes tables of comparison figures and dimensions, paired with reverb Hz figures, as well as practical construction details. Mfr: Industrial Acoustics Co., 1160 Commerce Ave., Bronx, N.Y. 10462. (Bulletin 7.0101.0)

Edward Wilson works at Mt. Sinai Hospital. He has epilepsy, a fact that scares many employers.

Most people with epilepsy can control their seizures. What they cannot control is the superstition and almost universal ignorance that exists about their condition. Misinformed employers won't hire them because they're afraid of higher insurance costs. Actually they are legally exempt from liability for the disease, and most people with epilepsy tend to have attacks not on the job but at home. There are over two million Americans with some form of epilepsy. The majority of them are able to work, yet half of them are unemployed. It's not surprising that so many try to keep their condition a secret.

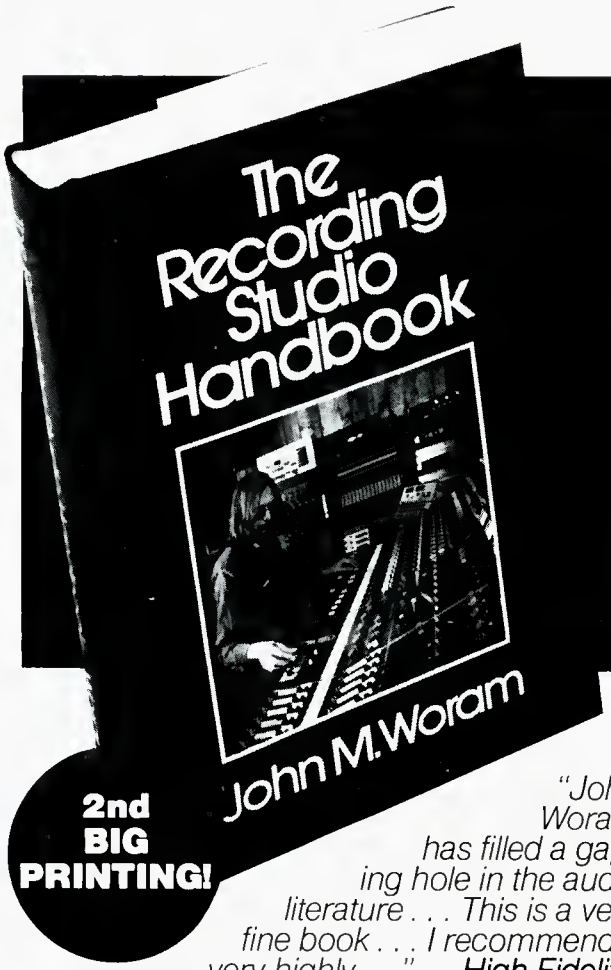
In the words of Edward Wilson, who worked as a handyman and made deliveries for a millinery firm before joining the Mt. Sinai Rehabilitation Workshop, "Employers didn't inquire into my medical history, and I didn't tell them about my attacks." Wilson, who distributes work and assists women at the sewing machines in the workshop, was at one time having several attacks a week.

"But I never lost a job because of epilepsy," Wilson says. Most people with the disease aren't so lucky. Many employers fire people after their first on-the-job attacks, in spite of the fact that epilepsy is, in Wilson's words, "no worse than diabetes or heart trouble."

The worst thing about the disease is people's fear of it. Discrimination is the real handicap. Until the public's attitude changes, that attitude will remain a barrier between people with epilepsy and the lives they could lead.

President's Committee on Employment of the Handicapped
Washington, D.C. 20210

The School of Visual Arts Public Advertising System



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The Recording Studio Handbook

by John Woram

The technique of creative sound recording has never been more complex than it is today. The proliferation of new devices and techniques require the recording engineer to operate on a level of creativity somewhere between that of a technical superman and a virtuoso knob-twirler. This is a difficult and challenging road. But John Woram's book charts the way.

The Recording Studio Handbook is an indispensable guide. It is the audio industry's first complete handbook that deals with every important aspect of recording technology.

Here are the eighteen chapters:

- **The Decibel**
- **Sound**
- **Microphone Design**
- **Microphone Technique**
- **Loudspeakers**
- **Echo and Reverberation**
- **Equalizers**
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- **Flanging and Phasing**
- **Tape and Tape Recorder Fundamentals**
- **Magnetic Recording Tape**
- **The Tape Recorder**
- **Tape Recorder Alignment**
- **Noise and Noise Reduction Principles**
- **Studio Noise Reduction Systems**
- **The Modern Recording Studio Console**
- **The Recording Session**
- **The Mixdown Session**

This hard cover text has been selected by several universities for their audio training programs. With 496 pages and hundreds of illustrations, photographs and drawings, it is an absolutely indispensable tool for anyone interested in the current state of the recording art.

Use the coupon at the right to order your copy of *The Recording Studio Handbook.* The price is only $35.00, and there's a 15-day money-back guarantee.

SAGAMORE PUBLISHING COMPANY, INC.
1120 Old Country Road, Plainview, N.Y. 11803

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SIDNEY L. SILVER

Digital Modulation for High-Quality Audio

Sampling, quantizing and coding, sample-and-hold, multiplexing—techniques for the digitizing of high-fidelity music.

THERE CAN BE little doubt that the application of digital techniques to high-quality audio systems will become increasingly dominant in the coming years. By transforming musical signals from an analog to a digital format, it is possible to derive important advantages in signal-handling operations which could not otherwise be achieved with the original program material.

For example, continuous-wave audio signals are subject to deterioration by various forms of distortion or by the addition of noise. These signals can be easily translated into a series of pulses, which represent digital numbers. The pulses can be delayed, recorded, or distributed to any degree of accuracy. Since the pulses are in fixed, predetermined positions, the simple presence, or absence, of a pulse (*not* its shape or amplitude) provides the information content of the signal. It is then possible to adjust or supplement the coded data to obtain a reproduction that is almost an exact replica of the original signal. All of this can be accomplished with a significant improvement in

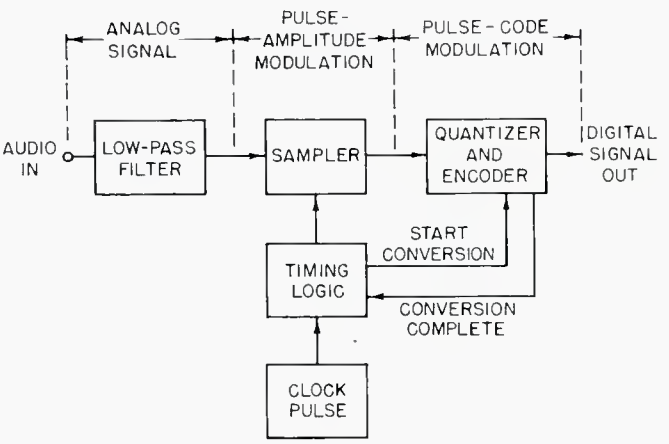


Figure 1. Simplified flow diagram of a PCM system for digitizing audio.

Sidney L. Silver is on the supervisory staff of the Telecommunications Section of the United Nations, where he is in charge of sound and recording.

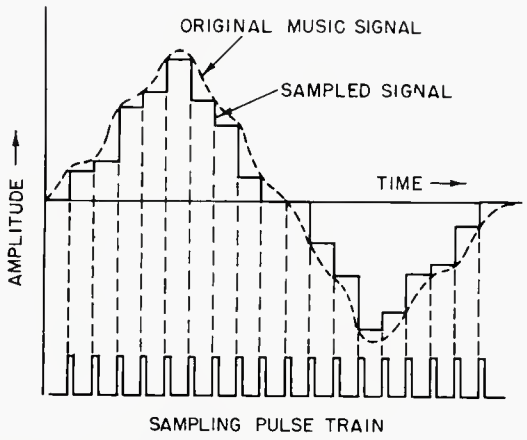
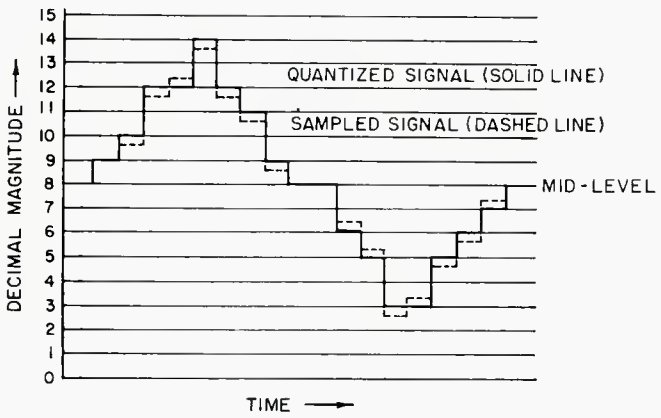


Figure 2. Sampling operation transforms continuous analog signal into a staircase waveform.

signal-to-noise ratio, greater reliability than possible when using other methods, and almost complete freedom from distortion, even at peak levels. The trade-off for these advantages is the large overall bandwidth required to transmit a digital signal, in comparison to its analog equivalent.

A question then arises: if the digitization of audio is such an elegant concept, why hasn't it been applied in the past to the processing of high-fidelity music? After all, the concept of transferring audio waveforms into the digital domain has been known for years. It is already well established in the processing of voice signals in telephone communications systems.[1] The answer to our question lies in the fact that until recently the required state-of-the-art had not developed sufficiently to make the application of digital techniques acceptable for high-quality sound. But new advances in microprocessor technology and higher density storage (memory) systems in lsi (large scale integration) form are now making such digital audio handling feasible. Sophisticated analog-digital converters are also available for encoding high-fidelity audio signals with exceptionally wide dynamic range, low distortion, and a high degree of precision.

Figure 3. The quantizing operation rounds off a sampled signal to nearest amplitude step. Note that the highest numerical value of the quantum steps is 15, but there are 16 levels, counting zero.



Among the various forms of digital coding, PCM (Pulse-Code Modulation) is a method commonly used to describe the instantaneous variations in an analog signal. In this system, the audio signal is measured periodically at discrete points by a stream of short-duration pulses before being converted into an equivalent digital word sequence. At the present time, PCM is considered to be particularly suitable for the digitization of high-quality music. The discussion which follows will be limited to that system.

SAMPLING

Because an analog audio signal has a smoothly-varying continuous range of values, it presents a theoretically infinite number of levels, or quantities. On the other hand, digital audio limits these quantities to a finite number of values. In the CM system (FIGURE 1), there are three successive operations needed to convert an audio signal into coded binary digits—sampling, quantizing, and encoding. Initially, the time-varying audio signal input is "sampled" at a suitable rate to form a sequence of pulses whose magnitudes and polarities are identical with the instantaneous values of the continuous waveform. To put it another way, the height of each individual pulse represents the amplitude of the original signal at a given sampling instant. This step in the sampling process (shown graphically in FIGURE 2), is defined as pulse-amplitude modulation (PAM).

Sampling is accomplished by introducing the audio signal into an electronic switching circuit driven by a narrow sampling pulse so that a staircase approximation of the signal is obtained. In operation, the switch samples the

Table I—4-Bit Offset Binary Code for ± 5V Range

Voltage Levels	Binary Number Assigned
+4.375 to +5.0	1111
+3.75 to +4.375	1110
+3.125 to +3.75	1101
+2.5 to +3.125	1100
+1.875 to +2.5	1011
+1.25 to +1.875	1010
+0.625 to +1.25	1001
0 to +0.625	1000
−0.625 to 0	0111
−1.25 to −0.625	0110
−1.875 to −1.25	0101
−2.5 to −1.875	0100
−3.125 to −2.5	0011
−3.75 to −3.125	0010
−4.375 to −3.75	0001
−5.0 to −4.375	0000

Table II—S/N Ratios Using A Linear Coding Format

Number of Bits	Quantizing Levels	S/N Ratio (dB)	Maximum Quantizing Distortion (%)
10	1024	60	0.0488
11	2048	66	0.0244
12	4096	72	0.0122
13	8192	78	0.0061
14	16384	84	0.00305
15	32768	90	0.00152
16	65536	96	0.00076

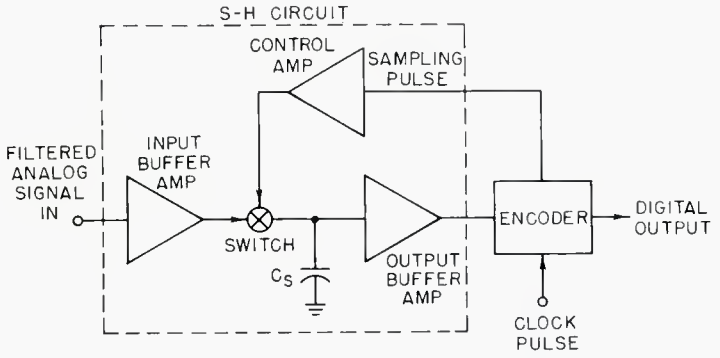


Figure 4. Simplified block diagram of a sample-and-hold circuit.

waveform at regular intervals and holds the sampled level while a corresponding digital number is generated during the conversion process. This "sample and hold" function is basically that of an analog memory used in the processing of high-fidelity music to minimize distortion. (More on this later.)

How often is it necessary to sample an audio signal? If sampling takes place infrequently, some of the rapid fluctuations of the audio signal will be lost. However, if sampling occurs too often, the equivalent binary digits will be generated at such a high rate during conversion that the overall bandwidth requirements of the system will be excessive. It has been demonstrated mathematically that if an analog signal is sampled regularly at a rate equal to at least twice the highest frequency component of the signal, the original waveform can be accurately reconstructed without loss of information. This means that if the audio frequency range of 20 Hz to 20 kHz is sampled at a minimum rate of 40,000 samples per second (i.e., one sample every 25 μsec), the analog signal can be faithfully reproduced with negligible distortion. Stated another way, any continuous waveform can be represented completely if at least two amplitude samples are generated for every cycle of the highest frequency of interest.

ALIASING

Unfortunately, frequency components in music signals that occur more rapidly than once every two samples cannot be distinguished from those which take place less frequently. Thus, when frequencies higher than one-half the sampling rate are present, the sampled signal energy will be transposed downward in frequency by the sampling process, and false information will appear at the output. For example, if the sampling frequency were 20 kHz (Fs) and a 12 kHz (Fs/2 + 2 kHz) sine wave were being sampled, the frequency would be recovered erroneously as 8 kHz. This represents 2 kHz below one-half of the sampling frequency (Fs2 — 2 kHz) rather than 2 kHz above, where it originated. The resulting distortion, known as *aliasing* error, is harmonically unrelated to the desired information and sounds like crosstalk interference. It can be avoided by ensuring that the audio signal spectrum to be sampled cuts off very sharply above the desired frequency range. So, if a minimum sampling rate of 40 kHz is chosen, the low-pass filter employed would have to produce an infinitely steep cut-off at 20 kHz in order to re-

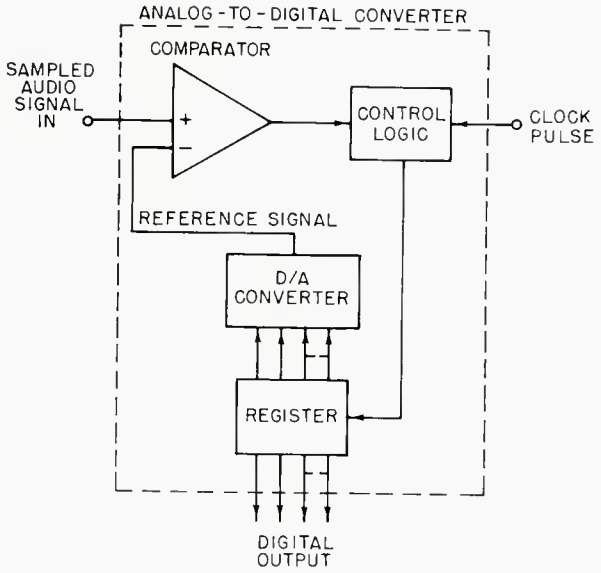


Figure 5. Encoder used for high-quality audio.

ject completely unwanted energy outside of the passband. Of course, such a filter is physically unattainable, so it is necessary to allow for the roll-off characteristic of non-ideal filters by raising the sampling rate, say, 20 per cent above the theoretical minimum. Practical considerations, in effect, would force us to increase the sampling frequency to about 48 kHz.

QUANTIZING AND CODING

After sampling, the next stage in the PCM process is to round off, *or quantize*, the amplitude samples to match the specific levels provided by the system. FIGURE 3 shows how each sample is compared to a scale of discrete values and assigned the quantum step closest to the actual magnitude of the sample. Usually, the signal level to be coded does not precisely match one of the available steps because only a limited number of levels can be represented. The resulting error introduced by the approximation is called *quantizing* noise, or quantizing distortion—its magnitude ranging from zero to one-half a quantum step. This type of noise is very different from the familiar thermal noise or interference noise which accumulates in analog systems, but it sounds like random noise. It would probably be most accurate to relate it to distortion noise, since its generation is due to the difference between an input and output waveform.

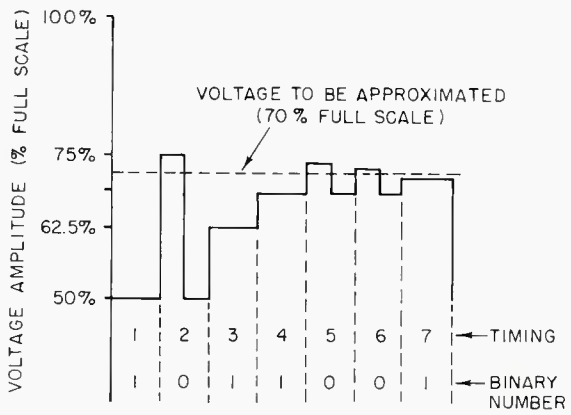
And now, to translate the quantized signal into a digital code, the total voltage range is divided into whatever number of increments can be handled by the binary word available for allocation. The number of voltage levels that can be used in the binary code is 2^n, where n is the number of binary digits, or bits. Thus, for a 7-bit code, there are 2^7, or 128 amplitude steps available: for a 9-bit code, there are 2^9, or 512 steps, etc. As an example, consider the 4-bit code shown in TABLE I. Obviously, a 4-bit code cannot handle the full range of positive and negative amplitudes necessary for high-quality music, but is illustrated here to simplify the discussion.

Note that the voltage range has been divided into 2^4 equal levels, so that one of the 16 possible binary numbers is assigned to each of the voltage levels. This particular type of code is referred to as an *offset binary code* because the zero voltage level is shifted to one-half full scale in relation to the binary number, 0000. In the offset format, note that the first bit in the series of binary numbers indicates whether the signal sample is positive or negative, while subsequent bits identify amplitude. This first bit is therefore known as the *polarity bit*, and from TABLE I it will be seen that binary numbers starting with "0" represent negative voltages, while "1" represents a positive voltage level.

It should be pointed out that when a particular signal sample has been quantized, it is impossible to know exactly where the sampled level lies in the corresponding voltage range. If, for example, the binary number, 1011, is assigned to a sample, it can only be determined that the sampled signal level was located somewhere within the range from +1.875 to +2.5 volts. But since this quantizing error cannot exceed one-half a quantum step, the maximum error for a 4-bit code (i.e. 16 steps) will be 1 part in 32, or 3.125 per cent. Clearly, the greater the number of discrete steps employed in the digital code, the closer the approximation to the sampled signal value, and hence, the lower the quantizing distortion.

One may ask: how finely must high-fidelity music signals be quantized? How many bits are needed to obtain an acceptable analog signal at the reproducing end? No matter how much resolution is utilized, it is not possible to produce an exact replica of the original waveform. Therefore, the answer lies in determining experimentally how many bits must be used in the code so that noise and distortion due to quantizing error is negligible. Subjective listening tests have shown that in a high-fidelity audio system, the signal-to-quantizing noise ratio should be about 85 dB or more if the noise is to remain undetectable in the quietest passages and distortion imperceptible on peak levels of the program material. The number of bits, n, that is possible to generate using a linar coding format (i.e., equally spaced quantum steps) can be found by the equation: $n = \frac{S/N}{20 \text{ Log}_{10} 2}$ where S/N is the signal-to-quantizing noise ratio in dB. Accordingly, we would need a 14-bit code (16,384 amplitude levels) to achieve the dynamic range of 84 dB. TABLE II shows the calcualted S/N ratios obtainable from PCM systems having from 10 to 16 bits

Figure 6. Analog-to-digital conversion by the "successive approximation" method.



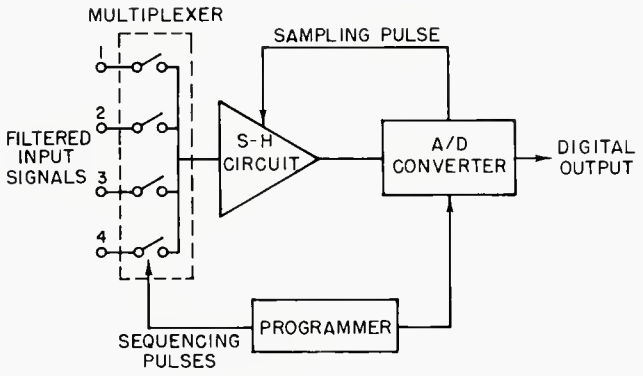


Figure 7. Analog multiplexer uses a single S-H circuit and A-D converter to process successively four audio input channels.

per word. Also shown is the maximum quantizing distortion to be expected from each digital code. Note that for each additional bit employed in the code, the number of available quantizing levels is doubled and the signal-to-noise ratio improves by 6 dB.

SAMPLE-AND-HOLD PROCESS

Since music is a blend of complex waveforms with multiple combinations of varying frequency components and amplitudes, the use of an analog-to-digital (A/D) converter with a high degree of incremental accuracy is required, in order that full advantage of digitization be attained. Because an A/D converter takes a finite time to establish each level and to convert it to a binary number, the digital output will be confused if the analog level (i.e., audio) continues to change while it is being measured for conversion. Unless the analog signal is held constant during the short interval of conversion time, the resulting distortion will be appreciable when the music is rapidly varying, especially in the case of loud, high-pitched sounds.

The solution to this problem is a circuit that briefly samples the analog signal and then holds this sampled value as a steady d.c. level for the full conversion time. This is the basis for the sample-and-hold (S-H) circuit shown in FIGURE 4. It consists of an electronic switch and storage capacitor placed ahead of the A/D converter, effectively isolated by input and output buffer amplifiers. Under ideal conditions, the mode of operation is as follows: A sample—command pulse is applied to the Control Amp input to "track' the signal voltage at the analog input. This causes the switch to close, rapidly charging storage capacitor, C_s, to the input signal level. At the end of the sample—command pulse, C_s is disconnected from the input circuit, but holds, or "freezes," the voltage it had at the instant the switch was opened. The Output Buffer Amp remains constant at the stored value, allowing time for the converter to quantize and encode the sample, with the proper digital number generated at the converter output. At the next sampling cycle, C_s recharges to some new sample level and maintains that value during the holding period. To minimize decay error, the Output Buffer Amplifier must have a very high input impedance, so that the voltage stored across C_s does not change appreciably.

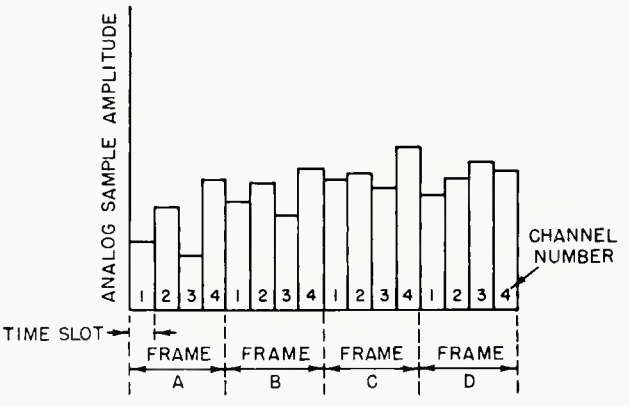
Let us take a typical example to illustrate the effects of sample-and-hold parameters on system speed and accuracy. Assume that the A/D converter can convert at a rate of 0.7 μsec per bit. Therefore, a complete 14-bit conversion will require 9.8 μsec, during which time the signal must not vary by more than one bit if a spurious output is to be avoided. Now, while 9.8 μsec seems to be fast, we would begin to lose accuracy when converting a $\pm$ 5 volt signal (10 volt excursion), if the input changed by more than one bit (10 $\div$ 16,384 volts; about 0.6 mV) during this conversion time. But with an S-H circuit operating at, say, 0.05 μsec, the input signal could vary at 9.8 μsec $\div$ 0.05 μsec, or 196 times as fast as the conversion time without losing 14-bit accuracy. In other words, during each 0.7 μsec increment, there would be one 0.05 μsec sample made. This sample would be held for 0.7 μsec, thereby substantially increasing the effective bandwidth of the converter.

CONVERSION BY SUCCESSIVE APPROXIMATION

Of the various methods available for A/D conversion, the *successive approximation* encoder is a suitable choice for the digitization of high-quality audio. It has the highest performance capability of any type, and permits a wide range of tradeoffs between resolution and conversion speed. Converters of this type compare the sampled input voltage with a number of precise voltage reference levels, each one represented by a digit in the binary code. A voltage comparator makes the decision as to whether the reference is greater or smaller than the signal sample. The output of the comparator then causes the reference value to be changed until it approximates the level of the sample. Referring to FIGURE 5, the sampled music signal to be digitized is fed to one input of the comparator and the reference voltage applied to the other input. The comparator output is then fed to a control logic circuit that drives a register, which in turn controls the analog output of a built-in digital-to-analog converter. The feedback loop thus formed operates by successive approximation to reduce the difference between the reference voltage and the sampled input signal.

FIGURE 6 shows how this works for a 7-bit code. Let us say the sample to be encoded is 70 per cent of the maximum permitted amplitude. Since this level is greater than the first reference voltage (which is 50 per cent full-scale), the first digit, or most significant bit, to be registered is a "1." Now, the second comparison voltage (25 per cent full-scale) is added to the first, and the sample is com-

Figure 8. Time-division multiplexing fits sequential samples into an allocated time frame.



pared again. Since our 70 per cent sample value is less than this 75 per cent reference, the second digit generated is a "0." The second comparison voltage is then switched out, and a third (12.5 per cent full-scale) switched in. The sample is then compared against a 62.5 per cent reference, and since it exceeds this, the third digit is a "1." Continuing, any succeeding bit that does not cause the combined bit values to exceed the sample level remains set at "1," while any succeeding bit that does cause the combined bit values to exceed the sample level is set to "0." The procedure continues, one bit at a time, through the seven comparison voltages until a binary word is obtained, equivalent to 70 per cent of the full scale of 128 levels. (A seven-bit word permits 128 different levels; $2^7 = 128$.)

When the last digit, or least significant bit, has been tried, the output of the register is the digital number, 1011001, representing the quantized analog signal. If the sample level had been 100 per cent instead of 70 per cent, the digital word would be 1111111. If both of these words are converted to their decimal equivalents (89 and 127), it can be seen that the former is indeed 70 per cent of the latter.

MULTIPLEXING

So far, the discussion has ben restricted to the digital processing of a single channel of music. However, the inherent characteristics of PCM make possible the use of time-division multiplexing to provide a multichannel capability to the system. Multiplexing is a technique which permits a number of separate music channels to be interlaced on a time basis and to share a common output line.

FIGURE 7 shows a block diagram of an analog multiplexing system, where four music channels are processed successively through a single S-H circuit and its matching A-D converter, to develop a corresponding digital output. Here the multiplexer acts like a sequential relay, which, upon command, switches from one channel to an adjacent one in regular order, and delivers the combined analog signals to the S-H circuit for sampling. Each music channel is assigned a given time slot referenced to a synchronizing signal, and these time slots are fitted into a frame time period representing one complete sweep of the multiplexer. This is illustrated in FIGURE 8. It can be seen that as the number of music channels is increased, the time interval that can be allotted to each channel must be reduced to accommodate the frame time.

In order to digitize music signals properly, all components of the system must be capable of operating at a rate equal to the product of the basic sampling frequency and the number of channels. Suppose, for example, we have four pre-filtered channels of music, each with a maximum frequency content of 20 kHz. The actual sampling rate then becomes 4 x 48 kHz, or 192 kHz, so that the conversion must be completed in 5.2 μsec or less. By synchronizing the sampling frequency at the receiving end, the decoded signals from each channel can then be reassembled by a demultiplexer, in their original form. ■

REFERENCE

1. Silver, S. L., "Digital Voice Communications," ELECTRONICS WORLD, vol. 84, no. 4, October, 1970, pp. 27-39, 78.

YOUR BEST EMPLOYEE COULD BE DYING OF A MISCONCEPTION

One out of six of your employees has high blood pressure. Anyone from the mail boy on up to the chairman. Some of them might even realize it. But might not realize that high blood pressure can only be normalized if they stay on daily medication.

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For literature about these and other high blood pressure misconceptions, how to set up a company work session, or obtain a speaker, write to Jerry Wilson, The High Blood Pressure Information Center, 120/80 National Institutes of Health, Bethesda, MD 20014.

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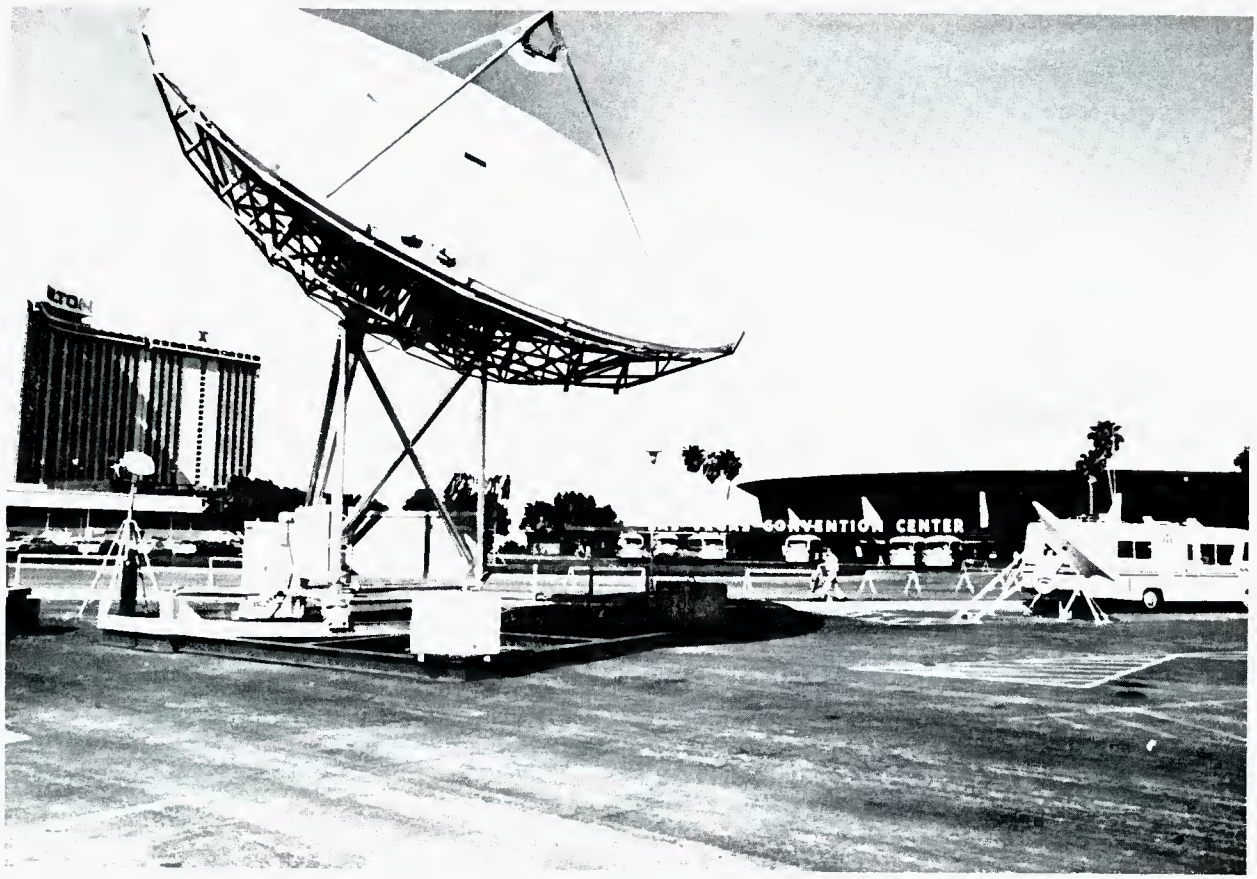
JOHN WORAM

N.A.B. Convention Report

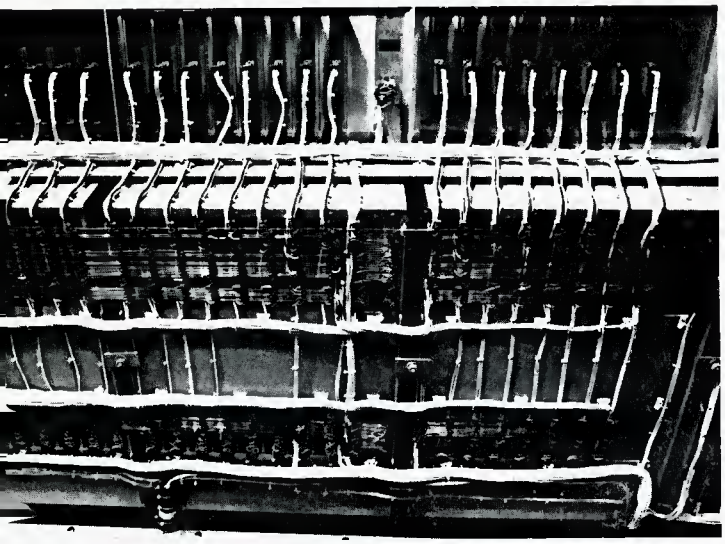
Of elcasets and consoles, transmitters and ppm's, a trip through the broadcasters' wonderland.

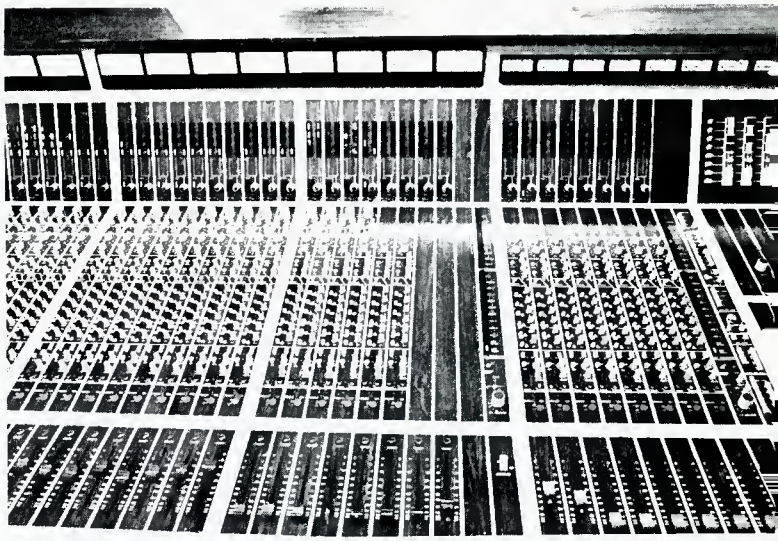


After last year's NAB (National Association of Broadcasters) show, I managed to get myself in trouble with at least some of our broadcast readers by commenting on audio in broadcasting. Now that the flak has died down a bit, I've been back to another broadcast show—this one in Las Vegas—and maybe I'll get myself in trouble again.

Actually, perhaps I won't get myself into too much trouble, since this time around I was on "booth duty," and so wasn't able to roam around too much. Specifically, I was at the show in my consultant guise, demonstrating the practicality of quadriphonic f.m. broadcasting.

Well, this article is not the proper place to launch into any sort of partisan activities for or against anyone's favorite quad broadcast system—mine included. (Notice I didn't even mention which one it is: how's *that* for objectivity?) However, from the vantage point of an exhibitor, I did manage to come away with some general impres-





Two views of McCurdy Radio's new broadcast console.

sions of the broadcast convention-goer. And, I managed to sneak out of the booth at least a few times to see what was going on elsewhere.

A TV SHOW?

Is the NAB convention a "television show"? It's easy to think so, from an audio man's point-of-view. The video exhibits were—to put it mildly—impressive, complete with elaborate stage sets, the latest models of t.v. hardware for sale, and of course a bevy of spectacular models—presumably not for sale. But then, this was Las Vegas, so who knows?

Due to the grand scale of the video industry, the audio portion of the show seemed small by comparison. However, there was no shortage of audio hardware on display, and I believe there were significantly more audio exhibitors here than at last year's NAB show in Washington, D.C.

Just like the conventions of the Audio Engineering Society, the NAB shows seem to get bigger each year, and this one required just about all of the facilities of the mammoth Las Vegas Convention Center. The convention center is adjacent to the also-mammoth Las Vegas Hilton Hotel—a mixed blessing at best. Dealing with the hotel's efficient staff is a sobering experience—not that anyone could actually get drunk on the hotel premises in the first place. Not that they don't have alcohol in the bars; they just don't like to share it with the patrons. About the nearest I came to it was when the man at the next table claimed he could detect traces of gin in his martini. Oh well, maybe next year.

But, let's get back to the exhibit area, and leave the Hilton for those with more courage than mine. As noted, the video exhibits were colossal, and seemed to draw the biggest crowds. For example, the Ampex booth—a modest little shack about the size of downtown Los Angeles—was strictly SRO. They really packed them in for a close-up look at the latest video hardware. I suppose there was an audio machine in there somewhere, but who could find it?

Yet, many audio-only companies were also on hand, and seemed to be pleased with the reactions they were getting. At our (audio-only) booth, I was intrigued by the variety of reactions observed. A little background information may be in order. The booth was a combined effort of JVC and Panasonic—both names well-known in video circles. Both companies were also exhibiting their video wares elsewhere on the convention floor. Here, we were set up with a sort-of simulation of a home listening room (and with no t.v., of all things!).

Some visitors arrived at our door, took a look inside and did an immediate about-face. What was wrong, we

Antennae outside the NAB convention hotel.

wondered, and, out of curiosity, chased after a few escapees. When cornered, they would explain that they were in video, and then run off in search of the latest color camera. Their interest in audio was—to put it conservatively—zero. But then, other video folks would wander in and stick around for a long time, asking all sorts of probing questions. They were clearly intrigued by the long-term potentials of quality audio broadcasting and wanted to know more. Some agreed with our approach, while others didn't, but that's not the point. What matters is that they were concerned about the audio portion of their transmission, and wanted to see (oops, *hear*) some improvements. Don't look for anything profound in all this; it's just that the video people, like the rest of us, have conflicting feelings about the importance of audio. Some think it matters, some don't.

ELCASET

As for the f.m.ers in the crowd, we found a growing fascination for—of all things—the elcaset. Some more background information: we had been carrying an elcaset recorder around the country with us, to use as just one more program source in our broadcast demos. In each location, including the NAB show, broadcasters have been intrigued with the high-quality potential that it could bring to automated radio. Although the elcaset format has not exactly captured the consumer market place, it does combine some of the advantages of open-reel with the handling ease of the cassette. A cue-track makes it automation-ready, and broadcasters seem to be interested. So, will this new format eventually find application in the quality-minded broadcast studio? Maybe we'll know by next year. (By the way, we'd welcome pro and con opinions on this subject from broadcasters.)

HIGH-POWERED CONSOLES

And, speaking of the quality-minded broadcast studio, dare I mention again that there were many high-powered audio consoles on display, and lots of broadcasters hovering around them? Some names (MCI, Neve and such) need no introduction to **db** readers; their products have been regularly seen at all the big audio shows. Many of these manufacturers—well-known in the recording industry—have expanded their product lines to include consoles tailored to the expanding needs of the broadcaster.

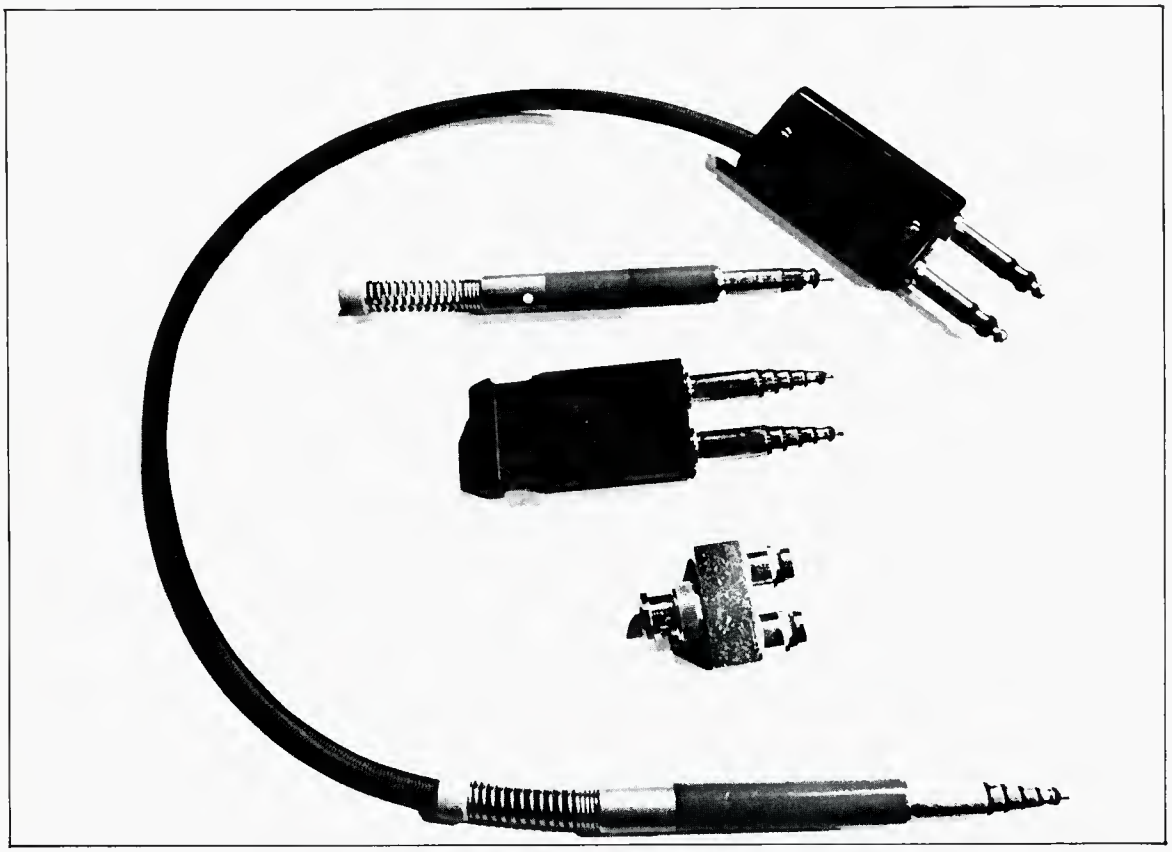
On the other hand, McCurdy Radio Industries is best known as a long-time leader within the broadcast industry. Of particular interest at this NAB show was the introduction of McCurdy's new SS7900 production and recording console. Here, we find a broadcast-oriented board designed to accommodate the recording requirements of in-house broadcast production work. Each of the SS7900's twenty input modules is switchable between mic and line level inputs, and contains a three-band equalizer, phase reversal switch, solo, channel on/off, aux. sends, pan pots—in short, all the paraphernalia usually associated with recording applications. The console is available with eight or sixteen outputs.

From Britain, Helios Electronics' R. Swettenham was on hand to demonstrate his firm's "Nordic" broadcast sound consoles. The boards are available in configurations from 12 x 2 to 24 x 8, with larger systems available on special order. An interesting point of the Nordic series is that, while the various input modules are generally supplied from standard company designs, built in conformance with Nordic N.10 and U.K. IBA standards, the output control and monitor panel sections are designed according to each customer's individual requirements. Therefore, the console may be easily tailored towards multi-track recording capability or basic stereo output, at the customer's option.

LINE-OF-SIGHT TRANSMISSION

For the broadcaster who is not in love with the telephone company, both Moseley Associates and Marti Electronics showed Aural Studio-Transmitter Links (STL) consisting of one or more transmitters in the control room, with matching receivers at the transmitter site. Recording studio types (like me) who are out of their field of expertise when the frequency gets above 20 kHz, may be dimly aware that many transmitters are situated at some distance from the radio station's control room. So, how does the console output get to the transmitter input?

Over phone lines, of course, and this may be a problem, depending on where you're located. Perhaps one of your phone lines goes more or less directly from point-to-point, while the other one meanders all around the countryside. By the time the audio gets to the transmitter, phase relationships, equalization and such may be out the window. And to keep things interesting, the performance of your lines may vary as they get rained-on, blown down or re-routed, depending on the whims of those two mothers, Nature and Bell. Well, the Aural STL may help lower the chief engineer's ulcer problems by providing a line-of-sight transmission system between the control room and the transmitter. Now, as long as someone doesn't build a World Trade Center between the two, life should be a lot simpler.



From Trompeter Electronics, some six circuit patch cords, and a convenient 2:1 BNC adapter.

For further information, here's a mini-guide to the manufacturers just listed:

Helios Electronics America, Ltd.
3416 Prospect Street, N.W.
Washington, D.C. 20007

JVC
58-75 Queens Midtown Expwy.
Maspeth, N.Y. 11378

Marti Electronics, Inc.
P.O. Box 661
1501 N. Main
Cleburne, Texas 76031

McCurdy Radio Industries, Inc.
1711 Carmen Drive
Elk Grove Village, Illinois 60007

Moseley Associates, Inc.
111 Castilian Drive
Goleta, California 93017

Panasonic Company
One Panasonic Way
Secaucus, New Jersey 07094

Eric Small & Associates, Inc.
680 Beach Street
Suite 365
San Francisco, California 94109

Trompeter Electronics, Inc.
8936 Comanche Avenue
Chatsworth, California 91311

In one corner of the Eric Small & Associates booth, an interesting display compared the standard vu meter with the firm's peak program meter. Various types of program material were played, while the listener compared vu and ppm readings on adjacent meters. The ppm spec. sheet points out that "ppm's are 'idiot-proof'. . . even a deaf person could do a reasonable job—not so with a vu meter."

Small notes that the relationship between actual peaks and the typical vu reading is generally unpredictable and varies according to the nature of the program. Therefore, interpreting the vu meter and leaving sufficient head room for peaks is a guess-work proposition at best. On the other hand, Small's ppm is *not* an instantaneous peak indicator. BBC tests have shown that the ear does not detect distortion that exists for 10 milliseconds. Therefore, the Small peak program meter was designed with a 10 millisecond integration time: thirty times faster than a vu meter, yet slow enough to prevent ultra-short peaks from influencing the meter-reader.

If you are planning to design your own super-system, you may want to look up Trompeter Electronics, who manufacture *six* line (!) audio patch cords and jacks. Also of interest are their 2:1 BNC adapters, plus an extensive line of BNC patch cords. Although the Trompeter catalog is geared mainly towards high frequency (t.v., digital, etc.) applications, BNC connectors are found on most high-quality audio test gear, and as for digital electronics, need we say more? If so, you just haven't been reading **db** lately. ■

MARSHALL KING

The Technician and His Union—Part I

Skilled craftsmen balance individual job pride with equity in labor practices.

ONE COLD NIGHT in November, nine men met secretly a few minutes after midnight in a run-down bar on Fourth Street. From time to time one or the other would glance apprehensively through the murky window with the neon *Coors* sign at the building housing the small radio station where they worked. If they could pull off this thing tonight they would be on Easy Street from now on.

It was risky and some of them felt growing doubts as they waited for their "contact" to arrive from Los Angeles with the Master Plan. I was one of those who didn't give a damn about the thing backfiring. The worst that could happen was . . . but why worry about that now?

A distinguished white-haired man in a natty business suit appeared in the doorway and surveyed the room. I approached him and asked if he were Claude McCue. When he nodded, we made our way to a corner table where the ten of us could talk undisturbed amid the clatter of billiard balls and a background of a muted juke box.

"I'll tell you quite frankly, Mr. McCue," I began, "some of us are a bit jumpy about this, and we've got to be convinced." I looked at the others and continued. "Just getting all of us together was no easy job."

McCue's lined face had the suggestion of patience that told us he'd been through this innumerable times in the past. "I understand how you feel," he said, "but let me assure you of two things. First, what you're doing is right; you should have done it years ago. Second, you are protected by law. What you're trying to do is one hundred percent legal."

"Legal, schmegal," one of us said. "We'll be fired in two minutes if the company finds out we're trying to organize."

Marshall King is a sound mixer at CBS Television.

"Your company will be in very hot water if they try that," McCue replied.

"You don't know the schmucks we work for," someone exclaimed. "They'd be too smart to fire us all at once. We'd be picked off one at a time for perfectly *legal* reasons. And if you want to know the truth, if I miss more than two weeks salary I'm down the tubes. I've got two kids, and what's more . . ."

"Guessing your ages," McCue interrupted, "I'd say you've *all* got kids and are more or less in the same situation. Which is precisely the reason why you can't afford *not* to organize. You'll be down the tubes forever if you don't do something about it now. What are your salaries?"

"Sixty eight bucks a week, for six days."

McCue shook his head slowly. "Medical plan?"

"No."

"Safety precautions?"

"Well, we're supposed to remember to use the shorting-bar whenever we step inside the transmitter."

WHY ALL THE DOUBT?

As we described the conditions under which we worked as technicians and announcers at a five thousand watt radio station, McCue studied us carefully, fingertips pressed together. At last he said, "Looks like you've answered all your own questions." He leaned forward. "Now look. You called me down here, I didn't call you. Now why all this doubt? On the phone it sounded as if you were raring to go with this thing. Now I find you're divided all over the place. You must know that for me to do anything at all. I've got to have a clear majority, and it looks to me as if you're divided about five to four. That doesn't give me much to work with. If just one of you changes his mind it's five to four the other way, which means we've just wasted our time."

The silence that followed had a flavor of guilt, for it was true that McCue was taking a lot of time to help us with our plan. He had driven seventy miles from the Los Angeles headquarters of AFTRA, the American Federation of Television and Radio Artists, to meet with a relatively insignificant group of nine men to help them organize themselves into a recognized labor union. Furthermore, after we had phoned several unions for assistance, it was McCue who had responded immediately and with enthusiasm. Now we sat in gloomy fear of losing sixty eight dollars a week.

He assured us from another direction. "Maybe it will help if we examine our positions. You say your bosses are schmucks, but remember that everything they're doing is perfectly legal. It's probably just what you'd do if you were owners and managers. What's more they offered a job at a certain wage and you took it. But that doesn't mean you have no right to keep working to seek better wages and conditions. That's also very legal. And *you're* not schmucks."

McCue pushed an ashtray aside so the smoke would go somewhere else and ended the meeting with a last word of encouragement. "Why don't I see you again next week? Think about what I've said. Convince yourselves completely that you're doing the right thing." He rose to go. "Then call me when you want me to come back here and get the machinery in motion. And remember, I'd like to see something better than five to four. Don't you think a hundred percent would be better?" We shook hands and he disappeared.

What happened? The company sniffed out the essence of our plan and fired two men for "incompetence," five men stayed on as before, and two of us quit our jobs and found work in Los Angeles at stations that already were organized. McCue never heard from us again.

Small town transmitter, typical of the low-pay, poor working conditions situations which led to union affiliation.

Episodes like this one, which took place in San Bernardino, California in 1950, have occurred throughout the years, countles times in countless cities. Not all have had the same endings, but the circumstances that led to this incident are the same ones that gave impetus to the tremendous growth of organized labor and the laws that govern it.

Not all radio, television, recording and motion picture technicians belong to a union, but so many do that it might be profitable to take a look at the great variety of conditions under which we work.

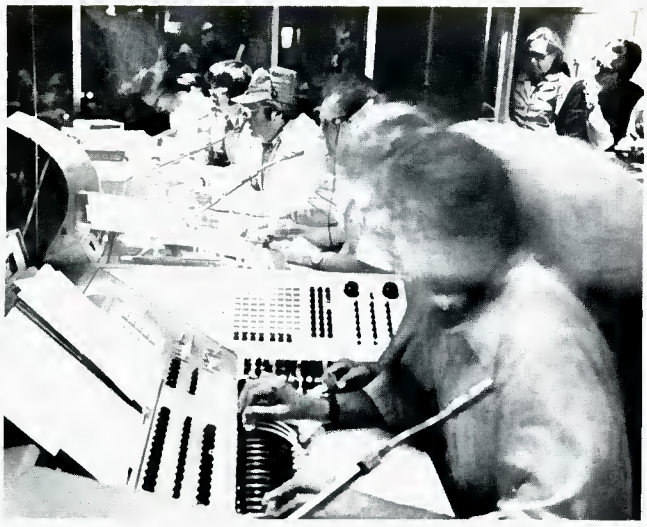
WORK DEFINED

Comments about *work*, and what it is or should be, have been recorded throughout history. The writers of the Bible dealt with it on nearly every page, and centuries later the Industrial Revolution led social-minded Adam Smith to write lustily on the subject. Kahlil Gibran has *The Prophet* say, "Work is love made visible." Another comment was made by Mark Twain when he said, "I love work. I could watch it for hours."

Millions of people take the pragmatic view that work is the best means at hand for staying fed and out of jail. In addition to these, perhaps the audio technician has yet another feel about work that underlies all the others—it affords us a means of pursuing craftsmanship.

This latter definition, regarding craftsmanship, is probably the one we must deal with here, but it is also useful to look at the official definition of work as used in scientific circles, for it inevitably leads us to the heart of the matter: working conditions and wages.

Scientists tell us that WORK is FORCE times DISTANCE, or W = F x D. From this we can see that very



Technicians in the control room during the videotaping of Your Hit Parade *at CBS represent a variety of unions; the mixer, IBEW; music coordinator, AFM; switcher, IBEW; director and assistant director, DGA; writer, WGA; lighting board operator, IATSE.*

great amounts of FORCE can be exerted without any WORK being performed, providing no DISTANCE has been traveled, since FORCE x 0 = 0. It might not be amiss to attempt a wry application of this to our lives as technicians and see how it affects our relationship with those who hire us.

It is clear that FORCE must be of a certain kind in order for it to be any good. A whole lot of inappropriate FORCE, such as misguided effort, wheel-spinning and bitching, can be expended by the most stalwart union member, but if no DISTANCE has been traversed—if nothing has been changed from its original state, no WORK has been performed.

Some see this as the classic and continuing stalemate between Labor and Management. The dual charges have been made that management is interested only in DISTANCE (the results) without regard for the required FORCE (the employee's sweat), while LABOR wants to be paid for the effort exerted (the FORCE) without regard for its effectiveness (the DISTANCE traveled).

If this were true, each would be putting forth an unacceptable proposition, for management's 0 x DISTANCE = 0 is just as much a goose egg as is labor's FORCE x 0 = 0. Scientifically speaking, what is missing in either equation is WORK, which, as we all know, is to be paid for. And as far as jurisdiction is concerned, who can deny that for work to be claimed it must first exist?

WORKING CONDITIONS/WAGES

Obviously these are the black and white extremes. It is the shades of gray that will lead us to our interest in the matter, which is in essence *working conditions and wages*. And to apply this for the last time to W = F x D, it is *how much* FORCE is required to travel *how much* DISTANCE that will describe our working conditions. And it is *how much* WORK is performed that will determine a scale for wages. Thus we give birth to the need for negotiations and contracts in an organized package, which requires the labor union.

There are as many opinions about labor unions as there are people to discuss them, and inevitably there is a *pro* and *con* to every issue. Some technicians, as already noted, do their work wtihout belonging to a union. However, there is strong evidence to suggest that if labor unions had never come into being we would be working for wages and conditions similar to those that prevailed in San Bernardino in 1950. The fact that some non-union technicians are working for relatively high wages undoubtedly is due, at least in part, to their being sucked along in the vacuum that follows the Labor Train. Employers have no other choice than to pay them wages somewhat in line with union scale.

At the other end of the spectrum is the opinion of my friend, Paul Courtland Smith, Associate Professor of Broadcast Communication Arts at San Francisco State University. A union member for years while an audio mixer in San Francisco, and for another decade as a videotape editor and recording mixer in Hollywood before turning to teaching in 1966, Smith's opinion makes a point.

"Unions stifle creativity," he said. "You get slapped down for getting the job done a little cleaner and faster."

Speaking to me in February of 1976, Smith spoke of another area of distaste. "Have you read the newspapers lately, or listened to the radio this morning? This strike in San Francisco that's caused the stoppage of trash pick-up is a real Labor gem. What's the price-tag, bubonic plague? Talk about crime in the streets."

AGREEMENT VS. DISAGREEMENT

Smith cites a recent experience in audio to bolster his claim that unionism may be running away with itself. As a member of the Television Committee of the National Academy of Recording Arts and Sciences, he is actively engaged in arranging for the televising of the *Grammy Awards* each year. "In 1975," he recalled, "we did the show in New York. The unions there nearly sabotaged the program with their constant in-fighting and squabbling over who does what, and this resulted in slow-downs. There were no less than three unions handling just the audio alone. This year (1976) we did the show in Hollywood, and even though several unions worked on the project, it was a co-ordinated symphony in accomplishment, for there was a can-do attitude all the way. It makes us hope that this will be the common situation in the future."

Professor Smith unwittingly touched on many points that have long deserved examination. One is the multiplic-

Revolutionary new equipment, such as the Ampex 2000, influenced new techniques and working conditions.

ity of unions doing the same work in the same area. Another is the *strike* as Labor's ultimate weapon. A third is reciprocal privileges for technicians whose work takes them into various jurisdictions. Other crucial items pertain to job classification, union cohesiveness, and federal regulations covering both labor and management.

The National Labor Relations Act, administered by people appointed to the "Board" (the NLRB), is the final justice in disputes between unions and employers. But many union leaders are not all that thrilled with the NLRB and its rulings.

Andrew Draghi, business manager for IBEW technicians in Los Angeles for over twenty years, would rather settle all issues directly with management rather than have them go to arbitration or to an NLRB hearing. "For one thing," Draghi says, "the very wording of the Labor Act is often loaded in favor of management. And even where it isn't, the decisions rendered by the Board too often work against the union."

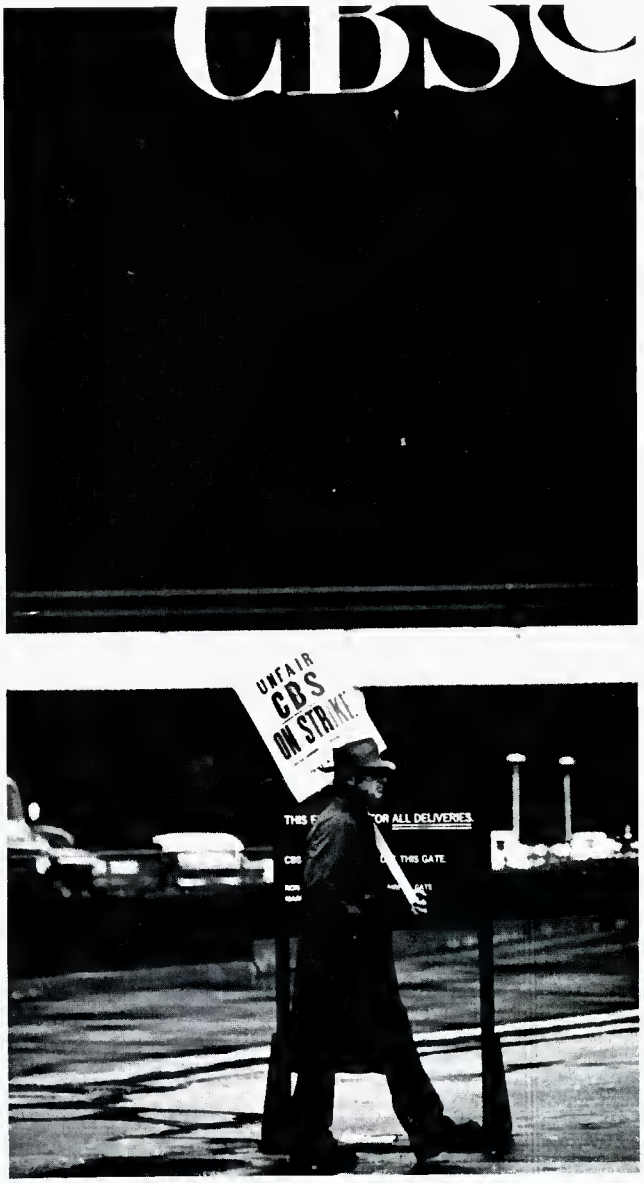
One of the most cherished dreams of union leaders is to have their members see their security with the union rather than with the company. The odds of this happening are probably about the same as finding Walter Cronkite wearing an Afro, for the technician's paycheck comes from the company, not the union.

THE COMPANY PAYCHECK

That the company paycheck has power detrimental to the union in subtle ways is seen in the testimony of witnesses during hearings of grievance, arbitration, or actions of the NLRB. Witnesses favorable to the union invariably are on the payroll of the company they testify against, and the record shows that an iron-clad testimony deposed in the union office frequently disappears during formal proceedings under the questioning of a high-priced company attorney whose every move is designed to remind the witness where his salary comes from. The union attorney, according to Draghi, is not only pitted against a battery of opposing lawyers who have behind them unlimited funds representing unlimited delays and other tactical advantages, but he cannot promise the witness another source of income if an unfavorable judgment leads to his dismissal.

Frequently there are several unions claiming jurisdiction over the same work, often in the same city, sometimes on the same job. In audio work alone there are at least three important unions competing for jurisdiction: IBEW, IATSE, and NABET. (AFTRA has some limited jurisdiction in the technical field, but their main body of work concerns performers.) Does this divisiveness work to the advantage of management? Can management pit one union against another to get a reduction in demands? Probably it can no more than unions can pit one company against another to get higher wages and benefits. But the situation points to an obvious question: Would an amalgamation of such unions give them more clout?

The fact is, top echelon meetings on a national level regarding amalgamation among those three unions have indeed taken place, but so far it has all come to naught for reasons pointing to man's foolishness. Issues that caused at least one meeting to break down involved such things as the desire for executive status, political position, and recognition. Perhaps it is understandable that the top officer of a lesser union would feel reluctant to exchange his letterhead and gold leaf for a third-rank title in a more formidable organization. Of course, the time to explain this to a rank-and-file union member is not when he is carrying a picket sign in the rain.



Audio technician Dick Oldaker celebrates his seventh week on the sidewalk as IBEW technicians strike CBS in 1973.

If amalgamation on a national level is not forthcoming, what can competing unions do on a local level to exchange labor strife for cooperation? "Ideally," says IBEW Andy Draghi, "they could start respecting each others' picket lines, stop raiding each others' ranks, and generally keep each other informed of future plans."

Draghi admits that to hope for such joint action may be visionary, for how can unions work together when they fight for the same jurisdiction and cross each others' picket lines? The audio technician, regardless of which union he belongs to, is in the middle of a dilemma, for he is pitted against fellow professionals for a fair slice of the pie.

IMAGINE TOTAL AMALGAMATION

What would our lives be like if amalgamation were *total*, if every employee belonged to one grand union? The best we can do is speculate. From the optimistic point of view, if new laws were enacted so that labor's new power did not run away with itself, chances are there would be a great leveling in the standard of living, whereby those

whose standards were raised would far outnumber the corporate heads who would have to live in something less than excess.

On the other hand, a science-fiction writer might see it this way: A strike would be as paralyzing as a hydrogen bomb. Everything would come to a standstill. A successful grievance by a garment worker would put idle the work of a tool-and-die maker. Bringing taxi cabs to a halt would stop the steel furnaces as well. In one harmonious symphony of hand-holding brotherhood, the audio technician's woes become the plumber's woes. A jittery society would daily wonder which labor grievance would pull the pin in a noble act of self-destruction. A nervous understanding might prevail, whereby a strike would never be called for the same reason that nations have thus far refrained from setting hydrogen bombs against each other!

Thus, in total amalgamation a strike would be unthinkable, all demands would be met, the average weekly salary would be one million dollars, and a loaf of bread would cost $4.625!

Since this glum picture offers no solution at all, and since a workable amalgamation of even *competing* unions is not on the horizon, we are left to wonder where labor's ultimate strength lies. Is the *strike* our ultimate weapon? For years it has been considered to be, yet now that we have seen the employees of ABC Radio and Television suffer through five months of unemployment due to their recent strike, wherein each worker lost an estimated minimum of $8,000, we can only wonder where we are.

EXAMINING THE IFS

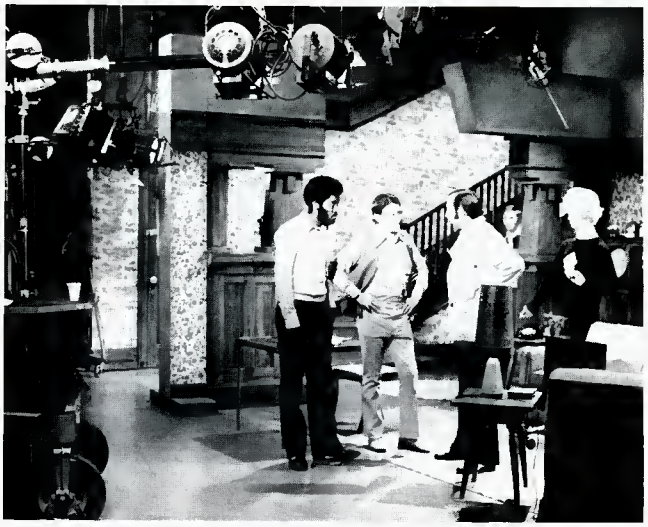
To consider an answer to this would be to look at the many "ifs" buried in the question. Andrew Draghi has already supplied the first one. "If Locals would cooperate with one another, respect each others' picket lines, for example, a strike's success would be practically guaranteed."

Another *if* lies in the nature of the business being struck. When a Teamster strike causes a nationwide stoppage of food delivery it is almost guaranteed that the strike will be short. But if the workers making hula hoops strike their employer, there is a strong chance that they'll be on the picket line long enough to see the next two passes of Halley's comet. The impact of a strike in our industry lies somewhere in between.

At times it seems that we have a chance of seeing Halley's comet at least once. Even the most casual observer has seen that the consumers of our t.v. product are not known to be discriminating. While we on the picket line have sneered and jeered at the up-cuts, wows, and dead silence that accompanied many shows engineered by management during our strike, the great Average American Viewer simply did not join in a national clamor to have things put right again. To hope for him to turn off his t.v. until a strike is over is about as foolish as applying for a job as a lighthouse keeper at a Salina, Kansas employment office. The t.v. viewer seems to regard his set much as he would a pacemaker for his defective heart: as long as the thing is ticking somehow, life goes on. This is not encouraging to the sound mixer celebrating his seventh week of carrying an UNFAIR sign.

WORK BY THE BOOK

What, then, is a better alternative to the strike? An idea has been growing, particularly among those who have hit the pavement a few times, that the solution has been within reach all along. Namely, instead of striking, stay on the job and work strictly within the terms of the (expired but extended) contract. If this seems too utterly simple, a closer examination may be in order.



The author (center) discusses an audio problem with boom operators Wendall Handy (left) and Jack Peters.

It is a well-known but seldom-discussed fact that virtually every technician in our industry—whether he is making phonograph records or installing public address systems—goes far beyond the tasks set down in the union contract as minimum requirements for job performance. He usually does this in the excitement or enthusiasm of getting professionally involved in turning out the product.

In television, for example, what good boom operator, by merely knowing the dialogue perfectly, doesn't save a forgetful actor by swinging around to cover the person who must inevitably deliver the next line? What good cameraman, in seeing an uncalled-for piece of business developing, doesn't widen out to cover the unexpected action?

What good mixer, in seeing well-rehearsed audio go down the drain because of disastrous last-minute changes in staging, doesn't point out to the director a good way to save the piece in post-production? What good tape editor, who knows very well how to cut seventeen bars of music, doesn't do so without demanding that someone tell him exactly where to cut?

What good technician in any job hasn't, at some time in his life, worked through a five-minute break in order to accommodate a producer? And perhaps most important of all, what good maintenance technician hasn't saved the whole project by working feverishly around a piece of malfunctioning equipment?

We do all of these things without thinking about them. However, the idea is growing that, during periods of contract negotiations, we *should* think about them. While work stoppages and slowdowns *per se* are illegal under most labor agreements, a distinction is made between that and a strict adherence to terms. The results would be, it is assumed, very much like a strike without being on strike. The obvious advantages are that no one hits the pavement and the paycheck continues.

On the other side of the fence, there is a segment of the mainstay who feel that this would be a feeble effort at best; it would be very much like being half pregnant. They feel that a strike is a strike, and that you either have one or you don't. They are so firm in this matter that not one has bothered to come up with even a suggestion for an alternate plan. ■

(This article will be continued next month.)

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Hollywood, Ca. 90028
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NEW PROFESSIONAL LINE of pre-assembled mic and patch cables in seven colors, two thicknesses; not a me-too copy of existing cables. Further info, **Sound Applications, 342 Lexington Ave., Mt. Kisco, N.Y. 10549. (914) 241-0034.**

SONY C-77, superdirectional, tele-microphones, @ $200. **Larry Godby, 9724 Columbus, Sepulveda, Ca. 91343. (213) 847-3059.**

WISCONSIN'S PRO AUDIO CENTER featuring equipment from Tascam, Klark-Teknik, dbx, TAPCO, Crown, AKG, Revox, Beyer, E-V, Shure, and many more! Complete professional consulting available. Large display in-store; in stock for immediate delivery, Tascam Series 70 ½" 4-track with 701 electronics and sync module, $1,995 — new, factory sealed. **Flanner & Hafsoos, 2500 N. Mayfair Rd., Milwaukee, Wi. 53226. Call (414) 476-9560, ask for Terry De Rouin, Tom Luell, or John Loeper.**

FANTASTIC SALE PRICES on all your recording and p.a. needs!!! Beyer M260 new, was $150, now $120; Beyer M500 new, was $170, now $145; Tascam 10 (24 channels, loaded with everything) mint, was $8,000, now $5,000; Bozak CMA10-2 mixer, mint, was $1,500, now $1,000; dbx 162 new, was $650, now $600; Sequerra tuner, demo, was $3,040, now $2,600; Clover reverb demo, was $500, now $350; Cerwin-Vega V-30 speakers, mint, was $500 pr., now $300; Yamaha PM-400, new, was $700, now $550; Edcor PM-1/ST-3 wireless system demo, was $600, now $480; Shure SR-107 new, was $250, now $200; Sennheiser MD-406 new, was $55, now $35; Sennheiser MKH-125 mint, was $472, now $300; Shure M-65 new, was $110, now $50; dbx 157 new, was $600, now $550; Beyer M111 mint, was $170, now $111; Sennheiser MD-21HN new, was $105, now $70; JBL 375 mint, was $294, now $200; Sennheiser MD-408 mint, was $108, now $75; Neumann U47 FET mint, was $833, now $650; Shure V302 system w/speakers demo, was $1,000, now $675; Ruscco "B" tables new, was $250, now $200; Sennheiser MD-411 good, was $54, now $30; Group 128 mic demo, was $275, now $200; Shure M610 new, was $149, now $100; JBL K145 new, was $162, now $130; Shure 571 new, was $88, now $50; Shure 404B new, was $30, now $15. Write for complete list, more details. Warranty. **David Beatty Stereo, 1616 W. 43rd St., Kansas City, Missouri 64111.**

MODERN RECORDING TECHNIQUE, by Robert E. Runstein. The only book covering all aspects of multi-track pop music recording from microphones through disc cutting. For engineers, producers, and musicians. $10.50 prepaid. **Robert E. Runstein, 1105 Massachusetts Ave., #4E, Cambridge, Mass. 02138.**

NAB ALUMINUM FLANGES. We manufacture 8", 10½", and 14". Also large flanges and special reels to order. Stock delivery of assembly screws & nuts & most aluminum audio, video, & computer reels. For pricing, call or write **Records Reserve Corp., 56 Harvester Ave., Batavia, N.Y. (716) 343-2600.**

MINI-STUDIO package systems from $2,599, using pro-recording equipment from Revox, Otari, Lamb Labs, Trident, Beyer. Write for full details of offers to **Entertainment Sound Services, Inc., 78 N. Franklin Ave., Hempstead, N.Y. 11550. (516) 538-2220.**

REVOX MODIFICATION, variable pitch for A-77; in/sync for A-77 or A-700; programmer for A-77; rack mounts, slow speed 1⅞; full track; auto rewind; high speed 15 i.p.s. for A-77; Slidematic for A-77. Machines available with or without mods at low cost (A-77 from $695). All mods professionally performed by Revox trained technicians. **Entertainment Sound Services, Inc., 78 N. Franklin St., Hempstead, N.Y. 11550. (516) 538-2220.**

ROADSHOW EQUIPMENT. Clearing wide range new & used items including mixers (from $350 to $3,500), bass & treble bins (w & w/o speakers, $125 up), lenses, horns, etc.; limited quantity; be first. **(516) 538-2220. Entertainment Sound Services, 78 N. Franklin St., Hempstead, N.Y. 11550.**

VAN EPPS variable pitch lathe, Neumann MH-52 cutterhead, Lang LDE-1, suction pump, spare pump, 100 assorted blanks, $650.00. Also two 175-B Universal limiters, 245-E Orban stereo synthesizer, $150 each. **(212) 575-0295.**

35MM RCA RECORDER; three 35mm Mangasync dubbers; two 16mm Westrex, 16mm wide range dubber; Audio-Designs digital footage counter; three-phase Selsyn system, 220V. **Jack Lieb Productions, 200 E. Ontario, Chicago, Ill. 60611. (312) 943-1440.**

TAPE MAGNACORDER duplicator in rack; master and three slaves, amp and mixer, $3,000. Also two older Magnacorders and amp, $750. **KICO (714) 357-1490. Box 861, El Centro, Ca. 92243.**

16-TRACK MCI, excellent condition; 8- & 4-track Scully. All recorders now being used in studio. **Virtue Studios. (215) 763-2825.**

JBL 4350 MONITORS, walnut; excellent; 4 available. $2,150/pair plus applicable taxes & freight. **R. Orban, Orban Associates, Inc., 645 Bryant St., San Francisco, Ca. 94107.**

REK-O-KUT drive belts. Specify model. $9.95 delivered. **QRK Electronic Products, 1568 N. Sierra Vista, Fresno, Ca. 93703.**

AMPEX 300 8-track; one-inch 300 transport; 354 electronics; 7½/15; metal console, $3,000. Thomson C.S.F., Volumax 4111; new, $1,000. **(203) 232-9785.**

FOR SALE: Stevenson interface mixer, 16 inputs, expandable to 24; also 3M M64, 410 series 2-track recorder. **(212) 641-5432.**

DISCOUNT PRICES on fresh name-brand tape. Check our prices in bulk, reels, boxes, carts, and cassettes. **P.B.P., 4100 West Kennedy Blvd., Tampa, Fla. 33609. (813) 877-7125.**

MAGNECORD 1024-42RX/remote; Revox A-77 1302/remote/rack, $550. **James Ebbert, 770 Holly Rd., Wayne, Pa. 19087. (215) 687-3609.**

TWO SUPER RED monitors w/mastering lab crossovers, $1,000; 8 Spectra Sonics 101 cards @ $60; one Ampex 440 deck w/portable case, $1,000. **Call (612) 521-7631.**

AMPEX MM1000, API comp/limiters, J.B.L. 2482 drivers, Exact Lin/Log function generator, Yamaha pro audio products. Call **Bursting Sun Sound. (413) 863-9711.**

USED EQUIPMENT, excellent condition: Altec 9860A ⅓ octave equalizer, $600; UREI LA-5 limiter, $250; LA-5 in road case with input/output panel, $900; dbx 194 mixer for Nagra recorder, $900; dbx 192 noise reduction for Nagra IVS, $400. **Technlarts, 8555 Fenton St., Silver Spring, Md. 20910. (301) 585-1118.**

TASCAM SERIES 70, ½ in. 8-track, 701 electronics, $3,000. Two Model 5 Tascam mixers, $1,500 ea. Dokorder 1140 four-track with sync, $800. Pioneer RT 1040 two-track, also ¼-track head nest, 7½ & 15, $450. Or total package, $7,000 or best offer. **Moonsound, Inc. (612) 824-2636.**

INSTRUCTION

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WANTED

WANTED: Recording equipment of all ages and variety; Neumann mics, EMT, etc. **Dan Alexander, 6026 Bernhard, Richmond, Ca. 94805. (415) 232-7933.**

WANTED: Old Neumann U47, 48, Ampex multi-channel tube electronics, sel/sync panel and ½-in. 4-track head assembly. **ETS Records, P.O. Box 932, Honolulu, HI 96808.**

WANTED. EMT Echo, **(707) 528-0304.**

EMPLOYMENT

POSITION AVAILABLE. First engineer position with major Midwest facility. **Call (612) 521-7631.**

CHIEF ENGINEER, established motion picture/t.v. sound recording studio has opening for E.E. with heavy experience in audio equipment maintenance, modification, design, and fabrication. Confidential interview; send resume and salary history. **Photo Magnetic Sound Studios, Inc., 222 E. 44th St., New York, N.Y. 10017.**

EXPERIENCED MUSIC MIXER
Major N.Y.C. studio. New automated 24-track. Send resume to **Dept. 83, db Magazine, 1120 Old Country Rd., Plainview, N.Y. 11803.**

db People/Places/Happenings

• Specializing in theatrical and audio visual presentations for theaters, conventions, and sales meetings, **L & M Stagecraft, Inc.** of Cleveland, Ohio has opened a new division, concentrating on theatrical lighting. The lighting effort will be headed by **Cassandra Henning,** formerly president of **Cassandra Henning and Associates.**

• **David Bain Asociates** of Port Washington, N.J. has been appointed metropolitan area sales representative for the **CCA Electronics Corporation.** They will handle transmitters, f.m. antennas and broadcast equipment.

• Complete responsibility for all communications has been delegated to **John C. Allen at TAPCO,** of Redmond, Wa. Mr. Allen has been an editor, writer, and illustrator. His work will involve corporate communications, marketing, advertising, and sales promotion.

• Westchester producers have a new recording facility. **Video Innovations,** located at Yonkers, N.Y. The company has a studio, post-production facilities on 2-in. quad and 3/4-in., as well as a mobile unit or on-location work. **Ken Wise** and **Bob Ahrens** are in charge. The telephone number is (914) 423-4400.

• Designed to streamline the connection between **Signetics,** of Sunnyvale, Ca. and its parent company, the **U.S. Philips Corp,** two new groups have replaced Signetics' single R&D department. **Dr. David Kleitman** has assumed responsibility for the Research Department and **Dr. Eugene Swystun** has been appointed director of the newly established Advanced Technology Department, which will concentrate on advancing the state-of-the-art in i.c. research and manufacturing techniques.

• Two new appointments announced at the **Sony Corporation,** of New York City are those of **Lary Benson** to the post of national manager, commercial technical support, and **Phil Horn** to the responsibility for technical support for dealers and servicers of products in addition to his previous chores as national service manager for consumer products. Mr. Benson replaces **Gerry McGinty,** who is retiring.

• Things have been moving at **TDK Electronics,** of Garden City, N.Y. **Mike Rosendale** has been hired as western region sales training manager and **Grant Saidiner** as western region territorial marketing manager. **Steven Danger** has been named midwest territorial marketing manager.

• The New York Chapter of the **Society of Broadcast Engineers** has elected a slate of officers for 1978-79. They are: **Lyn Snyder,** Chairman; **Larry Strasser,** Vice-Chairman; **Frank Cambria,** Treasurer, and **Tom Padwa,** Secretary. The New York Chapter normally meets on the 2nd Thursday of the month in the Theatre Studio of WQXR, 9th floor of the New York Times building. Information about meetings is available at 212-347-2940 and anyone who is interested is invited to attend.

• Directing sales of consumer blank magnetic tape products, **Bill Weismann** has assumed the post of national sales manager, consumer products, for **Ampex Corporation's** magnetic tape division. Mr. Weismann had been western area manager for the **3M Company.**

• A staff addition at **J.B.L.** is **Fancher Murray** who will serve as a senior transducer engineer. Mr. Murray will direct the analysis of motor elements of compression drivers and other transducers. He had formerly been associated with **Bolt, Berenek, and Newman.**

• **Philip Russo** has been appointed as president of the **Peabody Noise Control Company,** of Dublin, Ohio, rising from the post of vice president of sales. Mr. Russo will be in charge of the complet functional management of the corporation, which is under the leadership of founder **Laurence L. Eberhart,** chairman of the board.

• Three personnel changes have been made at **International Tapetronics Corp.** of Bloomington, Ill. **John Abdnour** has been promoted to the position of direct sales coordinator. **John Schaab** has been promoted from shipping manager to broadcast salesman. **Karen Ryder** has been promoted to the post of administrative sales coordinator.

• **Richard W. Burden** has been appointed engineering representative for the West Coast for **LPB Inc.** of Frezer, Pa. Mr. Burden will offer his services at 20944 Sherman Way, Canoga Park, Ca..

• Servicing the Canadian market, **John W. Howells** has been appointed as manager of sales by **RCA Ltd.,** Canada. Mr. Howells, who joined RCA in 1963, has served in Iran and the U.S. as well as in Canada. Sales of RCA's line of radio and television studio and transmitting systems in central California, Hawaii, Samoa and Guam are in the hands of San Francisco-based **Gaylen C. Evans.** Mr. Evans had been a radio/t.v. specialist in the U.S. Air Force. The appointment has also been announced of **Gary S. Moskovitz** as manager, electronic recording equipment products.

• Several changes have been in the works at **Ampex Corp.** of Redwood City, California. **Richard Sirinsky** has been named area manager of Europe, Africa, and the Middle East. Replacing Mr. Sirinsky as national marketing manager for the audio-video systems division is **Russ Ide.**

• An extensive duplication center has been added to the facilities of **Devlin Productions,** of New York City. It will provide duplication on all videotape formats, including 1/2-inch Betamax, VHS, and Quasar, as well as from all film and tape formats. An International Division will be capable of converting to and from the three world video standards. A newcomer to Devlin is **John Horvath,** who will assist in the maintenance, design, and modifications of the equipment.

• The position of vice president, new business services, at **Warner Cable Corp.** of New York City, has been filled by **Miklos B. Korodi.** Mr. Korodi had been director of corporate development at **American District Telegraph Company.** David W. Hamilton has been promoted to vice president and regional manager for Warner's southern region, with headquarters in Atlanta, Ga. A newly created staff post, vice president of municipal relations, has been filled by **L. Allen Williams.** Mr. Williams had been vice president and regional manager for the firm's southern region.

Today's performance requires the best in an audio test source. That's the new Sound Tech 1410A.

No question about it, the new Sound Tech 1410A is the finest audio test source available. It provides both sine wave (10 Hz - 110 kHz) and SMPTE intermodulation test outputs.

We classify it as an ultra-high-performance audio signal generator. Here's why:

Besides providing an ultra-pure test signal (typical distortion is **less than** .001% over most of audio range), the test signal is adjustable by precision output attenuators. And you have an exceptionally large output level range: from +26 dBm to −89.9 dBm in 0.1 dB steps. That +26 dBm can be a powerful help in line testing (no pun intended).

The output system on the 1410A is Sound Tech's special circuit. For minimum distortion, it has no output transformer, yet **it's both fully isolated and balanced.** That means **you can connect to any load: balanced or unbalanced, floating or grounded.**

INTERMODULATION TESTING

For intermodulation measurements, the 1410A provides the standard 60 Hz signal combined with a 7 kHz signal. You can vary the LF/HF ratio over a 100:1 range. The IM signal is provided from the same flexible output system discussed earlier.

With the high performance possible in today's audio systems, the 1410A (or its relative, the 1710 system) is what's needed for adequate testing.

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Call Mike Hogue/Larry Maguire and get our literature on the industry's most advanced audio test source.

They can also arrange a demo for you almost instantly.

REMOTE TESTING

In broadcast work involving remote transmitters, you can test by using the 1410A with the Sound Tech 1710A Distortion Measurement System. With its ½ watt of audio power, the 1410A can be used, say, at the studio to test studio-transmitter links, amplifiers, etc., while the 1710A is measuring at the transmitter.

SOUND TECHNOLOGY

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With HP's new 339A Distortion Measurement Set.

Automatic frequency nulling and auto set level features of the 339A speed your total harmonic distortion measurements (THD). And true-rms detection means accurate measurements as low as 0.0018% (−95 dB) from 10 Hz to 110 kHz. Just select the frequency of the built-in oscillator and the 339A's "turn signal" indicators show you how to make the proper range settings. Whether you're testing transceivers, sophisticated audio equipment or broadcast performance, here's how the 339A, priced at $1900*, can help you make quick and accurate measurements.

Transceiver testing. Automatic setting of the 100% reference level over a 10 dB input range means fewer critical adjustments. And true-rms detection lets you accurately determine thermal noise and harmonic components in making SINAD measurements.

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For a separate low-distortion oscillator, investigate HP's new 239A, priced at $575.* Like the built-in oscillator of the 339A, it provides less than −95 dB THD over the audio range. For details contact your local HP field engineer.

097/53A

* Domestic U.S.A. price only.

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