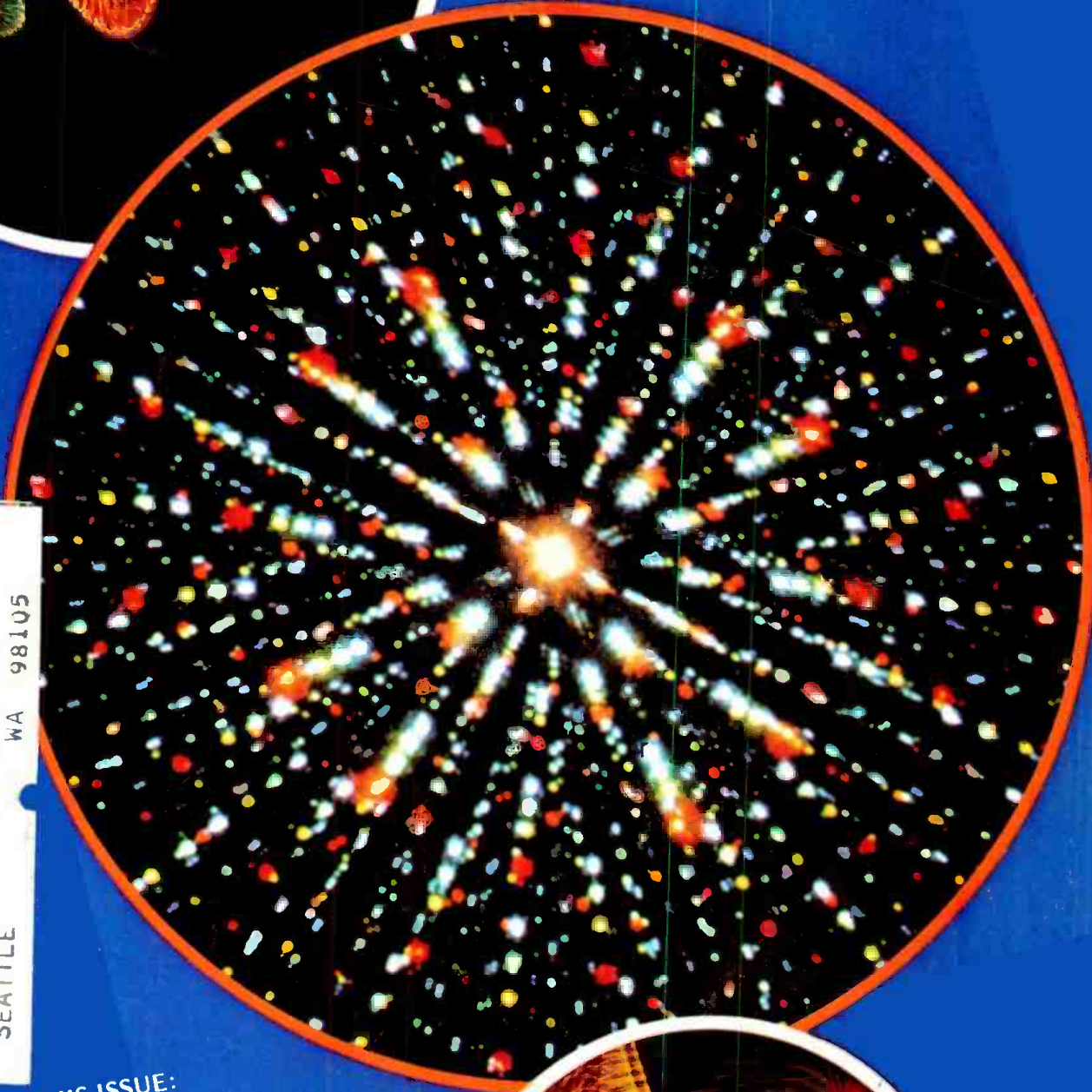
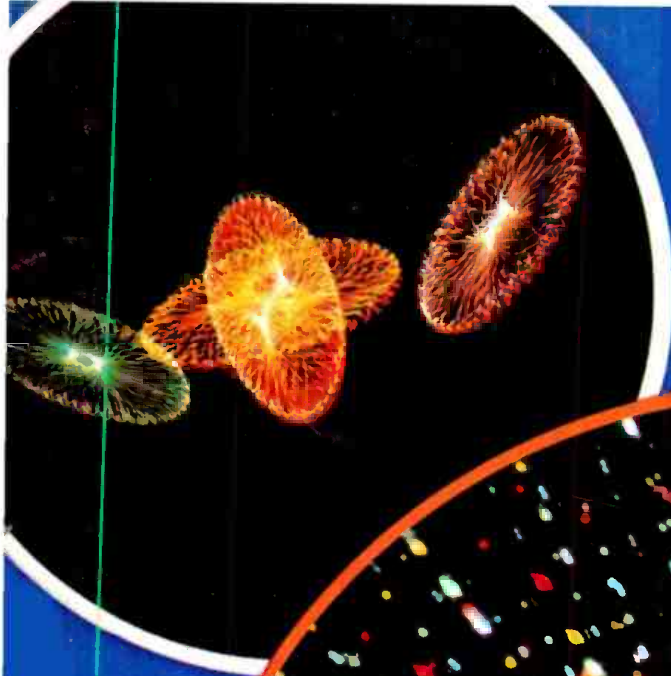


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THE SOUND ENGINEERING MAGAZINE

JULY 1975 \$1.00



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- Report on Los Angeles AES Convention
- Electret Microphones
- Handy Black Boxes



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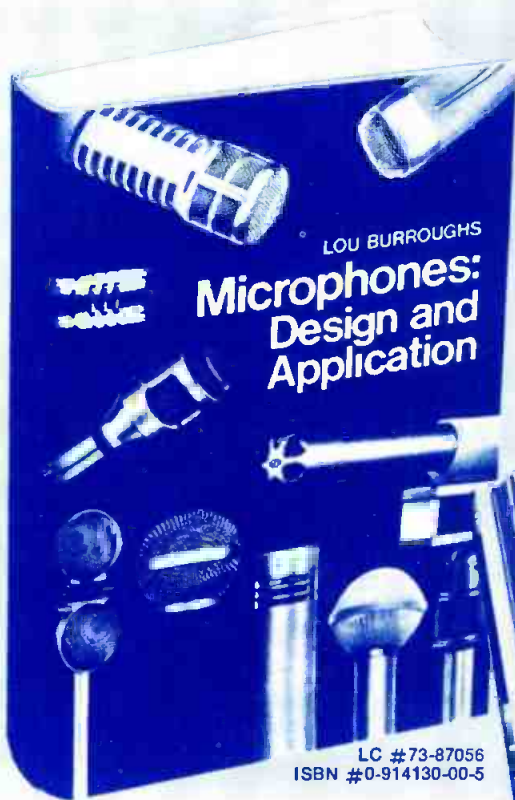
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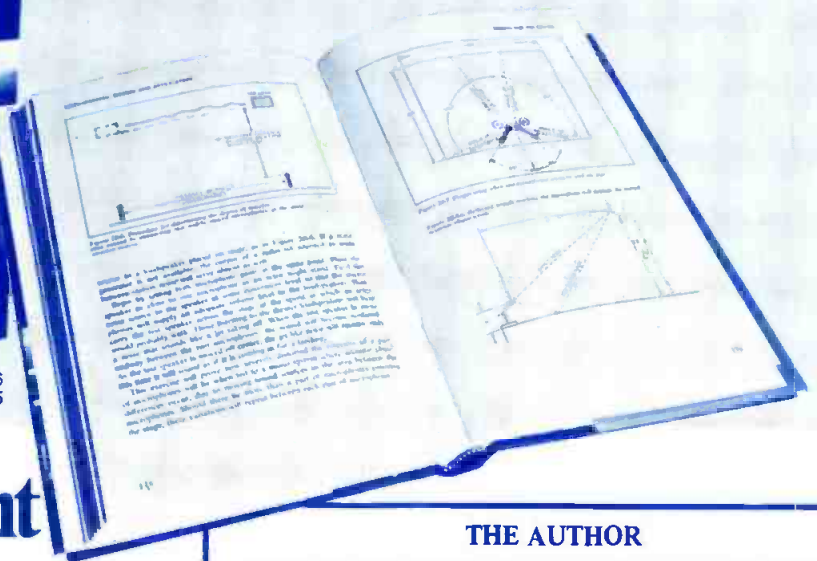
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THE AUTHOR

Holder of twenty-three patents on electro-acoustic products, Lou Burroughs has been responsible for extensive contributions in the development of the microphone. During World War II, he developed the first noise cancelling (differential) microphone, known as the model T-45. Used by the Army Signal Corps, this achievement was cited by the Secretary of War. Burroughs was the creator of *acoustalloy*, a non-metallic sheet from which dynamic diaphragms are molded. This material made it possible to produce the first wide-range uniform-response dynamic microphone. Burroughs participated in the design and development of a number of the microphones which have made modern broadcasting possible — the first one-inch diameter wide-range dynamic for tv use; the first lavalier; the first cardiline microphone (which ultimately won a Motion Picture Academy award) and the first variable-D dynamic cardioid microphone. He also developed the first wind screens to use polyester foam. Burroughs was one of the two original founders of Electro-Voice, Inc. He is a charter member of the Society of Broadcast Engineers and a Fellow member of the Audio Engineering Society.

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JULY 1975, VOLUME 9, NUMBER 7

● A composer's eye view of electronic music is presented by David Cope in A VIEW OF ELECTRONIC MUSIC. Composer Cope has had his works performed by major orchestras, is at present resident composer and director of the Electronic Music Laboratory of Miami University in Ohio.

● A better alliance between synthesizer, composer and technician is suggested in Robert Ehle's discussion, OPERATIONS OF MOOG SYNTHESIZER MODULES AND COMPONENTS.

● Martin Dickstein continues his reports on entertainment plus technical fascination with the inside story of THE NEW YORK EXPERIENCE, a multi-sensory exhibit currently running in New York City.

● The Best of db reprint brings back George Alexandrovich's BALANCED AND UNBALANCED LINES, first published in our July 1969 issue.

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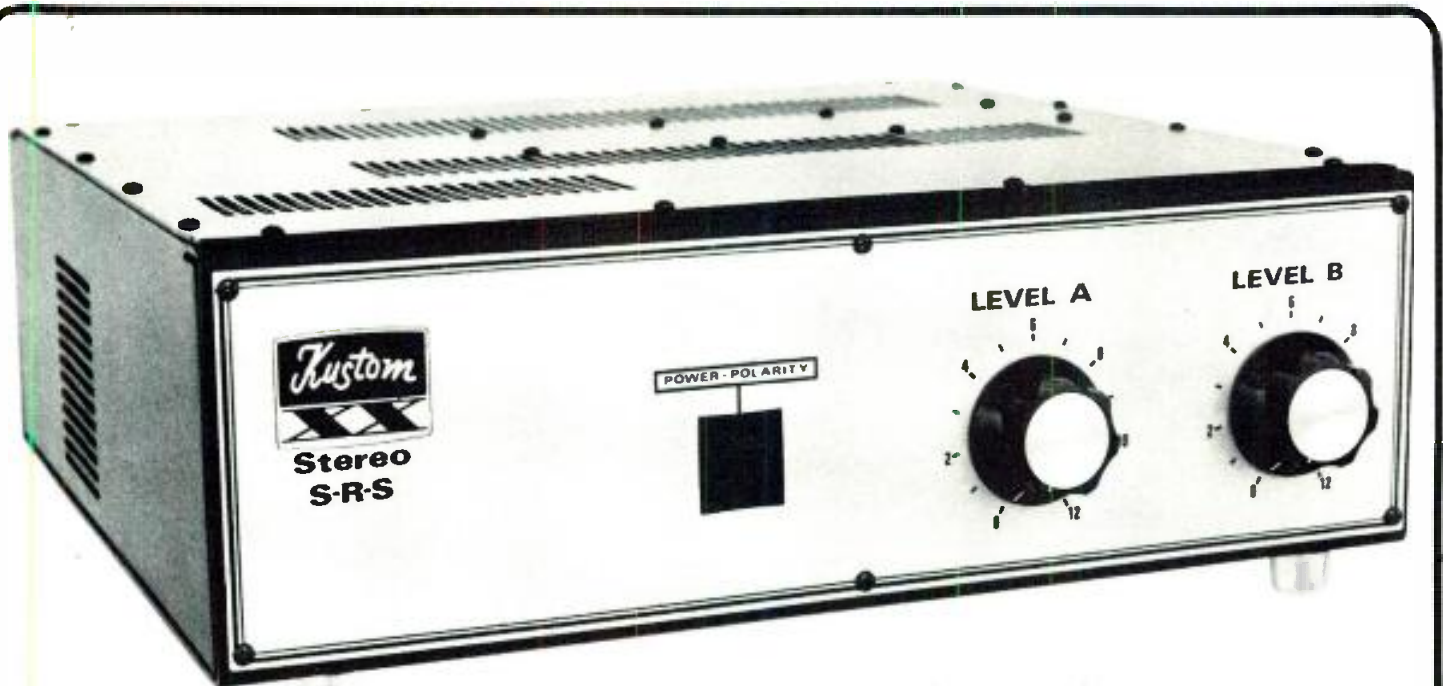
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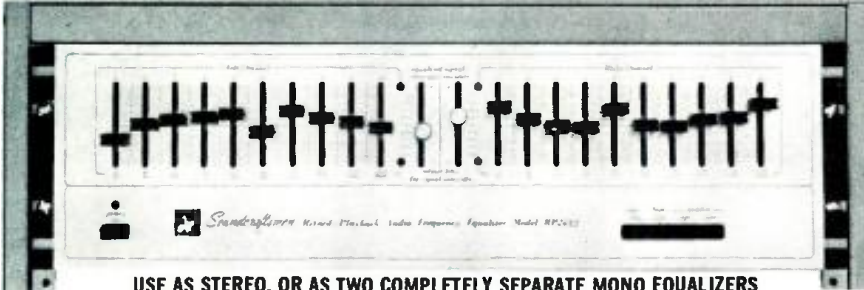
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db letters

THE EDITORS:

An article by Bob White in your May issue entitled "How to Make a Simple High Speed Duplicator" uses an Ampex 960. We have an Ampex 960 which we would be willing to sell at a reasonable price if the word could be passed along to any inquiring reader; we also have the Ampex 960 manual. Since this is probably a hard item to find, it may be of interest.

Burt Fisher, Chief Engineer
WOCB
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THE EDITORS:

I wish to acknowledge the fact that db Magazine is an invaluable furtherance of knowledge for the professional, quasi-professional, and novice, alike. I myself, am a striving and dedicated young junior recording engineer and the January issue of db was enlightening in numerous respects. Finally, I've stumbled upon an institution of higher education that contains an audio engineering curriculum concomittant with sound studios within the New York vicinity, namely, Syracuse University. I will seek matriculation there after my completion of my studies at the Institute of Audio Research. To me, mathematics has always been eventful but perplexing because of the frequent inconsequential terminology used, but the article on "How to Handle a Square" was concise and explicit and proved beneficial in explaining some theories I've often pondered. Last, but primary, was the "Sync Track," which, as intended, delivered pertinent and concrete advice and admonitions for the aspiring audio-minded. In closing, I would like to extend my congratulations for a quality and bona fide magazine. As soon as possible, I'll be hearing from you regularly.

WAYNE "ACEY" PEACOCK
QUEENS VILLAGE, N.Y.

Copies of all issues of db—The Sound Engineering Magazine starting with the November 1967 issue are now available on 35 mm. microfilm. For further information or to place your order please write directly to: University Microfilm, Inc.
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Microphones, microphone mixers, audio control components, stereo pre-amplifiers, and accessories are covered in this 24-page catalog. Mfr: Shure Brothers Inc.

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Plug-in transformers specifically developed for telephone interconnect are described in this leaflet. The low profile units, designated Ouncers, Sub-ouncer, and Sub-subouncer, are designed for wave soldering and quick insertion on card mounts. Mfr: TRW

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More than 20,000 items in the electronics field, many applicable to audio, are featured in this 104-page Engineering Reference Catalog. Included are a number of items designed for state-of-the-art use. Mfr: Herman H. Smith, Inc.

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CORRECTION

In our May, 1975 issue, p. 38, the two circular diagrams of connectors were inadvertently transposed. The correct diagram for XLR has three pins, while the one for MS-E/R has ten.

CALENDAR

JULY

- 7-11 **Nashville Audio Exhibition** seminar. Contact: Nashville Audio Exhibition, P.O. Box 12123, Nashville, Tenn. 37212. (615) 327-3918.
- 8-11 **INTER NAVEX '75** (Audio Visual Aids in Education) London.
- 16-18 **Second Conference of the British Society of Audiology**, University of Southampton, England S09 5NH.

AUGUST

- 27 **General Meeting of the Institution of Radio and Electronics Engineers**, The School of Electrical Engineering, University of New South Wales, Australia.

SEPTEMBER

- 15-17 **NOISE-CON '75** National Conference on Noise Control Engineering. Gaithersburg, Md. Pre-seminar at the Shoreham Hotel, Washington, D.C. Sept. 11-13. Contact (914) 462-6719.
- 21-24 **International MUSEXPO '75**, Las Vegas, Nev. Contact: Roddy Shashoua, International MUSEXPO, 1350 Ave. of the Americas, New York, N.Y. 10019. (212) 489-9425.
- 28-
Oct. 3 **SMPTE Technical Conference and Equipment Exhibit**. Century Plaza Hotel, Los Angeles. Contact: SMPTE Conference, 862 Scarsdale Ave., Scarsdale, N.Y. 10583.
- 29-30 **N.Y. Chapter of ERA, Commercial Sound & Communications Show**, Statler-Hilton Hotel, New York City. Contact: GIM Sales Corp., 375 N. Broadway, Jericho, N.Y. 11753 (516) 433-4080.
First Congress of the FASE on Acoustics. Groupement des Acousticiens Francaise (GALF), Paris, France, Secretariat: C.N.E.T., Issy-les-Moulin-eaux 92, Paris.

OCTOBER

- Fall Conferences, National Association of Broadcasters. Contact: NAB, 1771 N St., N.W., Washington, D.C. 20036. (202) 293-3500.
- 12-14 Atlanta
- 15-17 Boston

- 21-26 **International Audio Festival Fair**. London, England. Contact: British Information Service, 845 Third Ave., New York, N.Y. 10022. (212) 752-8400.
- Nov. 3 **Audio Engineering Society 52nd -31 Convention**, Waldorf-Astoria Hotel, New York, N.Y. Contact: AES, Room 929, 60 E. 52nd St., New York, N.Y. 10017. (212) 661-8528.

NOVEMBER

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● A very unusual technique for attracting and holding the attention of the audience during a slide-film exhibit was presented by the Organization of American States about 1½ years ago at the Pan Am Building in New York. It combined technical ingenuity plus showmanship.

The room was darkened, with just enough illumination for the visitors to see their way in and out. The projection screens (there were six images) were on the far wall as the room was entered. The images were shown on square or circular shapes and changed according to the script, sometimes individually, sometimes several at a time, some dissolving, or changing quickly. Nothing unusual here. A film running on one or more of the screens would still not be really unusual, as interesting as the material might be.

THE FIGURE OF COLUMBUS

The uniqueness came when the visitor noticed that the narration seemed to come from a figure standing between two images at the far end of



The talking head, made of plastic material, can be made to resemble the person speaking on the film.

the projection wall. Only the face and part of the shoulders were illuminated. In this exhibit, the figure represented Columbus, wearing a frilled shirt, a small string bow tie, and had dark hair with a beret. The coat had a big collar just as in familiar pictures of Columbus.

The figure did not move. Only the face moved. The eyes blinked normally, and sometimes looked from side to side. The mouth spoke the words the audience was listening to, and the nose twitched along with the facial movement. It seemed as if when the showing was over, the mannequin would come to life, doff his hat, and take a break until the next show. The exhibit was concerned with developments in the Americas since Columbus first came here and the image on the screens depicted visually what was told orally.

When the program ended, the eyes on the face closed, and the room stayed dark. The figure did not move. The screens went black, but the face remained with eyes closed, immobile. Then, after a short break, the eyes opened, looked from side to side as though looking the new audience over, the nose moved, the lips smiled, and the voice began again to tell the story of the slides. The screens came to life again, and the show was under way. The mannequin did not take a break. How long did this go on? The best way to find out was to wait the short time until the next show was over.

This time, after the show, a closer inspection of the figure was in order. The face was life-size, part of a full size head on a bust of Columbus. The base was a square pillar holding up the bust at the proper height. The

face was made of a white plaster-like material and although the features were cut out to make a face, there were no real features like color or brows. The moving face was actually projected onto this statuette, and gave the illusion of real-life animation. This is called the "talking," or projection, head.

PROJECTION HEAD

The head is similar to those used for demonstrating or holding headphones. For projection purposes, the face is reflective rather than opaque as it would be if made of styrofoam. The face is made life-size, if possible, or as close to that as it can be. The restriction on actual size might depend on the exhibit, the location of the mannequin with respect to the public, and the size of the projected face at the throw distance dictated by the display itself. When it can be done, the proper costume lends greatly to the realism of the display. The shape of the face is usually based on that of the actor being used in the film.

As you can see, when someone is speaking, his head usually moves up and down or side-to-side. However, since the projection in this case will be on a stationary head, the actor used in creating the film to be projected must keep his head perfectly positioned at all times. If he did not, the projected eyes and nose and mouth would not fall on the proper places on the head, most distracting, if not humorous.

In order to assure that the person on the film keeps the precise positioning, a brace is used to keep the head from moving. Naturalness of movement of the eyes, nose, the lips and the face can keep an illusion of realism, but the head must remain still. The background of the person speaking must, of course, be blank. By knowing the throw distance, the size of face to be projected, and then locating the bust in front of a black background, the total effect achieved is startling.

The sound can come from a speaker located in the base of the bust, or from some other hidden location in the vicinity of the face. The closer the audience can get to the head, the closer the speaker should be to the face for better realism.

The same technique can be applied in the event of a traveling show put on by a company, for instance. The face can be made of the actual per-

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son speaking on the film. When a plastic mold is being made to replicate a particular individual, the total effect is startling.

REAR PROJECTION

A similar presentation can also be made using rear projection. This time, the projector would be located behind the head or beneath it in the base, with mirrors to reflect the image to its proper positioning. The face would be made of a transparent material, and a similar illusion would be created.

The total number of projectors is controlled by the display size, the number of screens, and the method of operation, whether the slides are changed at random by a timer on the projector, for example, or from cues on a tape. The important thing for an automatic show, is that the slides either go all the way around on the drum or that they continue to an ending point and then recycle automatically.

The film of the face should be on an automatic loop which can either be made of a precise length with a definite amount of black space (where the head disappears during the pause) or with the face showing for a period of time with eyes closed or just looking around without speaking. In the latter case, the moving eyes and move-

ment of nose or cheeks would add greatly to the effectiveness of the "live" head, even though there was no sound. Perhaps, it might even be possible to use slight throat clearing from the "face" during these show breaks for effect.

TALKING HEADS ELSEWHERE

At present, we have learned of such heads being used in Wax Museums both in Paris and near Tokyo. The head is that of Madam Toussard, as she tells the entering visitors of the things they will see and some of the background of the exhibit. There were similar heads on the Freedom Train which traveled across the country recently. There are also heads at the Smithsonian Institute, in Copenhagen, Denmark, California, Florida, Tennessee, and other locations. One exhibit, in Washington, D.C., has actor Cliff Robertson as the "narrator." In this portrayal, he ages from twenty years to sixty years old in a few minutes. Many exhibits have also been prepared for corporations to use at traveling sales meetings or inter-office presentations.

There are possibly others, but we are familiar with the work of Ron Chedister Associates of McLean, Virginia, and Bergen Expo Systems of Clifton, N.J. as two organizations that

design the heads and have aided in the production of the display for an effective presentation. At present, there is work under way at Ron Chedister Associates to develop a moving head which will add further to the "liveness" and effectiveness of an already startlingly exciting exhibit technique.

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● In the January issue, we discussed education and received some immediate response, one letter of which was published in the April issue. However not everyone reads **db** immediately. More recently I received a letter from a dental student in Tennessee, referring to the January issue.

He was quite excited by my reference to the Teaching Research course on Dental Anatomy. As he wrote, it was six months since he had completed that course and he wrote to say that he had forgotten everything he was supposed to have learned except things he had himself used since.

He further commented, "You would be surprised at how much sheer memorization goes on in Dental and Medical schools, to no good purpose, except that's the way it was always done." He went on to explain that he reads **db** because recording and audio have been a long-time hobby of his. Then he says some flattering things about myself and other **db** columnists that modesty forbids me to repeat.

Finally, he says, "I just wrote to let you know that not all students who enter Dental School are 'incapable of creative or intelligent thought'." While I used those words, it is true, they were part of a quote, and did not represent what I think about any students, dental or otherwise. So perhaps a little clarification is warranted.

WHAT ABOUT IQ RATINGS?

In a way, I'm glad this came up. The **db** editor does not blue-pencil much of what I write, but here was an occasion where he had deleted a few words. In my original ms., the copy read, "I asked about the rote fact orientation of the course. If I revised the course, I wanted to change that. There was a reason for it, it was explained to me. Students who enter dental college all fall in the I.Q. bracket of 80 ± 5 , between 75 and 85, and are incapable of creative or intelligent thought, so we must not expect it of them!"

The editor had blue-penciled the joking reference to I.Q. numbers because of their manifest absurdity—such figures are in the low-grade moron category, possibly revealing what the program director thought of his students. But my point was not to quote such nonsense, but to underline the quick reference to I.Q., and the reliance so many people place on these scores.

The program director's generaliza-

tion of dental students as morons leads to other vocational I.Q. assignments. For example, one might say that medical doctors are a step higher than dental students, so their I.Q.s fall into the 85 to 95 slot. And as we do know, in order to succeed in an engineering school, a student should have an I.Q. between 125 and 135. Therefore, engineers can preen themselves on being more intelligent than dentists and doctors!

The above ludicrous reasoning is simply an exaggeration of the faith some people place in I.Q. scores. Upon observing the native capabilities of students with different scores, I have always failed to turn up any correlation between the score and performance.

The conclusion I came to some time ago was that a person's I.Q. score, rather than indicating anything about his intelligence, shows to what extent his mentality matches that of the psychologist who designed the test. Perhaps that doesn't make sense to you, but it does to me.

I've previously told the story about the psychologist who was touring schools, before the days of I.Q. tests, to get some data. He went into one classroom, and told the students he had a problem for them: "I have a road, that is 50 feet wide and 1 mile long. How old am I?"

You can imagine the blank stares from the students. But presently one boy in the far corner of the room slowly put up his hand, kind of thoughtfully. "Yes, Johnny?" said the psychologist. "44, sir." Well, by some fluke, Johnny had it on the nail, so the psychologist decided to play it along. "You're right, Johnny. Now would you tell the class how you figured that?"

"Well, sir, it's like this sir, I have a brother, sir. He's 22, and he's only half crazy, sir."

I guess he got his answer, all right. But that summarizes my idea about the reliability of a psychologist's conclusions. So if you're absolutely and completely crazy, maybe your I.Q. score could hit 200! Before leaving that, I should add that, a few years ago someone persuaded me to take one of those I.Q. tests. Imagine my surprise when my score came out at 185! Am I really that crazy?

REAL MEASURES OF LEARNING

Working on the materials for Educational Research Associates, I have had to devise tests that will really

measure the learning capability of the students. How can one do this? Learning is the dynamic of increasing or extending knowledge or skills. Measuring that a student can answer some specific question, or set of questions merely tests knowledge or skills, as they are. It is no measure of capability to extend.

So you need to take the student so far, with help, stimulating his own self-learning capability as you do so, then set him a step that he has not been shown, to see whether he can make the step on his own. Find a test that will allow some originality—that is, one that could be solved by more than one method, within not too much extension of the knowledge or skills he already possesses.

That may sound like a "tall order," until you get a little experience doing it. Probably the most important element is a desire to see others learn for themselves, then the development of ways to find out how they learn or, conversely, what their hangups are. Once you adopt such habits it becomes relatively easy. One trick is to try to remember your own former hangups, and then see whether your students stumble at the same places. They often do. Or if they don't, "confessing" where you did will get them to help you find their problems.

It is almost impossible to do this in a vacuum, i.e., without having live students on which to try it out. So the best way to start is in a classroom situation. After you have some experience working with students, you can help generate material that will work, based on the knowledge of how students think. And from that, it is not a big step to generate measures of their capability at learning.

REVERSION OF INVERSION

The important thing, emphasized by the discussion about that dental course, is to reverse the process by which most so-called teachers do what they call "teaching." Recently, I have been teaching an adult class on the metric system, using a classroom at the local junior high, where both my children "learned" geometry.

Both of them had a tough time. The teacher went by the book. It would have been no better had she gone by a strictly mediated course that did the same thing. There is no magic about media, if nothing else changes. The theorems must be memorized, using the same letters as those in the book.

TEACH YOURSELF FIRST

In my own education, I had trouble with the multiplication tables. I just could not memorize those things.

However, later, when I was learning to use logarithms (which are not used so much today, now we have those pocket computers) I found that I could remember nearly half the logarithms in the 4-figure log tables, because I *used* them, not because I tried to memorize them, which would have been impossible.

Algebra made sense because I had a good teacher, one that I call in my book "Taking the Mysticism From Mathematics," a "one-in-a-lifetime" teacher. Trig I managed, although it seemed a lot of trouble about nothing, until I got far enough into it to find it useful for problems I could not do any other way. Calculus I thought I managed. We had one of those profs who scratch stuff on the board so fast it takes all your time to get it down in your notebook.

Then you get home and try to do the homework. You get your notes, to see "what he did here," and you copy it off, with a different set of figures, and hope for the best. You think you are doing calculus. In a sense, I suppose you are.

But when I came to write my Basic Mathematics, all went well, until I was into trig and calculus. I could turn math around so the student would approach it as a way of finding solutions to progressively harder problems,

or problem types. But in trig and calculus, I found that I could only do it the way I had been shown. Before I could teach this the same way, I must find out why, and how a first mathematician could ever have arrived at that way to do it. Once I had found that out for myself, I could lead my students to do likewise, not by telling them, but by leading them to discover for themselves, using appropriate clues.

Now, teaching the metric system in the same classroom where my own children had "learned" geometry, I could see why the geometry teacher did what she did. She had learned it the way I had learned calculus. She knew only that that was the way it is in the book. What a waste of time!

The trouble is, that method becomes a habit. Suppose I had gone in and shown her how I would tackle helping students to learn one or two of those geometry theorems by the discovery method. What she would probably do is to observe that the students picked it up better that way, so it must be a "better form of proof" than the one in the book. Probably it was the same proof as the one in the book, but she would never recognize that.

RELATING TO AUDIO

That is why I keep emphasizing that audio people are in a singular

position to tackle "doing it right." We have IQs of 125 to 185, remember? Forgetting that baloney, our work has involved us in all kinds of problem-solving techniques. Which of us has not learned about grounding, the hard way? And so on. What every vocation needs, is a course in grounding!

A few years ago, when the federal government was after me, I needed a lawyer. I found that no lawyer would take on the federal government for me. But one district attorney helped me, probably more than he knew. He recognized me as a "scholar," said the county law library is public property, and suggested that law would be a "piece of cake" for me. Rather indigestible cake, I'd say. But the long and short of it is, I no longer hold lawyers in the awe that I once did, because I can teach most of them some law.

What I am saying is this: Don't allow yourself to be discouraged by the notion that you know nothing of the subject you have to mediate; neither does the student! And maybe the teacher doesn't either! So tackle it. You can learn it, if the student ever will, and you'd better, so the students can. Only so will you put together good mediated material.

You might even merit an I.Q. of 195, one day! ■

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MARTIN DICKSTEIN

New York IS a Nice Place to Visit

A new show at the Planetarium, a musical exhibit at the Metropolitan, with Central Park in between, offer rich family entertainment.

Now that summer has arrived, some of you may be thinking of sight-seeing in New York, whether you're from the big city or from out of town. Since most of you are interested in audio and/or visuals, here are a couple of suggestions which the whole family can enjoy. The rating is G.

PLANETARIUM

Almost all large cities, some small ones, and quite a few colleges have planetariums (or is it planetaria?). In New York, there is the Hayden Planetarium, associated with the American Museum of Natural History. It is located at West 81st St. and Central Park West, right alongside Central Park—on the west side of it, that is.

Funding for the Planetarium began in 1933, including a grant from Mr. Charles Hayden for a Zeiss projector. In 1934, ground was broken, and in 1935 the Hayden Planetarium opened its doors to the public. Right from the beginning, the Planetarium was to be innovative. During the construction of the 81-foot high dome, two "firsts" were established: the roof was made as a shell-within-a-shell with

In addition to writing his db column, Martin Dickstein is an audio consultant. Tom Jones and Howard Schwartz provided the information for this article.

only 3 in. between them at the top, and 3½ in. at the bottom. Secondly, it was the first building to have cement blown into place by a special gun.

This coming October, the Planetarium will be celebrating its 40th anniversary. Since it opened its doors to its first audience of school children, more than 20 million visitors have come, a great many of them several times, both as school children and then with their children. To this day, the Planetarium welcomes children both to the regular performances, and to special classes in astronomy and related subjects. There are also classes for adults, including navigation and aviation.

The original Zeiss projector, Model II, worked for 25 continuous years—seven days a week for an average of 5 shows a day. After about 40,000 showings, it was replaced in 1960 by Zeiss Model IV. Then in 1969, a new unit, Zeiss Model VI, was installed. This is the one presently in use.

This giant is 17 feet long, weighs close to 3 tons, and cost over \$1.5 million. There are only eight similar units in the whole of the Western Hemisphere. The unit has four main drive motors and 80 auxiliary motors. It is capable of being operated by a large control console, but it is so delicately balanced, if the motors are disconnected, the projector can be swung

easily in any direction with one finger.

The projector is also somewhat of an innovation. It is capable of 50 percent more light output than the previous unit as the result of the use of a gas-discharge (instead of incandescent) source. This brilliance makes it possible to throw a brighter moon which allows for greater surface features and to project a more brilliant sun which reddens automatically as it approaches the horizon. The projector can place stars on the dome in an authentic pattern taken from any time, past or future, as seen from any spot on earth. It can show 17 star clusters and nebulae and some 9,000 true-color fixed stars down to the 6.5 magnitude. The unit is also capable of variable speeds, zooms, and the ability to race one year past in ten seconds.

In addition to the star projector, there are also 25 special slide machines, made just for the purpose of single or multiple images, 2 x 2 in. slide projectors, 8mm film projectors, 16mm film projectors, 3 x 4 in. slide projectors, and film loop devices. Including special effects projectors, there are a total of over 100 units to help in the program presentations.

The sound system has a 2-channel Teac tape recorder with a Scully back-up unit feeding through two dual Crown amplifiers with an output of 300 watts each. The four main speakers, mounted above the perforated



Chinese bell and stand.



German 18th century guitar.

dome, are Altec A-7s. There is a microphone at the control console for the staff member narrating the presentation; the music and sound effects come from the tape machine. There are also six surround speakers for effects and fuller sound.

SOLAR THEATER

The program for the summer (July 1 to Sept. 22, 1975) is *Universe Calling*, a trip through space and time in search of any of the possible million habitable worlds in our own galaxy from which intelligent beings might be trying to communicate with other beings.

On the floor below the amphitheater, there are many exhibits and a solar theater. Here, in addition to a scale model of the solar system indicating proper relative orbital speeds, there are also 40 slide projectors in single or dissolve combinations, showing various programs in science on 22 screens. A 2-track audio tape with a cue track controls the show. An 82-channel punched paper programmer is advanced by the cues to trigger the movement of the more than 1,600 slides. The narration and music feeds through a dual 50-watt Kenwood amplifier and 20 Altec speakers. The audience either sits or stands in the

center of the circular arena.

There is no question but that the entire family will enjoy the presentation and exhibits at the Hayden Planetarium. Incidentally, as another step in its innovation, there is now a Laserium show on Friday, Saturday, and Sunday evenings, after the day's regular planetarium programs are over. These shows also go on in the main theater on the high dome. This can make a full day or weekend of enjoyment, including the fascinating exhibits at the Museum.

Time schedule for the Planetarium is: Weekdays, 2 & 3:30 p.m.; Saturday, 11, 1, 2, 3, 4, & 5; Sunday, 1, 2, 3, 4, 5. The telephone number is 212-873-8828.

METROPOLITAN MUSEUM OF ART

As long as we're on the subject of museums, there is another one with another interesting exhibit we would like to recommend. It is the Metropolitan Museum of Art and is right on the opposite side, the east side, of Central Park from the Planetarium, at East 81st St. Hours: Tuesday, 10-8:45; Wednesday-Saturday, 10-4:45; Sunday, 11-4:45; closed Mondays. Information: 212-879-5500.

Continued next page

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Box 35, Great Neck, N.Y. 11021

You are probably aware of the paintings and sculptures on exhibit at the museum, but you may not know of the Andre Mertens Galleries for Musical Instruments. Located on the 2nd floor, the exhibit takes up a full wing. It is the first permanent installation of the Crosby Brown collection of musical instruments of all nations.

Primarily, the exhibit consists of musical instruments from all around the world, but now, instead of just looking at the instruments, you can also hear them. Two years ago, Telesonic Systems, Inc., of New York City, installed the first of its sound systems in the U.S., but don't get the wrong idea. This is not a public address system we're talking about.

The Telesonic System comes from France and has been used since 1964 at the Louvre, the National Museum of Modern Art, various other museums both indoor and outdoor, and at theaters and famous places of interest. In Italy, a similar system is used in conjunction with a light show in Florence; it is the only sound system approved by the Vatican for taped lectures in the Raphael Room and the Sistine Chapel.

The Telesonic audio system allows visitors to hear reproductions of the music of the instruments in the display case. By renting, for a very nominal charge, a unit to be carried and a headset to be worn, a program running several minutes can be heard right in front of the display. As the visitor walks into the area of the dis-

play, the music or voice can be heard. There are about 50 exhibits, most of them with accompanying sound. As all programs repeat continuously and there is no specific order necessary, the visitor can see any exhibit as many times as desired.

The system consists of two parts. The music/narrative originates on a two-track continuous tape loop and feeds the audio to a modulator which puts the signal on a low-power low-frequency carrier. This is fed to a loop of wire run just around the matching display. Wiring is carefully hidden under the carpeting, and is run in such a manner that there is virtually no overlap between exhibits. Because 2-track loops are used, there are only half as many tape players as there are exhibits.

The second part of the system is a small, light receiving unit with a long string attached, and a headset which plugs into the receiver. While carrying the unit over the arm and wearing the comfortable headset, the listener has the rare opportunity to hear a very brief commentary on the instruments in the cases, and a short selection which was played on one or more of the exact items on display. The quality of reproduction is very good, indeed.

UNUSUAL INSTRUMENTS

The instruments are from all over the world, and from years long gone by. They range from scrapers (from Cuba) and rattles and a similar instrument, from the shell of an armadillo (from Mexico) to a nose flute and bull roarer from the Fiji Islands, to a tube zither (from the Phillipines) and a spike fiddle (from Borneo). There are also whistling jars from Peru. Pouring water from a reservoir into a jar with a narrow neck makes a particular note, and adding a tiny obstruction creates a warble-tone. There are many more odd instruments from the remote parts of the world.

Among those with which most of us might be more familiar, there are serpents, lyres, harpsichords, double flutes, dulcimers, guitars, and pianos of various types. There are also shawms and tanburas, and bagpipes from Eastern Europe and France, from Asia and Africa. One collection includes a baroque trumpet, another shows walking-stick violins (carried by dancing masters from student to student). This is only a small sample of what's on view.

Here you have a small but highly recommended selection of what to see in N.Y., and there's Central Park between them, with its zoo, carousel, and ever-changing rhythm of life. Lincoln Center is nearby too. ■

● E. Norman Rauland, one of the founders of the RMA (now EIA) in 1924, died in Chicago on April 1 at the age of 77. One of the pioneers of the radio industry, Mr. Rauland was a designer of transformers and other components and participated in the development of the superheterodyne receiver. A transmitter designed by Mr. Rauland was used by Commander Donald MacMillan for communication during his Arctic expedition. The two-way radio used in the first regularly scheduled airmail service between Chicago and Minneapolis was designed and built by E. N. Rauland. Another historic device created largely by E. N. Rauland was the "walkie-talkie" used in World War II. Through his company, the Rauland Corporation, later Rauland-Borg, he introduced the first solid-state commercial sound equipment in 1960, and in 1970 initiated the Telecenter System, utilizing solid-state telephone circuitry.

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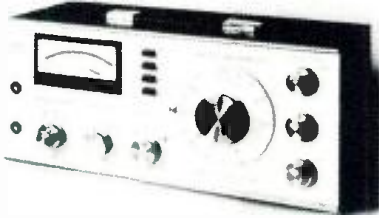
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- Square wave rise and fall time: 40/60 n.secs.
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- Price: \$770.00

AUDIONICS

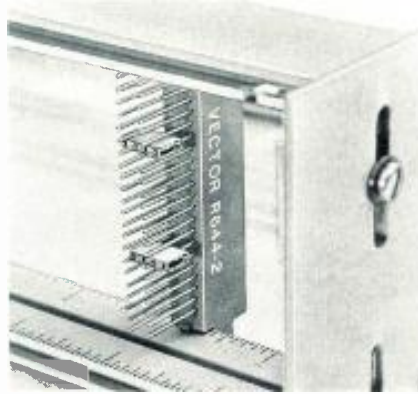
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Mfr: Vector Electronic Co.
Price: \$0.093 ea. in 500 quantities
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TERMINAL COVERS



● Molded vinyl (PVC) "Living-End" terminal covers come in a range of standard sizes and shapes to fit most wire and cable terminals as well as premolded shapes for wire assemblies, capacitor boots, solid state devices, connector sleeves, fuse covers, and other special applications. The covers require no heat or heat gun for installation. They are slipped onto the wire before terminating and pulled over the finished connection.
Mfr: Zippertubing
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TURNTABLE MIXER



● A turntable mixer designed expressly for use in discotheques, the Disko-Mix-Master I contains two stereo phono preamps with a stereo pan control for the smooth transition between turntables. In addition, a cueing amplifier capable of driving headphones or a small monitor speaker is included with cueing switches to permit monitoring of either input. Distortion levels are less than 0.1 percent and noise levels are below 0.8 microvolts. Output impedance is 10k ohms. An external power supply minimizes hum or noise pickup.
Mfr: Berkshire Audio Products
Price: \$129.50
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ELECTRONICS SLIDE RULE



● Of use to electronic engineers, the Key Electronics slide rule is basically a mechanical set of logarithm tables. The device offers the user multiplication and division, squares and square roots, and includes log-log scales, a reciprocal scale, a decibel scale and L/C calculator scales.
Mfr: Old Colony Sound Lab
Price: \$10.50
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CORRECTION

In our May issue, on p. 31, we reported on "Four-Channel Limiters," manufactured by Sound Genesis, designed to fit model 10 console. The name of the manufacturer of model 10 console, Tascam, was inadvertently omitted.

HAND-HELD WIRELESS MICROPHONE SYSTEM



● Microphone/transmitter and receiver model 54/58 delivers full fidelity sound to a p.a. amplifier without the use of wires or mic cables. The cardioid Shure SM-58 mic contains pop filters which do away with the necessity of an additional windscreen. The case contains the transmitter, antenna system and battery. Containing a compressor/limiter circuit, the transmitter suppresses loud sounds, keeping the wave form and overtones intact. The receiver has a meter and a 3-position selector switch for monitoring audio level, an r.f. carrier level, and self-contained battery or a.c. line. Also included in the receiver are a phone jack, volume control, and separate indicator light. Balanced audio outputs are provided at both mic and line levels.

Mfr: Vega (Cetec)

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COLORFUL ACOUSTIC FOAM



● Polyurethane foam with an embossed polymer film surface, known as Cabfoam, is available in a variety of colors. According to the manufacturer, the material resists scuffing and abrasion, is self-healing against punctures and can be repeatedly cleaned without using its efficiency. The hexagonal surface pattern can be folded, bent, and worked into complex configurations without interfering with its appearance or effectiveness. Delivered with pressure sensitive adhesive backing, Cabfoam is available in standard sheet sizes of 24 x 54-in. as well as in roll stock 54-in. wide x 60-ft. long. Colors include orange, yellow, bone, brown, tan, white, blue, and black.

Mfr: Soundcoat

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New Two-in-One Graphic Equalizer

The Model 530 Dual Graphic Equalizer is the newest of our equalizer line. It has two completely independent Graphic Equalizers with a common power supply. Each channel begins with a differential input stage, includes nine variable active equalizers centered at each octave from 50 Hz to 12.5 kHz, and ends in an output amplifier capable of delivering +20 dBm into a 600 ohm load. The inputs may be fed from balanced or unbalanced sources. The 530 offers wide application possibilities in recording, sound reinforcement, radio and TV, commercial and home music systems. You'll like the two for the money price, too. UREI quality, of course.

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products & services (cont.)

STUDIO 8 PROFESSIONAL RECORDER



- All controls and the interlocking between them are fully electronic and may be remotely controlled by TTL signals on the Ferrograph Studio 8 recorder. Modular signal electronics offer the ability to select a variety of input/output configurations. Lapsed tape running time is indicated in minutes and seconds on the l.e.d. display. "Zero recognition" stops the recorded automatically in record, playback or fast wind-rewind modes. The unit takes 1/4-inch tape on NAB or cnei-tape reels up to 10.5 in. Tape speeds are 15/7½ or 7½/3¾ in/sec. The unit possesses interchangeable

head blocks, which effect exchanges of track configuration for full track, single halftrack, or halftrack stereo.
Mfr: *Elpa Marketing Industries, Inc.*
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ROOM EQUALIZATION FILTER SET



- Intended for attenuation, 1/3 octave model 529 equalizer filter set has 27 1/3-octave active filters that each provide up to 15dB of attenuation to adjust for a desired house curve. They are centered on standard ISO frequencies, making the 529 compatible with all current room equalization measuring equipment. The filters combine for minimum ripple and phase shift. Band end tunable high pass and low pass filters attenuate 18dB per octave. Gain is adjustable to +20dB to make up for average level lost in equalization. The 529 is completely self contained with built-in power supply.
Mfr: *UREI*
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MINIATURE TORCH

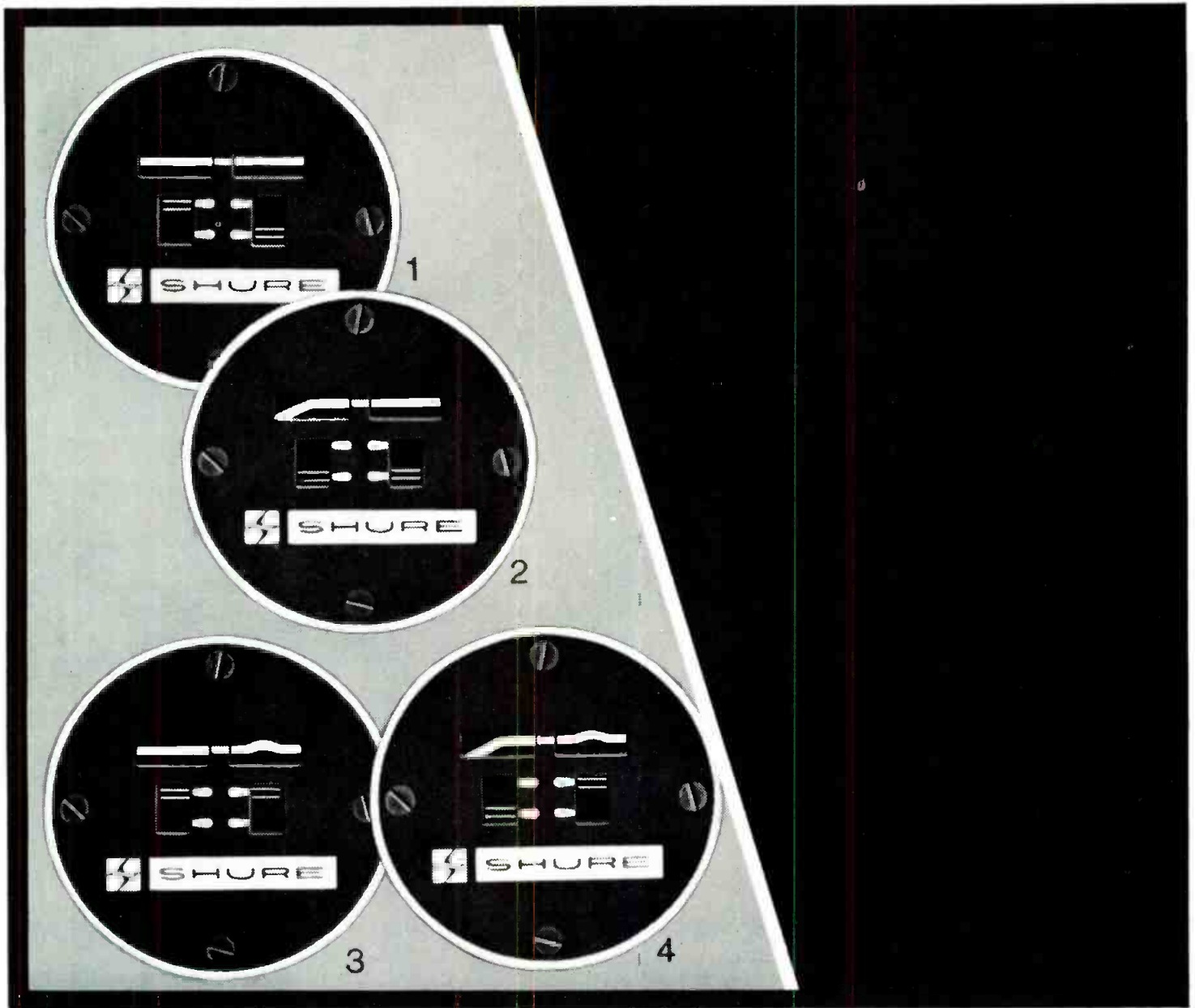


- Operating on oxygen and fuel gas, "the Little Torch" produces up to 6,000 degrees F. flames which are so small they easily go through the eye of a needle. The Little Torch is equipped with five different size tips, each with a sapphire jeweled orifice for durability and precision flame control. Tips can be swivelled 360 degrees to provide extra handling ease. The torch welds metal smaller than 0.002-in. wire up to 16-gauge steel. Useful for heat bonding, welding, and soldering, it can be applied to glass, ceramics and most experimental metals with high melting points. It operates with gas pressures from 2 to 4 pounds per square inch.
Mfr: *Tescom Corp.*
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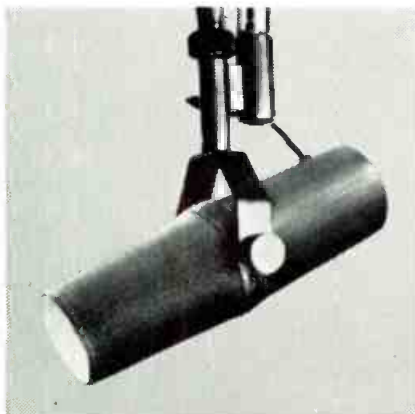
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What you see is what you get.



The extraordinary Shure SM7 professional microphone features something you've never seen before: a *built-in Visual Indication Response Tailoring System* that offers you four different frequency response curves—and shows you the curve you've selected with a graphic readout (see above) at the back of the microphone! Choose: 1. flat response; 2. bass roll-off; 3. presence boost; 4. combination of roll-off and presence. And there's more: the SM7 delivers exceptional noise isolation with a revolutionary pneumatic suspension mount . . . an ultra-wide, ultra-smooth frequency response . . . an integral "pop" and wind filter . . . and a cardioid pickup pattern that looks "text-book perfect." The Shure SM7 Studio Microphone was extensively field-tested in recording studios and broadcasting stations! Write:

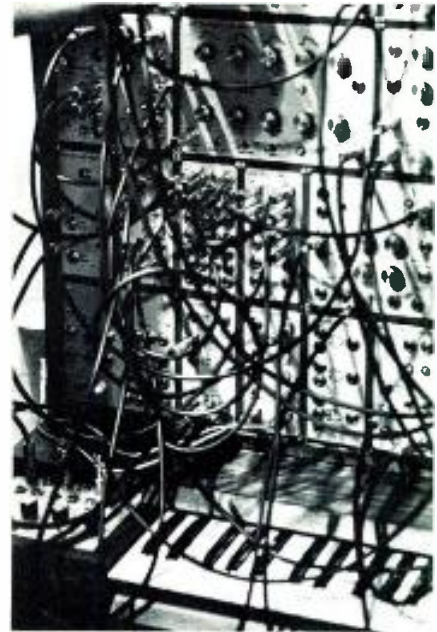
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A look into the West L.A. music booth.



"There's really nothing to it." One of the synthesizers at the Oberheim/E μ display.

JOHN WORAM

The AES Show

*Big interest in synthesizers, some fancy new gadgets—
a rundown on the L.A. show.*

GOOD LORD, not *another* A.E.S. convention report? What could possibly be new since the one in London a month or two ago?

I'm glad you asked. Although I didn't spot anything revolutionary, there were quite a few new exhibitors at the Los Angeles show, and many of the old regulars did indeed have a new gadget or two to display. Moreover, the interest in musical instruments seems to be growing. I've never seen so many synthesizers at a convention before. Arp was there—Moog wasn't—although both put on an electronic music concert at the awards banquet—more on that later.

SYNTHESIZERS

A large corner booth in one of the exhibit rooms contained synthesizers by Oberheim, E μ , and a String Controlled Synthesizer by 360 Systems. Here, the strings on a guitar (a real one, that is) are used to produce pitch control voltages, which are fed into the synthesizer, along with envelope control signals also derived from the guitar. Or if you like, the synthesizer's own envelope generators may be triggered by the guitar. A little imaginative knob twiddling, and the guitar can produce all sorts of unique sounds.

West L.A. Music was another new exhibitor, with four booths full of synthesizers, small mixers, assorted gadgets, and a real live piano—brought in to demonstrate the He-penstill piano pickup.

Also shown was the Bellis Visual Sync System, a big black box with six buttons and six colored lights on it. The idea is to tap out a rhythm pattern, or a beat, on the



Sound Workshop's 8 x 2 board.



The Ampex "Search-to-Zero" accessory for their MM-1100 recorder.

buttons, each of which feeds a different frequency tone to an unused track on your tape recorder. Then when you play back the tape, the corresponding lights flash on and off, giving a visual "click-track." I seem to have some reservations about a non-audible click track, and Bellis' recommendation of the system as ". . . a viable stand-in for a human conductor" boggles the mind. However, the box should be useful as a cue system to visually mark off various sections of the tape. Or, to flash time signals, entrance cues, or whatever. The box will also activate relays, so you might rack up an auxiliary tape machine, which would then automatically start when the proper frequency passed by. The possibilities are endless, but don't fire your conductor until *after* you've tried following the colored lights.

MIXERS

The Yamaha people were on hand with a series of sound reinforcement mixers, ranging from 4 x 2 (\$289) to 16 x 4 (\$6,600). Some are available in two versions: with unbalanced phone jacks, or, balanced XLR type plugs. Likewise, some units contain a built-in spring reverberation unit.

And, springing right along, Sound Workshop had a darn good spring reverb unit which I presume they are stealing from somewhere, since the price is suspiciously cheap (\$375). And that's with two outputs! Perhaps they should consider selling it for 20-40 percent more to satisfy those customers who know that a spring selling for less than \$600 can't possibly be any good.

Sound Workshop also has a nicely built 8 x 2 mixer. I'm glad to see that more companies are finally waking up to the advantage of eight inputs. This makes these little mixers very handy for hauling around on 8-track remote sessions to provide a quick and easy monitoring system. And, what about the studio with the limited budget that has jury-rigged its two-output console up to an 8-track deck? With a little pushing and pulling, it all goes together, except for monitoring. There's just no way to get those eight outputs back into the console playback section. But a little 8 x 2 mixer will do the job without driving the studio into Chapter 11.

RETURN TO ZERO CUE

Ampex—not exactly a new kid on the block—displayed a new "Search-to-Zero" accessory for their MM-1100 series machines. After cueing up to the desired location on the tape, the unit is reset to read 0000, and will then display the tape's relative location up to 1 hour, 59 min., 59 secs. before or after the zero reference. Hitting the

cue button sends the tape back (or forward) to the zero mark. The accessory will not return to other reference points, so if you want to work around several spots on the tape, you must reset to zero for each one. This shouldn't be too much of a problem, because with the money you save—it's \$895—you can buy a pencil and keep a record of the various important reference points. Then, when you're finished with one spot, you can shuttle off to 1:57 (or whatever), reset to zero, and start all over again.

A remote control display costs an additional \$275, and gives you *reset*, *cue*, and a readout at the console. It seems to me that Ampex might consider an additional accessory—a *cue* only button. This would help keep the overall price down, and still give the engineer the return-to-zero facility.

Tektronix was a welcome addition to the growing list of exhibitors. (By the way, there were over 100 exhibitors this time—an A.E.S. record, I believe). The Tektronix price tags are formidable—especially for the studio that does all its maintenance with a screwdriver and a Q-tip—but it sure is beautiful stuff. Note to the maintenance man: If you want to test your job security, tell the boss you must have a Tektronix setup like the one in the picture.

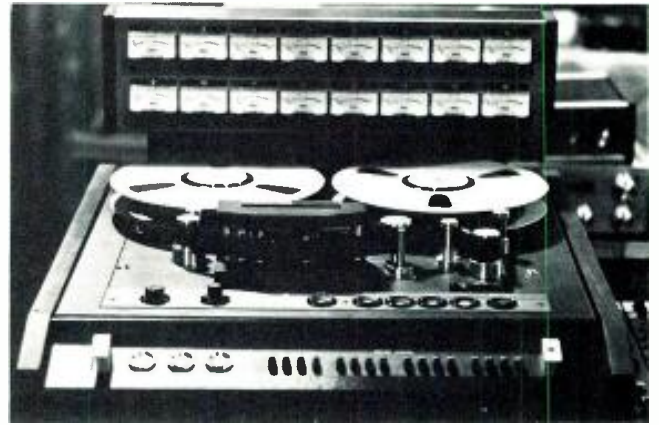
Amber Electro Design had a very interesting prototype of their multi-purpose audio test set on display. Multi-purpose is a bit of an understatement. It contains function, sweep, noise, and audio comb generators, a digital level meter, a frequency counter, a wave analyzer, spectrum analyzer, and probably makes ice cubes, too. Production



Some goodies from Tektronix.



The Amber multi-purpose audio test set.



Tascam's 16-track, 1-in., tape recorder.

details to be announced.

The budget class of tape recorders now includes a 16-track 1-in. recorder from Tascam, and Tascam console owners will be interested in a new 4-channel compressor/limiter by Sound Genesis. It's designed to "fit directly into the double module quad panner space in the Tascam console." There are two versions available: one with variable attack, release, and compression ratio, the other with just input and output level controls.

In looking over the Spectra Sonics exhibit, I got a chance to examine their instruction manuals, which fly in the face of tradition by being readable. Worse yet, the manual locates and describes various critical parts of the console, making service work reasonably uncomplicated. Now everyone knows that equipment servicing is supposed to be a jealously guarded art form, and that the written word is taboo. When instructions *must* be printed, they should, of course, be made incomprehensible. No doubt Spectra Sonics will eventually see the error of its ways, and conform to industry standards.

Otari's MX-5050 series of tape recorders features a two-speed four-head machine with front panel adjustable bias and equalization. Some machines in this general price class keep these controls well hidden—which is okay for the hi-finik, but can be a nuisance in the studio. As an additional bonus, the machine has a built-in test oscillator and XLR type plugs on line inputs and outputs.

BRIEFLY NOTED—AUTOMATION

Cetec joins the automated mixdown crowd, along with the Quad-8 board. Automated Processes had an elaborate system complete with video display, but their room was always too crowded for photos. I'm going to have to sneak out to their factory and find out further details.

And Neve is beginning to reveal their automation plans. First there was that sneak preview at the Midwest Acoustics Conference (June Sync Track), and in L.A. they had a sample module that did all sorts of interesting tricks, like storing and recalling all your panning, and channel assignments. But automation should really be covered in a separate article.

Enough of this technical nonsense. Allison and her friends at the Kepex Kool-Aid Factory have apparently taken over Tennessee, or at least 225 acres of it. They're dividing it up into 5-acre lots, and inviting people in the "creative enterprises" to think about working and living in what they call Tin Pan Valley. Hopefully, the Valley will attract recording industry folks and other artsy-craftsy

types. If your idea of the good life is a take-out lunch from McDonalds, a couple of Allison's goons will kick you across the state line if you come prowling by. But if you think you could adjust to fresh air and Tennessee Green (I think it's some kind of grass), this might be worth exploring.

AWARDS BANQUET

The A.E.S. Awards Banquet was well attended. This year, three honorary memberships were awarded. One went to Alexander M. Poniatoff. By now, perhaps everyone knows the word *Ampex* is formed from Mr. Poniatoff's initials, plus *ex* for excellence. Mr. Poniatoff was cited for his pioneering work as *Ampex's* first president.

Mark Gardner, recently retired from Bell Labs, was also honored for his long history of contributions to audio engineering, beginning with his early work with Harvey Fletcher, of Fletcher-Munson fame. In fact, Messrs. Gardner and Fletcher continue their collaboration to this day. I have it on reliable authority that they spend a lot of time together depleting the trout streams of central Utah.

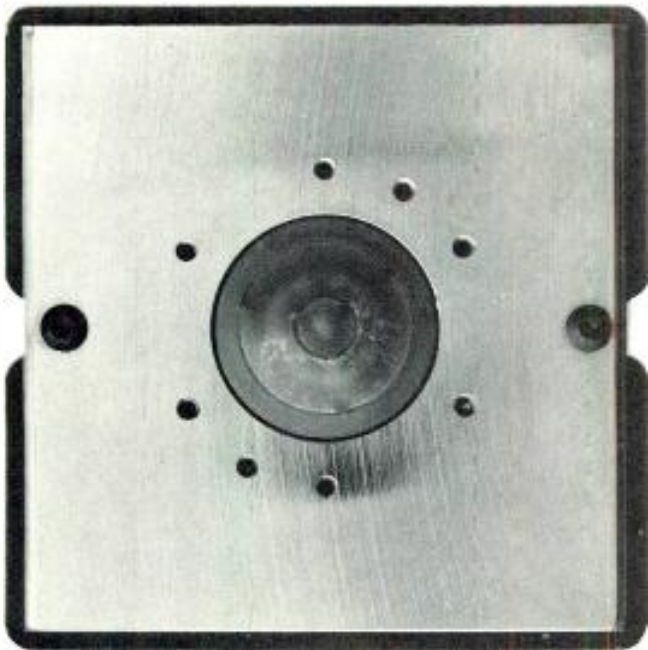
John Mullin, better known as Jack to his many A.E.S. friends was also awarded honorary membership. In the late '30s, Mr. Mullin's work paralleled that of Alan Blumlein in England. At the end of World War II, it was Mr. Mullin who introduced the tape recorder—then the magnetophon—to this country, and the rest is history. Speaking of which, Jack owns a superb collection of recording apparatus, showing the history of recording science from its earliest days. His museum was an important feature of several recent conventions.

P.S. on noise, hum, and ground loops. There seems to be a continuing interest on the subject, and I've received several interesting letters, which I'll try to get to in a future column. To those who have written, thanks for your interest!

SOME LAST MINUTE CHANGES

As a result of some positive feedback from convention visitors, Ampex has modified the Search-to-Zero accessory. With the addition of a third button, it is no longer necessary to reset to zero at every cue point. Now, if you want to keep returning to say, 3:12, you just push button #3 as the tape passes 3:12. This makes 3:12 the new reference point, so the cue button will shuttle the tape to 3:12 rather than to zero. When you're finished working around this point, you find the next reference point and repeat the process. Ampex reports no increase in price (!) as a result of this improvement in the basic design. ■

INSIDE 22



Loading plug with circular slots achieves near perfect loading. All points on diaphragm are within .254 inches of a slot. Driver throat flare is as suggested by V. Salmon (J.A.S.A. 17, 199 1946) and permits a high horn cut off frequency and high power output at low frequencies with very low diaphragm movement. Thus, spacing between diaphragm and loading plug is reduced, maximizing high frequency response and minimizing distortion due to modulation of high frequencies by low frequency diaphragm motion.

One piece aluminum diaphragm voice coil improves heat transfer from coil plus eliminates metallic sound and peaky high frequency response by increasing diaphragm edge stiffness. Polyimide half roll suspension is more linear than flat plastic or tangential aluminum. Suspension reduces low frequency distortion since it never reaches its elastic limit.



Ceramic magnet structure with precision machined plates and pole piece provides high field strength in gap (17,500 gauss) at lower cost than metallic magnets. One piece diaphragm assembly and cover has field replacement time of two minutes with 3/32" allen wrench.

Our objectives were high efficiency, high power handling and high fidelity. Model 22 is 30% efficient, handles 40 watts of wide band noise continuously, has 500-15,000 HZ response, and sounds so nice.



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Electret Microphones

The use of electrets in capacitor microphones reduces the need for a bulky power supply, opening the way for miniaturization and economy.

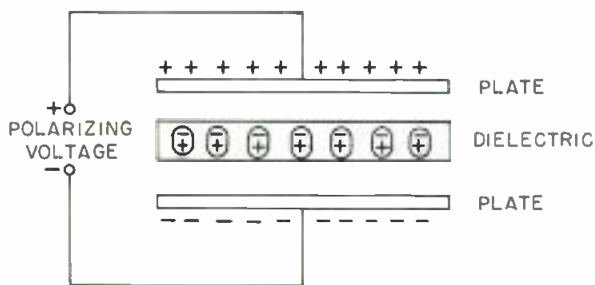


Figure 1. Polarization of the insulator.

ALTHOUGH electret microphones seem only to have been invented in recent years, the idea has been around for quite some time. The first electret microphone was credited to Eguchi, a Japanese physicist in 1919.

An electret is rather analogous to a permanent magnet; it is an insulator which has acquired an electrostatic polarization. Unlike most of the permanent magnets we are used to, an electret has a lifetime that can vary from a fraction of a second to a projected one thousand years or more. Heaviside first discussed the existence of such an effect in the 19th century, but at that time he did not fully appreciate the mechanism.

Subsequent to Eguchi's experiments, Olson experimented with a design in 1929 to be followed by the first commercial appearance of an electret microphone called the No-Voltage Velotron in 1938. These microphones used solid-wax electrets and remained on sale until 1940. During World War II, the Japanese made extensive use of solid-wax electret microphones in field equipment, but these suffered badly from poor electrical stability. A more practical electret appeared much later.

In 1948 further experiments were undertaken to produce more reliable electrets, the effect demonstrated in several types of thermoplastics. In 1953 and 1955, research papers from the University of Kansas revealed considerable information on the use of electret plates in microphones, followed in 1960 with a suggestion for a ceramic electret. This has been used in a new pick-up cartridge introduced in Great Britain this year.

The idea of using Mylar and Teflon as electret materials, which would also serve as a microphone diaphragm, was first proposed in 1965. Practical use of these materials reached fruition in a commercial electret microphone in 1968. Today, the manufacture of electret microphones represents a significant part of the audio industry. By estimate, Japanese production alone accounts for well over 10 million units a year.

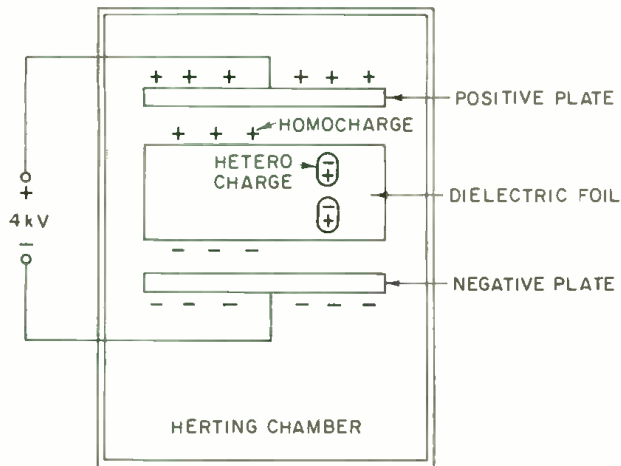


Figure 2. Forming of a "permanently" charged dielectric.

WHAT IS AN ELECTRET?

A dielectric is a material of low conductivity and can therefore be classified as an insulator. Since in an insulator there are almost no free electrons to create an electric current when a voltage is applied, the internal molecular structure becomes stressed and distorted instead. This means that a temporary polarization of the insulator occurs to produce a net positive charge on one side and a net negative charge on the other (FIGURE 1). Removal of the applied voltage causes the atomic structure of the molecules to restore to its former state and the net charge disappears.

It is possible to arrange for a dielectric to retain a net charge for a period of time. In one method, well known to schoolboys, a wax and sulphur plate is rubbed with fur, the charge transferred to an insulated metal plate which is then discharged in a bright spark onto the end of some unfortunate's nose! Here the effect is one of surface charge, which was used in early electret microphones.

The bulk polarization caused by the application of an external voltage to a dielectric can be retained on a more permanent basis if the dielectric is made of a thermoplastic and is heated to a plastic state during the forming process. FIGURE 2 shows one popular method, in a very simplified form, for the forming of a "permanently" charged dielectric. Plastic foil (Teflon or another fluorocarbon is heated to a temperature of 150C (polyester) or 230C and a high voltage of about 4kV is applied and retained while the foil cools. That is achieved by sandwiching the foil between two metal plates separated by a small air gap, which helps to reduce the possibility of sparks which may perforate the plastic foil.

Sometimes, two additional sheets of dielectric substitute for the air space, thus making a completely solid sandwich. After cooling, the voltage is removed and the foil left with a net "permanent" charge, practically frozen into place during the cooling process. The resultant dielectric is now an electret.

The charge-storage mechanism which predominates depends on which of the two spark-suppressing dielectrics was used during the forming process—air or a solid. When an air gap is used, a *homocharge* exists and is dominant as a result of the relocation of electrons in the foil or by migration from the metal plates. Where a solid has been used to prevent sparks, a *heterocharge* occurs. That is caused by the previously described process of molecular and atomic distortion which produces a net electrostatic

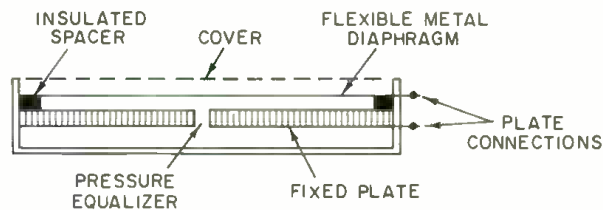


Figure 3. Cross-section of a typical transducer.

dipole. The polarity of the charge is different for each of these mechanisms. In electret microphones, the homocharge mechanism is most normally evident.

THE CAPACITOR MICROPHONE

One thing should be made clear: An electret microphone is a capacitor microphone using precisely the same basic principle to convert sound into a varying electrical voltage. The differences between what we know conventionally as a capacitor microphone and the so-called electret will become obvious later. To keep to a logical sequence, however, the principle of using a capacitor to transduce or convert acoustic into electrical signals should come first. One other point. A condenser and a capacitor microphone are the same.

The capacitor microphone was first invented about 45 years ago by E. C. Wentz. FIGURE 3 shows a cross-section of a typical transducer, consisting of a thin conductive diaphragm stretched over a fixed metal plate and separated from it by a small air space. A small hole in the plate is used to equalize air pressure inside the capsule. It also controls the low frequency roll-off. The smaller the hole, the lower the frequency to which the transducer will respond.

These two plates form the components of a capacitor, the value of which would nominally be about 50 pF. Variation in the separation due to vibration of the diaphragm causes fluctuation of the capacitance. A polarizing voltage of up to 200V is applied to the plates, although modern studio types usually require only about 50V for this purpose.

The varying value of capacitance due to sound vibrating the diaphragm modulates the polarizing voltage and this is amplified by an amplifier with very high input impedance. Normally, the amplifier will be located in the microphone body, or very close to it. In modern capacitor microphones, metallized plastic diaphragms are used. These give a relatively better frequency response than earlier

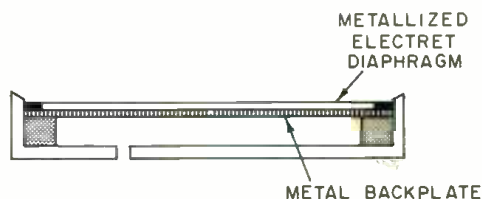


Figure 4. Simple construction of an electret microphone.

types and higher values of capacitance. However, it does make them sensitive to temperature; fluctuations outside the operating range affect diaphragm tension and thus the frequency response.

The combination of high impedance and a high polarizing voltage also makes the capacitor microphone sensitive to humidity, which tends to add considerably to the noise level under such conditions, presumably by permitting dielectric breakdown to occur. In general though, capacitor microphones are renowned for their stability, flat frequency response and a unique transient performance.

USING ELECTRETS

A principle disadvantage of the conventional capacitor microphone is the bulky power supply required to provide the polarizing voltage and also the power for the microphone pre-amplifier. An electret can eliminate the need for the polarizing voltage across the capacitor plates. Early electret microphones used a solid dielectric electret plate between the metal backplate and the metal diaphragm. That, however, did not prove too successful because of the large plate separation and low resulting capacitance.

Plastic foil electrets, as described, prove to be more suitable. When made with a metalized surface, they have a construction identical with the modern studio capacitor microphone. Sensitivity is comparable or higher, though the electret microphone does still require a high impedance pre-amplifier close to the transducer to eliminate signal losses.

The design in FIGURE 4 is fairly simple. Since 1966, many variations have appeared to improve characteristics. For example, in early designs the diaphragm was exclusively arranged to be supported only by tensioning from a clamped edge. Since a relatively low tension is required to achieve the required frequency response and sensitivity,

this method gave rise to undesirable fluctuations in both of these parameters, due to relatively small temperature changes. That prompted the development of a ribbed backplate, which offered several point supports, either as a series of concentric rings or as a rectangular grid.

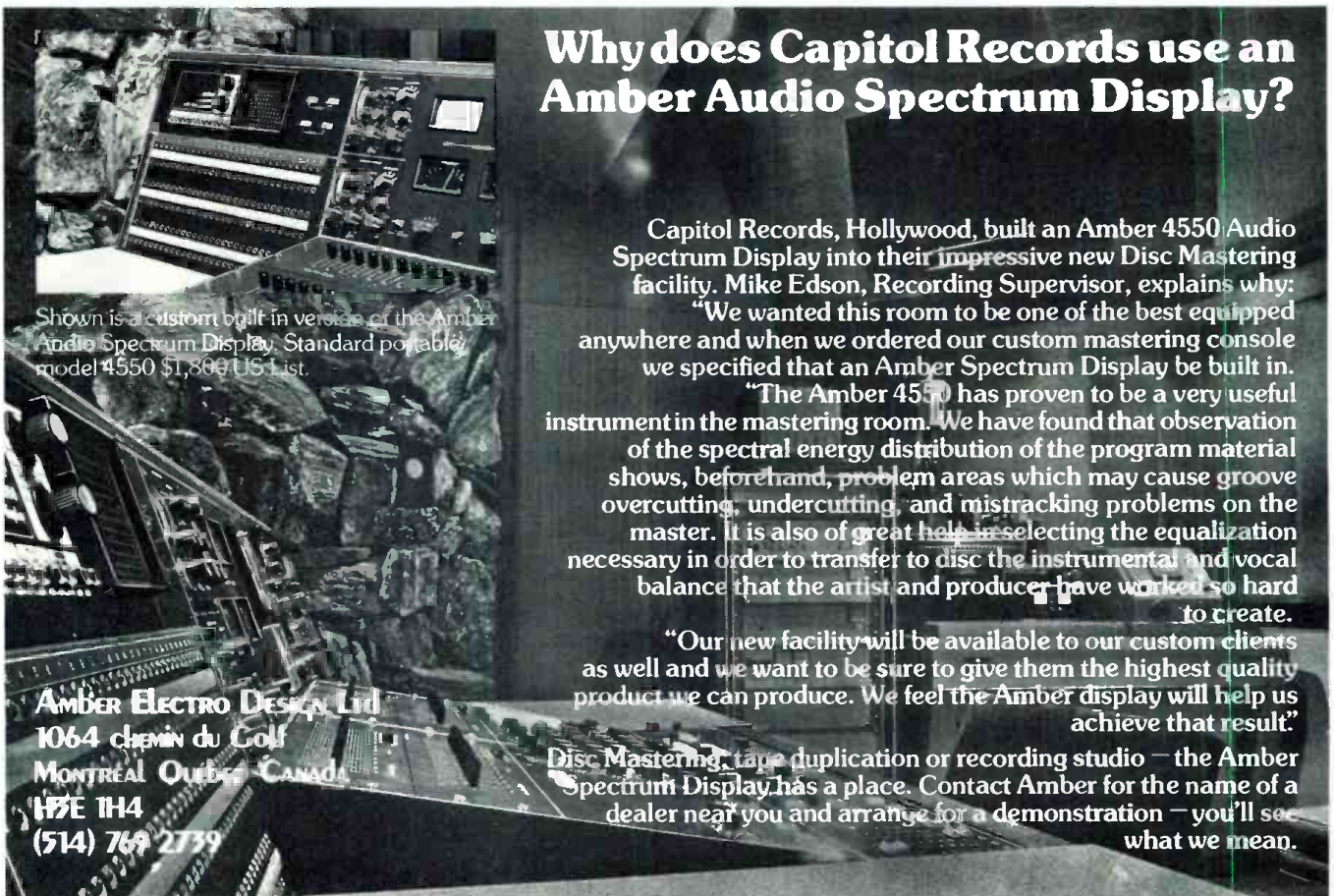
A further advantage of using additional supports is to reduce the possibility of the diaphragm collapsing onto the backplate due to the attractive electrostatic forces. Other variations have appeared, using an electret which contains only a monocharge, i.e., a charge of single polarity. Here the diaphragm is stretched between two perforated metal plates from which the signal is taken. Movement of the diaphragm produces a push-pull effect of very low distortion.

An alternative push-pull transducer uses two normal electrets sandwiched back-to-back with metalized layers touching and stretched between perforated plates. In fact, the modern electret microphone can, in its most advanced form, be quite complex, resulting in extremely high quality signal outputs. Some versions even have been developed for instrumentation purposes with a performance equal to the best conventional capacitor type.

LIFETIME OF AN ELECTRET

Obviously, any microphone using the electret principle should not have a lifetime restricted to something less than that of any other type. The solid dielectric types mentioned earlier were prone to early failure due to the electret discharging itself. Considerable research work has been undertaken to establish the causes of electret failure, and that is now sufficiently well understood so as not to cause any real problems.

Since the sensitivity of an electret microphone is indirectly related to the charge in the electret, information about the decay time is important. Charge decay is de-



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pendent upon the electrical resistance of the plastics foil used. Generally speaking, the fluorocarbons Teflon FEP, Teflon TFE and Aclar (CTFE) have proved to be superior to the polyester types. Invariably, the largest losses occur within hours of the foil being charged, but after that the decay in normal room conditions is very slow, resulting in a predicted lifetime of up to 300 years! However, elevated temperature or extreme humidity can reduce this lifetime considerably to about 30 years or less, depending upon how extreme the conditions are. Polyester foils have a room temperature lifetime of only one to three years.

Certain experiments have shown that if the foil is initially subjected to an artificial aging process, the lifetime is considerably extended. There is, however, a trade-off of sensitivity resulting from this exercise.

SELF-NOISE IN ELECTRET MICROPHONES

Since the electret is simply a dielectric in an otherwise normal capacitor, the factors which determine the noise level are the same as for a capacitor microphone. The principle noise generators are found in the pre-amplifier associated with the transducer. These are the noises arising from the input resistor and the noises within the first active device—usually a field-effect transistor (f.e.t.). The design of the transducer can directly affect the noise contribution from these sources. Above the high-frequency cut-off of the transducer, the noise comes from the f.e.t. and over the whole of the audio spectrum, dominantly from the associated input resistor. The low-frequency cut-off also influences noise and should be low to reduce in-band noise, although reduction of the low-frequency cut-off will increase ultra-low frequency noise. By setting the low-frequency cut-off below the lowest frequency of interest, the value of the input resistor can then be used to

control noise, i.e., a higher resistance will reduce noise. The best noise compromise arises from a juggling of cut-off points and the capacitance of the transducer, coupled with appropriate selection of f.e.t. and value of input resistor.

Since the design problems are no different from those of a conventional capacitor microphone, equal performance potential is there to be exploited.

APPLICATIONS AND ADVANTAGES

Many remarks about the electret are equally applicable to conventional capacitor mics. The main difference is the problem of the polarizing voltage required for the latter.

Electrets are readily designed to withstand mechanical shock and handling noise. And this, coupled with low power requirements (for pre-amplifier only), has made them eminently suitable for use in telephones, hearing aids, portable radio equipment and the like. In addition, their resistance to mechanical handling noise makes them very suitable for lavalier and hand-held situations.

Since the transducer is basically very simple, a variety of polar patterns from omni-directional to hypercardioid are readily achieved. Above all, the ability to make very small capsules has resulted in applications such as built-in cassette recorder microphones and sub-miniature lapel types.

Modern electrets will resist most normal environmental conditions without suffering and have a lifetime more than adequate for most purposes. Given good design, they can produce results equal to a capacitor microphone at far less cost—though the best can be still quite expensive.

The principal advantages of electret microphones, apart from relatively low cost, are reliability, excellent transient response, low handling noise, the fact that they can be made in very small sizes, and their potential for a performance equal to any studio microphone. ■



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Handy Black Boxes

The mark of the seasoned sound man is his little black box, in which he tucks devices guaranteed to create instant solutions to sudden and perplexing problems.

THE BEGINNING AUDIO ENGINEER, perhaps with a university degree, a full acquaintance with the latest audio products, and a magnificent set of ears, often finds that he can't achieve the same results on an actual sound job that a high school dropout with 20 years experience does with ease. What mysterious advantages does 20 years experience provide? In part, a knowledge of the usefulness of the black boxes you must have but often *can not* order over the counter. (Today, many of yesterday's "black boxes" are indeed offered over the counter if you know which counter.) What does the mysterious black box contain?

A BRIDGING ATTENUATOR

Here comes Violent Wotan, the mad modern musician who wants to put his a.c./d.c. tube-type instrument amplifier into your microphone line. That is, he'd like to connect an electrical cord between the output of the miniature Boulder Dam he has to the front end of your all-transistor microphone preamp with its EIN = -130 dBm. With experience, you go to the "black box" closet and *voila!* a bridging attenuator. It will provide electrical isolation, impedance matching, proper grounding and shielding, and best of all, it will feed your preamp a normal microphone level. (See FIGURE 1)

A MICROPHONE LINE TESTER

Marjorie Tonsils and the Leadfoot Ballet have hit town. You need to interconnect your console to the City Convention and Riot Center microphone lines. It's obvious that they used part-time help from the Asylum to wire

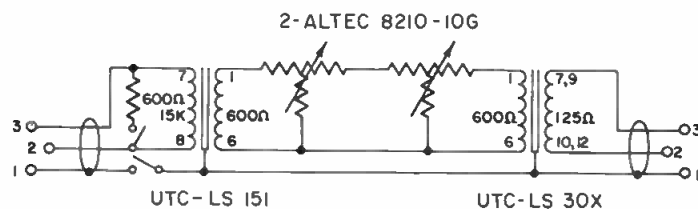


Figure 1. A bridging attenuator box. Courtesy Steven M. Hodge.

what you're looking at. This is where you use the microphone line tester. (See FIGURE 2) Your assistant plugs in the little diode carrying plugs and you watch the lights light as order rises from chaos and you raise the fee an extra 10 percent. Only those who have spent hours doing this will appreciate the pleasure of doing it in minutes.

A CABLE TESTER

Early in the game, you've discovered that talking into a microphone only tells you it can make a noise. But experience has shown that it can radically change response between uses and be hard to detect by a voice check. When a musician uses it, it becomes a case for the Sanitary Department. So, you have learned to use a real time spectrum analyzer to look at the microphone's response by driving it with an equalized test loudspeaker. You're casually plugging microphone system after microphone system into the real time, when *blooey*, the front end blows up. Why? Because the cable in the last set was being shorted and the 200 Vdc for the condenser measuring microphone was put to ground. Back to the "black box"—after waiting an interminable time for the real time to be repaired, for your cable tester. (See FIGURE 3)

Don Davis, who travels hither and yon conducting training workshops, is the president of Synergetic Audio Concepts, of Tustin, California.

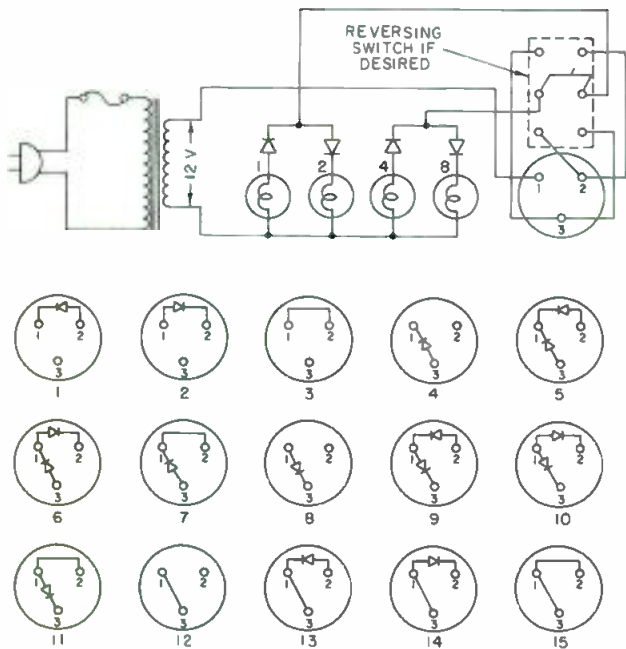


Figure 2. Microphone line tracer. Courtesy David S. Edmonds.

This time, all cables associated with all microphones are checked with your cable tester. If light Two lights up on button One, polarity is reversed. If lights One and Two light up on button One, there is a short. If no light lights when button One is pushed, it's open, etc. And the perfect condition is when button One lights light One, etc. (Sescom makes an over-the-counter cable tester.)

GROUND CHECKER

Back in my formative days, the way d.c. was identified, as compared to a.c. in a wall socket, was that d.c. melted

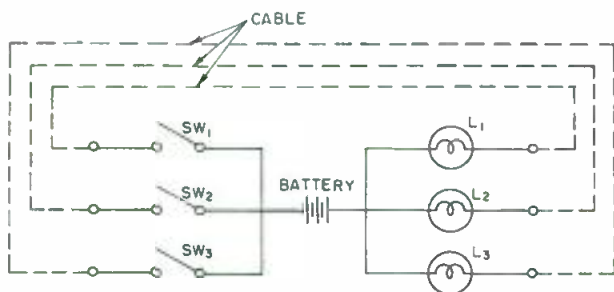


Figure 3. Cable tester. Courtesy Lynn A. McCroskey & Sam Adams.

SW₁ should light L₁ (If any other lamp lights, check polarity)

SW₂ should light L₂ (If any other lamp lights, check polarity)

SW₃ should light L₃ (If any other lamp lights, check polarity)

Two more lights on at once indicates a short circuit.

Failure to light indicates an open circuit.

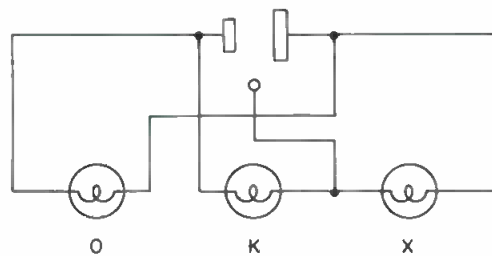


Figure 4. A. C. Circuit tester.

O and K = Circuit okay

O and X = Reversed polarity

O only = Improper ground

the cutters and a.c. merely notched them. There is an easier way called the neon bulb or circuit tester.

No one is more surprised than the road-show sound man to find out after plugging his new 60-input board into a d.c. wall socket that the reason the lights are so good on this stage is that they still have d.c. circuits in this older downtown area. A quick check with a handy shirt-pocket neon tester would have saved a great deal of agony. (If only one of the two filaments lights up, it's d.c.) What fun to find out that the third hole in a three-hole socket is connected to air or that the entire house has reversed polarity! A very handy tester is Dearborn Wire and Cable Co.'s Ground Monitor which looks like a standard plug without a cord. On its top (where the cord would have connected) it has three letters—X, O, and K. If the circuit is okay and a.c., the O and K lights flash. If you see the O and X lights, it's a case of reversed polarity, and if O only lights, it's an improper ground. (See FIGURE 4)

A photocopy machine salesman came to our office one day, wired up an adapter to the center of our older two-prong sockets and plugged in a three-prong adapter. He then whipped out his circuit tester and turned in dismay to me and informed me the office was wired backward. I reached over, turned his adapter plug around and re-plugged it into the wall and his tester now read okay (cheaper than re-wiring). Proof that it takes a little intelligence to use the simple black boxes.

The smart musician has learned to approach the sound

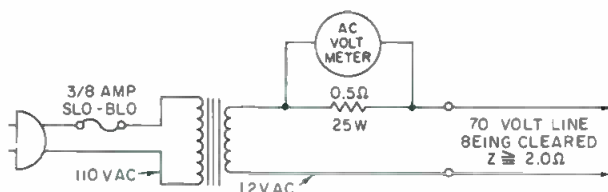


Figure 5. Unauthorized tap detector. Courtesy Albert N. Corry.

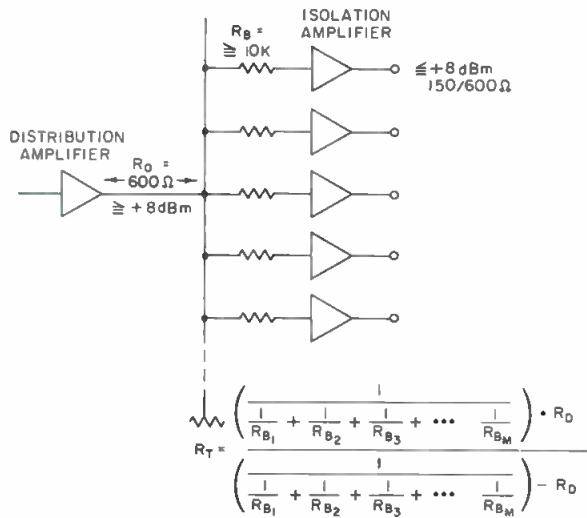


Figure 6. Program distribution amplifier providing isolation.

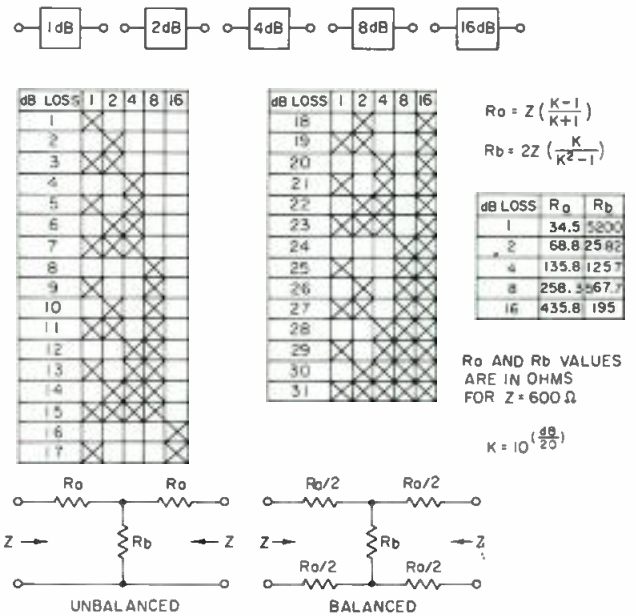


Figure 8. A five-element universal test pad.

system's microphone stand with his guitar (held by the wooden body) and touch the strings to the microphone and its stand to see how big an arc he can draw. Less informed colleagues have been seriously injured.

UNAUTHORIZED TAP DETECTOR

Times without number, a really well-engineered distributed sound system (25 or 70 volts) has been left in perfect operating order. Several months later, a call from the owner reveals that the system is barely functioning and that you, your engineering, and your equipment stink. Don't send an inexperienced man. Out of the black box closet comes the unauthorized tap detector (See FIGURE 5).

At the scene of the suspected crime, your impedance bridge reveals that the amplifiers are indeed working into about 1/10 or less of their rated load. You check several easily accessible loudspeakers to be sure they still have their transformers (reason why in a minute). Then connect your unauthorized tap detector to the loudspeaker

line. A very loud noise is usually heard in one of the janitor's closets and out comes a slightly deafened maintenance man who was in the wire closet reading his *Playboy* and listening to the Muzak over his own little private speaker connected at voice coil impedance across your 70-volt line. His little speaker has either burned out or climbed out of the ceiling and you now have a cleared line that again measures its normal impedance.

Why did you check a couple of transformers first? At a ski resort in Vermont, a TV repairman was called to service a wide-area paging system. When he arrived on the scene, only one loudspeaker was clearly audible. It had no transformer. All the loudspeakers that weren't playing properly had transformers, so naturally he did the logical thing and disconnected *all* the transformers.

SHURE'S HANDY DEVICES

There you are checking out your first mammoth stage system: twenty microphones to be checked for polarity. In the approved manner, you dedicate one of the mics to the god of audio and christen it properly polarized. You now check #2 against it, #3, #4, etc. After each check, you hand the mis-polarized microphones to a technician for rewiring. When you are all done, you find that all were alike except for the first one, so he's rewired 19. A simple polarity reverser, Shure #A15PR, would have allowed a quick and easy check of all units first. You want to be sure it is the microphone that is mis-poled. I have checked out sound systems where the patch cords have been mis-wired.

Also included among the same handy connectors is a 100 Hz-12 dB/oct.-12 dB/oct. low-pass filter, A15LP; a presence adapter (4 dB peak at the 3-5 kHz region), A15PA; a line input adapter (-50 dB at 1,000 Ohms bridging input to microphone low Z), A15LZ; a response shaper (4 dB dip in 6 kHz region), A15RS; a bridging transformer for matching unbalanced to balanced devices and high Z to low Z A15BT. No professional sound man's tool kit is complete without a full set of these basic helpers.

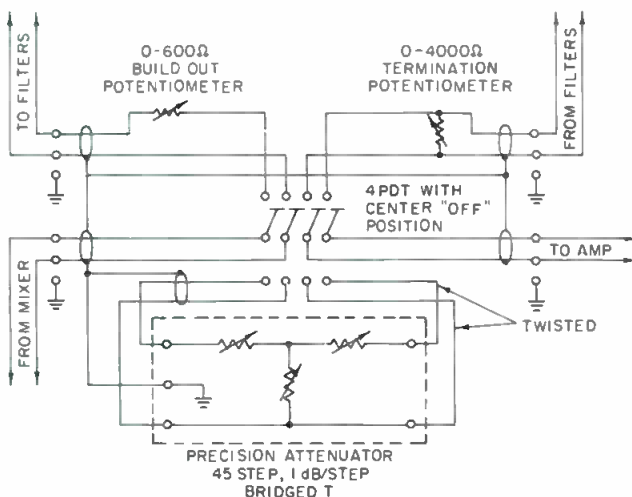


Figure 7. Switching and attenuator comparator.

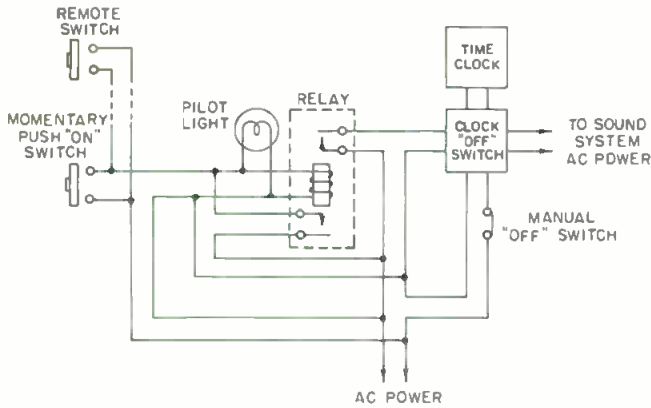


Figure 9. Example of a "push on" automatic off system. Courtesy Floyd Cooper.

1. Press momentary "push on" switch.
2. Relay makes two contacts (one activates the clock, thereby closing the clock "off" switch, the second supplies a.c. power to the relay, keeping it on).
3. Pilot light lights, clock starts and runs set period and then opens clock "off" switch, shutting off sound system.
4. Sound system may be shut off before clock time runs out by opening the "manual off" switch.

A DISTRIBUTION AMPLIFIER

The Great Man arrives. So, unfortunately, does the national press, radio and TV, security, etc. All want feeds from your system. If you're unprepared and take a chance feeding them from a very low impedance line, etc., they reward you by attaching to your line a unique collection of one-of-a-kind grounding, shorting and interfering signals.

Again, the experienced sound man, realizing that the network's devices to be hooked to his feed are about as reliable as their version of the news, employs a completely brute force isolated program distribution amplifier using a rugged, exceptionally well-regulated distribution amplifier driving a bridging network that feeds a series of 20 or even 30 plug-in card isolation amplifiers. (See FIGURE 6) Everyone gets a feed and how he abuses it is up to him.

A-B BOX WITH PRECISION ATTENUATOR

Merlin himself complete in pointed hat with quarter moons on it has done his special incantations for four days and declares the sound system equalized. To his horror, you would like an A-B comparison between equalized and unequalized. You can't just throw a switch without a very expensive noise. FIGURE 7 shows the perfect answer. In fact, no room-sound system equalization should ever be completed without one of these magic boxes. It supplies the buildout and termination and allows both signal paths to be adjusted an equal number of dB below feedback. It is also amazingly useful in setting gains in a complex system. Once the gain is adjusted through the use of the precision attenuator, one glance at the dial tells you what value pad to construct for that link circuit.

A UNIVERSAL TAPPED PAD SET

You're out on a job in East Alongapoo and find that you need an 18-dB pad. The only thing related to the

sound business in this metropolis is an antique store that has an Edison cylinder phonograph. Who carries a thousand resistors with him? Our pro doesn't, but he does have a half-dozen little boxes that contain 10 values and allows him any attenuation from 1 dB to 31 dB in 1 dB steps. (See FIGURE 8)

AN AUTOMATIC CHURCH BLACK BOX

It is an axiom in the audio business that every church has to buy a minimum of three sound systems. The first is the garbage specified for the cut-price bid market. The second is the one installed by the congregation's expert. And, if they are lucky, the third one will be designed and installed by a professional. Hopefully this is changing. One sound contractor in Syracuse area told me that he received his first bid job after many years in business—and he was high bidder. And "local experts" are getting training. Two young men were paid by their church to fly from Phoenix to Philadelphia for a Syn-Aud-Con class because the church is planning a large sound system and they wanted to be informed in order to evaluate the sound contractor's proposal.

The most frequent cause of church service calls is due to misuse of the controls. "The microphone has gone dead" usually means the mixer control has been turned down, etc. One very successful answer to this problem is the closed, locked equipment cabinet with an "on-off" switch that after being punched lights up a "go" light and then 90 minutes later turns itself off. (See FIGURE 9)

The moral of the story is that technology needs black boxes to solve the human engineering problems that arrive via Murphy's Law. May you always be a black box ahead of Murphy—therein lies happiness and harmony. ■

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Architectural Acoustics, part 2

A good sound-system design includes proper acoustical match, correct signal flow, noise control, and sound isolation.

DESIGN OF A SOUND AMPLIFICATION SYSTEM is an integral part of the over-all acoustical design of a theater, concert hall, auditorium, or a studio (if a reinforcement system is included in a studio).

The three basic considerations in designing systems are:

1. Providing a proper acoustical match to the room acoustics,
2. Insuring correct signal flow, or a proper match to the functional needs of the owner, and
3. Satisfactory appearance.¹¹

Basic Purposes

The primary goal of the amplification system in a typical theater, auditorium, or concert hall should be high speech intelligibility. Intelligibility depends upon the orientation and location of the loudspeakers with respect to the live sound sources, together with the shaping and acoustical characteristics of the interior room finishes, as discussed in Part I, and the directional characteristics of the loudspeakers, the operating sound levels, and the background noise within the space, as discussed in this article.

The second goal of any sound system should be naturalness for all reinforced or amplified program material. For music reproduction or reinforcement the system must clearly have a flat response, wide range, low noise and distortion, in other words, *high fidelity*. For speech, sound should appear to come from the person speaking, and the sound system's operation should go unnoticed; the amplified sound should be a clearer and more intelligible version of the speaker's natural voice.^{9,11}

Use of Central Systems

By positioning a central loudspeaker system so that the amplified sound arrived slightly after the live sound (10 to 20 milliseconds is best), and by insuring that the amount of amplification is not excessive, it is possible to "fool" even highly experienced listeners into believing the amplified sound is coming from the live sound source.^{4,9} The time of arrival and loudness of *both* the amplified and live sound for any

particular room design must be studied carefully to achieve this effect.

Our ears are at the sides of our heads; our ability to localize a sound source is more efficient in a horizontal plane than in a vertical plane. Therefore, a loudspeaker location directly above the live sound source can produce sound energy appearing to come from the live sound source, even when the sound level from the system is considerably higher than its natural source or arrives first.⁴

The ratio of live sound to amplified sound can vary somewhat throughout an auditorium, but it is important that live and amplified sound both arrive at the listener's ear at approximately the same time (within 30 milliseconds) if their contributions to speech intelligibility are to be additive rather than cancelling. The central over-the-proscenium loudspeaker location can maintain approximately the same path length between amplified and live sound throughout a typical auditorium or concert hall.

Directional Characteristics

Since loudspeaker and microphone must be close to one another in a central sound system design, their *directional* characteristics are important. Loudspeaker equipment should be chosen to provide the most even coverage possible over the entire audience seating area, while minimizing the sound energy directed at the microphone position and at any wall or ceiling surface that may reflect energy back to the stage. Directional microphones should be chosen to minimize pickup in the direction of the loudspeaker and, in many cases, minimize pick-up of room reverberation.

It is important that the coverage pattern of the loudspeakers (or loudspeaker cluster) be based on a realistic appraisal of the loudspeaker's characteristics. This coverage pattern should assure that all listeners receive the signal with smooth frequency response at a sufficient level to assure an increase in speech intelligibility.¹⁰

Even though one directional loudspeaker could be chosen to provide coverage for an entire seating area, it may be advisable to divide the seating area into two or three sections and assign two or three loudspeakers in a cluster, (rather than one) to provide a uniform level throughout. The input

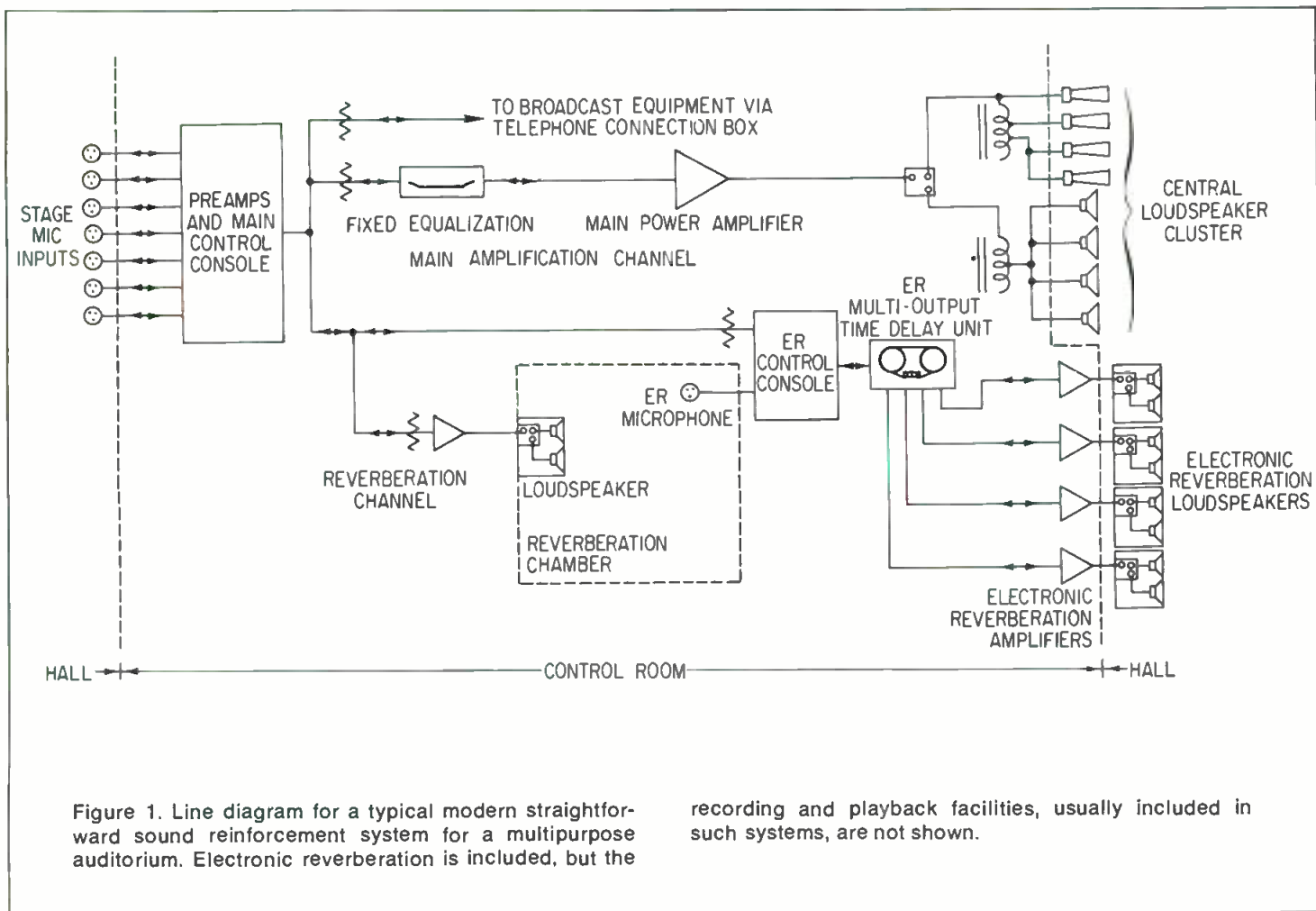


Figure 1. Line diagram for a typical modern straightforward sound reinforcement system for a multipurpose auditorium. Electronic reverberation is included, but the

recording and playback facilities, usually included in such systems, are not shown.

signal to the loudspeaker directed to cover the forward seating area may be reduced in level, thus maintaining a more uniform level than possible solely with one loudspeaker.^{9,10}

Reducing Reverberation

For spaces with a relatively high reverberation time, including concert halls and those churches where music is an important part of the service, central loudspeaker systems employing loudspeakers with the proper directional characteristics can actually minimize room reverberation by concentrating sound on the sound-absorbing audience. Therefore, such systems can produce high intelligibility by minimizing the masking effects of reverberation on the transient speech sounds and allow satisfactory intelligibility in reverberant environments ideal for music. Large radiating surfaces are required for directional control, and these are most often in the form of line-source or *column* loudspeakers or arrays of direction horns (usually multicellular or radial horns).¹⁰

Increasing Reverberation

Sound amplification systems designed to increase the reverberation time of an auditorium or concert hall are a separate category — electronic reverberation systems. Generally, such systems and their equipment are separate and in addition to the basic "house" sound systems discussed earlier. ER systems frequently employ many loudspeakers to provide maximum diffusion and minimum ability to localize the source of amplified reverberant sound. The most frequently encountered ER systems use conventional close microphoning and then use magnetic tape delay devices to insure that the sound from any ER loudspeaker reaches the listener after

live sound from the stage or after the direct (main system) amplified sound from the stage. Multiple successive delays are usually employed, with the loudspeakers farthest from the stage receiving the longest delayed systems.⁵ In some ER systems the time delay tape mechanism is also used as the reverberation generator, with delayed signals from the playback head(s) mixed into the record head via a scrambler circuit signal. One such system, designed and installed by the Aeolian-Skinner Organ Company, has had over ten years of experience in use for increasing the liveness of "dry" churches.

Other systems use supplementary reverberation devices or, better yet, a separate echo chamber or reverberation room where a loudspeaker plays back the sound picked up near the source. A microphone in the reverberant rooms picks up the multiple reflected sound. A mix of the direct sound and the reverberant signal then feeds the record channel of the time-delay system. One such system, together with a fully-developed stereophonic "central" stage reinforcement may be observed in the Purdue University Hall of Music, Lafayette, Indiana.⁵

There are other types of ER systems, such as that installed in London's Royal Festival Hall; these pick-up reverberant or delayed sound at various points within the hall and distribute it via many separate simple amplification channels (perhaps with electrical or acoustical filtering); and it will be interesting to learn which type will find most frequent application in the future for improving the liveness of existing relatively dry halls and smaller than optimum new halls.^{5,11}

Noise Control and Sound Isolation

Intruding sounds that require control may be divided into

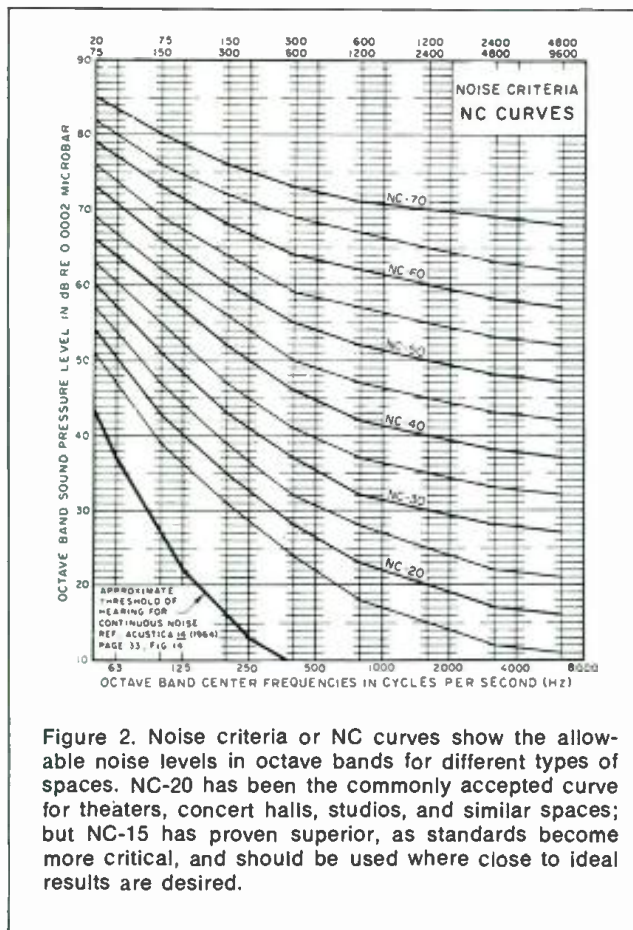


Figure 2. Noise criteria or NC curves show the allowable noise levels in octave bands for different types of spaces. NC-20 has been the commonly accepted curve for theaters, concert halls, studios, and similar spaces; but NC-15 has proven superior, as standards become more critical, and should be used where close to ideal results are desired.

two categories: (a) continuous and relatively innocuous sounds, usually produced by the ventilating system, and (b) intruding discontinuous sounds having programmatic content, such as sounds from adjacent auditoriums or studios. One of the most important concepts of modern noise control engineering is use of the first type of noise to mask the second type.⁶

Naturally, even the steady-state or innocuous ventilating system noises must be held below certain levels or they will be annoying in themselves. Criteria for the allowable background of *all* types of noise have been established for the spaces we are discussing. FIGURE 2 shows a family of noise criteria curves (NC curves) showing the allowable noise levels in octave bands as a function of the octave-band center frequency.^{2,3} For critical broadcast and recording studios NC-15 appears the appropriate criteria curve today; although both NC-15 or NC-20 have been considered applicable for the concert halls and theaters.

Mechanical Equipment

Having established the criteria for noise control of air-handling equipment, the responsibility for meeting it rests on the mechanical engineer (with the help of the acoustical consultant) and the contractor installing the equipment specified. All parts of the air-handling system and mechanical equipment design should be studied from the standpoint of noise control.

The noise of air supply and return fans must be estimated properly; then noise control must be incorporated into supply and return ducts by use of lining (lined bends are particularly effective) and/or by use of packaged sound attenuating mufflers.^{5,7} For spaces requiring a background

noise as low as NC-15, it is good practice to locate the supply and return fans very remotely from the hall or studio, and then lining or mufflers may not be required. The sound attenuation or unlined ductwork, lined ductwork, and mufflers or various configurations is predictable, allowing the engineer to design the required amount of sound attenuation into the air-supply and return system.¹

Similarly, air supply and return grilles or diffusers should be chosen to meet the requirements imposed by the criteria. Larger grilles, with lower "face velocities" (feet of air-movement per minute or fpm) mean less hiss for a given amount of air moved.⁸

Care must be taken that air velocities in ductwork within or near the hall or studio are not so high as to create turbulence noise* without appropriate sound-attenuating duct construction and lining or mufflers to control sound transmitted to the diffusers or grilles.⁸

Generally, the further all mechanical equipment is from the critical hall or studio, the easier will be the noise control job of the mechanical and acoustical engineers. It is wise to locate mechanical equipment in a basement area under the lobby of a hall, rather than under the hall itself. The practice of mounting fans in attic space directly over hall or studio ceilings should be avoided if at all possible. The equipment will produce a "problem" sound level in the area it is mounted; if this area is directly adjacent to — or above or below — the hall or studio, then special sound-isolating construction may be required.

Equipment mounted near critical spaces also requires careful attention to mounting arrangements; otherwise the equipment can easily introduce vibrations into the building structure, and these vibrations can be radiated as noise inside the studio or hall. Springs, sometimes in combination with concrete inertia blocks, are required for isolation of low-frequency vibrations; ribbed rubber, neoprene, or cork pads are often useful for high-frequency vibration isolation. On occasion, concrete vibration-isolation bases may be supported off the floor on springs — or the entire floor of a mechanical equipment room, located above a studio or hall, many consist of a triple-sandwich of concrete-springs-and-concrete.

Sound Isolation

There are many potential sources of intruding sounds that should be considered in the design of a studio or hall, in addition to those from mechanical equipment. Potential sources from inside a building include performances located in adjacent studios or halls, footfall noise, casual conversation in corridors, lobbies and other circulation areas, and even in control rooms and viewing rooms. Offices can contain problems including office machinery ranging from typewriters to computers. External noise sources include aircraft flyovers, street and highway traffic, railway lines, and subways.⁷

Any acoustical engineer will urge that as many of these problems as possible be solved in the basic planning of a new hall or studio facility; but inevitably studios and halls will be planned adjacent to each other within the same facility — or a hall or studio facility will be located in the main flight path of an airport. The acoustical engineer, working with the architect, can still accomplish much in planning the facility even after the basic decisions are made. Adjacent studios or halls can be separated by circulation

*Mixing boxes and dampers are potential producers of turbulence noise, which then requires control by lining or mufflers.

spaces, control rooms, storage rooms, etc; and a concert hall within the main flight path of an airport can be built into, rather than above the earth, with circulation spaces, lobbies, ticket offices, etc., located between the hall and the building roof. The basic technique is to surround and separate the most critical areas (from the standpoint of acoustics) with less critical ones.

Eventually, the basic wall, ceiling, and floor construction for the critical area must be chosen. The sound-pressure level on the *sending* or *source* side of the boundary must be estimated as a function of frequency; the criterion for noise levels in the critical space subtracted, and the difference is the required "noise reduction" for particular boundary surface.

The ability of the particular wall, floor, or ceiling construction (or any other partition) to isolate (stop) sound energy is expressed by the *transmission loss* of that construction. The transmission loss (TL) of a construction is a ratio, expressed in decibels ($10 \log_{10}$) of the acoustic energy incident on the wall to the acoustic energy transmitted through it, and it applies to a unit area. (In the U.S., this is usually one square foot.) Transmission loss curves (as a function of frequency) may be calculated for various types of construction (based on mass, stiffness, distance between elements in sandwich construction, etc.), measured in a laboratory, or calculated from field measurements of noise reduction (NR).

Unlike transmission loss, noise reduction includes the effects of the area of the boundary surface and the room acoustics of the receiving room, so the expression relating the two concepts is:

$$NR = TL - 10 \log_{10} \left(\frac{1}{4} + \frac{S_w}{R_2} \right) \text{ dB}$$

where

NR = noise reduction (reverberant levels on source side of partition minus receiving room levels measured near the partition)

TL = transmission loss of partition construction ($10 \log_{10}$ ratio of incident energy to transmitted energy.)

S_w = Area of partition

R_2 = Room Factor of receiving room

($R = S_2 \alpha_2 / C I - \alpha_2$) where S_2 is the total interior surface area of the receiving room, α_2 is the average absorption coefficient, and $S_2 \alpha_2$ is the total absorption in the receiving room.

The quantities S_2 and α_2 will be known or calculated from the room-acoustics design of the receiving room (the hall or studio).

Generally, the more massive a partition construction is, the higher its transmission loss. Really high-TL partitions employ multi-layer construction. For example, a typical wall recommended to separate two music practice and teaching rooms — and matched to a ventilating system noise level of NC-35 — would consist of 8-in. solid masonry or concrete, with a separate 3/4-in. plaster wall on each side. Only resilient connections would be employed between the plaster walls and the masonry or concrete core, and glass-fiber may be installed in the two air-spaces of this triple-layer construction.

A somewhat heavier construction technique would be employed to isolate halls or studios requiring a lower background noise level (NC-15 or NC-20). Where one hall is located above another, a vertical slice through the common floor-ceiling construction might show a 3-in. concrete floor slab floated on 2-in. glass fiber, a 12-in. structural concrete slab below and then a resiliently suspended 1-in. plaster

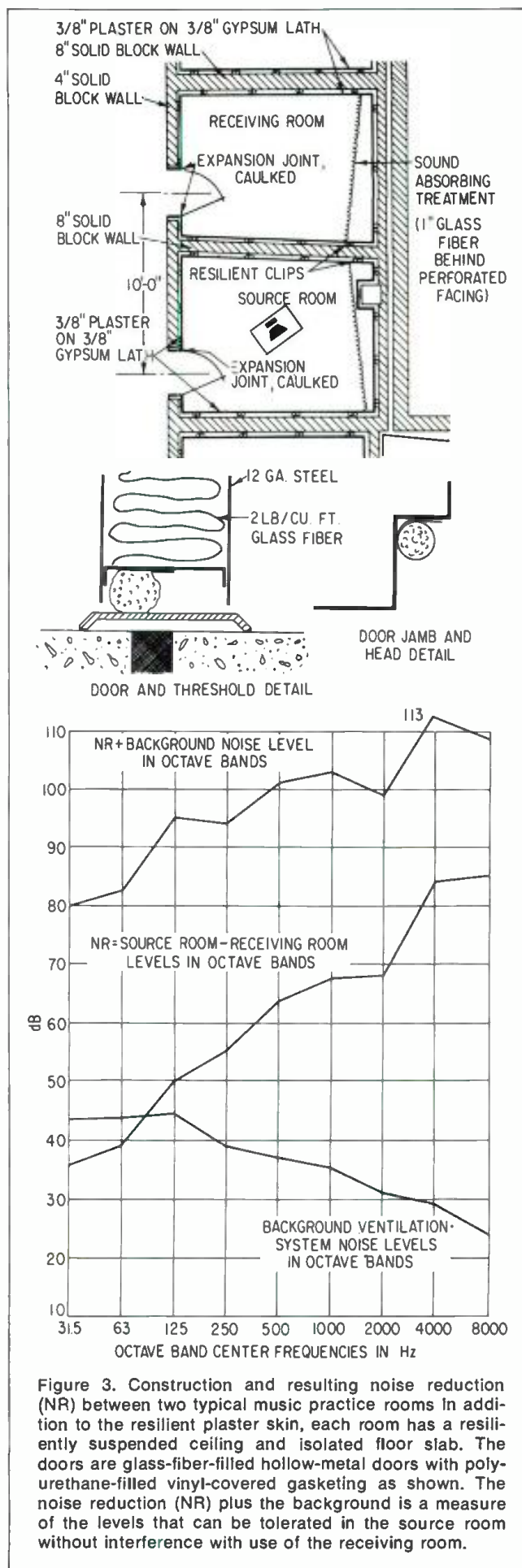


Figure 3. Construction and resulting noise reduction (NR) between two typical music practice rooms in addition to the resilient plaster skin, each room has a resiliently suspended ceiling and isolated floor slab. The doors are glass-fiber-filled hollow-metal doors with polyurethane-filled vinyl-covered gasketing as shown. The noise reduction (NR) plus the background is a measure of the levels that can be tolerated in the source room without interference with use of the receiving room.

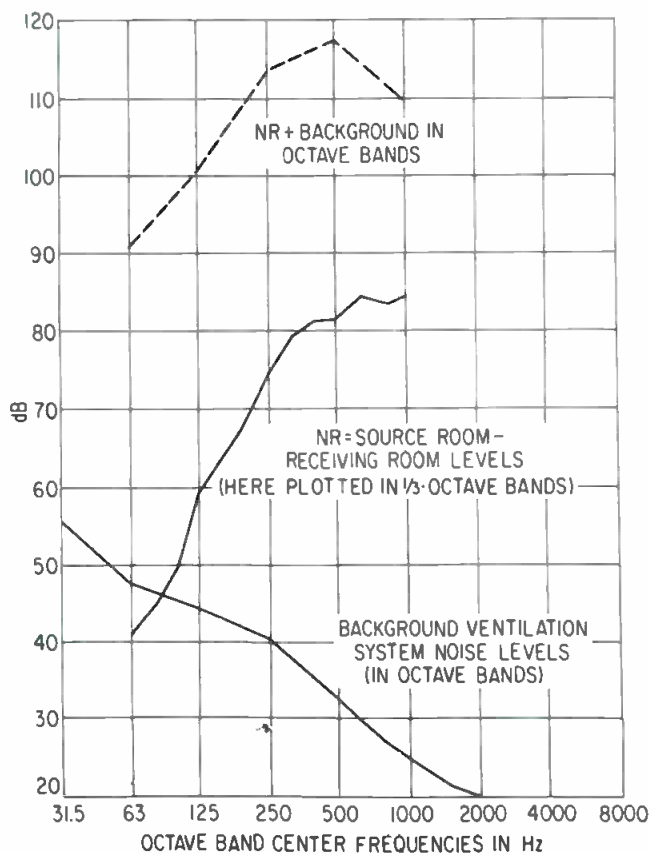
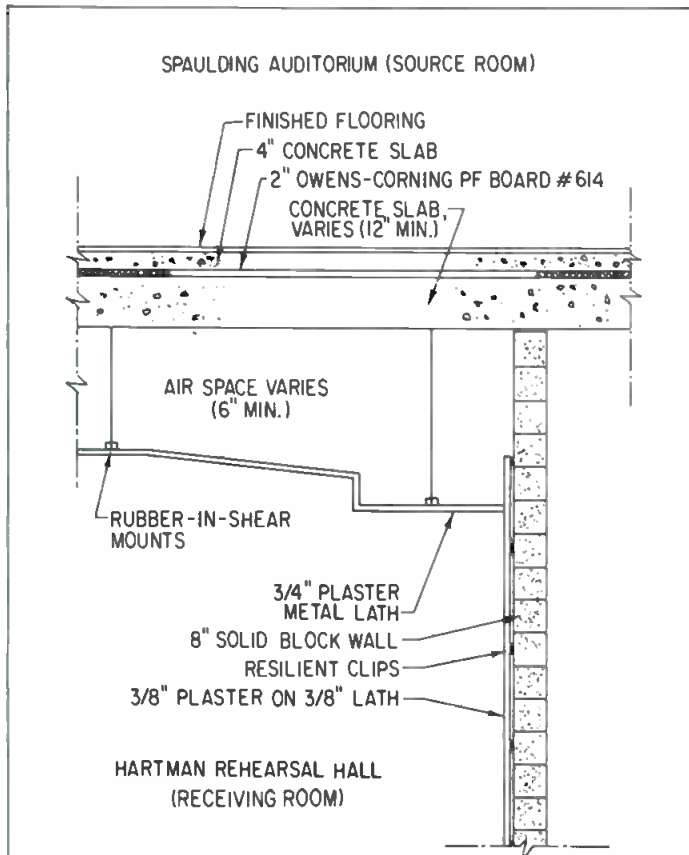


Figure 4. Construction and resulting noise reduction (NR) between a multipurpose auditorium (concert hall—lecture hall) and broadcast studio—rehearsal room below. Values of NR above 1000 Hz are not shown because the test signal source (horn loudspeaker) was not high enough in level to be measured above the ambient in the receiving room, but are known to be above 83 dB. Again, the NR plus background indicates the tolerable levels in the source room.

ceiling below the structural slab. FIGURES 3 and 4 show the noise reduction possible with the construction techniques mentioned.

Doors and windows in high TL-walls must be matched to the construction they interrupt. Details for windows separating control rooms from studios or halls have been refined for many years, and such windows now generally include the following characteristics:

1. Double construction, using two panes of different thicknesses, with one pane sometimes sloped.
2. Resilient airtight mounting for the glass.
3. Sound-absorbing material applied to the frame in the space between the two panes.

High TL doors may now be purchased complete with frames and gasketing (weatherstripping), and careful installation will allow matching the sound isolation of the surrounding constructions.

Details — and airtightness — are very important in all sound isolating construction; light fixtures, grilles, electric outlets, and conduit must all be handled specially to avoid compromise to the basic construction. In this respect, achieving high noise reduction is no different than other areas of acoustical design: details make the difference.

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SCULLY, ELECTRO-VOICE, NEUMANN, Shure, Spectrasonics, Quad Eight, Masterroom, ARP, Pultec, Microtak, Russco, dbx, Interface, EMT, and others. The Audio Marketplace, Div. United Audio Recording, 5310 Jackwood, San Antonio, Texas 78238. (512) 684-4000.

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WANTED

WANTED: Gately SM-6 mixer & EQ-6 equalizer in excellent condition. Gerald Bennett. (Home) (713) 488-5095. (Office) (713) 474-4144.

COLLECTOR WANTS back copies, electronics and radio magazines. Donald Erickson, 6059 Essex, Riverside, Ca. 92504.

WANTED: Educational public broadcast station needs surplus studio equipment, particularly magnetic tape and mixing equipment. Contact Boulder Community Broadcast Association, 885 Arapahoe, Boulder, Colorado 80302.

WILL TRADE SYNTHESIZERS for professional audio and video equipment. New Electron Farm—CBS Buchla synthesizers: for multi-track decks and electronics, amplifiers, monitors, microphones, mixing consoles, etc., video decks, cameras, monitors, etc. Gregory Kramer, Electron Farm, 59 Wooster St., New York, N.Y. 10012. (212) 431-3618. Los Angeles, (213) 396-6339.

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DAVIS

● Research activities at CBS will be encompassed in a new Technology Center, located on High Ridge Road in Stamford, Connecticut. **Benjamin B. Bauer** will head the new center as vice president and general manager. Major departments will be headed by **Robert A. Castrignano**, **J. Kenneth Moore**, **Emil L. Torick**, and **Louis A. Abbagnaro**. Mr. Bauer, who was formerly CBS Laboratories' vice president, acoustics and magnetics, is widely known for his published papers and extensive lecturing. He holds more than 50 patents. Mr. Moore, who will direct advanced television technology, has been engaged in work on systems for image data handling and photo-transmission, as well as the Vidifont graphic arts quality titling system for t.v. for CBS. Mr. Castrignano, in charge of high density recording technology, has worked in the development of television systems for CBS, specializing in signal enhancing techniques, high resolution scanning, rapid film processing, and pulse circuit design. Mr. Torick, director of audio systems technology, has been a violinist with the Pittsburgh Symphony and is a holder of patents in signal control circuitry, noise control, and broadcast devices. Mr. Abbagnaro, director of sound reproduction technology, has been involved in the design of advanced acoustic transducers, transducer arrays, and signal processing techniques. Advanced technology activities at the new center will be totally funded by CBS.

● **Joseph P. Dash** has been appointed director of new product development by **CBS Records** of New York City. Mr. Dash's responsibility will revolve particularly around the expansion of the four-channel market. He will work closely in this area with **Stan Kaven**, vice president of planning and diversification. Prior to joining CBS in 1969, Mr. Dash was associated with the **Celanese Corporation**.

● **Capitol Magnetic Products** of Los Angeles, recording tape division of **Capitol Records, Inc.** has named **William C. Bollinger** as director of marketing. Mr. Bollinger will be concerned with the marketing of Capitol's consumer, professional, and audio-visual product lines. Mr. Bollinger was previously with the **Memorex Corporation**.

● **McFadden Sales, Inc.** has been appointed as sales representatives for the territory of Indiana, Kentucky, and Ohio by **Synergetic Audio Concepts**. Synergetic, operating from Tustin, California, and focalized by **Don Davis**, conducts 3-day sound engineering seminars at regular intervals in cities across the country.

● Becoming increasingly involved in setting up individualized sound systems for performers, **Martin Audio** of New York City, audio equipment suppliers, has expanded this aspect of their business under the supervision of vice president **Larry Grossberg**. Artists using Martin's services have included **Alice Cooper**, **Harry Belafonte**, **Emerson, Lake & Palmer**, **The Who**, and **Seals & Croft**, as well as a number of foreign performers working in the U.S. In addition to designing systems, the company also offers repair and checkout services for existing setups. A new division of the company which will supply parts, replacement parts and construction materials to the professional broadcast, recording studio, and sound reinforcement market, has also been organized. It will be operated by **Bruce Martin**, **Jonathan Gildersleeve**, and **Pat Chamberlain**.

● **Coastcom**, of Concord, California, has been awarded a contract to provide a program multiplex for the national Iranian radio and television network. Coastcom's multi-channel network quality multiplex system will be

integrated with existing and new **Granger Associates'** 960 MHz radio systems. The new installations will extend high fidelity broadcast network service to approximately 100 communities in Iran.

● **Wally Heider Recording's Studio One** was the scene of six weeks of vocals, overdubs and mixing for **Paul and Linda McCartney's** new **Wings** album, "Venus and Mars," on **Apple Records**. Featured sidemen were **Jimmy McCulloch**, lead guitar; **Denny Laine**, bass, and **Joe Ireland**, drums. **Allan O'Duffy** was the McCartney's engineer and **Biff Dawes** engineered for **Wally Heider**.

● Two additions have been added to the regional marketing staff of **TDK Electronics Corporation**, of Garden City, N.Y. **John Schuttin** is territorial marketing manager for the eastern region, encompassing New York State, New England, and northern New Jersey, based in Garden City. Mr. Schuttin was formerly with **Ampex**. **Mark Needle**, who comes from **Saxon Products**, is territorial marketing assistant, responsible for Virginia, West Virginia, Maryland, Pennsylvania, southern New Jersey, and the Carolinas. He will be based at **Green Belt, Maryland**.

● **Phoenix Enterprise, Inc.** has acquired the assets of **Infonics, Inc.** from **Electronic Associates, Inc.** **Ross Terry**, formerly manufacturing manager of the video products group of **Visual Educom** of Michigan City, Indiana, has been elected president of **Infonics, Inc.** **Carol Lant** will serve as president of the **Infonics** subsidiary, **Infonics International, Inc.** **Phoenix** has moved to a new manufacturing facility in Michigan City, where **Infonics** products will continue to be produced.

● Audio designer **Richard W. Burden** has joined **Automated Processes, Inc.** of Melville, N.Y. as a broadcast sales engineer. Mr. Burden's projects have included audio console design, product development, system design of studio facilities, f.m. transmission systems, and limited area transmission systems. He holds several patents in the field and has published a number of technical papers. Mr. Burden has been very active in professional standard-making committees. He will maintain his office in **Canoga Park, California**.

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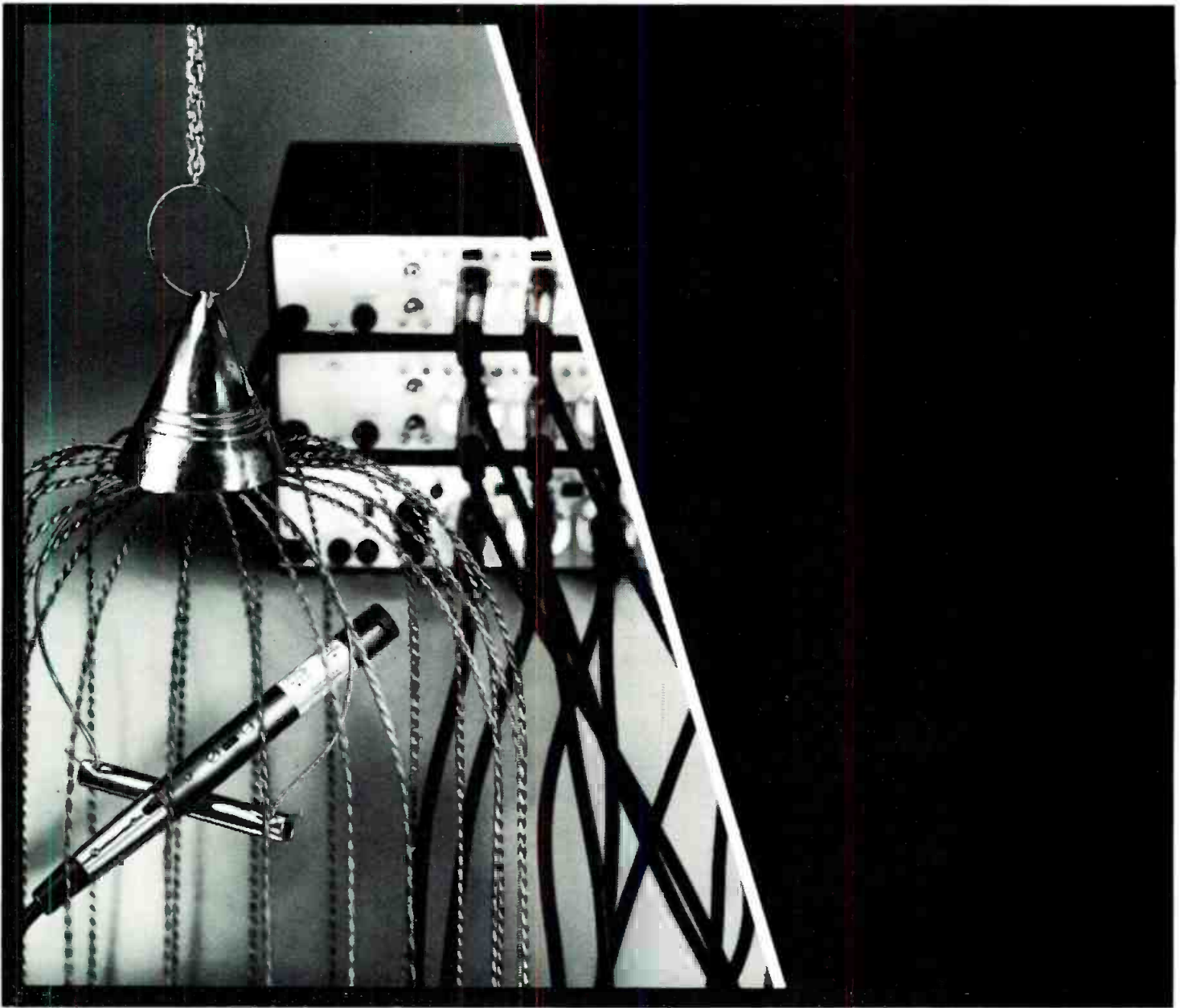
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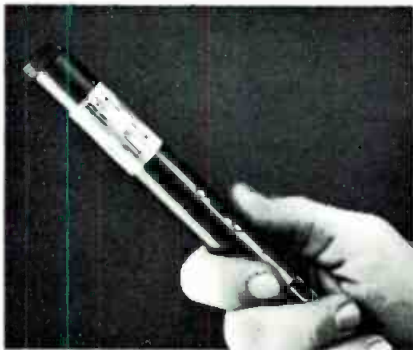
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A Yamaha sound mixer is the central focus, resting on a wooden surface. A red parrot is perched on top of the mixer. The background is dark, with a red light source creating a glow. The letters 'F O' are visible in the upper left. A license plate with the number '489' is partially visible.

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