"SYN-AUD-CON"

SYNERGETIC AUDIO CONCEPTS

newsletter

VOLUME 4, NUMBER 1
October 1976

P.O. BOX 1134, TUSTIN, CALIFORNIA 92680

SYNERGETIC
Working together; co-operating; co-operative

SYNERGISM
Co-operative action of discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

EXCHANGE OF IDEAS

I met a man with a dollar
We exchanged dollars
I still had a dollar

I met a man with an idea
We exchanged ideas
Now we each had two ideas

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NEW HP CALCULATORS

The Hewlett Packard Company has again developed a new family of battery operated, hand-held calculators.

One, the model HP 25-C has continuous memory in a programmable calculator that even remembers *when turned off*. The most interesting unit is the new HP 97 attache case sized (9"W, 8"D, 2.5"H and weighing only 2.5 lbs.) printing computer calculator. This unit is small enough and light enough to carry about in one hand while calculating and printing. It also features a substantially larger LED display that makes reading data much easier for aging eyes. Syn-Aud-Con has purchased an HP 97 for use in handling our sound system design program problems and will have the programs available shortly.

The HP 67 is a unit the size of the earlier HP 65 but with the identical features of the HP 97 minus the printer. Both the HP 97 and 67 have 224 step memories, with all instruction steps merged to take only one program step per instruction, and 26 storage registers for data.

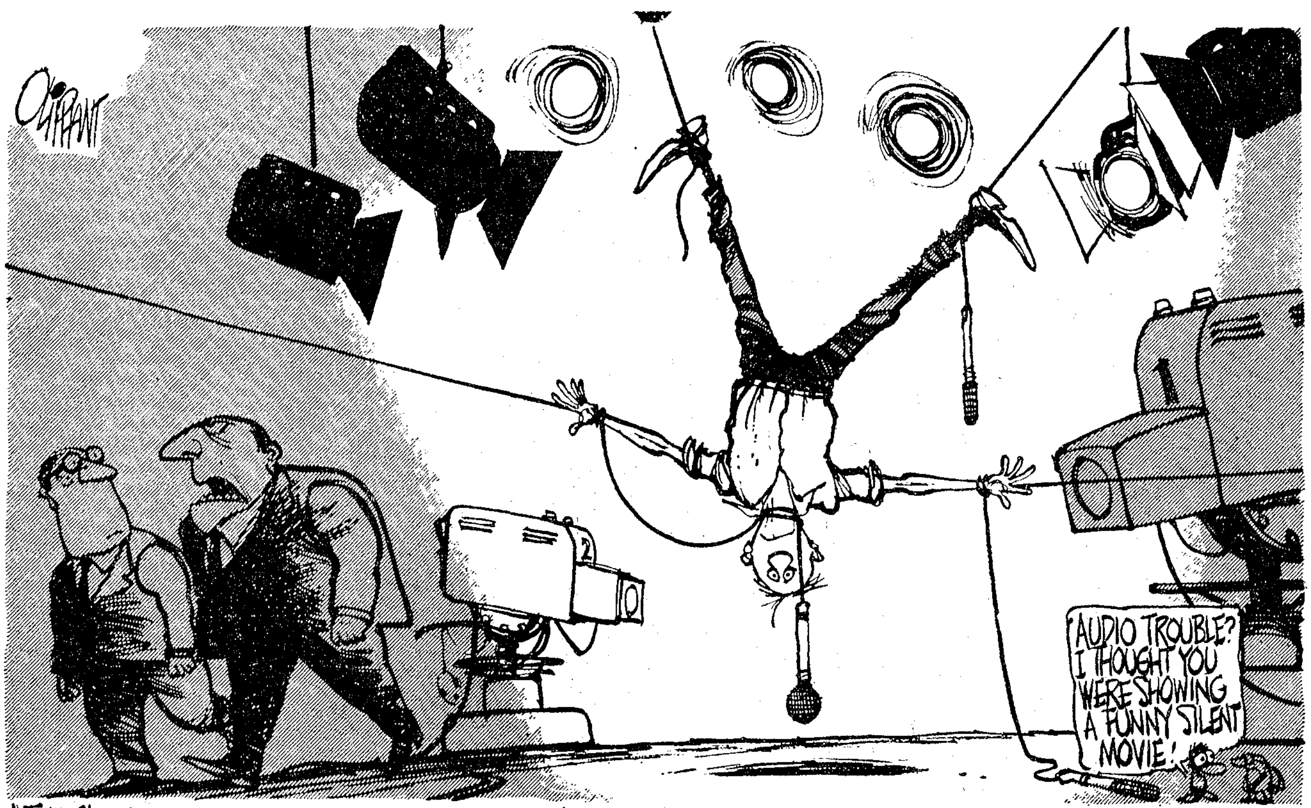
A new wrist watch by HP is also just about to be announced and should be ready for the Christmas season (guess price around $750). This will be a calculator wrist watch (four functions only) plus a number of setable alarms. It seems worthwhile to wait until HP produces a scientific calculator wrist watch.

The HP 21 is now selling for less than $80; the 25-C for $200; the 67 for $450; and the 97 for $750.

We have already heard from 6 graduates that they have purchased the 67 or 97.

NATIONAL COUNCIL OF ACOUSTICAL CONSULTANTS

The National Council of Acoustical Consultants is an organization made up of men who own their own consulting firms. In many of our classes we are asked where one can obtain a directory of acoustical consultants that they can recommend for acoustical work. You may write for their directory: National Council of Acoustical Consultants, 8811 Colesville Rd., Suite 225, Silver Spring, Maryland 20910.

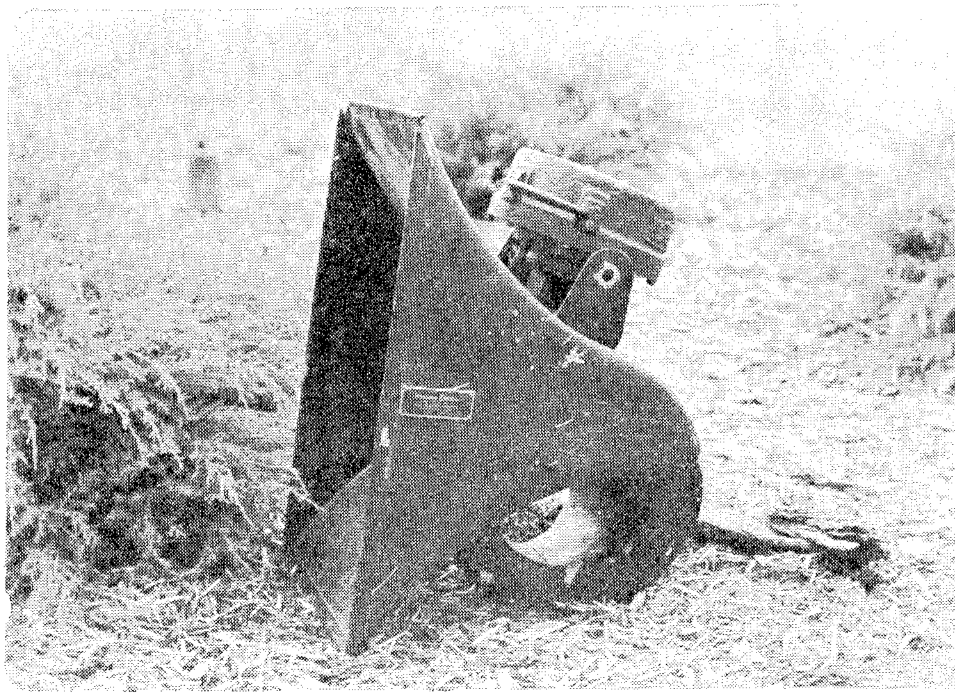


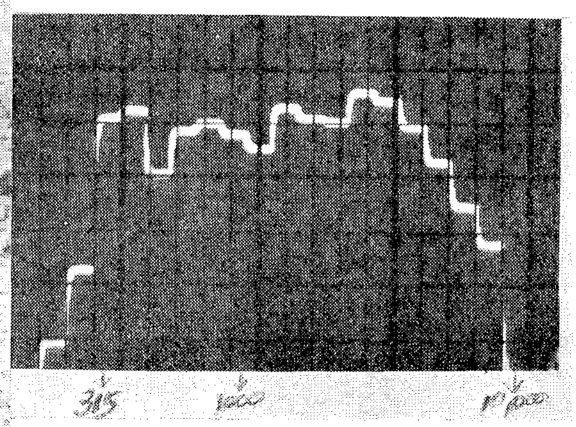
"THAT'S OUR SOUND ENGINEER —— HE'S BEING CONVINCED HE MUSTN'T BOTCH UP THE AUDIO ON THE NEXT DEBATE!"

W.E. HORN & DRIVER, CIRCA 1928

TED UZZLE, Cinephone Co. (Boston class 1975 &'76), and a very competent motion picture theatre designer and engineer, brought a Western Electric horn and Model 555 driver, circa 1928 into this year's Boston class. CHRIS BALLOU, 16 year old member of the Boston class and daughter of GLEN BALLOU, co-editor of the revision of the *AUDIO CYCLOPEDIA*, took the picture for us.

The 555 driver is one of the W.E. forerunners of the modern compression drivers produced by Altec, JBL, Emilar, etc.





The RTA photograph shows the acoustic amplitude response of this famous combination. Ted tells us this smaller horn was used primarily in monitor systems and that there was a larger horn for use in the theater itself.

It's not hard to see where the "Academy Curve" came from after looking at this response. Not only was this ancient unit response smooth but "talk tests" over it exhibited exceptional transient response and very low distortion. RON ADAMS, Audio Visual Engineering in Woonsocket, R.I., also in the class, owns a theater service company and says that he services theaters that have the W.E. horn and driver operating!

Wente and Thuras, the original W.E. engineers who designed these units in the 1920s, deserved the respect accorded them at the time, and from the perspective of 1976 allows, their efforts reflect true genius.

GRIN

Did you hear the one about the man who had the old dog kennel and didn't know what to do with it - so he put a loudspeaker in it and called it a woofer! (From Bill Symmes, San Francisco 1973)

GRIN

Crinkle, crinkle, little spar
strained beyond the yield point far,
Up above the world so high
Boy! I'm glad that I don't fly.
Anon.

RAULAND NEW SYN-AUD-CON SPONSOR

We are pleased to announce that Rauland Borg Corp. of Chicago, Ill. has become Syn-Aud-Con's ninth sponsor. Included in this Newsletter mailing is a brochure from Rauland describing the scope of audio activity by the company.

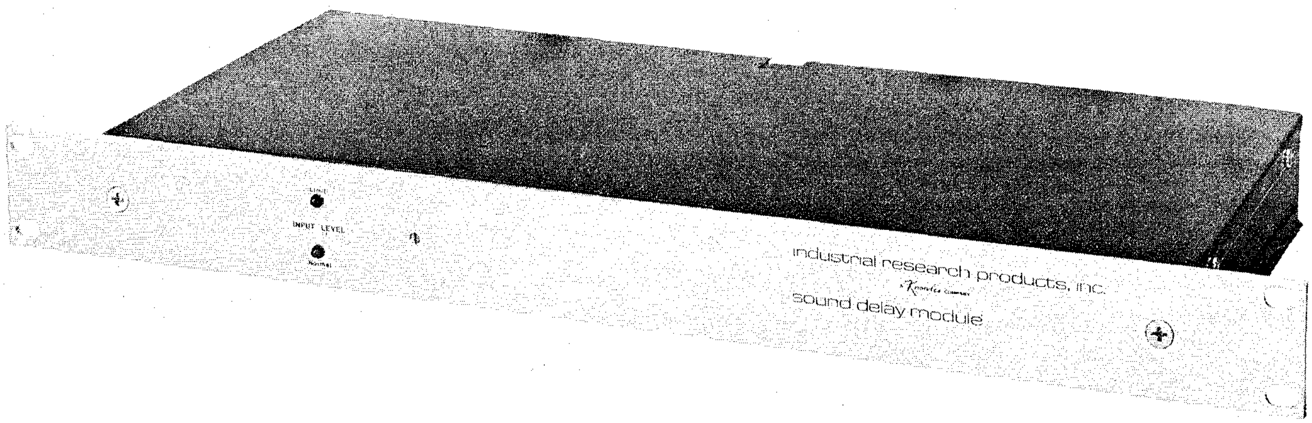
Mr. Harro Heinz, President of Rauland, has already attended Syn-Aud-Con's 1976 Boston class and is investigating the possibilities inherent in Rauland's sponsorship of Syn-Aud-Con.

Don and Carolyn Davis will attend the Rauland national sales meeting in late October and are looking forward to finding out more about Rauland's extensive line of sound equipment.

One aspect of Rauland's serious intentions in the professional sound field is their OEM agreement with Emilar to supply the Rauland compression driver for use in a series of new loudspeaker designs.

IRP NEW SOUND DELAY MODULE

Industrial Research Products has brought out a new sound delay module DA-4009 for under $1,000 to the sound contractor.

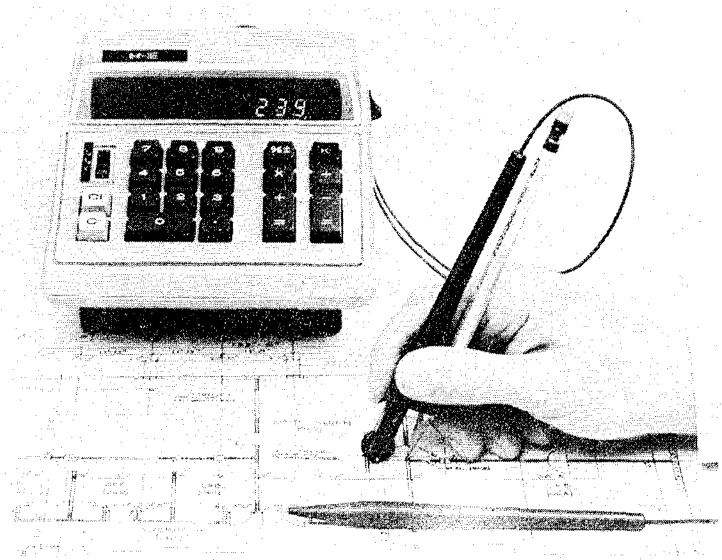


Write Industrial Research Products, 321 Bond St., Elk Grove Village, Ill. 60007 for specifications.

This unit places time delay for home, studio, and small auditorium well within reasonable reach. One of these units on an A-B ambience channel at the rear of the room in a deluxe home stereophonic system would allow remarkable control over the apparent size of the space the recording originated in. Syn-Aud-Con is currently carrying one of these units for the classes.

ELECTRONIC ESTIMATING CALCULATOR

Kueffel & Esser Co. has a new advanced electronic estimating calculator, with and without printer, designed with the architect, engineer, and estimator in mind. The calculators measure, calculate and display length, area, and volume directly from a drawing in either architect's or engineer's scale for immediate extension by cost or labor factors. In addition, the K&E estimating calculators count, mark and display individual items on a drawing for extension by other factors.



Two probes make the calculator unique -- a counting probe and a measuring probe.

To use the counting probe, the user touches the probe to the items being counted, presses down lightly and the count is displayed. To use the measuring probe, the user selects the appropriate scale, then places the probe at a starting point on the drawing and rolls the wheel along the distance to be measured. The actual length in feet will be displayed, and by setting a constant, such as height, into the calculator, square footage is automatically calculated too.

The K&E calculator does all this in addition to the normal functions of adding, subtracting, multiplication, dividing, calculating mixed, chain and constant totals, and so on.

Write Kueffel & Esser Company, 20 Whippany Rd., Morristown, New Jersey 07960

CONSTANT CURRENT IMPEDANCE ADAPTER

The method most often used by manufacturers to measure impedance (Z) is the constant current method. By connecting a high impedance (2000Ω) in series with a conventional power amplifier's low impedance (4-8Ω) output, you obtain a readily available source of constant current. When a constant current source is connected to a varying impedance, the voltage varies in relation to the impedance.

Building a Constant Current Impedance Adapter (C.C.I.A.)

In order to be able to quickly and conveniently make such measurements with any available power amplifier, it is best to build a simple adapter box to facilitate the necessary interconnections between the source, test instruments, and the device being tested. The interconnection diagram and the C.C.I.A. diagrams are shown below.

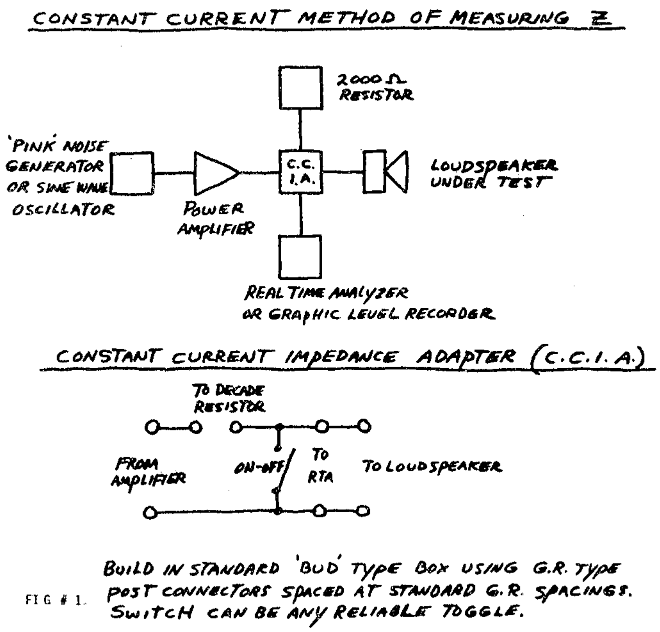
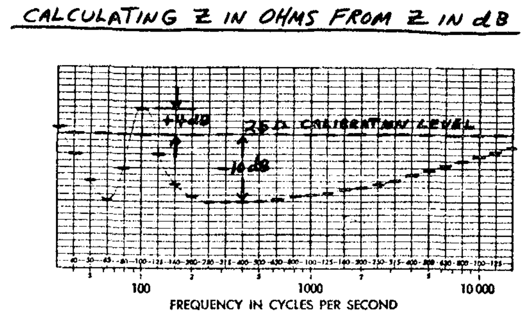


FIG # 1.

CALCULATING Z IN OHMS FROM Z IN dB



$$Z = REF.\ Z \times 10^{\left(\frac{\pm dB}{20}\right)}$$

WHERE ±dB IS THE DIFFERENCE IN dB BETWEEN THE CALIBRATION LEVEL IN dB AND THE Z IN dB

$$Z = 25 \times 10^{\left(\frac{-10}{20}\right)} = 7.9\ \Omega$$

$$\pm dB = 20 \log\left(\frac{Z}{REF.\ Z}\right)$$

$$\pm dB = 20 \log\left(\frac{7.9}{25}\right) = -10$$

Fig. # 2

DAVID FARAGHER of Hollywood Sound Systems built our C.C.I.A. just prior to the special class for Hollywood Sound Systems in April.

Calibrating the Measurement

With the noise generator or sinewave oscillator (either method may be used) connected to the input of the power amplifier, the C.C.I.A. connected to the output of the power amplifier (toggle switch closed on the C.C.I.A.), and the 2,000Ω resistance connected to the terminals marked "to decade resistor", turn the noise generator and power amplifier "on". Place a calibration resistor across the terminal labeled "to loudspeaker". (I use a 25Ω unit but any reasonable value can be chosen). With the power amplifier's gain turned as low as it will go, open the toggle switch on the C C.I.A. and then raise the power amplifier's gain until you have a straight line display about midscreen on the real time analyzer (RTA). This line is the 25 ohm level. Again close the toggle switch on the C.C.I.A. and then replace the calibration resistor with the intended test load. Once again open the toggle switch on the C.C.I.A. The Z by frequency will appear across the screen of the RTA (or be traced on your graphic level recorder chart if you are using the sine wave method.) At the conclusion of the test, close the toggle switch on the C.C.I.A. before disconnecting the test load. This avoids an accidental overload of the RTA's input.

Brief Intrepretation of Z Curve

The rated Z of the loudspeaker will be the lowest reading just above the resonant frequency. In the case of Fig. 2, 400 Hz shows approximately

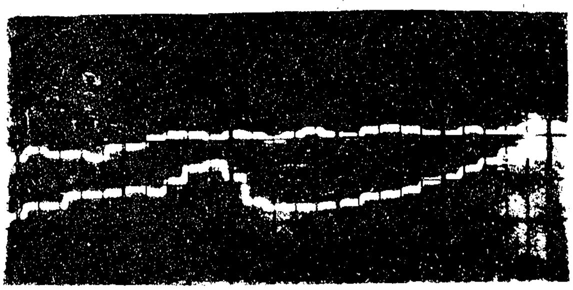
$$Z = 25 \times 10^{\left(\frac{-10}{20}\right)} = 7.91\Omega$$

This is essentially resistive as the curve is "flat" at that point. The resonant peak at 100 Hz is also essentially resistive and reads

$$Z = 15 \times 10^{\left(\frac{+4}{20}\right)} = 40\Omega$$

Constant Current Impedance Adapter, cont.

The difference between 40Ω and 7.9Ω is approximately 32Ω, which is a likely value for the motional Z (blocking the diaphragm so it couldn't move and re-measuring would confirm this).



The slopes that rise in Z with increasing frequency are acting essentially as an inductance and the slopes that decrease in Z with increasing frequency are acting essentially as a capacitance. It is thus possible at a glance to see the resistive components, the inductive reactance, and capacitive reactance.

The highest Z value you should attempt to read with this technique is about 1/10th the value of the resistance connected across the "decade resistor" terminals on the C.C.I.A.

This method offers valuable insights into the components that make up the impedance of a loudspeaker on a 70 volt line. The type of reactive component can be viewed and a workable Z value chosen. In the design of a loudspeaker driver or its enclosure, the data is fundamental.

MIDWEST ACOUSTICS CONFERENCE

The Midwest Acoustics Conference 1977 program is scheduled for May 7, 1977 from 8:30 a.m. to 6:00 p.m. in the Norris Center of Northwestern University, Evanston, Illinois.

This year's program is of special interest to Syn-Aud-Con graduates as it provides an opportunity to interface with some of the top experts in our professional audio business.

We are reproducing the MAC 77 program in full now to let you see the depth of the program and the wealth of knowledge that is going to be available there. Probably there is no practical, reasonable audio question that the group of experts could not provide the best answers to in the industry. Bob Schulein, Juergen Wahl, Don Keele, Stan Miller, Mahlon Burkhard and Dave Klepper are the caliber of audio talent Syn-Aud-Con talks about when setting its own goals and seeking data for classes. MAC is a chance to meet them, ask them questions, and really get to know them.

MAC 77 PROGRAM

(Final Revision from 5-18-76 Proposal)

Conference Title: Sound Reinforcement

Conference Date and Location: May 7, 1977, Norris Center Northwestern University, Evanston, Illinois

Brief Description: A one-day comprehensive conference covering the component and system design engineering aspects of sound reinforcement systems.

Morning Conference

I Introduction (45 minutes)--An audio-visual presentation produced by the MAC Program Committee. The key topics of this presentation would be as follows:

A. Why are sound systems required?

B. What can a sound system do?

1. Reinforcement.
2. Reproduction.
3. Creation.

C. What are the objectives of a sound system?

1. To provide audience coverage.
2. To provide intelligibility.
3. To provide a suitable bandwidth and dynamic range.

D. What are the problems associated with the creation of sound systems?

1. Determination of functional requirements.
2. Environmental analysis.
3. System design.
4. Implementation.
5. Performance verification.

Coffee Break (30 minutes)

II Elements of Sound Reinforcement Systems (emphasis on important performance parameters)

A. Microphones (30 minutes)--R. Schulein, Shure Brothers Incorporated

B. Electronics (30 minutes)--Juergen Wahl, U.R.E.I.

C. Loudspeakers and Loudspeaker Systems (30 minutes)--Don Keele, Klipsch and Associates, Inc.

Afternoon Conference

III Sound Reinforcement System Applications

A. High level Sound Reinforcement Systems for the Performing Artist (30 minutes)--Stan Miller, Stanal Sound

B. Creating the Concert Hall Outdoors with Time Delay (30 minutes)--Mahlon Burkhard, Industrial Research Products.

Coffee Break (30 minutes)

C. Sound Reinforcement for the Theater (30 minutes)--David Klepper, Klepper, Marshall, King, Ltd.

IV Education in Sound System Design and Implementation (30 minutes)--Don Davis, Synergetic Audio Concepts.

This presentation will concentrate on those individuals in the sound system industry and what they are seeking or should be seeking to learn. In addition the paths and methods of communication among system designers, manufactures, installers, and users will be discussed.

V Panel Discussion--What are the Future Aspects of Sound System Design and Implementation (1 hour)--Don Davis to be panel moderator, with all other speakers participating.

RBS:NJD
6/25/76

Reprinted from Vol 2, No. 4

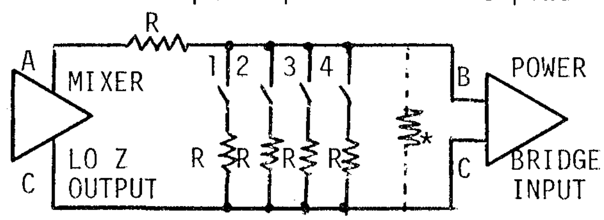
NOMA - NUMBER OF OPEN MICROPHONES ATTENUATOR

In an unattended sound system, it is desirable to utilize automatic microphone switches to achieve higher acoustic gain before feedback and to reduce garbling caused by the pickup of unwanted sounds and reverberation. The problem, of course, is that if more than one microphone opens up, the feedback margin is reduced by $10 \log_{10}$ NOM where NOM is the number of open microphones. In a typical church system, the organ or the choir can easily open up all the microphones and drive the system into feedback.

For several years, Diversified Concepts, Inc. has been successfully using a system of mixer bus loading to achieve a reasonable approximation of the $10 \log_{10}$ NOM curve. The circuit was designed around the Fairchild 692DAT lamp/photocell card and performed the attenuation function via the mixer bus in the system mixer.

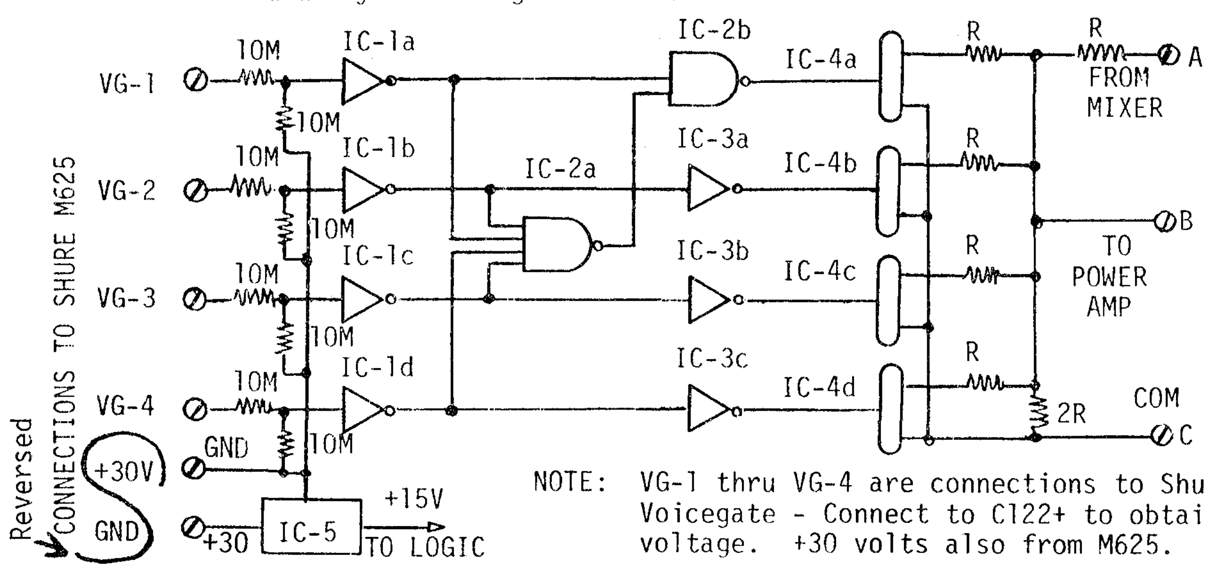
With the advent of the Shure M625 Voicegate and the availability of CMOS logic devices, we have significantly improved the performance of the DCI-NOMA to the point where it has become a standard feature of most of the systems we are now designing.

If the mixer output impedance is less than 0.1R and the input impedance of the power amplifier is at least greater than 2R, then this circuit will provide attenuation that follows the curve of $20 \log_{10}$ N where N is the total number of resistors R. Therefore, with all switches open, the attenuation is o dB, one switch gives 6 dB, two switches provide 9.5 dB, three switches 12 dB, and four switches 14 dB.



This is the wrong curve however, for a NOMA since we want $10 \log_{10}$ rather than $20 \log_{10}$. We can approximate the proper curve if we preload the circuit to N=2.5 by adding a resistor (*) equal to 2R and turning on one switch. This will give us a basic starting loss of 8 dB. Closing the second switch increases the loss to 11 dB which is equal to the 3 dB change we are looking for. The third switch raises the loss to 13 dB which is still quite accurate, and closing the fourth switch brings the total loss to 14.8 dB which departs from the desired curve by 0.85 dB additional loss.

If you examine the application of a NOMA, the critical point is really the change from one to two microphones open. When you reach the fourth microphone, the source of sound is usually something extraneous so the additional loss is not a critical item.



PARTS LIST

National Semi.

IC-1 MM74C14N
IC-2 MM74C20N
IC-3 MM74C04N
IC-4 CD4016AE
IC-5 LM342P15

PC Card can be obtained from DCI.

R =1800 ohms typical value

NOTE: VG-1 thru VG-4 are connections to Shure M625 Voicegate - Connect to C122+ to obtain control voltage. +30 volts also from M625.

Circuit can be used with balanced lines by using R/2 in each leg A&C from mixer. Some mixers will operate well with B&C connected across their mix bus but this may affect S/N ratio in critical applications. [With Shure M67, use R=4200 ohms]

Completely assembled and tested boards figure out to cost as follows: NOMA-4 $60; NOMA-8 $100; NOMA-12 $140; NOMA-16 $180; and the NOMA-20 $220. Costs would drop if we could make up more boards at a time, of course.

Diversified Concepts, Inc., 3920 New Seneca Turnpike, Marcellus, New York 13108

BATTERY POWERED LINE AMPLIFIER

It would seem to me that many of the simple but effective techniques that SAM ADAMS (Atlanta 1973,'74,'75) has developed to meet the military's needs would serve very well at fairgrounds, race tracks, summer church picnics, etc. (When we finally get to the point where special graduate seminars are held at our place in California, or Indiana, I'm backing SAM ADAMS to run away with the 100 yard shoulder-blade-and-heel race -- Sam led troops under the barbed wire while under fire so many times he can move across a room on his back with nothing but his shoulder blades and heels in motion as fast as I can walk.)

SAM writes: Over the last 20 years the Sound Branch of the United States Army Infantry School has had the opportunity to put into immediate application many new and novel circuits shortly after they were first published in the electronic industry technical press.

By the extensive use of peg-board type breadboards, with appropriate values of resistors, capacitors, potentiometers, transformers, and transistor sockets previously mounted on plug-in units, the testing of new ideas and hardware has been greatly facilitated. Each time a new circuit or a new semiconductor comes to our attention that appears to be applicable to our Sound Support mission, the hardware items are procured and the new circuit and/or item of hardware thoroughly tested. By this technique we have kept pace with the State of the Art and have been able to build the required items of equipment, in many cases, years before equipment of similar quality and/or capabilities would be available on the market.

Specifically the Sound Branch now has 100 battery powered amplifiers suitable for mounting in military vehicles and operating from the 24 volt wet cell battery of that type vehicle, all designed, built, installed and maintained here in the Sound Branch Electronics Shop.

These amplifiers each have 3 microphone inputs and 2 high level (0 dBm), high impedance (500 Kohm) inputs. Each input individually controlled by its own volume control knob. Each amplifier has a simple 1 knob type tone control. The power output is approximately 19 watts, into a speaker load of 250 ohms. The loudspeakers used are the standard army issue LS-103/TIQ2. In fact, the amplifier was developed to replace the standard army issue amplifier, AM-20/TIQ-2, which required 110 volts AC. This required the Sound Branch to provide a gasoline powered, trailer mounted, AC Power Generator to provide AC electric power to all of the ranges and training sites here on the Fort Benning Reservation that are not equipped with power line terminals. Would you believe this applies to close to 500 numbered and identified locations?

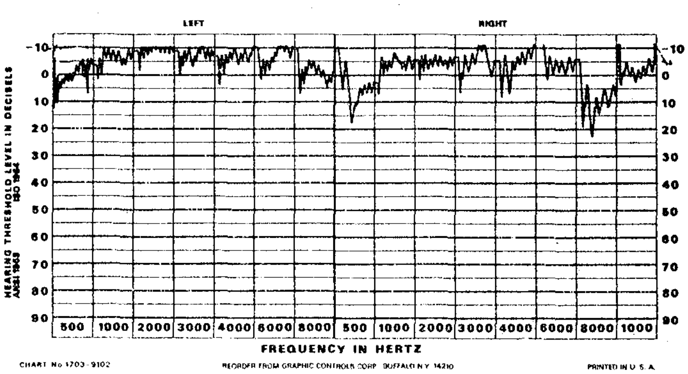
We also have 40 dry battery powered amplifiers mounted on a 2'x4' panel of plywood along with a battery box and a pair of Electro-Voice CobraFlex loudspeakers. These units have a change-over switch to outlet terminals, so that the amplifier can *either* feed the 2 mounted CobraFlex loudspeakers or (thru the output terminal connections) up to ten of the loudspeakers, LS-103/TIQ-2. These units have 2 microphone inputs, and only 1 high level, high impedance input. The internal building blocks of the above described amplifiers are *identical*, which really simplifies maintenance and repair parts storage. We also have 50 or so tape playback preamplifiers that we have developed, and built right here.

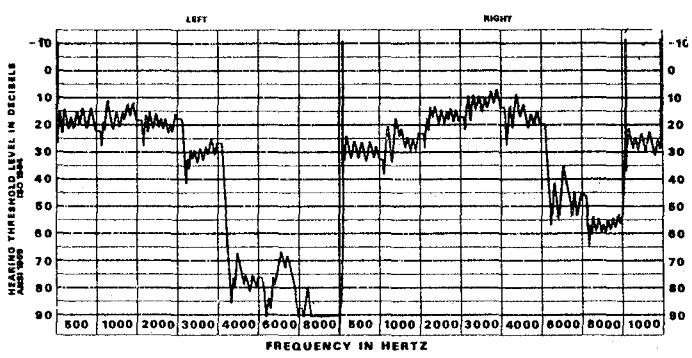
We always use the best quality internal parts that we can obtain. We have potentiometers *mounted* on each circuit board for each critical biasing point in the circuit, so that we can adjust the bias for each stage of each building block to optimum characteristics, and, when a semi-conductor is replaced, can just read as required.

AUDIOMETRIC HEARING TESTS AT SYN-AUD-CON

Syn-Aud-Con classes have a new feature. Picture a Syn-Aud-Con class-member sitting quietly in a corner with a set of earphones inside a set of ear defenders over his ears, eyes shut, concentration intense, holding an on-off switch in his hand as he listens intently.

What you have is a member of the class being introduced to GenRad's Model 1703B recording audiometer. This unit provides fixed frequency, pure-tone signals and Bekesy-type recording of the subject's response. Reproduced below are examples of audiograms obtained on this instrument.



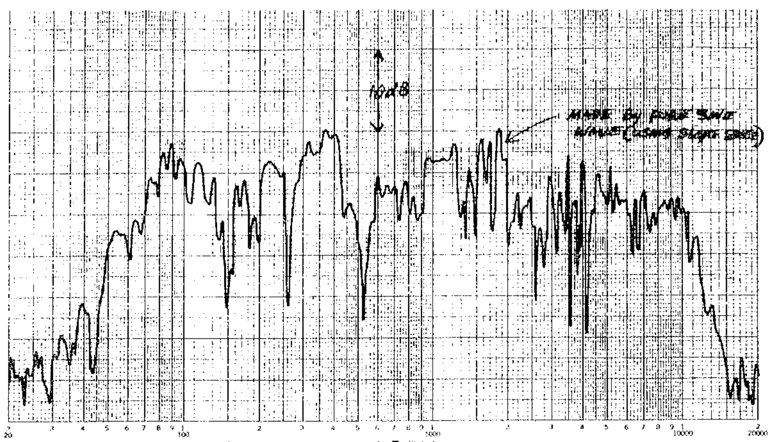


The first illustration is of one with very good hearing (above normal sensitivity -- 0 is normal, -10 is 10dB above normal.) The second example is of a person with hearing damage in the left ear and more than normal losses for the age group in the right ear. (Identification information has been cut off the top of the chart.) Audiograms such as the second one can result from pistol shooting, racing cars, acoustic trauma, ear infections, flying, exposure to heavy artillery, etc. Many of this year's Syn-Aud-Con attendees are finding it interesting to take the test and others enjoy finding out how such tests are conducted. An audio engineer needs adequate hearing coupled to lots and lots of listening experience. One can't see such damage as that incurred in Example Two without wanting to own a pair of David Clark ear protectors.

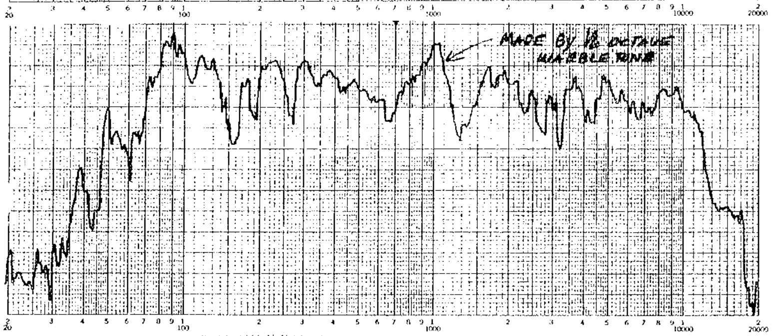
WARBLE TONE CONVERTER FOR UREI 200

We have published data on the UREI model 200 level recorder in Syn-Aud-Con Newsletter Vol 3, no. 2, pages 17-18. Just before we left California in September, UREI delivered a prototype *Warble Tone* Converter to us for use with the Model 200. This deceptively simple box, battery operated, allows 1/2, 1/3, 1/6, 1/10, etc., or pure sine wave response characteristics of a signal to be plotted with magnificent accuracy.

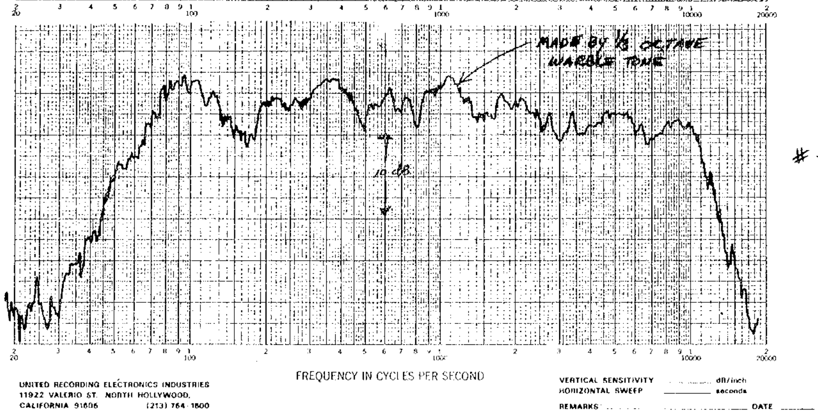
Warble tone oscillators were used before constant percentage bandwidth filters were developed but were extremely awkward in physical realization. Not so with this item. The warble tone Model 200 is rapidly becoming the second most used test instrument in our Syn-Aud-Con classes and for my own personal experimentation as it now allows easy access to permanent records of both sine wave electrical response of electronic components and warble tone acoustic responses of transducers with any conceivable degree of resolution that could possibly be useful.



#1



#2



#3

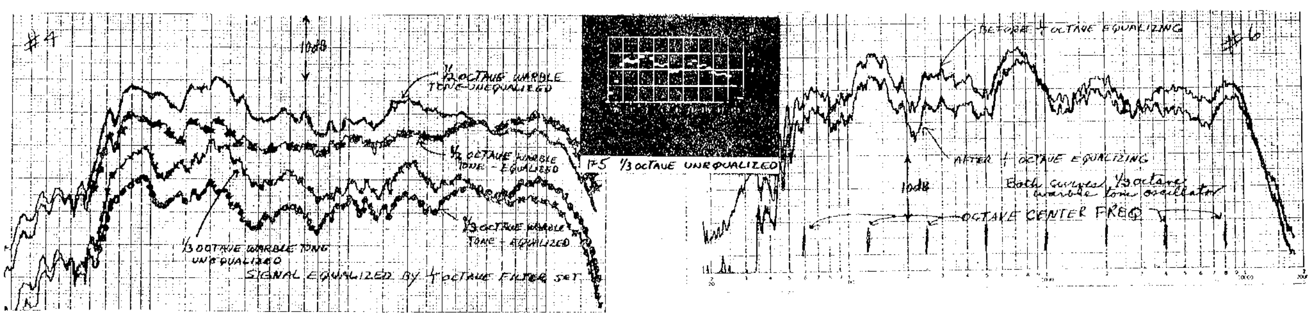
The first three illustrations show the effect of changing the degree of resolution. A really skilled and experienced viewer *might* be able to determine the upper envelope shape from the sine wave signal. The 1/6 octave signal really has isolated the equalizable upper envelope. The 1/3 octave signal shows the part of the upper envelope that has slope rates that can be equalized without serious damage to the integrity of the system's ability to reproduce transients as well as steady state signals.

Illustration # 4 shows how an equalization performed with an 1/1 octave filter set looks when viewed equalized and unequalized with an 1/2 octave warble tone oscillator as a test signal. The bottom curves show the same equalization as viewed both equalized and unequalized with a 1/3 octave warble tone oscillator test signal. Note that in both cases the 1/1 octave equalizer provided substantial control over the signal.

Illustration # 5 shows the same unequalized signal as it appears on a conventional 1/3 octave real time analyzer with a pink noise test signal. The excellent correlation between the UREI 200's 1/3 octave warble tone and the RTA is evident.

Finally, we have an Illustration # 6, a 1/1 octave equalization that ran into trouble as three of the peaks fell exactly halfway between the center frequencies of the octave band analyzer also being used to do the tuning. The octave band analyzer said the signal was essentially ±1 dB in octave bands (probably a close-to-the-truth statement) but the 1/3 octave curves quickly reveal that several serious peaks were overlooked by not having enough resolution in the analyzer.

It can be seen that the ability to increase and decrease the plotter's resolution capabilities is a very worthwhile feature of such a level recorder. When it comes at the remarkably low price and with the high accuracy of the UREI Model 200 with warble tone converter, we can expect to see heavy professional usage in proof-of-performance documentation associated with sound system specifications.



In future classes we will be experimenting with regenerative response curves at high resolution as a method of locating the final "ringing" bands in a finished equalization.

HOW TO HANDLE A SPEAKER

RANDY GAWTRY, Electronic Design Company (Minneapolis class 1975) wrote: "Enclosed is a short set of instructions on care and handling of speakers, written by Don Ringham of Minneapolis Speaker Company. We have distributed copies to all our technicians and engineering personnel.

The subject of speaker care seems to be one of those areas where familiarity breeds negligence. Of course, most of the instructions apply to microphones as well as speakers. Don has consented to allow us to use this note as we see fit, and we thought it may be of interest for the Newsletter. The subject of speaker reliability and lifetime has come up fairly often as we see an increasing number of life safety voice communication systems. We have seen very little, if any, quantitative written data, and are wondering if anyone has done any significant work on loudspeaker lifetime and reliability."

MISCO® Red Line®

A Misco speaker is an unusually high quality device. In order to function as designed, it must be handled and installed with care. Following are a few do's and don't's that will help assure optimum performance of any speaker:

1. Remove the speaker from its packing carefully. Take care not to puncture the cone with a corner of the corrugated packing material. A puncture, regardless of how small, will degrade the performance of the speaker, just as a leak in the diaphragm of any air pump will reduce its performance. Also, any puncture in the cone will become enlarged with use and eventually cause a rattle or buzz.

2. Always grasp the speaker by the magnet assembly, and keep hands and tools away from the speaker except for mounting and wiring purposes. Fingers and hand tools are great enemies of speaker cones.

3. Always place a speaker, cone down, on a smooth clean surface if a carton is not conveniently available. This will protect much of the cone area from accidental damage.

4. Keep the speaker away from areas that have small metal parts or filings present. The magnetic field of the speaker can attract these parts or filings which can result in rattles, buzz, or possibly even reduce the efficiency of some magnetic circuits.

5. Never drop a speaker - Damage to the cone, voice coil, or the magnet assembly will surely occur.

6. When mounting a speaker in an enclosure, it is good practice to clear any obstructions from the mounting holes before attempting to place the speaker on the mounting studs. Gently pushing a screw driver through the mounting holes will accomplish this, and will reduce the possibility of puncturing the cone with a mounting stud.

7. Tighten the mounting nuts snugly, but do not draw them down tight. One good rule is finger tight and then one full turn. It is important that the frame of the speaker not become warped, because misalignment of the voice coil can easily result. The voice coil often has only a few thousandths of an inch clearance within the air gap, and very little distortion of the frame can render the speaker defective.

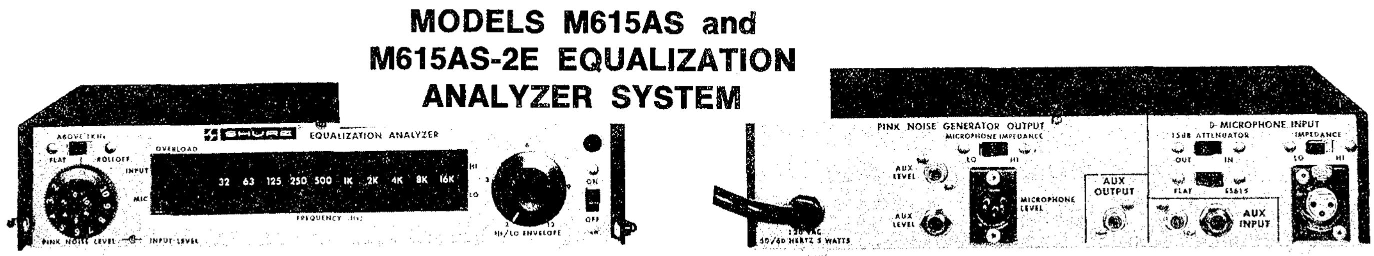
8. In soldering wires to the speaker terminals, care should be taken not to overheat the terminal so that the soldering connections from the terminal to the voice coil are damaged.

By treating a speaker as the delicate, precision device that it is, you will reap the rewards of reliable, maximum quality, sound reproduction.

SHURE EQUALIZATION ANALYZER SYSTEM

Shure Brothers has produced three new products based upon an innovative engineering idea. Our sole reservation regarding the execution of this idea is the fact that it is 1/1 octave rather than 1/3 octave band.

The three units consist of an omnidirectional measuring microphone specifically adapted for sound system equalization work: ES 615 analyzer calibrated microphone; the Model SR 107 octave band equalizer with 10 octave band filters covering the range from 20-20,000 Hz; and the Model M615AS, a really unique Equalization Analyzer System.



The microphone is specially adjusted internally as well as compensated for in the analyzer. The analyzer includes two rows of LEDs that can be set for a measuring window of 12 dB wide down to a window of 2 dB width It is this variable envelope control that we feel is a major breakthrough in analyzer convenience.

Another breakthrough is the price -- an unbelievably inexpensive $260 (approximately) to the Shure sound dealer for the analyzer, calibrated microphone, cables and accessories, plus carrying case.

How does it work? In two cases, after tuning with the Analyzer System we found that we had obtained a substantially smooth 1/3 octave response. In the third case, while the octave band response indicated ± 1 dB, the 1/3 octave response was ±5 dB. The reason for this was that each of the three peaks in the room response fell precisely midway between octave band centers.

This seems to verify what we often point out in Syn-Aud-Con classes, that 1/1 octave equalizers will not handle all the problems you can encounter.

We eagerly await the 1/3 octave versions of these units in addition to these excellent beginner's training tools.

IMPROVE YOUR SOUND SYSTEM CALCULATOR

The scales numbered 28, 29 and 30 are labeled the "Room Constant". Above Scale 28 is a black arrow. This arrow should now be labeled "Ft^3 by you.

Place the black arrow opposite 10^4 on Scale 28. Just the thickness of a line of ink from a ball point pen with a medium point above 3×10^3 (to the left of the black arrow), make a second black arrow and label it M^3.

Whenever you have your dimensions in the metric system, use the left arrow for V and when your dimensions are in the English system, use the right hand arrow for V.

When using the left hand arrow, the figures on Scale 29 are in M^2 and when using the right hand arrow, the figures are in ft^2.

Including this new arrow allows all of the scales on your Syn-Aud-Con Sound System Design Calculator to be used with either basic system. Remember that in the metric system sabins are in square meters whereas in the English system, they are in square feet.

Reprinted from Vol 2, # 2

SYNERGETIC AUDIO CONCEPTS

DAVE EDWARDS, Sound & Communications, Jackson, Miss, (Atlanta 1973, Orlando 1974) worked out the Microphone Line Tracer over lunch one day with Franklin Johnson:

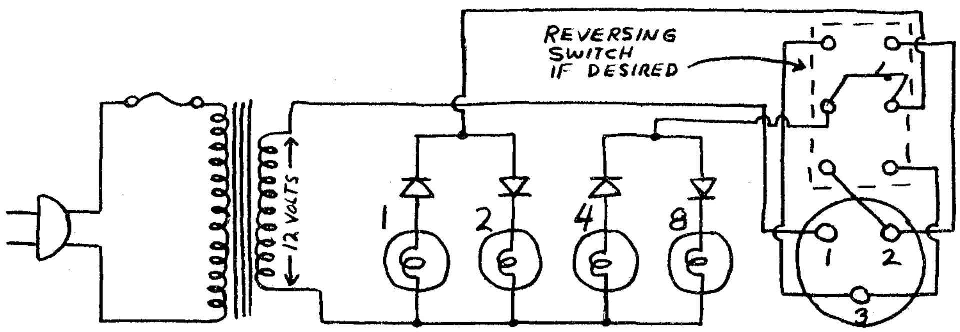
MICROPHONE LINE TESTER

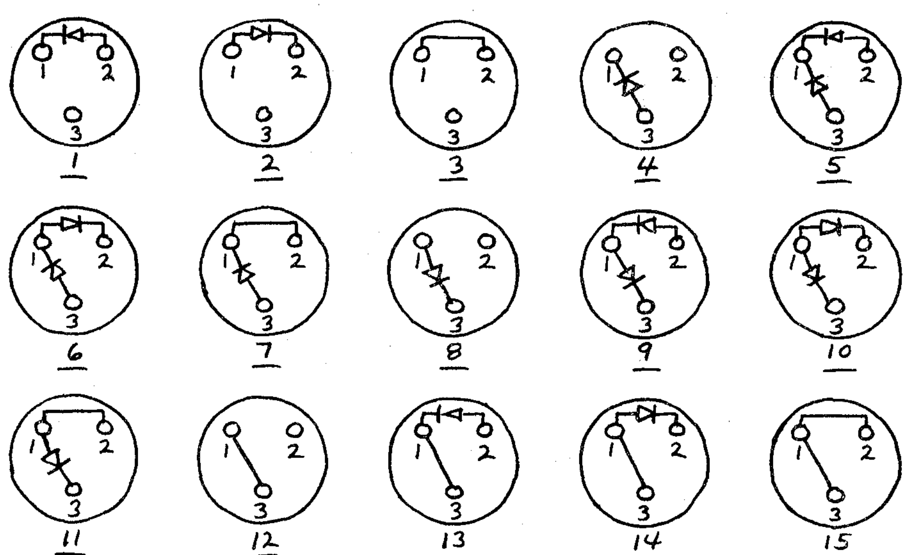
When a contractor has a number of microphone lines feeding from various positions to a control console point, the lines must be "rung out" before connection to the console or patch-bay. This "ringing out" can be accomplished by two men and a VOM in about a 1/2 hour, or by one man and a VOM in 4 hours, or by using the device described here, by one man in about *3 minutes*.

The tester unit is built in a mini-box or other type cabinet, and incorporates a separate pigtail with alligator clips, in case the console end of the mic lines doesn't have connectors.

The remote diode units are built into switchcraft A3M or equal connectors, and should have the numbers etched on the connector shells. The reversing switch is incorporated in order to find backwards-wired connectors.

To use this device, the diode units are plugged into the microhone receptables, and their positions noted. Then, by using the tester at the console location, all lines can be "rung out" with little effort, in *very little time*. When a line is connected, one or more lamps will light. The sum of the numbers indicates the number of the diode unit at the other end of the line.

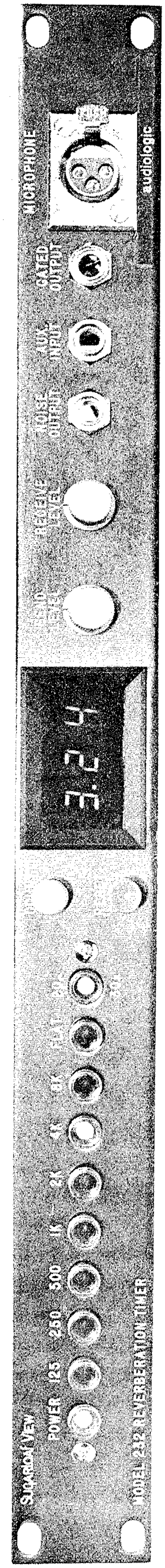




Reprinted from Vol 2. No. 2

CORRECTION TECH TOPIC VOL 3 #6

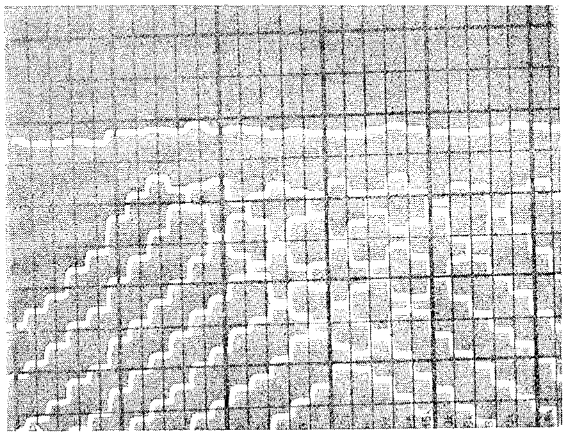
JIM KITAGAWA, Ministry of Transport. (Edmonton, Canada class 1976) found in working through the problems in Tech Topic Vol 3 # 6 with his TI SR-50 that in Table II - Subtracting decibels, step # 6 dropped off the final entry: +/-.



ACOUSTILOG MODEL 232 REVERB TIMER

ALAN FEIERSTEIN called just before the last New York class to ask if he could bring along a reverberation meter that he had developed since last year's class.

Al demonstrated his prototype reverberation meter. Our judgment of the unit was that it exhibited extreme accuracy, ease of operation, and maximum versatility. Beautifully done. We are reproducing some initial data on the ACOUSTILOG (Al was calling the unit Audiologic but ran into "prior use".) Contact Al for pricing (approximately $1,000) and additional information. The real time analyzer photograph shows the response curves of the filters used and the overall response curves of the Pink Noise signal generated. As a precision method for the measurement of reverberation time, we believe it is well worth investigation by those seeking such a valuable tool.



Quoting now from Al's preliminary specification sheet:

The ACOUSTILOG Model 232 Reverberation Timer is a state-of-the-art measurement system that will compute room decay time within each of seven octave-wide bands. Using a digital readout system with superior resolution, the Model 232 allows the operator to make accurate measurements with complete confidence.

ACOUSTILOG's exclusive level detection system does away with those tedious and error-producing manual calibration procedures. For operational convenience, the Model 232 contains its own built-in pink noise source and all measurements may be easily made by one person. ACOUSTILOG's system design features two sets of octave band filters; one each in the send and receive lines. The addition of send-line filtering permits greater accuracy of measurement, and provides improved protection of the test loudspeaker.

With the Model 232's 10 millisecond resolution capability, small studio control rooms, with decay times of less than 300 milliseconds, may be measured quickly and accurately. The employment of a free-standing microphone (user-supplied) prevents interference effects in the vicinity of the system case from causing misleading readings.

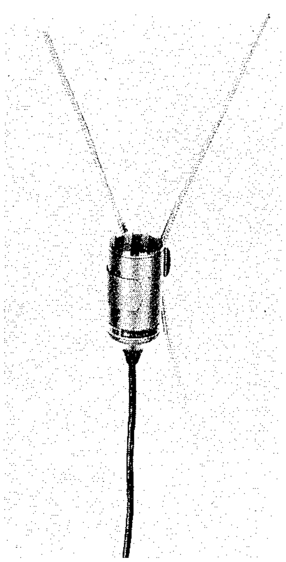
The ACOUSTILOG Model 232 Reverberation Timer requires only 1 3/4" of rack space, and can be mounted with a test amplifier, equalizer or gain set in a convenient portable rack cabinet for acoustic measurement jobs. Its anodized front panel is clearly engraved, and a new, high-brightness LED readout combined with a circularly polarized filter assures readability under even the most unfavorable lighting conditions.

A front panel jack provides a convenient output for the pink noise generator which, together with the built-in octave band filter set (or flat), may be used for making room or system equalization tests.

We won't reproduce Al's specification sheet but items of special interest are: Decay Time Selector-- 20 dB (x3), 30 dB (x2) for greatest accuracy; Filter Center Frequencies -- 125, 250, 500, 1000, 2000, 4000, 8000 Hz, ±10%.

Write Alan Feierstein, Alan Feierstein Co., 19 Mercer St., New York New York 10013.

SHURE LAVALIER SM-11



We are currently using the Shure SM-11 Lavalier microphone in classes and consider it an exellent unit.

The SM-11 is lightweight, a reliable dynamic and has a most useful belt clip connection, to a standard microphone cable from the very flexible lightweight cable attached to the microphone.

TOM THOMSON, Thomson Audio Services Co, Iron Mountain, MI (Chicago 1976) sent in the following newspaper clipping from the Chicago Tribune.

Choosing a butcher in '48

H. L. Mencken, one of the most acerbic critics of the American scene, covered his first national political convention in 1904. For those who have forgotten his mastery of the stinging phrase, here is a reminder, just in time for the opening of the 1976 Republican convention in Kansas City, Mo. This is Mencken's first report from the GOP convention of 1948 in Philadelphia, where Thomas E. Dewey was nominated to run against Harry S. Truman. It is from "Mencken's Last Campaign," edited by Joseph C. Goulden [The New Republic Book Co., Inc.].

PHILADELPHIA—The loudest bursts and blasts of sound ever heard on earth will greet the heirs of Lincoln when they assemble here on Monday to choose a David to butcher the pocket-size giant of Independence, Mo.

This, at all events, is what I gather from the uproar and hullabaloo on the part of engineers who have been swarming over the convention hall all day. They have rigged up a loudspeaker system that is to any loudspeaker system of the past as the range of the Himalayas is to a crabcake.

Turn up your radio to the highest point it will go, so that your walls shake, all the bottles fall off your cellar shelves, and your neighbors howl for the police. Well, the sound coming out of it will be only one eight-hundredth as loud as that the heirs are booked for.

The prayers of the chaplain, as magnified, will drown out a choir of lions, and the sweetest, coyest remark of the youngest and least hideous of stateswomen will match a series of boiler explosions.

No less than twenty loudspeakers are already hanging from the ceiling, hooked to an overhead rail system which permits them to be rushed from place to place as circumstances dictate, and on the platform are four supercolossal loudspeakers, each measuring a cubic yard, and all aimed at the hard chairs on which the delegates and alternates will sweat and suffer.

There is a branch of it which will afflict and macerate what is hoped will be an overflow meeting in the exhibition hall downstairs. There is another which will run into a banquet hall somewhere else in the huge building.

There is a third which may be turned upon any crowds or crowds that may be gathered outside.

KRAKATOA VOLCANO ERUPTION

The Krakatoa volcano eruption in the Netherland Indies on August 27, 1883 hurled about one *cubic mile* of rock into the air. It was directly detected over 3,000 miles away and indirectly by the massive air pollution it caused as well as the barometric pressure variation occasioned by the explosion itself.

CONTINUOUS SINE-WAVE WATTS

Hooray! Someone finally had the intestinal fortitude to do it. Years ago Klipsch suggested ASP in place of the misnomer RMS watts. Average Sine-wave Power is what *should* be meant when the term RMS watts is used.

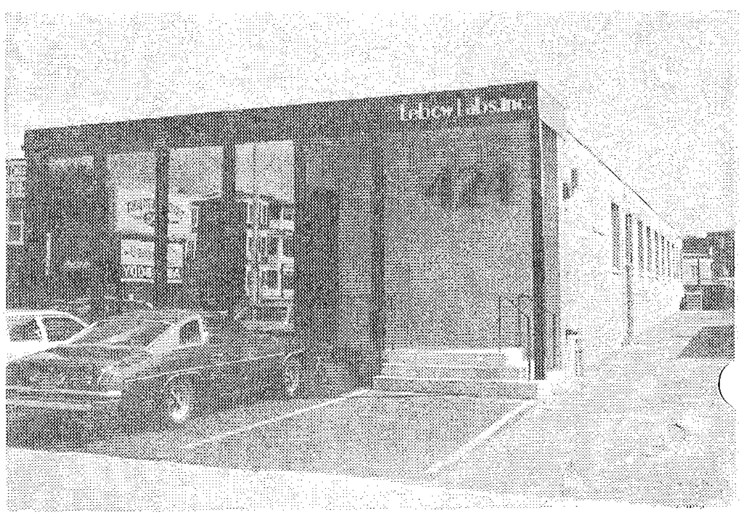
A recent Marantz ad calls their output power continuous sine-wave watts. Let's hope more manufacturers get bitten by the ASP watt.

LEBOW LABS

Fred Lebow, Lebow Labs (Boston class 1975) is one of the best supporters of Syn-Aud-Con, having had at least one of his men in each of our Boston classes (5 in 1975).

It was with delight that we visited his new extensive, expensive, and expansive headquarters.

There is depth in equipment availability backed up by many energetic, expert employees who are genuine professionals in audio.

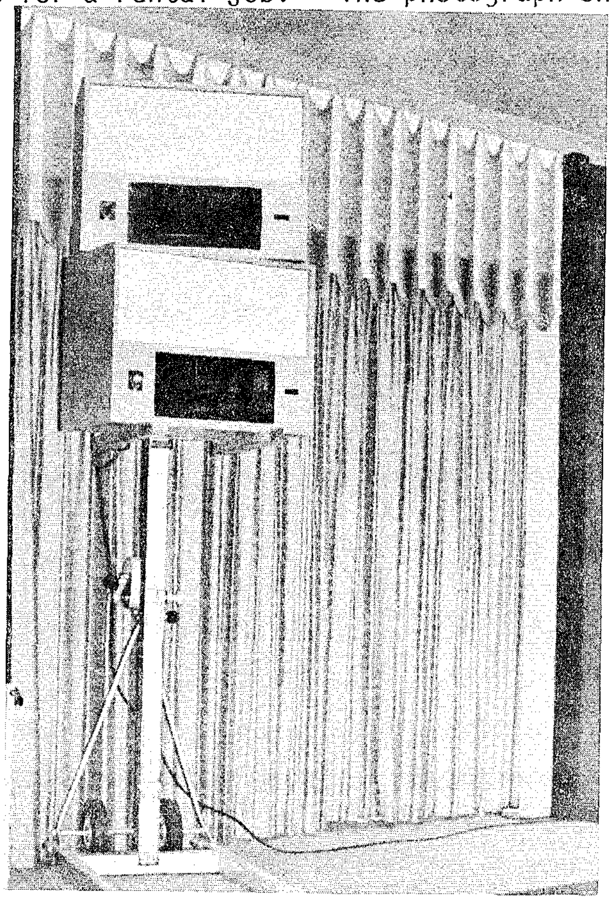


Reprinted from Vol 1, No. 4

VERMETTE LIFT

It is often necessary to make a demonstration in a space to show the prospective buyer that you can solve his problem. Equalization and time delay are sold much easier if you can demonstrate their effectiveness. If you don't have a hoist to enable you to make a quick and effective demonstration, you should consider purchasing one.

CARROLL ADAMS, Carroll Adams Enterprises, (Los Angeles 1973 and 1974) sent in the photograph which illustrates his use of the lift for a rental job: "The photograph shows 2 Altec 9844A speakers atop the high lift. You will note that they are neither stacked nor splayed. The reason was strictly cosmetic, in that the second speaker was only for redundancy. I feel this configuration would lead to a horrendous lobe problem with this speaker if you tried to operate both simultaneously." The bottom speaker adequately covered a ballroom which was 60'x90'x13', and the center of horn (bottom) was 7'6" off the ground.



The lift is a perfect tool to demonstrate a high Q array in a space where no previous array has worked and the owner is skeptical that any sound system can solve his problem.

With the Vermette Lift one man can elevate up to 500 lbs up to a height of 20 feet. It is sold through a nationwide system of authorized wholesale distributors. It costs approx. $300-$400, depending on the model.

Write Vermette Machine Co., Number 7 - 143rd Street, Hammond, Ind. 46230

SOUND TEMPLATE BY LOCKWOOD ENTERPRISES

Lockwood Enterprises makes a set of Sound Templates, selling for around $45, which many Syn-Aud-con graduates have purchased, so Mr. Lockwood tells us.

But many graduates feel that they don't need the entire set of templates and inquired about the cost of a single template. Lockwood now offers a single template with instruction manual for $9.95 including postage (cash with the order). Delivery is about 45 days.

Write for their literature if you are not familiar with their product: Lockwood Enterprises, P. O. Box 2729, Rochester, New York 14626

WHAT IS MEANT BY THE TERM "IN PHASE"?

Two signals are said to be "in phase" at a given point of observation whenever their *amplitude peaks* coincide exactly in time. The peaks *need not* be at the same frequency or the same amplitude but must reach their individual peak amplitude values at precisely the same time at the point of observation.

A NEW NOMA IDEA AND (N+1) SIMPLIFIED

MICHAEL TOLLERTON, electronic engineer at Northern Communications Area (Griffiss Air Force Base class 1974) sent in two most useful items.

The first is the equation

$$(n+1) = \frac{\text{Total \# of overhead speakers in system}}{\text{\# of speakers providing direct sound}}$$

The second one is an extremely creative one wherein Mike "used a voice operated relay as an input controller similar to the microphone controller by Shure (Voicegate).

"Each circuit may be cascaded with others, either like itself or the other two, which results in a controlling network that brings about a reduction of NOM to NOM = 1 at all times." (A deluxe priority system.)

More information can be obtained by writing Mike Tollerton, Electronic Engineer, EPEWI HQ NCA, Griffiss AFB, Rome, New York 13441

SOME INTERESTING REFERENCE VALUES

A new metric pressure value has been named the Pascal (Pa). One Pascal is approximately equal to 94 dB-SPL, or one Newton per square meter

$$20 \log \frac{1 \text{ Newton/m}^2}{0.00002 \text{ Newton/m}^2} = 93.98 \text{ db-SPL}$$

Older values of a similar nature are

$$1 \text{ microbar} \approx \frac{1}{1{,}000{,}000} \text{ of atmospheric pressure} \approx 74 \text{ dB-SPL} \approx 1 \text{ dyne/cm}^2;$$

therefore, 1 Pascal ≈ 10 dynes.

You may also find these figures of interest:

Atmospheric pressure fully modulated ≈ 194 dB-SPL

1 lb/ft^2 = 127.6 dB-SPL

1 lb/in^2 = 170.8 dB-SPL

50 lbs. of TNT measured at 10' = 200 dB-SPL

12" cannon, 12' in front of and below muzzle = 220+ dB-SPL

CONVERTING THE BEL INTO THE DECIBEL

Definition: 1 dB is 1/10th Bel

$$\log_{10}10 = 1 \text{ Bel}$$

$$\frac{1 \text{ Bel}}{10} = \frac{\log_{10}10}{10} = \frac{1}{10}\text{Bel} = 1 \text{ dB}$$

Therefore: $X \log_{10} 10^{1/10} = 1$ dB

Thus: $10\log_{10}10^{1/10} = 1$ dB

$$10^{(\log_{10}10)} = 10^1 = \text{power ratio}$$

$$10^{\left(\frac{\log_{10}10}{10}\right)} = 10^{1/10} = \sqrt[10]{10} = 1.25893\ldots$$

$$X = \frac{1 \text{ dB}}{\log_{10}10^{1/10}} = 10$$

EXAMINING HOUSE AND FILTER CURVES

In Syn-Aud-Con classes we often illustrate how the raw house curve can be compared to the inverse of the filters' electrical response curve.

The inverse of the electrical response of the filters is the filter's frequency response curve turned upside down and looked at through the rear of the plotting paper. It should then match the raw house curve. Figure # 1 shows a before and after equalization, and the inverse of the filter response curve. Note that the finished response had two diaphragmatic absorption notches (which have to be corrected in the room, not with the equalizer). Because the person tuning the system undersood how to proceed, his filter's inverse response matches the raw house curve. The anechoic chamber response of this loudspeaker proves that the "notches" observed are in the room domain.

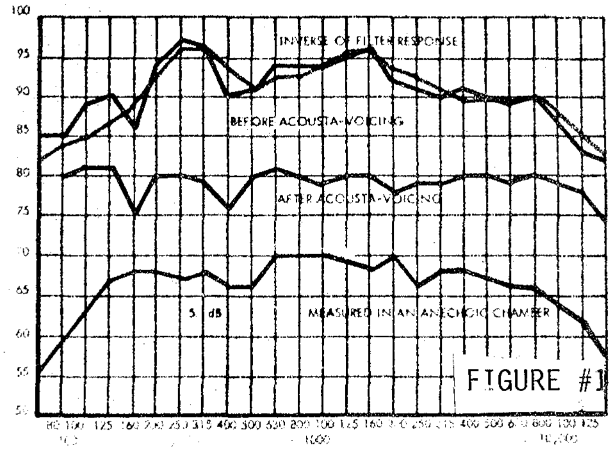


FIGURE #1

PLAYBACK CURVES IN A RECORDING STUDIO

Our Figure #2 shows what happens when the filters have been used to correct problems that are not in the filters' domain. The departure from agreement between the filter response and the house curve response at 250 Hz was due to a *mechanical coupling* of the stage platform to the microphone stand, causing persistent feedback. In this case a deep notch was put into the filter set's response. The correct answer lies in the sound system's domain and he should have shock mounted the microphone on the microphone stand to de-couple it from the mechanical vibration.

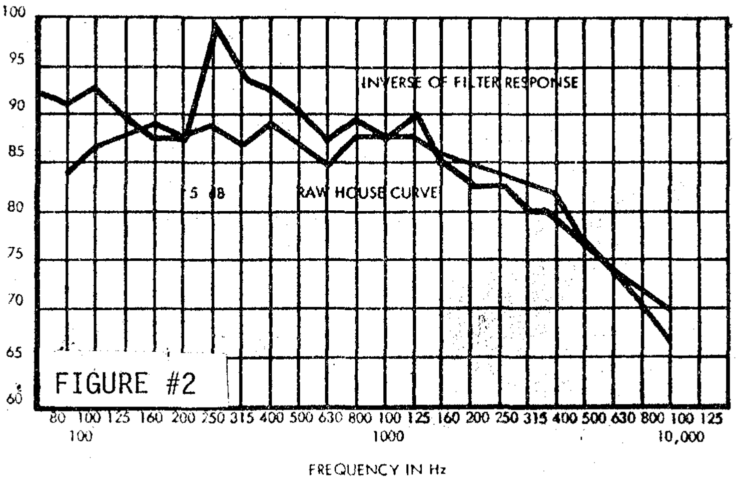


FIGURE #2

The departure from agreement in the two curves at 1250 Hz is the "proximity mode" of the microphone as it has its sound field upset by the presence of a large object. In this case, the dip of approximately 2 dB (seen here, of course, as a 2 dB peak) in the filter set is a correct solution. On some occasions a really deep notch may be present indicating that the proximity correction was overdone.

Running an electrical response curve of the equalizer and carefully comparing it to the raw house curve quickly identifies those areas where the equalizer has been inadvertently applied incorrectly to some problem not in the domain of the equalizer.

PERFORMER MONITOR SYSTEMS

Increasingly today we hear of performer monitor systems being used not only in the entertainment part of audio systems but in church sound systems, lecture systems, etc.

One interesting variation is the additional monitor that feeds back to the performer the acoustic response of his audience. Care must be taken to locate the microphone picking up the audience's acoustic response close enough so as not to introduce a disturbing time delay (might be a legitimate use for a highly directional microphone).

Syn-Aud-Con is interested in hearing of your experiences with such monitors.

MULTIPLYING FACTORS

Multiplying factors correct power for ac waveforms

by William D. Kraengel, Jr.
Valley Stream, N.Y.

The growing use of waveform generators, voltage-controlled oscillators, and multivibrators as signal sources means that engineers often have to measure currents and voltages in the form of rectangular, triangular, or sawtooth waves or pulse trains. (Conversion factors for voltmeter measurements on such waveforms were tabulated in *Electronics*, Aug. 30, 1973, p. 104.) The average power that one of these waveforms dissipates in a resistor (R) over an integral number of cycles is given by the root-mean-square voltage across the resistor (V_{rms}), the rms current through the resistor (I_{rms}), or both:

$$P = V_{rms}I_{rms} = V_{rms}^2/R = I_{rms}^2R$$

If measurements are made with meters that give true rms readings, the correct value for power can be calculated from the equations given above. But if the response of the ammeter or voltmeter is not truly rms, power values must be calculated from equations that contain a factor to correct for the meter response:

$$P = (V_mI_m) \times M = (V_m^2/R) \times M = (I_m^2R) \times M$$

In these equations, V_m and I_m are voltage and current values shown by the meters, and M is a multiplier that provides the correct value for power. Thus M is a combination of the conversion factor for meter response and the form factor for the waveform. Multiplier M is dimensionless.

The accompanying table shows values of M for various waveforms and various meters. For example, if a sawtooth voltage across a resistor is measured with a meter that responds to average voltage and is calibrated to rms for sine waves, then the power dissipated in the resistor is given by

$$P = (V_m^2/R) \times (32/3\pi^2)$$

For meters with a true rms response, M is always 1, so no column for true rms is included in the table.

If power is found from readings of both current and voltage meters, and the two meters have different responses, the power must be calculated from

$$P = V_mI_m(M_VM_I)^{1/2}$$

where M_V is the multiplier in the table that corresponds to the voltmeter response, and M_I is the multiplier that corresponds to the ammeter used in the measurement.

The accuracy of some of these correction factors depends on how nearly the actual waveform approaches the ideal. Also, most ac meters do not give accurate readings for frequencies below 10 or 20 hertz, and they do not give any indication for dc. Thus the full-wave-rectified square wave may produce zero readings, depending upon the meter used. □

MULTIPLIER (M) FOR POWER CALCULATION

Waveform	Ammeter or voltmeter response (see below) I	II	III	IV	V
Sine	1	1	$\pi^2/8$	1/2	1/8
Full-wave rectified sine	1	1	$\pi^2/8$	1/2	1/2
Half-wave rectified sine	2	1/2	$\pi^2/4$	1/4	1/4
Sine pulse	T/t	t/T	$\pi^2T/8t$	t/2T	t/2T
Segmental sine	4E/C	E	$\pi^2E/2C$	E/2	E/8
Full-wave rectified segmental sine	4E/C	E	$\pi^2E/2C$	E/2	E/2
Half-wave rectified segmental sine	8E/C	E/2	π^2E/C	E/4	E/4
Sine squared	$12T/\pi^2t$	3t/4T	3T/2t	3t/8T	3t/8T
Fractional sine pulse	$4B/\pi A$	B/π	$\pi B/2A$	$B/2\pi$	$B/2\pi$
Triangle or sawtooth	$32/3\pi^2$	2/3	4/3	1/3	1/12
Full-wave rectified triangle or sawtooth	$32/3\pi^2$	2/3	4/3	1/3	1/3
Half-wave rectified triangle or sawtooth	$64/3\pi^2$	1/3	8/3	1/6	1/6
Triangle or sawtooth pulse	$32T/3\pi^2t$	2t/3T	4T/3t	t/3T	t/3T
Square	$8/\pi^2$	2	1	1	1/4
Dc and full-wave rectified square	$8/\pi^2$	2	1	1	1
Half-wave rectified square	$16/\pi^2$	1	2	1/2	1/2
Rectangular pulse	$8T/\pi^2t$	2t/T	T/t	t/T	t/T
Exponential pulse (critically damped)	$2T/\pi^2e^2t$	$e^2t/2T$	$T/4e^2t$	$e^2t/4T$	$e^2t/4T$

$A = [(\sin\alpha - \alpha\cos\alpha)/(1-\cos\alpha)]^2$
$B = [2\alpha + \alpha\cos 2\alpha - (3/2)\sin\alpha]/(1-\cos\alpha)^2$
} $\alpha \equiv \pi t/T$ radians

$C = (1-\cos\theta)^2$
$E = (\pi\theta/180) - (\sin 2\theta/2)$
} θ = Conduction angle (degrees)

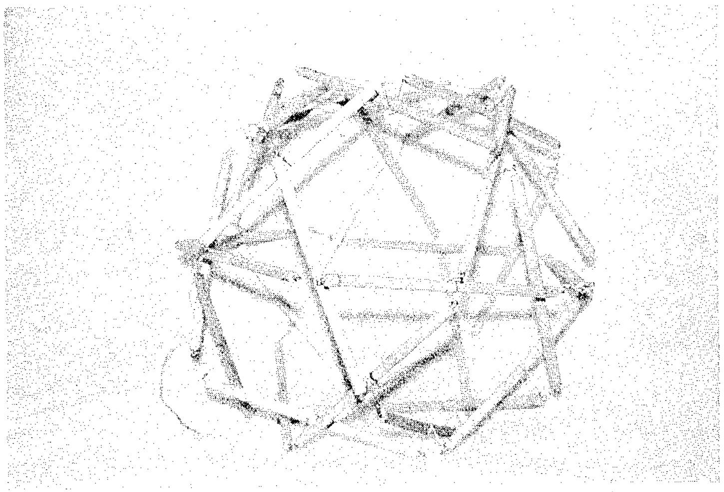
$e = 2.71828\ldots$ $\pi = 3.14159\ldots$

Ammeter or voltmeter response

I = Average-responding, calibrated rms for sines
II = Peak-responding, calibrated rms for sines
III = True average
IV = True peak
V = Peak-to-peak

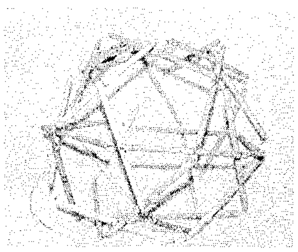
TENSEGRITY SPHERE

In the Chicago class several people understood me to say that the plans for building the Tensegrity Sphere that we have in each class was in one of the Newsletters and asked where to find it. Since there was so much interest, we are reproducing the plans from *Bucky, A Guided Tour of Buckminister Fuller* by Hugh Kenner.



APPENDIX II

Model Making



Tensegrity Icosa

You need some ¼″ dowel, a dozen little picture-framers' screw eyes, wire no finer than #28. Cut six sticks, each 9″ long; put a screw eye at each end. Cut twenty-four pieces of wire, each 10″ long. With a pencil, number the two ends of the first stick, 1 and 2, the next 3 and 4, and so on on up to 11 and 12.

When you wire it up, each wire runs 5⅞″, screw eye to screw eye. Cut a strip of cardboard this length to measure with. Connect as follows, referring to your penciled numbers. When you finish, there will be *four* wires at every screw eye.

1 to 11, 1 to 12; 3 to 11, 3 to 12. Let sticks 1–2 and 3–4 lie parallel, with stick 11–12 sandwiched crosswise between them.

2 to 9, 2 to 10; 4 to 9, 4 to 10. Stick 9–10 also lies crosswise between stick 1–2 and stick 3–4.

5 to 1, 5 to 2, 5 to 11, 5 to 9.

6 to 3, 6 to 4, 6 to 11, 6 to 9.

7 to 1, 7 to 2, 7 to 10, 7 to 12.

8 to 3, 8 to 4, 8 to 10, 8 to 12.

Now go around it and tighten wires as much as you can. When you're satisfied, twist all joints securely.

Tensegrity Sphere

Materials as for Tensegrity Icosa, but more of everything. You cut thirty sticks, each 9″ long, and put a screw eye at each end.

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322 | APPENDIX II: MODEL MAKING

Cut thirty wires, each 5″ long. Have five crayons ready, for color-coding as you go.

Drill a small hole straight through the midpoint of each stick, pass a wire through the hole, loop around and pass it through again, leave equal lengths hanging.

When you join two sticks, you always use the wire that passes through the center of a third. Call the crosswise stick in the middle of a joint the dangler. Length of wire, dangler to screw eye, should be about 1¼″. Twist surplus to fasten.

Make a pentagon— five sticks, five danglers—and hang it from a shower-curtain rod with its top stick horizontal. Put a green mark on each of the five sticks of this pentagon.

The wire that passes through the top stick of the green pentagon now gets a stick at each end. Connect a dangler to each of these sticks, to each dangler another stick, to each stick another dangler. The free ends of the wires from these danglers are now joined to the dangler at the bottom of the green pentagon. You now have two intersecting pentagons. Code the five sticks of the new one red.

The dangler to the right of the top stick on the green pentagon goes to the middle of a top stick on the red pentagon. Code it blue, and work around, completing a blue pentagon. You'll introduce three new sticks and incorporate another dangler near the bottom. This dangler is in the red pentagon, and goes to the middle of a stick on the green pentagon.

You should see the symmetry by now, and it's easier to be guided by that than by instructions. Just keep color-coding the pentagonal rings and refer to the pictures in the text. Each pentagonal ring runs straight around the system; if it changes direction suddenly you've made a mistake. When you're nearly done, the system will suddenly pull out into a spherical shape. When you're finished, go around the sphere tightening wires till every stick is very slightly bowed and the system is springy but firm.

NO COMMENT

From ELECTRONICS, March 4, 1976: A Penny-wise Guide to IC Design. At less than 3 cents a design, the best IC design aid may be a new little book called "*101 Analog IC Designs*", by the staff of Interdesign Inc., Sunnyvale, CA, an IC house headed by Hans R. Camenzind. The $3 book gives circuit diagrams for amplifiers, oscillators, phase-locked loops, timers, voltage regulators, comparators, and so on. It's aimed primarily at potential users of Interdesign's Monochip ICs, but would be useful to anyone considering setting up a small custom-IC development program.

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From THE NEWS AMERICAN (Baltimore): When Edison Was Wrong. It is a little-remembered fact that electricity was widely assailed as an evil genie by the fearful when it was first introduced as a source of household lighting in the early 1880s. Critics charged that this mysterious and invisible "fluid" carried in copper wires would burn the cities down. Some insurance companies refused to supply fire insurance for any home wired for the outrageous stuff.

Equally bitter was the controversy toward the end of the 1880s when the fledgling electric utility industry sought, for economy reasons, to replace low voltage direct current with the higher voltage alternating current that is universally used and taken for granted today. What is really remarkable is that the inventive giant Thomas Alva Edison threw his great reputation into the fight to ban commercial use of alternating current.... Writing in the November 1889 issue of The North American Review he charged that alternating current was unreliable as well as dangerous and said, "There is no plea which will justify the use of high alternating currents, either in a scientific or commerical sense....(such) systems should be prohibited."

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From STUDIO MAGAZINE, March 1976: Letter to the Editor from Dr. James Crabbe, University of Manchester: "I was most interested in the article by Michael Gerzon... on Dummy Head Recording. The article dealt with three important criteria in dummy head recording (and thus in the way we hear direction) ie microphone spacing, the acoustic shadow of the head, and the influence of the pinnae...I would like to draw attention to a paper by Brown in the Journal of the Proceedings of the Physiological Society, 1910. In this paper, Brown hoped to demonstrate an analogy between three-dimensional perception of sound. He placed one end of a stethoscope on a watch, while the ear-pieces were placed in the auditory meata of the subject's ears. Thus the sound by-passed the pinnae and was transmitted to the inner ear via the auditory meatus. The sound of the watch was heard outside the subject's head, central, and to the front. Closing off one of the flexible tubes to either ear transferred the sound directly to the other ear (ie not in front), while a gradual closing off of the tubes could make the watch move from a central position outside the head, to either ear in the plane of the ear.

"This simple experiment can easily be repeated, and gives the results indicated by Brown, our sense of hearing being unlikely to change over the past 60 years! Thus, the precise role of the pinnae in providing horizontal direction location may not be so marked as previously thought. Where they may be more effective is in the location of sounds in a vertical plane, ie about or below the plane of the head. This is borne out 1) by the fact that the sound via the stethoscope appears in the same horizontal plane as that of the ears, irrespective of the watch position relative to the listener's head, and 2) from Figs 5a and 5b of Gerzon's article showing the relative time delays in the horizontal and vertical planes."

REVIEW OF "SOUND SYSTEM ENGINEERING"

Authors always await book reviews with a certain degree of apprehension. Will the book fall into the hands of a reviewer who is equipped to understand it? Will the reviewer have the practical experience that matches the authors'? All kinds of worries can abound when authors present their book to the public.

On these two pages are examples of reviews dreamed of by authors. The reviewers, both world renowned acoustical consultants, are senior to the authors in both practical experience and in expertise in their chosen fields. Both reviewers have, over the years, provided much appreciated guidance to the authors' own technical growth. It's with a genuine sense of pleasure that we reprint these two reviews of *SOUND SYSTEM ENGINEERING*.

SOUND SYSTEM ENGINEERING, *Don and Carolyn Davis,* Howard W. Sams & Co., Inc., and the Bobbs-Merrill Co., Inc., Indianapolis, 295 pages. Price: $19.95.

This book fills a long-felt need for a text on electronic sound-reinforcement systems and is, in the reviewer's opinion, the very best book on this subject. Don and Carolyn Davis have been known for some years by the excellent seminars held by their firm, Synergetic Audio Concepts. Through these seminars, and through Don's previous work on preparing "clinics" for Altec, they have been leaders in an ongoing revolution that has brought a high degree of professionalism into a field formerly dominated by mere salesmanship. We may even say that a majority of the better engineers working for sound system contractors today owe at least part of their education to this team.

The book largely grew out of a need for a text for the Syn-Aud-Con seminars, but it can be read, studied and reread with profit, independently of the seminars, by anyone interested in the field of sound reinforcement. It covers a wide variety of subjects, from basic sound-system planning to details of installations. Mathematics is used wherever appropriate, but is never too complex for anyone capable of operating a pocket engineering or scientific calculator, or even a good engineering slide rule. In developing formulae, the authors must occasionally simplify, but they are usually careful to indicate the underlying assumptions, and these can help in indicating areas where the formulae are not applicable or where they must be modified, if not always *how* they must be modified.

There are a few areas where this reviewer disagrees, at least in part, with the authors. Their view of the entire narrow-band equalization concept may be summed up in their statement on Page 141 that, "It has not been demonstrated that it is possible to either: (1) Raise the acoustic gain by using filters narrower than 1/10 octave; or (2) Improve the articulation-loss-for consonants percentage by using filters narrower than 1/10 octave." However, the reviewer has had experience with *one* church where use of a few very-narrow-band filters was necessary to get adequate gain, and the reviewer suspects there may be a few occasions where articulation-for-loss-for-consonants can be reduced also. These are believed to be confined to examples where the microphone (and loudspeaker) arrangements remain fixed and the acoustical environment does not change to any measurable degree. The reviewer would agree with the authors' two statements for the *majority* of sound system installations. The reviewer's few other disagreements are of a similar nature; even when the Davises are not absolutely correct for 100% of all situations, they are correct for a good 95%!

Large Step Upward

The reviewer continues to be delighted with the encyclopedic nature of the book, with the amount of data presented, and by its overall practical usefulness in the day-to-day work of designing sound systems. Some of the material was available to some consultants and contractors from a variety of sources; the convenience of having all this material between two hard covers, along with much new material, and with all the material available to anybody, represents a large step upward in the professionalism to be expected in the sound system field.

Although most of the material in *Sound System Engineering* is applicable to systems employed in reinforcement of live sound, the designers of background music, paging, sound-effects, disco and motion-picture playback systems will also find much of value. The entire field of masking noise systems, particularly useful for open-plan offices, is compressed into a few pages with the important facts and practices presented very well.

However, don't for a moment think that by buying this book you have forever solved the question of where to find all information on the field of sound reinforcement. The authors are very happy to exchange views with graduates of their symposia and with any sound system professional. They, like all of us, are constantly learning, and they can be expected to produce revised and expanded editions of the book. Meanwhile, I suggest that you use the existing book for its excellences, and peruse the extensive bibliography for papers and books that can further your education in this field.

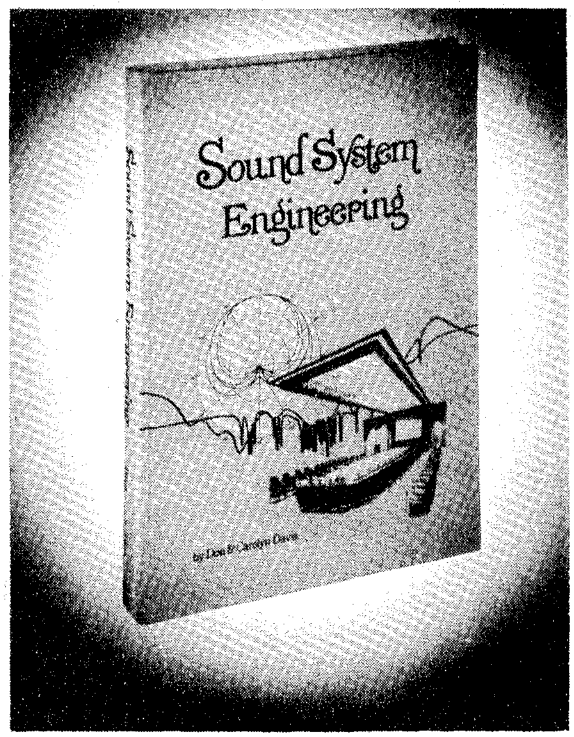
DAVID L. KLEPPER
Klepper Marshall King Associates, Ltd.
White Plains, New York

JOURNAL OF THE AUDIO ENGINEERING SOCIETY
JULY/AUGUST 1976, VOLUME 24, NUMBER 6

BOOK REVIEWS

Sound System Engineering

Don and Carolyn Davis
Howard W. Sams (Bobbs-Merrill), New York, 1975
295 pp. Price $19.95.



This publication is the compilation of an enormous amount of information in the field of entire audio systems. It integrates all available useful data in a form which is accurate, concise, and complete. The authors' direct experience in sound system design and field measurements extend over a period of more than 20 years. This period represents the transition from cut and try methods to the scientific approach to design and evaluation of sound reproducing systems before they are constructed. In this period, instrumentation such as real-time analyzers, narrow-band filters, noise generation, and level recorders were available not only to well-financed research laboratories, but to professional sound engineers who must provide a performance specification and document the final result.

Many types of audio systems are described and excellent illustrations of the completed installation are shown. They include home music systems, indoor and outdoor systems having an installed amplifier capacity of 30 000 W. The contents include the decibel notation system, loudspeaker directivity and coverage, the acoustic environment, design for acoustic gain, interfacing the electrical and acoustical system, installing the sound system, equalizing the sound system, instrumentation, and sample design applications.

It has been only in the last ten years that important advances in performance has been achieved and this has been accomplished by the interfacing of the electrical and acoustical systems. Equalizing the sound system has in many cases changed a marginal or unsatisfactory sound reinforcement system to an entirely adequate system so that the entire audience is in a satisfactory signal to noise ratio.

The authors present a comparison of response for a set of very narrow band filters and a set of critical band width combining filters. They make the point that any slope rate greater than 18 dB per octave is to be avoided except in very special cases. This slope rate has been well documented beginning with early motion picture sound recording and reproduction systems.

The authors probably have more combined experience on sound system equalization than anyone else. The information in the chapter "*Q* or Directivity of Loudspeakers" is the most complete that the reviewer is aware of. The book combines all of the essential information needed to create sound reinforcement systems of high performance and it should be in the reference files of everyone in the sound system engineering field. Congratulations to the authors for their excellent coverage of the subject.

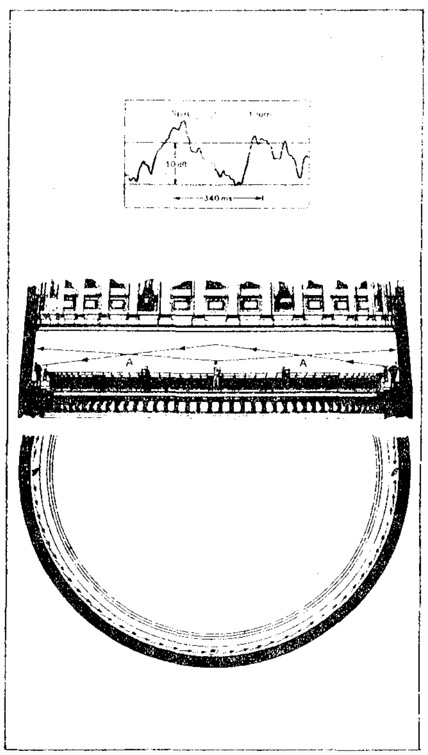
JOHN K. HILLIARD
Bio-Acoustical Engineering Company
Tustin, California 92680

J. Acoust. Soc. Am., Vol. 60, No. 3, September 1976

OF INTEREST

ARCHITECTURAL ACOUSTICS by Vern Knudsen. Whispering Galleries: A phenomenon closely associated with the reflections from curved surfaces is the tendency for sound, especially high-pitched sound, to travel or "creep" around a large concave surface. This phenomenon has become famous in connection with St. Paul's Cathedral in London, and can be observed in many other concave structures. A whisper directed along such a concave surface may be heard distinctly at least 200 feet away. The new shell for the Hollywood Bowl, which is made up of one half of a truncated right circular cone, has a series of large triangular grooves which extend along the entire semicircular span of the shell. Two persons standing at the opposite end of one of these grooves, although 90 feet apart (measured across the stage), can carry on a whispered conversation even when there is loud conversation on other parts of the stage. Rayleigh, referring to St. Paul's whispering gallery, states that the "whisper seems to creep around the gallery horizontally, not necessarily along the shorter arc, but rather along that arc toward which the whisperer faces." He ascribes this to the "very unequal audibility of a whisper in front of and behind the speaker," a phenomenon which is well known and which results from the marked directional effect of the high frequency vibrations which comprise whispered speech. Rayleigh's explanation of this phenomenon predicts, and Raman and Sutherland's experiments in St. Paul's show, that the whispered sound, for the most part, is concentrated in a narrow band skirting the circular base of the dome, and that the thickness of this band decreases with diminishing wave length. (End of quote)

On the same subject, *Sound and Vibration,* June 1975, wrote about the "Whispering Gallery." Quoting from the article, "In this dome, probably by pure chance, the famous "Whispering Gallery" was constructed. It consists of a very smooth wall leaning inwards 7° that is completely circular. By facing the lower part of this wall, one can communicate with another person standing with his ear to the wall on the opposite side 35 meters away by simply whispering. Some believe that it is reflections from the dome that explain this peculiar phenomenon, but a simple geometric examination excludes this possibility.



Sound pressure level time history showing the fading sound of a hand clap after it has traveled once around the "Whispering Gallery" of St Pauls Cathedral in London.

Lord J. W. S. Rayleigh, one of England's most famous physicists from the turn of the century, described the phenomenon as early as 1878 in his classic "Theory of Sound." His idea was that sound was transmitted along the surface of the gallery wall. Lord Rayleigh admits, however, that an explanation is difficult to give. But in 1910, he gave the exact mathematical explanation of how sound of relatively high pitch can cling to a concave surface with very little attenuation when the surface's degree of acoustic absorption is insignificant and the surface itself completely smooth.

It is amazing that Lord Rayleigh at that time, without measuring instruments, was able to achieve such a result, purely by applying common sense and being a master in handling mathematics.

A trip to the "Whispering Gallery" leaves a deep impression on the visitor, for a whisper can indeed be very clearly heard across this great distance, even above the considerable noise of the enormous room and its dome.

***

We point out in most classes that an auditorium is "a place to hear". Sam Adams of the Sound Branch at Ft. Benning, Ga. says that most auditoriums are actually Visitoriums. And he defines Visitorium as "a place to see".

OF INTEREST

One can never learn less from conducting an experiment -- always more.

***

Sound & Communications, June 1976, reprinted with permission. (Algie Broome, Vice President and Co-Owner, Sound and Communications, Jackson, Miss. addressing a group at NEWCOM, New Orleans). Bear in mind, gentlemen, that I speak from a very local base. I know, and I will tell you what I know exists in my trading area.

I know, for instance, that we would never have been successful if we did not ask ourselves the questions our prospects asks us: How much service do I get for my money? What'll it do, and what'll it cost? What benefits do I get? and, for how long will I get them? Hence, we engage in a deliberate "sell smart" technique, abandoning the soft sell, and totally eliminating the hard sell. We do not oversell because we make it a point to understand that the man we are talking to is as good a professional in his field, as we are in ours. Thus, we are equals. We tell him we can perform in any manner he suggests, we will deliver what he says he wants. But, what he wants may not always be the answer to his needs. If he will allow us to look around, we may come up with a better answer to his problem than he has devised.

More, we are going to provide him with a continuity of service in all departments at a cost efficient figure that will please him. And he is offered a choice of purchase or rental; and in some cases where we are renting a system, he can rent an operator also. We also tell him that a sound system has to perform two functions concomitantly/equally:
- -- the information coming out of the speaker must be highly intelligible.
- -- the system must have a utilitarianism equal to the most efficient piece of machinery in his shop.

Our sales approach is merely a reflection of our technical approach to the sound system/ communications systems business: to stay alive and prosper we have to have the latest technical information from our supplying manufacturers on products, designs, applications and financial terms on purchases and credits.

***

UPI. Drinking Linked to Hearing Loss. When a person sits down at a nightclub the amount he drinks may pose as large a threat to his hearing as the decibel level of the music he enjoys.

Dr. Martin Robinetter, associate professor of audiology at the University of Utah, says the natural mechanism which protects the inner ear from loud noise loses its efficiency as the body's alcohol content increases.

***

Concert News, August 6, 1976. An incredible sound system suspended from the ceiling of the elongated hexigon hall (Omni, Atlanta) provided clean reception. Elton is noted for spending nearly half of what he makes on his sound equipment. Even 17,000 voices singing along to "Saturday Night" could not drown out the music.

***

The very, very bright young engineer from Electro-Voice, Don Keele, is now chief engineer at KLIPSCH & ASSOCIATES!! Anyone with an interest in loudspeaker design is watching to see what will come from a pot stirred by Don Keele and Paul Klipsch.

***

The Christian Science Monitor. 'Put in an acoustical ceiling to cut down noise,' a federal job safety agency ordered a Virginia poultry processor. He did. 'Take out that ceiling it's a sanitation hazard,' said Agriculture Department inspectors. He did. 'No ceiling? then make your workers wear earmuffs, or you'll be fined,' said the job-safety people. He did.

BOOKS OF INTEREST

PAUL W. KLIPSCH, Klipsch and Associates, Hope, Arkansas, offers a unique opportunity to the collector of basic papers in the audio engineering field.

For $7.00, Mr. Klipsch sells a three-ring binder containing 22 papers by Mr. Klipsch (many of timeless interest) plus the reprint of Bell Telephone Laboratories' *Symposium on Auditory Perspective* and W. B. Snow's *Basic Principles of Stereophonic Sound.* (These two last may be ordered separately for $2.00 each). We believe that the entire package at $7.00 represents a fantastic bargainin today's overpriced world of mediocre work. As Paul Klipsch is fond of pointing out, fundamentals don't change. Write Paul W. Klipsch, Klipsch and Associates, P O Box 688, Hope, Arkansas 71801.

ARTICLES OF INTEREST

Gerald Stanley, Chief Engineer at Crown International, called my attention to an article that is easily the most exciting paper that I have read in recent years on the subject of hearing: "*Models of Hearing*" by Manfred R. Schroeder, an invited paper in the Proceedings of the IEEE., Vol 63, No. 9, September 1975.

This paper abounds with powerful ideas and I will quote a few to give you the feeling for the level at which the author proceeds:

A Kind of Super Stereo

....Because we have only two ears (and since head motion is not crucial in localization), two loudspeakers should suffice to evoke all the proper perceptions of acoustic space -- provided the sound waves radiated from the two loudspeakers are tailored in such a way as to produce, at the listener's eardrums, pressure waves indistinguishable from those that the ears whould have received in a free sound field set up by the desired sources (including sources to the rear, overhead, and to the extreme sides.)...

Suppose two loudspeakers are placed in front of a listener, one, say 30^{o} to the right and the other 30^{o} to the left....If there was no crosstalk" from the loudspeakers to the "far" ears the task of providing each eardrum with a specified sound signal would be simple.

However, regretably for our purposes, there is crosstalk to the "other side" ear due to sound diffraction around the human head. This crosstalk must be cancelled.

This can be accomplished by the other loudspeaker radiating an appropriately filtered crosstalk compensation signal. (A detailed discussion of such a filtering system to depth of several crosstalk paths is then discussed.)

The practical experience with the filtering scheme illustrated...has been nothing less than amazing. Although the two loudspeakers are the only sound sources, virtual sound images can be created far off to the sides and even behind the listener. In fact, even the elevation angle of a sound source is properly perceived (by people with proper head shapes).....

With this new reproduction method, instantaneous comparisons of identical program material has become possible. The author will never forget the moment he first switched himself from a seat in the Berlin Philharmonic to one in the Vienna Musikvereinssaal listening to a British Orchestra playing Mozart's Jupiter Symphony. All he believed about the differences of the two halls based on two separate visits (but was not too sure about) suddenly became a matter of easy distinction."

As we have been saying in Syn-Aud-Con classes for the past four years, "they haven't learned how to use two channels yet" has turned out to be devastatingly true.

EVALUATING OPEN-PLAN ACOUSTICS by HERB CHAUDIERE (Seattle class 1974) in the July-August AES JOURNAL Vol 24, No. 6, pages 461-464 contains many practical observations by an experienced Syn-Aud-Con graduate who has had the opportunity to plan, measure, and adjust a significant number of Noise Masking systems. Much useful interpretation of the PBS C1 and C2 documents into English is included.

ARTICLES OF INTEREST

Avery Fisher is getting a lot of publicity right now concerning the 8-10 million dollars that he has contributed for the complete remodeling of Avery Fisher Hall alias Philharmonic Hall in New York. And there are a few words about Leo Beranek's role in the original Philharmonic Hall. The October issue of HIGH FIDELITY has a good article, *"Back to Square One for Avery Fisher Hall"* by Hans Fantel.

The High Fidelity article makes interesting reading in conjunction with an article in the Rolling Stone, September 23, 1976. In High Fidelity, the architect is quoted as saying that Leo Beranek was informed of every change in plans by sending a copy of the changes to his office while Leo Beranek remembers that he first became aware that the building being constructed was not the same one for which he had done his acoustical design when he saw the foundation being poured.

The Rolling Stone article says that Avery Fisher spends one or two days each week IN the architects' office and much time on-site. No communication by memo here.

An interesting quote from the Rolling Stone article about Avery Fisher's early success, *"Back in the Fifties, seeing the burgeoning of our quality instrument business, RCA came out with a line called the Berkshire, with prices ranging from $2500 to $4000. Bell and Howell also came out with high-quality radio/phonographs. And they all failed.*

I knew most of these people on an industry basis and they wanted to know why they failed. I told them, very frankly, 'You went out for the bottom line and we went out for top quality, and the bottom line somehow took care of itself.'

CLASSIFIED

WANTED: A good audio frequency oscilloscope. Tektronix or HP quality necessary, such as Tek 503, 504, HP 130C, etc. Charles Townsend, Division of Communications, 651 Larson Bldg., Tallahassee, FL 32304.

WANTED: Real Time Analyzer. Bruce Thayer, WMT Music & Sound, P O Box 2147, Cedar Rapids, Iowa 52406. 319-393-8200 ex. 252.

POSITION WANTED: Present job: Audio engineer, Crew Chief, and Stage Manager. Present activity: sound system design, placement and operation, equipment purchasing, maintanence and repair. Three years experience. Willing to take job anywere in U.S. Stephen M. Scully, 410 N. Main Ave, Scranton, PA 18504. (717) 961-0987. (Chicago class 1976)

FOR SALE: Communications Company ARA 112 and trade/buy either an HP 8050A or 8056. Steve James, Nevada Audio Visual Services, Inc., 3062 Sheridan St., Las Vegas, Nevada 89102. (702) 876-6272.

FOR SALE: Tektronics Tech 31. 2,000+ steps, 256 registers, tapes, thermal printer. Software provided. Almost new. $2,000. Ralph Gibson, Gibson Assoc., Town Hill Rd., New Hartford, Conn. 06057. (203)379-2754.