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THE SOUND ENGINEERING MAGAZINE

AUGUST 1969 75c

Dolby Revisited

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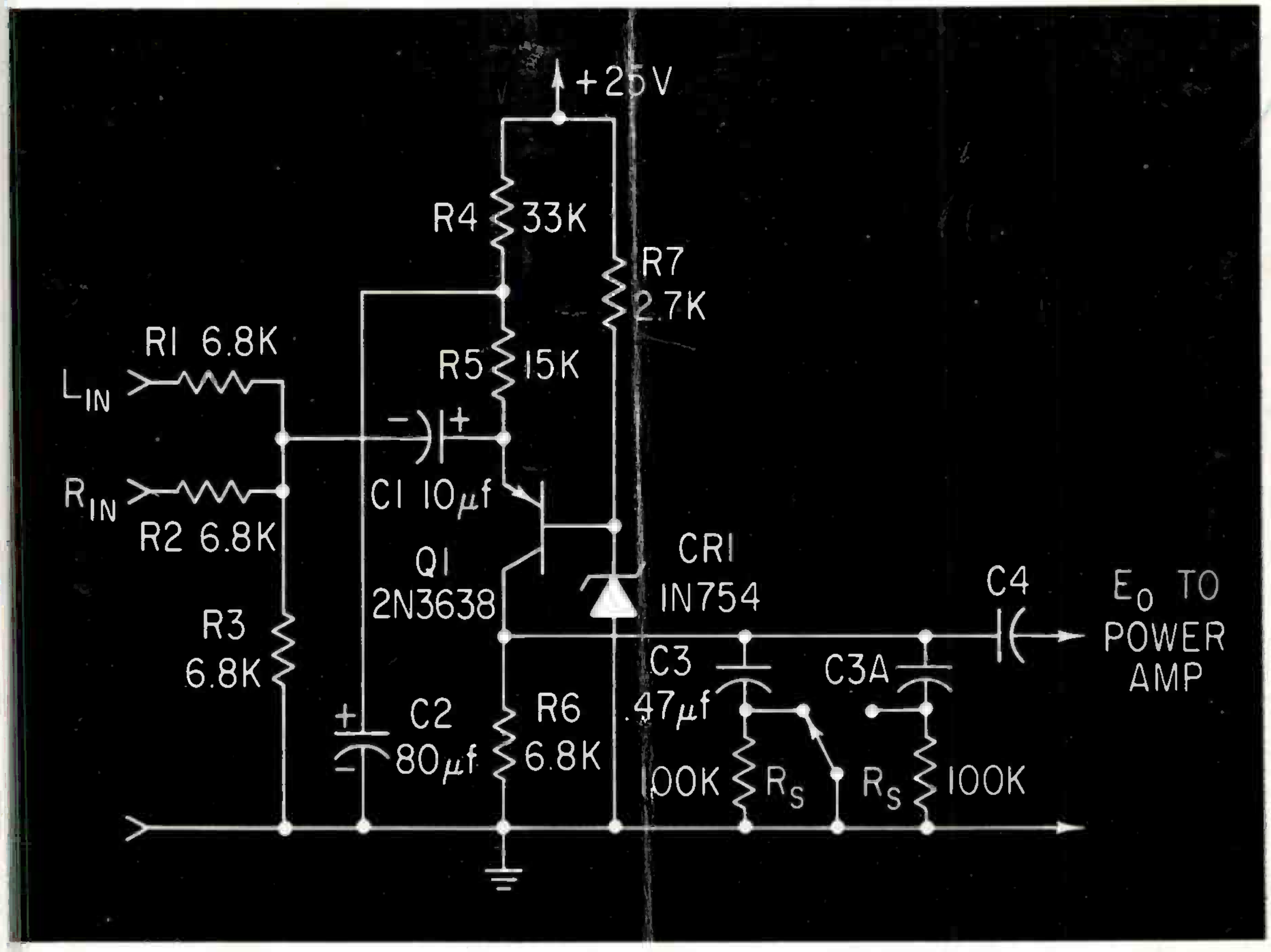

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Coming Next Month

●Sound Reinforcement and public address will be the subject matter for all of our feature articles in September.

John Borwick returns to describe the uses of a new giant anechoic chamber. Various recording problems are being studied. One such, the notorious echo in London, England's Royal Albert Hall, is now cured. The article, NO SOUND MAKES NEWS details this sound-reinforcement tool.

Another combination of audio and visual techniques is described in a feature article by **db** columnist Martin Dickstein. New York's American Museum of Natural History has recently unveiled a complicated display entitled CAN MAN SURVIVE? Mr. Dickstein's article takes us behind the scenes of this system.

M. S. Sumberg is preparing an article with the title CHOOSING A PUBLIC-ADDRESS AMPLIFIER. Somewhat basic in its approach, this paper will do much to clarify the thinking that must be done to secure the correct amplifier for a given p.-a. job.

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

About the Cover

●The schematic shown represents a method for deriving a common-bass signal for a speaker from a stereo original. Many tight-for-space stereo monitoring installations might find a solution to their bass reproduction problems in Walter G. Jung's article beginning on page 26.

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THE SOUND ENGINEERING MAGAZINE

AUGUST 1969 • Volume 3, Number 8

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Letters

The Editor:

I was very glad to see your editorial of last December, which was recently brought to my attention. The James Weldon Johnson Community Center began two years ago to build a small studio in East Harlem to provide recording services locally and as a job training site for young men in the community. The studio is more or less completed and in operation with three high school students from the neighborhood learning to operate the equipment as Neighborhood Youth Corps enrollees. We have sought funds to expand the program from a variety of sources, including Urban Coalition; the Department of Health, Education and Welfare, and private foundations, thus far to little avail. Our latest effort is for a grant from HEW to set up a complete two year job-training curriculum in sound recording. Included is a copy of this proposal, which is now being considered (how, seriously we do not know).

Our facility consists of a twenty-by-eight foot control room facing a twenty-by-twelve foot studio through a double window. Our equipment includes a three-console, purchased with a grant from the Hayden Foundation; p.a. amplifiers driving RCA LC-1A's as monitor and playback system; a Sony TC-355 deck as master deck; an old Ampex 910 for dubbing; and assorted antique test equipment.

For community recording service this equipment is adequate, but for training purposes, obviously, it is not.

For training and placing sound technicians, we need from the recording industry:

(1) A committee of representatives to provide information needed, establish curriculum, define job categories, estimate necessary background education for trainees, and promise employment to program graduates.

(2) Studios and individual audio professionals willing to volunteer equipment time and manpower for training if federal funding is not forthcoming, and to lease studio space and provide professionals as part-time paid instructors if federal funding comes through as was originally expected.

(3) Tape deck and cutter adequate to train the young men already enrolled in the program. Below is a list including these and other items we are trying to beg, borrow, build, and steal to complete the training facility and for use in other areas of the Theatre Arts Center.

EQUIPMENT NEEDED

1. *Record cutter*—Presto 8N with 1D head or similar. In other words, any old antique that is adequate for cutting acetates.
2. *High-fidelity headphones*—for cuing system in studio.
3. ¼-in. 1.5 mil *recording tape* on 7-in. reels.
4. Empty 7-in. reels.
5. *Stereo power amplifiers*—for studio playback, monitors, and theater sound reinforcement.
6. *Tape decks*—any deck with the following professional features will be adequate for studio operation and training: half-track stereo record and playback, solenoid controls (for remote control), accepts 10-in. reels.
7. *Microphones*—We need a condenser mic and shotgun for training purposes, would also use the shotgun for recording speech from the stage; dynamic cardioids for recording music off the stage.
8. *Mixer*—Three to six channels, mono or stereo, for location recording and theater sound reinforcement.
9. *Reverb system*—mic, amp, speaker, and ideally a full, half, or quarter track three-head home deck for an added delay loop; to be incorporated into the console which is wired for it already.
10. *Turntable* — anything manual, three-speed for transcription purposes. Preferably Bogen, Garrard, AR, Gates, Thorens.
11. *Speaker systems*—two speaker systems for studio playback.
12. Professional tape-*splicing blocks*.
13. *Equalizers* for console—need three, eventually eleven.
14. *Air-conditioning equipment*—Best: two units, 11,500 and 14,000 btu's. A single 11,500 btu unit and two window-mounting exhaust fans would be adequate.
15. *Vacuum-tube voltmeter*
16. *Oscilloscope*

Jonathan Thayer
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We can only hope and urge that there be an outpouring of response to Mr. Thayer's requests. Ed.

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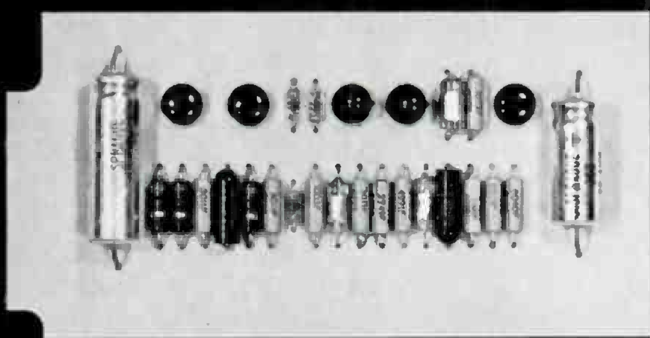

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The Editor:

In Norman H. Crowhurst's June 1969 column there are some statements which need qualification.

1. "Horn speakers need 12-dB per-octave crossover networks". (p. 14, col. 2). Perhaps some horns do. We have been building horn speakers since 1946 and have been using 6dB networks since about 1951, based on over-all improvement in performance.

2. "—response is 12-dB down in each output at crossover." (p. 14, col. 2). In a properly constructed constant −K network, the loss will be about 13 dB down at one octave from design-cutoff frequency, and between 1- and 3-dB down at cut-off.

3. He assumes a three-speaker system needing 64 watts for the woofer, 25 watts for the squaker and 25 watts to the tweeter, and by adding peak voltages arrives at the need for a 400-watt amplifier. More realistic values are represented by an over-all power requirement of ½ watt r.m.s. or perhaps one watt peak for "realistic reproduction of music" if one is using fairly efficient speakers. For low-efficiency speakers, about 25 r.m.s. watts seems to be the transition from fine to gross distortion. To corroborate this point we often demonstrate a recording of the Wurlitzer of the Palace Theater in Dallas at 100 dB s.p.l. at the listener location, and read ½ volt going to the voice coil—about 1/64 watt r.m.s. (since the pipe organ does not generate peaks, we can take this r.m.s. power as about half the peak power).

Orchestral music might involve peaks of 17-dB higher than r.m.s. so "realistic reproduction" would be accomplished with one-watt peaks.

4. The assumption of 25-watt tweeter demands when the woofer is absorbing 64 watts is also unrealistic. The ratio of power (assuming crossover at 5000 Hz) is of the order of 100 to one. We have destroyed lots of tweeters with 4-watt peaks, yet have never lost one with a 100-watt amplifier clipping several times a minute (that was *loud*, by the way!).

5. After finding that 400 watts from a single amplifier is necessary, he concludes that 3 amplifiers of 32, 25 and 25 watts r.m.s. are needed if one employs an electronic crossover. Powers of 32, 3.2 and 0.32 might be more realistic but I'd still rather have a single 60-watt Marantz and a network designed for the speaker by the maker of the speaker.

6. "—what appears to be a 'cheap' way—mounting a lot of inexpensive speakers on a large common baffle, may really be a superior way". It could be if the individual speakers were good, except that the polar characteristic may look like spokes of a wheel, and such systems so far tested here exhibit poor frequency response (and therefore poor transient response) and the distortion is 10 to 100 times as high as for speakers employing basically good design. (We tend to ignore harmonic distortion; we have measured in excess of 14 per cent modulation distortion in some speakers including those employing several driver units covering the same part of the spectrum.)

Please do not consider this as discrediting Mr. Crowhurst, but rather as a clarification of some of his points. We build loudspeaker systems for a living, and endeavor to maintain our reputation of purveyors of high-quality speaker systems. We removed a capacitor of a 6-dB crossover network as being unnecessary, and obtained a 3-dB improvement in the output response curve, without affecting total distortion which remained under one per cent at a pretty high acoustic power output. One must say that particular network slope is not 12- or 6-dB-per-octave, but zero! What appears in a magazine as a *rule* can be mistaken by the reader as a *law* and what was expressed as *opinion* may be mistaken for *fact*. When it comes to over-all loudspeaker system design, we start with the formal rules as a "point of departure" and the 12-, 6-and zero-dB per-octave network slopes are examples of such departure.

Paul W. Klipsch
Klipsch and Associates, Inc.
Hope, Arkansas

Mr. Crowhurst responds

Paul Klipsch' letter is typical of my good friend. And while I only know what I meant when I wrote the piece to which he refers—I cannot know how the average reader will interpret it—I do feel that he reads everything more with horns in mind than does the average reader. And probably I would too, if my name was Paul Klipsch To take his points one at a time:

1. Good, this means Klipsch horns are good speakers, which everybody knows.

2. I don't believe he read the context here properly, unless I did not express myself clearly enough: I was not writing about constant-K networks, and it is impossible to construct a constant-K network using 4 R-C elements without interaction in the form of feedback. So his comment is not relevant to the situation.

3. I won't argue with my friend that the order of efficiency to which I was referring is coincident with "the transition from fine to gross distortion." However, if I insisted that this essentially *happens—and maybe it does—some other speaker manufacturers would be "on my back."*

4 and 5. Here he seems to be supporting what I was saying: if tweeters can be destroyed by 4-watt peaks, and yet not be destroyed when fed from a 100-watt amplifier clipping several times a minute, obviously the peak power is at least 25 times the nominal peaks of actual energy.

6. Without arguing about the "goodness" of the units used, Paul himself relates distortion to efficiency: the higher the efficiency, the lower the distortion. Mounting speakers on a common baffle raises their efficiency, as compared with working them individually, because of the common air coupling. So, regardless of the distortion the speakers generate when operating individually, they will generate less *distortion when operating in a number on a large common baffle, by Paul's own argument, earlier.*

In his closing paragraph, perhaps some reader can explain to me what he means about the "point of departure". Maybe I'd understand if I were to visit Hope, Arkansas

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The Audio Engineer's Handbook

GEORGE ALEXANDROVICH

PROFESSIONAL SOLDERING

● You may wonder why I picked a topic like this. Well, it is summer and most of the studios dedicate a lot of this time to the repair, revision, and improvement of their equipment. There will be a lot of students working during the summer recess on electronic equipment. Some of them will be holding soldering irons and pliers in their hands for the first time.

A good soldering job is one of the most important pre-requisite conditions for any type of electrical work. It is unthinkable for poor soldering to appear in any of the systems. We all know too well what poor solder or intermittent connections may do to a studio. Every poor contact will create hundreds of gray hairs on the engineer's head. It only takes a little effort for any one to be a good solderer and do a professional job. All it requires is that you understand why soldering can be bad and what must be done to make it perfect. Let us divide our discussion into four sub-topics.

- Soldering tools.
- Materials and their preparation for soldering.
- Soldering techniques.
- Cleaning of soldering joints.

TOOLS FOR SOLDERING

These are usually an iron or soldering gun, rosin-core solder, and maybe a wire brush. Regardless of the size of the job, the soldering temperature for best results should be within certain limits (from 70° to 150°F, above the melting temperature of the solder).

Many modern soldering irons have thermostatic controls. Soldering guns have three-position trigger switches to help maintain proper soldering temperature. Depending on the job, the iron should be selected for proper heat capacity. While a 30-watt soldering iron is adequate for most conventional wiring, it will be quite inadequate for soldering the bus wire to the chassis — where its surface acts as a heat sink, lowering the temperature of the iron the moment it touches the surface.

An important role is played by the shape and the size of the soldering tips. Narrow long tips, attached to the heating element of the iron conduct small amounts of heat to the joint being soldered, but are convenient in places where servicing space is small. Short and chubby tips hold more heat and can solder larger, more heat-demanding joints.

A word of caution. Some soldering irons (with a.c. filaments inside the tip) and soldering guns produce strong a.c. fields. When soldering sensitive instruments such as meters, magnetic phono cartridges, and tape heads, you can demagnetize as well as magnetize those devices. If the joint is small, before approaching it with the hot iron, disconnect the power. There will be plenty of heat left to solder for 20 to 30 seconds without the danger of damaging the sensitive instruments. Turning the soldering gun *on* or *off* produces strong transient fields around the soldering tip, capable of magnetizing the tape heads or damaging sensors.

MATERIALS AND PREPARATION FOR SOLDERING

We usually solder with rosin-core solder which presents little danger of creating electrical shorts or leakages in the part we are working with. Usually, it is a mechanical contamination by the rosin which can cause trouble by the deposition of the rosin on the switch contacts, connector pins, or other exposed contact surfaces.

Preparation of the surface for soldering usually is not necessary since all of the surfaces of today's electronic components to be soldered normally are pre-plated or treated for soldering. Rosin core inside the solder is usually combined with a certain amount of

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acids to help remove the tarnish of the contact area.

Sylvic or abietic acids, d-pimeric and l-permeric acids make up rosin which is itself a composite part of pine sap. These acids are capable of reducing slight metal tarnishes at certain temperatures. Above or below this temperature pure rosin becomes inactive. Additives to pure rosin are chosen for wider temperature range and more effective surface cleaning. So-called activated rosins contain additives which are more prone to cause electrical leakage, especially in the tightly packed pc boards, unless all of the flux is exposed to the temperature of the melting solder. At that time acids in rosin evaporate leaving non-conducting pure rosin on the surface.

There is a wide variety of solders available on the market. We need only be concerned about the kind which pertains to our applications. The most commonly used types for soldering alloys are 50/50, 60/40 and 63/37. For economy reasons, alloy 40/60 is also used but it has a higher melting temperature. The 63/37 has the lowest melting temperature and is used extensively in pc work. (The first number stands for the percentage of tin, the second number is for the percentage of lead.) When you buy solder, do not use the corrosive types (used for nicrome or stainless steel) unless you are prepared to brush clean all of the flux after soldering. They can put a beautiful short between conductors, connector pins, or switch terminals. Corrosive fluxes, if not fully removed, will ultimately corrode the metal around the contacts so badly you will be sorry you ever used it. For all electronic work you normally do, *always use rosin-core solder*.

SOLDERING TECHNIQUES

Let us assume that you have to solder a connector on the end of the mic cable. You strip the wire, position the connector on the table or in a vise. Then you take the cable with one hand and insert the first wire into its respective contact. Now you have to pick up the soldering iron and solder in order to join two parts. Well, who can do that? You are short one hand! We now come to the part that separates the good solderers from the bad solderers. If you want to botch the job completely, apply the solder to the tip of the soldering iron and using the left hand to hold the wires, solder with the right hand. You will get a beautiful cold-solder joint which will never have the appearance nor electrical or mechanical properties we desire. Recall what was mentioned before, that heated flux evaporates and loses its stability to wet the contact area. By the time you bring the iron to the joint there will be no flux left.

The way to solve this problem is to first tin the wire. Touch the wire with the tip of the iron, then touch the spot with rosin-core solder. The solder will flow freely and easily. The trick is to bring into contact three items simultaneously at one point; the wire, iron and solder. As soon as the solder covers the tip of the wire, remove the iron and solder. Some flux should remain on the tip of the wire. The whole operation should not take more than a couple of seconds. The ability to hold the wire between your fourth finger and pinky while feeding the solder using the thumb and index finger of the same hand helps considerably in obtaining the status of a good solderer.

Naturally, many connections do not require the holding of the wire as when a soldering lug is being used to anchor the wire. For the past several years it has been generally accepted that wrapping the wire prior to soldering or executing a wrap-and-a-half around the terminal not only does *not* improve the reliability of the joint but makes the joint more difficult to service afterward.

Almost all producers of electronic equipment use the technique of inserting several components into the ear of a soldering lug or contact and just allowing the solder to fill all the space between the component metal parts of the joint. It has been proven that such a joint is just as durable as a wrapped type. This then is the basic technique; simultaneously bringing into contact the soldering iron, wires from the components, and rosin-core solder.

In the case of the mentioned mic connector, pre-tin all the contacts before soldering. Pre-tin all the wire ends of the cable. Then, with some flux remaining on the connector pins and on the ends of the wire, all you have to do is bring them together and apply heat without adding any more solder or flux. Hold the soldering iron next to the joint until the solder flows evenly, filling the area between the two metal parts.

The heat of the iron is one of the very important points of good soldering. Solder melts at 350° to 380°F. The best soldering temperature is 70° to 150° above melting point (420° to 530°F). According to the graph of temperatures in Figure 1 for different irons with power dissipations of 13 watts to 170 watts you can see that a 13 watt iron at 110 volts produces heat of 630°F. The point is that the iron cools down the moment it touches the solder or the metal which is to be soldered. Depending upon the joint, the iron should be capable of raising the temperature of this joint to the desired 420° to 530° range. A good solderer, just by watching the solder flow through the contact wires will detect the right moment when the solder reaches the proper temperature and forms a good joint. At that instant the iron is removed and the

soldered area allowed to cool and solidify. A very important point about soldering is not to disturb the solder after removing the iron until it solidifies. Disturbing the contact will cause crumbling of the solder. Also, the contact should never be over-heated, for not only may damage to the electrical parts occur but the solder will reach temperatures at which it will start oxidizing. If it is then chilled rapidly, it will crystallize, forming a brittle joint. One good indicator of excessive temperature is darkening of the rosin. A soldering joint done at the proper temperature will never have its rosin residue change its color to dark or black.

Most of you will encounter the task of changing components on pc boards. Let this be a warning: practice on old boards until you are sure you can do the job correctly. Overheating pc boards means running the risk of lifting the copper clad from the board. The best way is to use an iron with a suction tool which removes the solder from the joint as soon as it is melted. Use a small iron. Don't use 100- or 200-watt units. If you don't have the recommended suction tool for soldering, another way to unsolder the joint is to heat up the connection with a small soldering iron until the solder melts, then shake it off with one fast drop of your hand. If the board has no delicate components, you can try to tap the board on a wooden block to get rid of the molten solder. If the joint is too small and solder solidifies before you get a chance to shake it off, apply additional solder to the joint which will prolong the time needed for solder to chill. If you are certain that the component is faulty on the pc board, you may clip the lead from it and use the component body to undo one side of the component. The clipped side will be taken off with the excess solder.

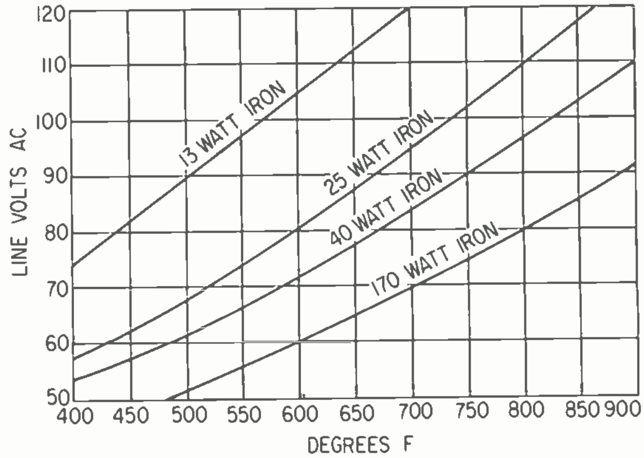


Figure 1. Line voltage for temperature for several a.c. iron wattages.

CLEANING OF SOLDERING JOINTS

If you are soldering the contacts of electronic components that are located far apart, it isn't necessary to clean the joints to prevent electrical leakage. You are only concerned about appearance or the possibility of excess rosin later on contaminating the exposed contacts.

The opposite is true in circuit-board work. Today, you will run into pc board designs with high component density. It means the connectors and components on the board are spaced very closely. There, the danger of partial shorts or leakage, especially in high-impedance circuits (fet), can be dangerous. In manufacturing plants, cleaning of the boards is now done using special heated tanks of freon, where the soldering flux is diluted by the fumes of freon. There are aerosol cans of freon available for the purpose of cleaning boards; this is one of the most effective cleaning agents available.

Another method that is both less efficient and less costly uses an alcohol bath or brushing. This is not as dangerous as freon and cleaning is thorough. Another method not recommended, simply because it is highly dangerous to health, is the use of carbon tetrachloride. Only if ventilation of the area is such that the fumes will not be inhaled, can it be used. Carbon tet does the cleaning fast and well, but it is cumulative in our lungs and prolonged breathing of the toxic fumes may cause death. The use of solvents such as acetone, thinners, toluol or toluene, MEK or other industrial chemicals can cause substantial damage to the components on the pc boards, the majority of which use soluble plastics for encapsulation.

Be careful when cleaning switches or pots after soldering. The lubricating oils which should last the lifetime of the components may be removed in the cleaning operation, shortening the life of the components.

The Feedback Loop

ARNOLD SCHWARTZ

● "All news all the time" Radio Station WINS is on the air 24 hours a day—7 days a week with a constant stream of news and sports. How does WINS achieve its smooth, fast-paced presentation? Bruce Ratts, WINS' capable chief engineer, was kind enough to satisfy my curiosity by conducting me on a tour of the station's studio facilities which are located on the 19th floor at 90 Park Avenue in New York City.

The extensive studio facilities required for the WINS all-news format consists of four similar control rooms with associated studios, and two edit rooms. One of the four control rooms is an on air studio and a second serves as a back up. Because of the fast-paced presentation and the type of material, all recordings are on tape cartridges; there are no turntables. All six technical areas are frequently in use simultaneously, and an average of 40 cartridges are played on the air each hour. Approximately 1000 cartridges are in the active category at any one time. These facts give some idea of the amount of material prepared and used, and of the imposing problem of handling this flow of information.

WINS' present installation, which went on the air in July 1965, was designed for the all-news format. The basic element in all four control rooms is the remote-control console. Virtually all the electronics for the four control consoles are located in one central equipment area (or master control room). The consoles, containing only potentiometers and switches, represent a radically different approach. As will be seen, this type of console has great versatility.

A simplified block diagram of the WINS remote control console is shown in FIGURE 1. The console panel contains only d.-c. control potentiometers which are connected to amplifiers in the central equipment racks. All microphone and remote signals are fed directly to these centrally-located amplifiers. By means of jack fields for the audio, and connectors for the d.-c. controls, the consoles are connected to control the appropriate inputs and outputs. This feature makes for an enormously flexible and versatile control console. The d.-c. potentiometer functions as a gain control because it is used to vary the bias on a diode bridge in the associated remotely-controlled amplifier.

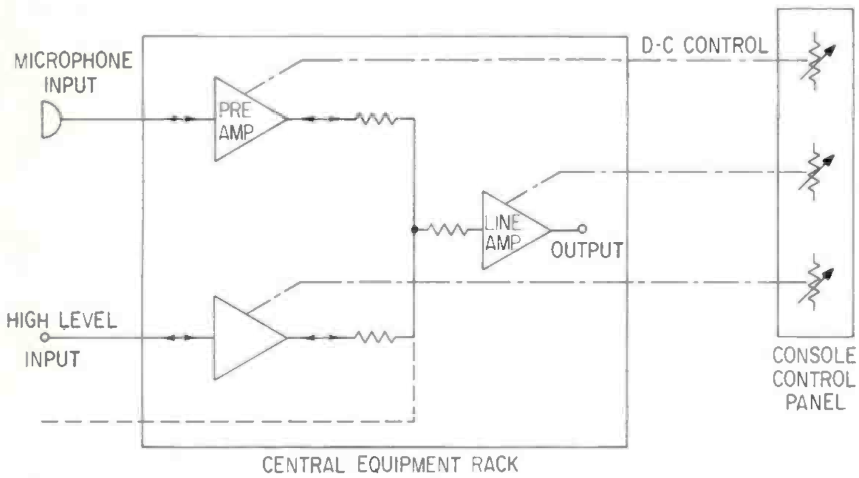


Figure 1. A simplified block diagram of the WINS console.

Consistent with the WINS fast-action format, amplifier replacement and servicing is accomplished in the central equipment area. Neither the console operator or the control-room functioning need be disturbed. Servicing or replacement of components can be done while the control room is in use. The console has nineteen inputs in a panel space of 36 inches. Fourteen channels have one input such as a microphone or cartridge player, and five are fed from an eight-input, push-button selector switch. The selector switch does not switch audio directly but operates a crossbar switcher in the central equipment rack.

Equipment performance is checked regularly and Bruce told me that the system equivalent input noise is −124 dBm. Putting it another way, a −60 dBm signal at the system input will be 64 dB above the noise level at the system output. This low noise level is achieved despite the fact that the Empire State Building with all the metropolitan area TV and FM transmitting antennas on top of it, is less than 3,000 air feet away from the WINS studio installation. System distortion is 0.3 per cent at +26 dBm output.

In addition to the numerous remote feeds available on telephone lines there are five mobile inputs. Each mobile input represents a vehicle, roaming the metropolitan area with a two-way radio. R.-f. and audio facilities are available so that mobile feeds can be broadcast live while the event is happening, or can be recorded on tape for later use.

It has been found that maximum speed and efficiency can be achieved if all fader levels in all consoles are maintained at the same setting. This is possible because care is taken that all cartridges are recorded at the same level. Console operators can use any cartridge on any console, and on any channel of that console without having to adjust the fader. To further increase the speed of operation, tape-cartridge players are operated with the motors going all the time, and with the console faders left open to their normal position. When the start button is actuated a relay closes, feeding the signal from the cartridge player to the appropriate console amplifier. At the end of the tape the cue tone de-energizes the relay and disconnects the cartridge-player output from the amplifier.

Bruce showed me a novel cue-monitor box which is in use throughout the station. This device allows the director —or anybody else for that matter— to have headset or loudspeaker monitoring in any control room or studio. There are fifteen monitor circuits at +16 dBm. The cue-monitor box has a high-quality, sixteen-position, rotary-selector switch and gain control. Two cue-monitor connectors, each with the fifteen feeds and d.-c. power, are located in every control room and studio. With the cue-monitor box connected a high-impedance headset can be plugged into it to monitor the selected line. If the director wants to have loudspeaker monitoring he can, in place of the headset, plug in a loudspeaker monitor box. The d.c. is used to power an amplifier which drives a small speaker.

Another interesting feature at WINS is the method of wiring jack fields. Each jack field is wired to a connector which can be used to terminate the feeds, or can be conveniently used to connect the feeds to yet another jack field. While on the subjects of jack field and wiring, I found that the wiring and workmanship throughout the entire installation were of the highest quality. With all that r.f. in the neighborhood, anything less would be an invitation to trouble.

From the engineering aspect, WINS' effectiveness is due to modern equipment, designed for the purpose, and run by a well-organized and competent engineering staff.

Theory and Practice

NORMAN H. CROWHURST

●This column has been running for well over a year, during which time it has covered quite a range of what we might call the ***nuts and bolts*** of relationship between theory and practice. And there's undoubtedly almost as much of this detail stuff still waiting to be said, as there was when we started, because there's an awful lot of it.

But when I met your editor at the West Coast Audio Convention in Hollywood, he suggested that I don't ***have*** to stay with nuts and bolts aspects. Immediately he said that, I was reminded once again how compartmented our minds become: I write this for **db**, and various something elses for other publications; and I tend to think along the tracks made for each purpose.

However, philosophy knows no subject boundaries. And, although we go about our compartmented lives, we have frequent reminders of this fact. Someone will write to me, resulting from reading something in this publication, or in one of the other publications for which I write, or perhaps after reading one of my books. And before long, we find that we hold many fields of interest in common. This has happened many times.

Some will write and tell me they read everything I write. But then they get a surprise to find that I write on educational and religious topics as well as technological ones. And our mutual interest grows. However, I can't write about theory and practice in all those subject areas in **db** — or can I? After all, this is a sound-engineering magazine, and what I have to say here should be related, however remotely, to that subject, shouldn't it?

Perhaps this viewpoint is what creates so many conflicts between theory and practice: the result of excessive compartmentation. A group of engineers in Hollywood were commenting how often a new company starts with some dramatic new concepts, builds itself a sizable market, and then seems to "stagnate": at a certain point in its development, it ceases to generate new ideas, and from then on merely keeps going on variations from the original theme that started its success.

Name after name illustrated this pattern. Having been with the industry these many years, and being aware of personality movements, in most instances I could name the engineer who left the company at the time the change occurred. Today's world insists that only big teams of engineers can achieve anything, that the individual "genius" is passe. But the more we thought about this, the more we realized that creative ideas still come from individuals, although teams may be needed to develop them.

From this, the discussion went to the "quality" of young graduates leaving college, theoretically fully fledged to start life as junior engineers. Now there's another angle on the theory and practice question! In more ways than one!

Yes, there's far more to this than meets the eye at first glance. It goes right back to school days, when these same people were supposed to be learning algebra (along with other subjects). And this touches another interest area of mine, although maybe the main reason is that the two are related: if we could get more sense into teaching at the grade- and high-school level, our later problems would largely disappear.

Earlier this year, I was asked to tutor a high-school sophomore who was having difficulty with Algebra 1. He and his parents want him to be an engineer later on, but to qualify he must pass his

Algebra 1 this year, if he is to get Geometry and Algebra 2 in his remaining years in high school.

Frankly, the whole thing was a terrible struggle. My objective was to get him understanding what it's all about. But this gets difficult when all teacher wants is "problems" worked the way he shows them, with no explanations offered.

It's getting near the end of the school year, and this teacher now realizes that, to cover the curriculum, he must rush through simultaneous equations and quadratics, to make it. To cut down on time, he's skipping all the verbal problems. So all these students are getting are the abstract problems, to solve for *x* and *y*.

What are *x* and *y*? *Variables* is the stock reply. When I was in school, they were ***unknowns***, but that doesn't help much either. If he's had story problems, word problems, or verbal problems before, he's found that variables can take a mystifying variety of forms. And always the cart comes before the horse: the abstract before the applications. No wonder our children have a tough time!

And they're going from bad to worse. That could account for more recent graduates having a tougher time than we did.

Remember how we learned lowest common denominator, before we learned to add fractions? Nobody told us why we needed *lcd* — it seemed like a pretty stupid exercise, until we came to add fractions. The further we progressed the worse it got, even in our day. It wasn't too long after we did *lcd* till we found ourselves using it to add ⅓ + ¼, for example.

But when we came to calculus, all that talk of little bits of *x* and little bits of *y*, leading to infinitesimal bits, seemed to go on for ages, before, one day, we found out that differential calculus was useful for some everyday problems.

Can you imagine our ancient forebears discovering mathematics that way, because I can't. I see mathematics as growing out of the practical need to calculate. As more complicated calculations presented the need for being performed, men found more direct ways of attacking these problems. It was a dynamic growth. So why not teach it that way?

Instead, they're moving more toward the abstract. Because the need is for understanding (which we agree about entirely), instead of teaching multiplication tables, they learn the principles of commutativity, associativity, and distributivity, and hope to acquire the multiplication "facts" as they go by.

In our day, some students couldn't see how finding the area of a floor from its dimensions was a problem in multiplication. Now they can't see how multiplication is an exercise in the principles named. It gets vaguer and vaguer. Always from the abstract, which the newcomer can never understand, to the specific, to which few students know how to apply the meaningless abstract thing they've just learned.

Talking to a parent the other day, I learned that her son's teacher has just announced a practice that appalled the boy, because he wants to learn to do things right: from now on, teacher will not correct mathematics homework; anyone who does it will get an A, anyone who doesn't will get an F. Having correct answers doesn't matter. Not even when the student wants to know! The reason? It's too much work for the teacher!

When I was in school, I enjoyed math, but I had a nasty little habit of making silly mistakes. But then, grades depended on correct answers: teacher didn't give you the marks for having the correct method, but a wrong answer. So I taught myself methods of verifying my answers: checking by a different method. This was a good habit, that served me well when I became an engineer.

I remember a junior who discovered that the reason a cathode-ray tube had its heater burned out was that he had provided it with ten times the correct heater voltage, through a mistake in calculating the transformer turns in the one he had specially wound for the job. His face was red, when explained the situation, and he found ways to check his calculations after that.

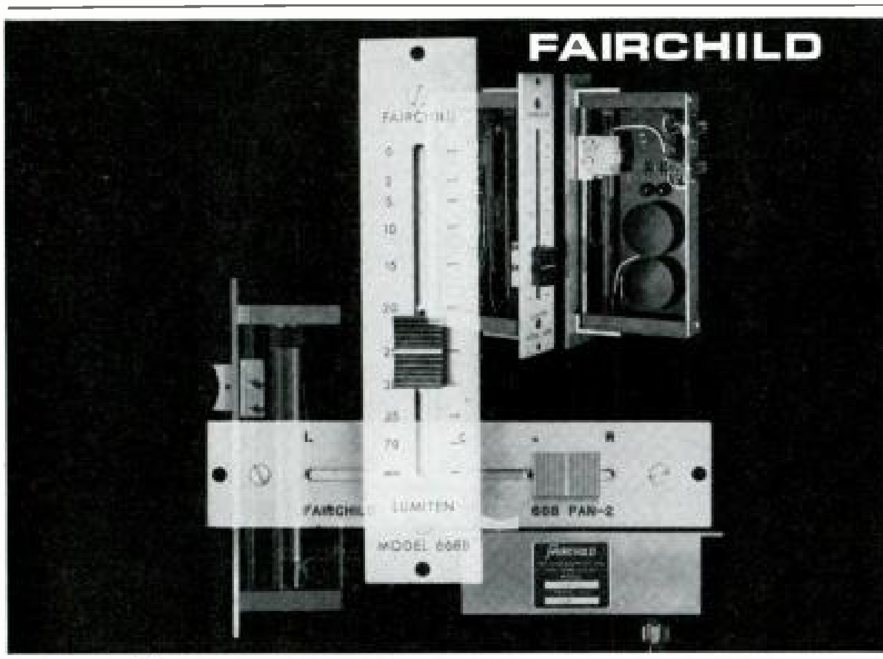
The casualty there was only a cathode-ray tube he couldn't afford to pay for. But what about engineers who miscalculate in bridge designs—the kind that cars and trains go over? Or dams for controlling water flow? Their mistakes can have more serious consequences.

The good habit of checking by an alternate method not only improves understanding of the subject, it becomes a way of life that may save lives, or at least one's job, later.

That boy I mentioned earlier: I just about had him understanding how to solve simultaneous equations for *x* and *y*, so I thought I'd try him with the first "verbal problem", which was:

"A man buys 4 lunches and 5 dinners one week, for a total of $30. Another week he buys 2 lunches and 7 dinners for a total of $33. What is the price of each kind of meal?"

The boy couldn't find an *x* or *y* in that question. So I showed him how to solve it. But then I noticed something the algebra didn't tell me (although it could have): he bought the same number of meals each week, 9. So simple deduction, which could be put into algebra quite easily, told me the dinners were $1.50 more than the lunches.



From that, solution was easy. The simultaneous equation could be solved that way too, but that's not the way the rules spell out. How much better if the student spent some time deducing answers to questions like that, and from the result, formulated algebraic procedure that does the job, and a generalized abstraction. But nobody does it that way!

That's why, a few years ago, I wrote a book titled *Taking the Mysticism from Mathematics*, in which I tackle various problem areas, from learning to count and multiplying, through division and fractions, starting into algebra, geometry, trigonometry, calculus, and including some facets of the so-called new mathematics. But I had problems getting the book published.

I tried over twenty publishers myself. They all turned it down, either because they were textbook publishers and my book wasn't, or *vice versa*. So I thought I'd try an agent. The first agent I tried liked the book: it grabbed him — and he'd never been interested in math before. He was sure he could find me a publisher.

Over twenty more publishers later, he sadly told me his luck was no better than my own. So now I've just got it published by what many people call a "vanity publisher": Vantage Press. All kinds of people like the book, but the profession rejects it: my approach is going the wrong way — from theory approach to practice approach. But many individual teachers like it, which is encouraging.

It's time someone debunked the notion that school is where you learn theory, and the outside world is where you learn practice — the hard way! Theory and practice belong in the same world, don't they? Each helps the other, rightly handled. But what would inbred theorists, which most college of ed professors are, know about practice? They just hope someone practical services their car, or their TV set, and disdainfully regard that as a menial chore.

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Sound with Images

MARTIN DICKSTEIN

AUDIO-VISUAL DEVICES I (16mm PROJECTORS)

●With the field of audio-visuals becoming constantly both larger in scope and more complex in operation and requirements, it might be wise to review briefly some of the devices now available to the user of equipment whether it be for education, sales, top management meetings, or advertising and industrial shows.

With an assumption that the 8mm film projector will be used primarily for the home rather than industrial application, although it is being used in many places for its small size and convenience, and assuming further that the 35mm and 70mm film systems border on the more professional installation, these units will not be included in this brief coverage.

Most audio-visual systems include a 16mm projector. These units are made by several manufacturers with varying specifications, accessory devices, and applications. Basically, the equipment is capable of projecting a 16mm film at either a silent (16 frames-per-second or 24 feet-per-minute) or sound (24 frames-per-second or 36 feet-per-minute) speed. Many projectors are capable of projecting either way and are provided with a switch for speed selection. Generally, projectors in this class are provided with 2-inch lenses but the range of lenses available, depending on the barrel diameter and image size required, typically run from about 1 inch to 4 inches. There are lenses made outside this range should they be required for special application. There are also models for which zoom lenses are available to cover approximately 2 to 4-inch focal lengths.

Among 16mm projectors there are those which provide the capability of "stop-frame" whereby the projector can be stopped on a selected single frame for study. The control for this action is readily accessible to the operator and offers the user the possibility of studying a movement at any point. However, the stop-frame image is necessarily not as bright as the picture when the film is in full motion because of a film-protecting shutter or lens that comes into place during stop-motion operation.

Speaking of image brightness, another difference in 16mm film projectors is the lamp housing and the illumination capabilities. Incandescent light sources range generally from a 500-watt lamp to the 1000-watt lamp. Some are capable of using a 1200-watt lamp, others can be adapted for (or come with) the new Marc 300 lamp while still others can be purchased with (or adapted for) arc or xenon sources for high-intensity applications.

Sound on a 16mm film can originate from either an optical track or a magnetic stripe along the side of the film. Here, again, some units are available which will play either type only or both; some come with interchangeable heads to permit them to reproduce either type at will. Built-in preamplifiers for magnetic heads and power amplifiers for both types of reproduction are available with different power ratings, running from about 5 watts to 25 watts, in either tube or transistor version. There are small built-in speakers (on most projectors) some of which are removeable with long extension cords to permit placing the speaker near the screen. Other manufacturers provide accessory speaker units.

An interesting note on sound- and silent-film projectors is that those units made to project exclusively silent film usually have sprockets with two rows of teeth to conform with silent film stock which is made with a row of sprocket holes on each side of the picture area. A sound film has sprocket holes only one one side, with the sound track on the other side of the picture. Thus, playing a sound film on a silent-only projector could ruin the film.

It might also be of importance to indicate that in sound-film projectors, the sound drum and photo-electric cell are at a location on the unit other than at the aperture opening, as space limitations make it a physical impossibility to mount both at the same point. Thus, the sound-reproducing head is located a pre-determined number of frames ahead of the picture as it is showing up on the screen. This, therefore, makes it necessary for the operator to thread the film properly with a fairly precise depth of lower loop on the film. Should the loop be too small, the sound will preceed the corresponding image. If the loop is too large, the image will show before the proper sound.

Another variable in film projectors is the method of threading. Some are manual and require that the operator physically maneuver the film through the mechanism and up to the take-up reel. This is when the operator has control of the size of the loops made above and below the aperture. A good feature of this type of projector is that the projectionist can remove the film quite easily when the entire film is not played all the way through.

The much easier method of threading the film is on an automatic or self-threader. Here, the film path is enclosed by guides to provide a path for the film. It is necessary to have the front tip of the film cut properly so that the threading will be accurate, and a cutter is usually provided on the projector. The operator need only insert the film in the proper slot and start the projector for the film to thread itself. The take-up reel is made with sprocket teeth to catch the film and with a little practice, the operator can learn to hook the film with no effort or without stopping the projector.

Several other variations are available. Some projectors are capable of holding reels large enough for 5,000 feet of film but this is usually true of only the more professional units. Such length is generally not required in audio-visual installations other than theaters or movie-preview projection rooms.

Most projectors are capable of playing a film in reverse which allows a portion of a film to be repeated by rewinding during the presentation before the entire film has run out. In some such units the sound is cut during rewind, while in others it is necessary to turn down the volume during rewind to avoid annoyance, then the volume must be returned to normal setting for normal play. Some projector units also have the capability of rewinding the film at high speed.

Another feature found on some projector units is the capability to use the amplifier as a p.-a. system. A microphone jack is available and by throwing a switch the unit's speaker can now be used to distribute live sound or turntable pickup.

There are systems made which include a 16mm projector which project the image onto a rear screen mounted right on the projector enclosure. This feature makes this type of projector a self-contained presentation and by using a continuous-cartridge film they can be left in automatic operation for any length of time desired. Several systems of this type are also capable of playing a film onto a normal front-projection screen for greater versatility. Repetitive projectors are provided with automatic cut-off safety switches in the event the film snarls or splits.

Remote control of the operation of 16mm projectors is available only for some of the units made. Others may be capable of being adapted for remote operation depending on whether it is necessary to run the motor without the lamp being on or whether it is necessary that the projector be run in reverse.

There are other variations available such as special lens attachments, etc. However, this is a brief and admittedly sparse coverage of all the 16mm projectors used in normal audio-visual systems. Film strip, slide, opaque, and overhead projectors as well as special features and accessory equipment will be reviewed in subsequent discussions.

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Dolby Revisited

JOHN BORWICK

The author recently visited the Dolby Laboratories in London to give us this fresh view of the revolution in recording caused by the A301 system

Though it was way back. in 1966 that I first visited Dr. Ray Dolby in his South London laboratory, the Dolby Audio Noise Reduction System continues to make news. The first key man in the recording industry to see the potential of the system was Arthur Haddy, technical director of the Decca Record Company (London). And since then, month by month, more and more of the large and small studios — more than one hundred of them — have been 'going Dolby'.

Apart from the primary Dolby application — of an ingenious 'black box' through which professional tape masters are recorded and replayed with 10-15 dB reduction in tape hiss, print-through etc. — we are now seeing the extensions of the principle to the domestic market. The KLH Model Forty stereo machine, selling in U.S. at $650 has simplified noise-reduction circuitry manufactured under exclusive license from Dolby Laboratories.

To find out about this and other possible developments (how about a disc-player Dolby? — noise on broadcast landlines? — film and TV? I have just re-visited Ray Dolby, who has now moved into a roomy new four-story building.

John Borwick, BSc. is a Scot now living near London. He was with the B.B.C. for 11 years as a program engineer and later became a lecturer in studio operations. He wrote the B.B.C. Programme Operations Handbook. *He is technical editor of* The Gramophone, *the well-respected British high-fidelity journal, and is also secretary of the Association of Professional Recording Studios which has close to 150 member studios throughout Britain.*

This contribution marks the first of what will be a more or less regular feature to appear in our pages. Mr. Borwick will report on the goings-on of professional audio in Europe in issues to come.

THE BASIC IDEA

Most readers will already be familiar with the main points of the Dolby invention — as presented to the A.E.S. Convention on the 25th of April, 1967 and described in numerous articles (see *Further Reading* at the end of this article). But some of these write-ups have failed to emphasize the difference between the Dolby principle and conventional compression/expansion methods of achieving wider dynamic range. So a brief run-down may help.

Dolby's primary aim is to present the listener with a wider dynamic range. Taking the peak volume of signals as a fixture, we can only extend the sound range downwards — into the region where quiet passages in the music, and subtle points of timbre and expression, are normally overlaid by intrusive noise components. Chief among these, notwithstanding recent advances in low-noise coatings, is tape hiss and the Dolby characteristic is biased towards this arch-enemy. But other pernicious nuisances inherent in the record/replay processes include hum, crosstalk, print-through, editing clicks, etc.

Starting at the replay chain (Figure 1B), Dolby's pallative to all these types of noise is to erect a differential *subtractor* network which, operating only on signals below a chosen datum level, pushes everything down by some 10-15 dB. Reducing the noise components by this amount can give a startling improvement in clarity and realism which has been universally welcomed by engineers and music critics alike.

To see how it works, let us assume that the signal to be replayed contains a high-level signal followed by a low level — we can call them H and L (Figure 1B). The H signal is allowed to pass through a unity-gain amplifier, but is blocked

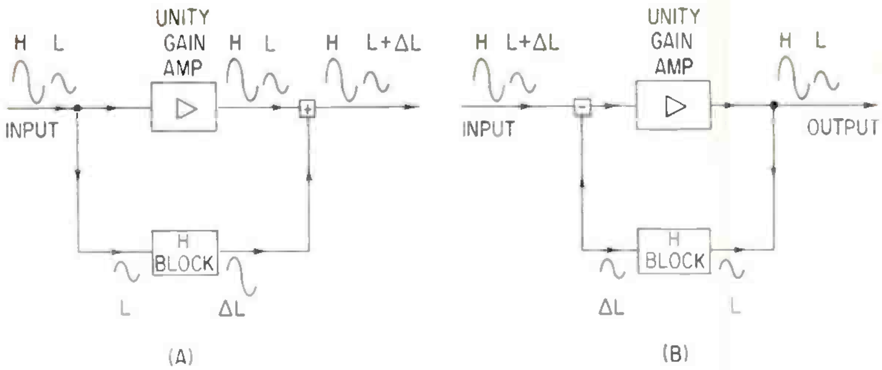

Figure 1. The basic principle of the noise-reduction system. At (A) the processor raises the level of a low-level signal L to (L + ΔL). During replay (B) the processor suppresses the level by −ΔL, thus restoring the program signal while reducing the noise components.

from the side chain, which attenuates H by up to 40 dB. However, the L component is allowed to pass and partially cancel low-end noise components in the night signal.

Of course, it goes without saying that this *subtract* network can be applied to the replayed tape signals only if an equal and opposite *add* network has been inserted in the record chain — because desired low-level signals are now being attenuated along with the undesired noise.

Figure 1(A) shows the record arrangement in outline and indeed a sensible circuit economy is adopted: to make quite sure that truly reciprocal pre-emphasis is applied, the network used on record is exactly the same as that on replay, but in a *negative* feedback configuration.

Now we have the component ΔL *added* to L and, provided ΔL is strictly the same in the record and replay processors, the *program* signals emerge unaltered — while any acquired noise signals are suppressed.

NO POST-OPERATION SCARS

Like all good inventions, the Dolby system owes as much to imaginative clear-thinking as to engineering know-how. It will be seen from Figure 1(A) and (B) that the middle- and high-level signals are not tampered with. This, in one jump, makes conventional compression methods look old-fashioned because they are obliged to operate on the high level *and it shows.*

Any distortions or aberrations introduced by a system on loud sounds will be strongly apparent to the listener. But electronic treatment of small signals dodges most of the risk of distortion and any which does occur will be so tiny as to be inaudible.

Dolby treats only the quiet signals, where noise is most intrusive: he can ignore the louder signals because, thanks to the masking effect of the ear, noises cease to annoy in the swamping presence of louder sounds. Indeed, one of the realizations that started Dolby on this invention was the fact that most compressors worked on the entire 70 dB sound range just to get rid of noise components about −60 dB below peak, a mere 0.1 per cent of the signal. It was like bull-dozing a hill because you were bothered by the grass growing at the bottom.

Figure 2 contrasts the transfer characteristics of (A) the normal no-stretch system, (B) conventional compandor and (C) the Dolby system. In Figure 2(A), straight-line transfer occurs on both record and replay, lines AO and BO, with the usable dynamic range hemmed between the overload and noise levels. In Figure 2(B), the curves CO and DO show the compression and expansion characteristics applied to high-level signals. In Figure 2(C), curves EF and GH illustrate the add and subtract processors acting at low signal levels.

Another give-away feature of standard compression techniques is the breathing effect due to the long recovery time and the whole level of background noise moving up and down with the control envelope. This is avoided in the Dolby system partly by the use of automatically variable recovery time constants and partly by splitting the audio spectrum into bands. This latter, necessarily complex, scheme means that the boost and subsequent cut is applied only in the pass bands where no over-riding higher level music signal was sounding. Thus the reduced masking effect of a high-level signal on a component in another band is taken into account.

It would be best to divide the spectrum into an infinite number of bands: but Dolby has found that four bands give the optimum compromise between effectiveness and reasonable economy. He has chosen his four bands as follows:

Band 1. 80 Hz low-pass: (hum and rumble)
Band 2. 80-3,000 Hz band-pass: (broadband noise, crosstalk, print-through)
Band 3. 3,000 Hz high-pass: (hiss, modulation noise)
Band 4. 9,000 Hz high-pass: (as Band 3)

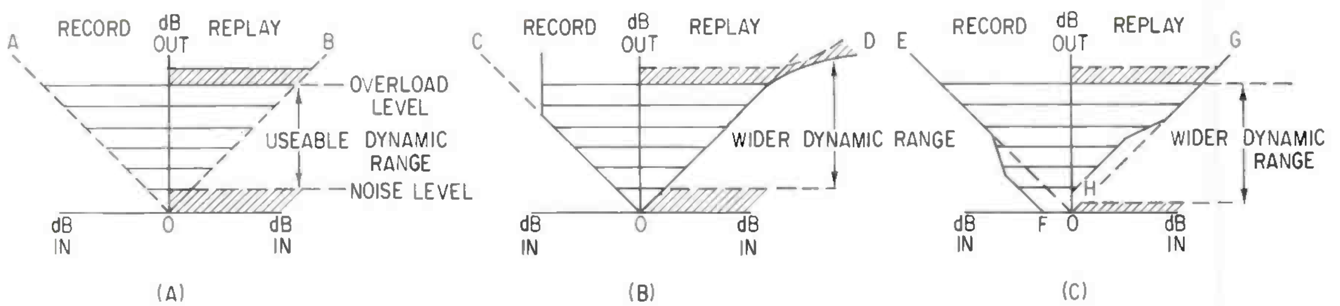

Figure 2. Contrasting transfer characteristics. (A) is no stretching, (B) is a compandor, and (C) is the Dolby unit.

Figure 3. The standard Dolby A301 unit. It contains two processors, each suitable for record or replay.

THE ROLLS ROYCE APPROACH

Figure 3 shows the Dolby Signal/Noise Stretcher A301 unit. Each A301 chassis comprises two Dolby circuit chains and each of these is reversible to the record or replay mode to give either two-channel record, two-channel replay, or simultaneous one-channel record and replay (monitoring). Even so, the list price of $1495 per unit (New York) must seem steep to a small studio operator. And the need to double and quadruple up on units for multi-track recording — where the Dolby is particularly useful to keep down rising noise levels due to narrower tracks and copy/reduce operations — makes the Dolby a considerable capital investment.

On this, Ray Dolby was refreshingly frank. "Yes," he said "I could build the units more cheaply. But right from the beginning I knew that nothing less than a Rolls Royce approach would do. The units had to be so well made and 100 per cent tested that no single case of in-line failure could tarnish the system's reputation while it was still fighting off the scepticism of this new technique."

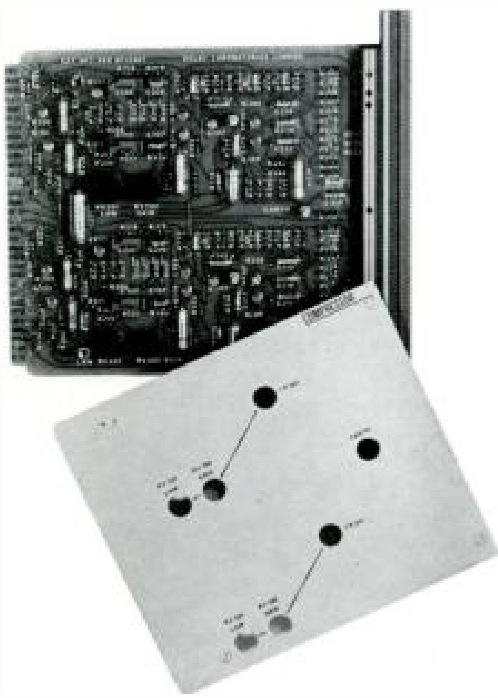

Figure 4. A compressor module from the A301. The board is glass fiber and has gold-plated edge connectors. The assembly, as well as the other functions, slides into the unit from the front as shown in Figure 3.

Everything I saw at Dolby Laboratories confirmed this philosophy. The first thing that happens to the thousands of passive components, diodes, and transistors on arrival is that they are measured to high accuracy. This is because of the absolute necessity for every pre-emphasis/de-emphasis chain and band-pass filter to track its partner faithfully. In fact, more than 200 components per unit are matched to better than 1 per cent. The 103 transistors are high-gain silicon planar type to allow high levels of negative feedback; of the 167 diodes, 44 are used for temperature compensation.

Again, in these days of globe-trotting recording engineers and trans-continental traffic in tape masters, every Dolby A301 must be a carbon copy of every other one. Even while I was in Ray Dolby's office a well-known American recording engineer called in for a unit which he had ordered to use on a week-long assignment in Denmark.

All the glass-fiber circuit boards (see FIGURE 4) are silk-screen printed and soldered by hand. Sub-assemblies are measured at each stage and the complete units are soak-tested for several days. I looked at the logbooks of some of these; 0.05 per cent distortion and ±0.3 dB frequency response were standard.

FUTURE DEVELOPMENTS

A clever idea, so painstakingly applied, is already giving added listening pleasure to the thousands of purchasers of recent records from about 35 record companies, including Decca (known as London in the U.S.A.), Columbia, Caedmon, Elektra, Pye,RCA Victor, and Vanguard.

The future would seem to be one of ever-widening usage. Already the KLH Model Forty domestic recorder is claiming a dynamic range at 3¾ in./sec. well up to professional 15 in./sec. standards. This uses a simplified one-band Dolby circuit, manufactured under license. No doubt other home tape applications will follow. (Ray Dolby gave me an impressive demonstration of a Dolby-ized compact cassette recorder his engineers were working on.) About ten broadcast companies now have Dolby units, including the British Broadcasting Corporation, Canadian B.C., Swedish Radio, and VNIIRT (Moscow). Thus radio programs of station-taped music, as well as Dolby-ized records, will have enhanced dynamic range and send/receive units on radio and landline terminals can similarly combat transmission noise.

Ray Dolby is also taking a hard look at the gramophone record. Now that tape hiss has been minimized on the tape masters, the old flaws in record stamper operation — tearing, sticking etc. — and grains and ripples in molded pressings are beginning to show up more than ever. It would be perfectly possible right now to begin selling Dolby-processed discs and build suitable de-processors into the record players. But a scheme of more universal application is probably what is wanted and I for one expect to see Dr. Ray Dolby come up with the first right answer.

FURTHER READING

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R. M. Dolby. *Audio*, June and July 1968.

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A Computer Electronic Music System

ROBERT C. EHLE

The author describes a computer-controlled synthesizer. Several labs are experimenting with such configurations but none are yet available.

WITH THE GROWING INTEREST in digital computers for use in the electronic-music laboratory, the possibility of a complete "composition machine" has become a reality. Such a system would consist of a digital computer and an analog synthesizer with suitable interface and control units. I would like to describe a possible man-machine sequence of events as a composer would work with such an instrument.

First, the composer sits down at a control terminal and plays the parameters of several "notes" into the machine's memory. This could be done while sitting at an ordinary-looking musical keyboard. The computer memory stores the parameters (such as duration, pitch, envelope, spectrum, etc.) in its memory and plays them back on command of the composer. The computer also assigns indexing codes to each note thus allowing the composer to alter each one at will.

In playing such a stored program, the computer controls the synthesizer just as the composer would do directly if he were playing a conventional synthesizer. The big difference is in the use of the computer as a memory and as an indexer of the various events in the piece. When the composer wishes to alter one or more of the events recorded in memory he types their index numbers on a teletype console and then plays the notes he wants to have replace them on the musical-instrument keyboard. The computer handles the technicalities and replaces the indicated notes with the new ones. If fewer notes are played, silence would replace the remaining indicated notes, and if too many are played some would not be recorded. Special instructions could be given for replacing one number of notes with more or fewer than were erased. The computer would automatically close up the gap and no discernable break would occur. The reason this is possible is that the computer does not really store the sounds themselves as in conventional recording but simply the control voltage values which are then used to control the synthesizer. Thus for a long note a larger number would be stored than for a short one, but no more space is required in memory.

Instructions for such a machine would include changing any of the pre-recorded parameters of a note and of other editing functions which are normally now performed by tape splicing. Since the synthesizer would probably be a monophonic instrument, the total machine would probably be monophonic too but it is not beyond imagination to have analog tape recorders under control of the computer so that several parts could be played, edited, and recorded, one at a time, and then dubbed onto various tracks of the analog tape with the computer handling all the syncronization problems. This would probably be easiest to accomplish with one digital syncronizing

> The computer required would be a small unit similar to the Digital Equipment Company's PDP-8 or the Scientific Control Corporation's SCC 4700. The cost for such a computer is from ten to twenty thousand dollars. The interfaces required for analog conversion of the digital outputs from the computer and for multiplexing might cost several thousand more. This is thus not a do-it-yourself project but will interest experimenters with access to the needed equipment.

Robert C. Ehle is a consultant and teacher of electronic music. He holds a master of music degree in composition and has taken advanced courses in mathematics, electronics, and computer-systems technology.

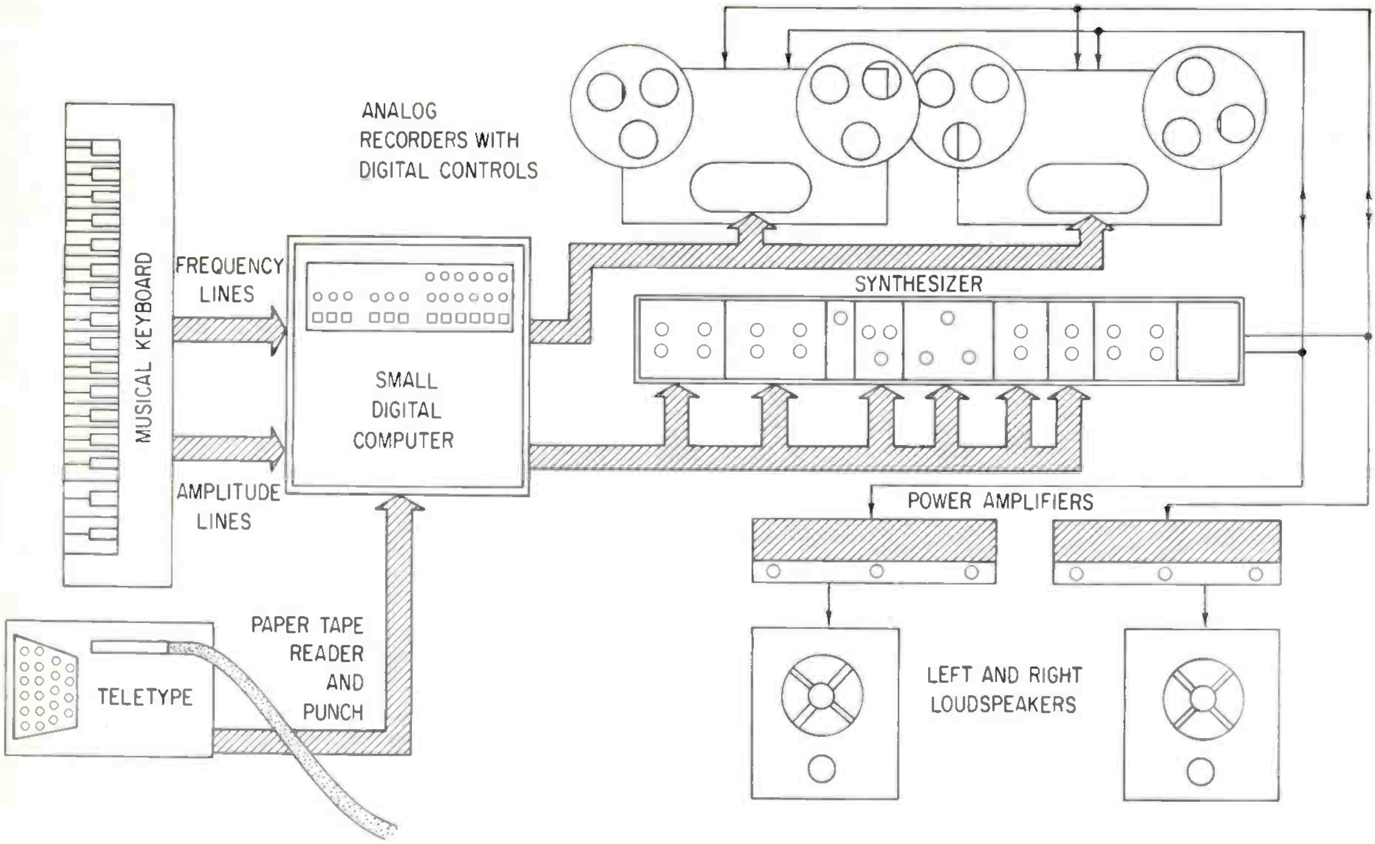

Figure 1. A block diagram of a real-time computer-synthesizer system.

track on each analog tape. Digital controls could be identical with those on the regular digital recorder.

Permanent or semi-permanent storage of material in the computer memory could be easily converted to punched tape by most teletype units supplied with present small computers. Thus, when quitting for the day, the composer reads his memory storage onto paper tape and when he comes in next morning he reads out that same tape back into memory and takes up where he left off the previous day. This leaves the memory clear for someone else to use in the meantime.

It should be clear that the advantages of the system described here are those of simplification of electronic music procedures. Tape splicing and editing are virtually eliminated; dubbing of parts onto other tapes to produce overlays of various sections of compositions is simplified and controlled so that the composer has more accurate control over his material. In addition, there is the possibility of performing small pieces of compositions, making alterations easily for test, then, returning the original if the change is unsatisfactory. Many different tests and changes may be run in this way in the course of an hour or two. Thus the composer has the opportunity of actually hearing his work as he goes along and making only the changes he feels are best.

Although an instrument as described in this article does not yet exist it is not beyond the state of the art. Several individuals and organizations are presently working on the development of an instrument and the elimination of problems which invariably have to be solved in such a development as this.

INSTRUCTION SET FOR THE SYSTEM

Every computer has its instruction set. The instruction set consists of the instructions which the computer recognizes and which make it do its work. The instructions correspond to the knobs and controls on a more common type of electronic equipment, only, instead of operating them directly they are fed into the computer from an input/output device such as a card reader, a paper tape reader, teletype, etc. Groups of these instructions may be assembled into large sets and translated by the computer into other forms which are more recognizable and which the computer is then able to perform. The process involves more advanced languages such as assemblers and compilers the most common of which is Fortran.

Our computer will have its instruction set as all computers do. This will have to be a real-time language since inputs must be processed immediately for the system to be of any practical value. Before attempting to define an instruction set several definitions must be made.

1. An EVENT is a musical building block; it consists of an envelope, a frequency, a harmonic spectrum, and a specification of frequency or amplitude modulation.
2. All input data will specify all of these parameters. No specification will assume a default value of 0.
3. Events will be numbered consecutively from one; no unnumbered time slots are allowed. Rests are events with frequency = 0.
4. As indicated on the accompanying illustration, all events can be specified by means of five control voltages. These voltages are 1. the frequency of the basic signal, 2. The frequency of the modulation signal, 3. the amplitude of the basic signal, 4. the spectrum of the basic signal, and 5. the amplitude of the modulation

signal. A useful addition would be a waveform switch (sin, square, sawtooth, triangular) but this might remain a manual control on the synthesizer.

5. Some parameters, such as envelope must have several parts (attack, steady state, decay, sustain level), and envelope type variations might be specified for timbre or pitch change. If this introduces too great a complexity to the computer language an envelope may be specified by four or more successive events having different amplitude specifications.
6. A convenient way of specifying varying parameters is to specify the type of curve (usually exponential), the rate of curvature, and the time allotted. This could be simplified further in standard cases by deciding that the attack on an event will always be exponentially increasing and that, by specifying an average rate, only the time allotted to the attack need be given. While this might be satisfactory for attacks which are relatively fast, decays must allow for the specification of a variable for the rate of decay. For special cases the linear curve would be necessary as well.
7. The problem of specifying rates of change is more complicated than specifying fixed values. Several other possibilities exist. 1. The computer could calculate incremental changes from a formula input. 1. A repertoire of standard curves could be stored in a memory device to be called on when needed.

As indicated above, many of the problems remain to be ironed out. This will probably require actual installations and much experimental work.

The following is a preliminary instruction set for the computer-synthesizer instrument. It should be realized that this set is a language, at least on the level of an assembler and, thus, will require development and debugging of its own. It will also require assembly time when data is input to the computer.

Load instructions (play while loading)

1. Load x events in y time slots. Define x, y.
2. Replace x events in time slots beginning with y.
3. Redefine a parameter of event in time slot y.

Play instructions

1. Play entire memory consecutively.
2. Play events from x to y.
3. Play entire memory in retrograde.

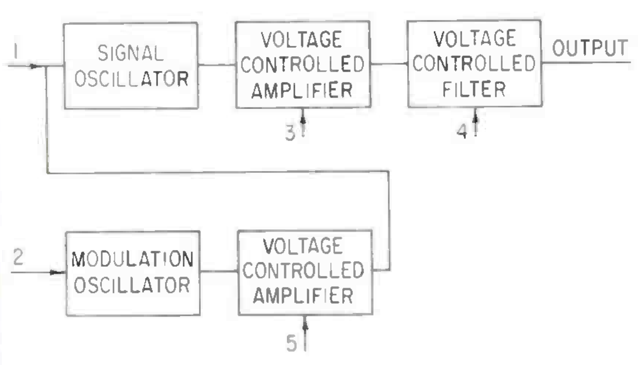

Figure 2. A basic synthesizing system usable with the computer control described in the text. Five control voltages from the computer interface are required. Two such units could be used for polyphonic work or for stereo sounds.

4. Play events from y to x.

Editing instructions

1. Erase entire memory
2. Erase events from x to y, (convert to rests)
3. Erase events from x to y, close gap.
4. Interchange events x and y.
5. Add events a thru b before event x.
6. Reverse order of events from x to y.

Print instructions

1. Print contents of memory.
2. Print events x thru y.

Record instructions

1. Record entire memory on analog tape. Save tape cue mark.
2. Record entire memory on analog track two. Match cue mark.
3. Record entire memory on analog track n; Match cue mark. (where n equals number of track to be recorded)

In using these instructions the procedure is as described earlier. The composer might type the first load instruction, and specify $x = 6$ and $y = 1$. Then he plays six "notes" on the musical keyboard. He plays the modulation frequency with a control or a linear controller. He sets the envelope with envelope controls in a conventional manner (as in present synthesizers) and he set the filter with a fixed control or with a linear controller.

The parameters, from the moment of key depression to the moment of release, are detected and stored by the computer. He hears the sounds as they are being played and he can rehear them by specifying a *play* instruction on the typewriter. After the composer has loaded several dozen events in this manner, and he can no longer remember their order in the memory, he calls for a *print* contents of memory instruction. This causes the computer to print each event on the teletype with all parameters and the event's index number in memory. This is the number needed to refer to the event for editing purposes.

After listening to this material several times and making notes on the printed "score" the composer is ready to start making changes. He may remove several events and insert new ones, playing them on the musical keyboard after preparing the computer for them by printing a *replace* instruction on the teletype.

After performing each editing instruction desired, the composer plays the entire score with a *play* instruction and records it on the analog tape recorder from the output of the analog synthesizer. By using a *record* instruction rather than manually operating the analog recorders, the composer is able to store a cue mark which allows him to place a second track on the tape with great precision. He can then do a third track and so on, up to the limit of the tape deck. (At least four tracks should be available here).

This description is a preliminary one and many aspects of such a system need to be worked out. Still, the technology exists to make a reality of an integrated analog-digital composition system and it is sure to be accomplished in a few years, if not sooner. I have tried to describe the plan of such a system in the light of the benefits it promises to the composer. This article amounts to a preliminary specification. As such it is a working tool in the development of the system and it will be updated as new improvements are devised. It may serve to suggest a direction to those already working on such a problem.

A Common-Bass Mixer-Filter Amplifier

WALTER G. JUNG

Multiple-channel sound monitoring systems with restricted speaker space availability can well benefit from common-bass feeds — without any real loss of multi-channel identification. The simple amplifier feed circuit described herein will accomplish this.

An interesting and practical approach to a combination mixer and filter unit is represented by the one-transistor circuit shown in Figure 1. This circuit arose out of the necessity to combine the two channels of a stereo signal in a one-to-one relationship and simultaneously roll off all high-frequency information above 50 Hertz. The resultant output is suitable for driving a common-bass amplifier in a system similar to that of Phillips[1].

The circuit design is quite simple, easily and predictably modified for different cutoff frequencies and uses economical, readily available, non-critical components. The circuit can be described in two parts, a mixing portion and a filtering portion. The mixer action will be described first, since it takes place prior to the filtering.

Walter G. Jung is a senior engineer in the electronic design department of Maryland Telecommunications Division of KMS Industries, Inc.

MIXER ACTION

The transistor Q1 functions as a grounded-base, low input-impedance mixing element. The impedance looking into Q1's emitter is very low ($\approx$50 ohms) with respect to the 6.8 k input resistors. As a result, these two inputs appear effectively as current sources and the L and R voltage signals are translated into current variations and summed in the common 50-ohm impedance. This dynamic emitter current will be $I_e = \frac{E_{in}}{R_{in}}$ or $\frac{E_{in}}{6800}$ Each input sees essentially a 6800-ohm termination to ground (the resistor value) with very little interaction between the inputs due to the low mixing-bus impedance presented by Q1's emitter impedance. (For those readers interested in an analysis of this technique reference 2 is cited.)

The current injected into Q1's emitter via R1 and R2 also appears as collector current of course, and develops an output voltage proportional to the load impedance. With R6 equal to 6.8 K, a 1 to 1 voltage transfer will take place between either input and the output voltage developed across R6, the common load ($E_o = I_e + R6$ or $I_e + 6800$).

FILTER ACTION

Since the output voltage is developed by current variations in a load impedance, it naturally follows that a reactive load impedance will give an output voltage which is a function of frequency. As a consequence, a simple shunt capacitor, chosen so its reactance = R6 (6.8K) at the desired corner frequency will yield a smooth, 6 dB per-octave low-pass filter. With the value shown (C3, = .47µF) a cutoff frequency of 50 Hz is realized. Different cutoff frequencies can be chosen by selecting $C = \frac{1}{2\pi f X_c}$ or $\frac{1}{(6.28f(6800)}$ where f is in Hz and C in farads.

This technique is attractive for a number of reasons. First, the common base, high output impedance transistor Q1 serves as an excellent isolation device between the input mixing circuit and the output filter. No interaction is possible with any of the input network parameters, thus making the output characteristics readily predictable with the selection of 2 component values, R6 or C3, or by leaving R6 fixed at 6.8 k, just C3. Second, in the range of frequencies under consideration ($\approx$50Hz) the value of C3 is under 1 µF, allowing it to be a non-electrolytic type. This means it can be of reasonable size, available in close tolerance for good repeatability, and not subject to leakage problems. Third, variable corner frequencies can be made available with the addition of a single-pole, multiple-throw switch. High value polarizing resistors are easily added to eliminate charging thumps when the switch is activated.

ADDITIONAL CIRCUIT DETAILS

Several other aspects of the circuit are worthy of comments to illustrate their purpose.

The transistor type specified Q1 is by no means critical, almost any reasonable silicon type may be used, even an npn if more expedient (proper polarities being observed, of course). Beta need not be exceedingly high because of the forced emitter current, so actually the only consideration is that the

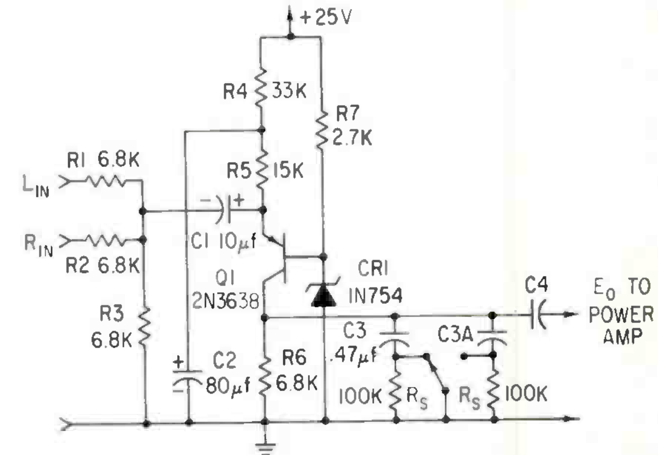

Figure 1. The common-bass, mixer-filter described in the text. To calculate the value of C3 for different frequencies let $X_c = 6800\Omega \therefore C = \frac{1}{2\pi f6800}$

device used have an H_{ib} which is low with respect to the 6.8 k mixing impedances.

If a low ripple supply is used, filtering action provided by C2 may be unnecessary. In this case the combination of R4 and R5 can become a single 47K resistor back to the supply.

C1 is used as an input d.c. blocking capacitor for the mixing network, and R3 is a d.c. return for the input network R1-R2 and C1. C4 is a simple output blocking capacitor.

SUMMARY

The circuit described has several unique characteristics which enhance its suitability for this particular application. The design concept is very straight forward and can easily be adapted to any number of inputs and various cutoff frequencies, or switched operation.

The biasing of the transistor is very conservative and most tolerant of parameter and device variations. Interested readers who may want to adapt the basic configuration to other supply voltages or polarities will find the transition quite painless if proper attention is given to the laws of Mr. Ohm.

For those who are systems-minded, the unit is easily designed for unity insertion gain (as in the example) below the cutoff frequency. It consumes little power, is conservative of components and is an extremely reliable design. With appropriate values, gain or attenuation ratios can be realized. In all the unit is an extremely flexible circuit for its simplicity.

REFERENCES

1. C. William Phillips, *The Wooden Monster*, AUDIO, October, 1965. Page 48.
2. Earl E. Swartzlander, Jr. and Charles H. Downey, *Two Transistor Summer Boasts Stability* EDN., December 1968. Page 85.

New Products and Services

STUDIO MONITOR

● In request to the recording industry for a deluxe wall-type system similar to the Altec model 844A but with a larger enclosure for extended bass, the manufacturer is offering the model 9845. The components include a model 416 type 15-inch low-frequency speaker and an 806 type high-frequency compression driver coupled to a cast aluminum sectoral horn (model 511A) which operates from the 500 Hz crossover up to 22,000 Hz. The enclosure uses 13-ply hardwood in it along with cross braces for strengthening. Over-all weight is 130 lbs. A data sheet is available.
Mfr.: Altec-Lansing Div.
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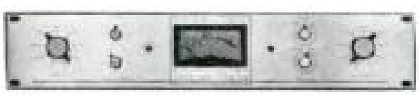
COMPLIMITER



● The coined word above is used to describe this new limiter/compressor. It will peak-limit and volume compress, with either independent or simultaneous action—as a direct function of the type of program input and amount of compression desired. Model 610 Complimiter[tm] will peak limit with extreme speed—100 nanoseconds to 2 microseconds. This peak limiting can be accomplished with low distortion, typically recordings will be affected by 0.05 per cent over a 30 Hz to 20 kHz range—at significantly higher than conventional 0 vu. There is visual lamp indication for the essentially instantaneous peak limiting and also for system overload. Compression ratios are continuously variable from 1.1:1 to over 100:1.
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FLUTTER METER

● Reasonable price is one of the features of this new tool designed for broadcasters and recording studio use. The model 8155 provides precise flutter measurements according to NAB or certain DIN standards. It also provides a precise 3 kHz test frequency, which may be used for recording and reproducing without a standard tape. The instrument has a self-checking feature and will maintain calibration with measurement consistency between an unlimited number of units. The meter operates from standard reproduce electronics. A completely detailed specifications sheet is available.
Mfr.: Data Measurements Corp. (formerly Micom).
Price: $450
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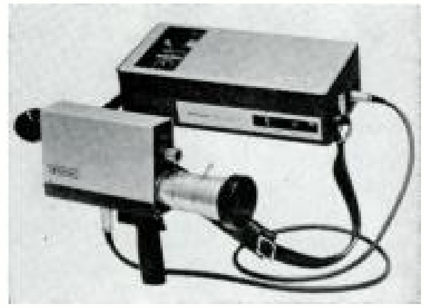
CAMERA RECORDER



● Portability is one of the strong points of this new video camera/recorder combination that has been added to this company's line of closed-circuit TV. Model 2965 is a black-and-white system including an f/2 zoom lens and microphone. It operates on either a self-contained rechargeable battery pack or normal a.c. power. Maximum recording time is 20 minutes with a five-inch (800 ft.) reel of ½-inch video tape. The camera accepts standard C mount lenses and has a built-in electrical viewfinder. Weight of the camera only is 5 lbs. The recorder itself weighs 21 lbs. The recordings employ 2:1 interlace and are compatible with other B & H recorders for playback.
Mfr.: Bell & Howell
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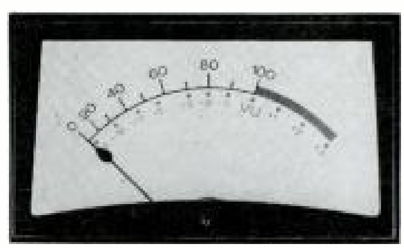
STANDARD VU



● An expanded line of vu meters, featuring models with modernistic styling has been announced. The instruments conform to all specifications of ASA Standard C16.5-1954. Attractive recessed-mounting meters, and models for use in narrow rack panels are among the new designs. In all there are nine new models with either clear plastic or black phenolic cases in widths from 3¼ to 4½ inches.
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Mfr.: Consultronics Associates, Inc.
Circle 79 on Reader Service Card

OPERATIONAL AMP

● Model 435 is a differential d.c. operational amplifier with a matched pair of low-noise input transistors coupled to an Opamp 4009 d.c. operational amplifier with a class AB power output stage. Any supply voltage from ±6 volts to ±25 volts may be used. There is no output crossover distortion and the output voltage is high, along with the current capability. A complete data sheet is available.
Mfr.: Opamp Labs
Price: 1-99—$30; 100-999—$25.00
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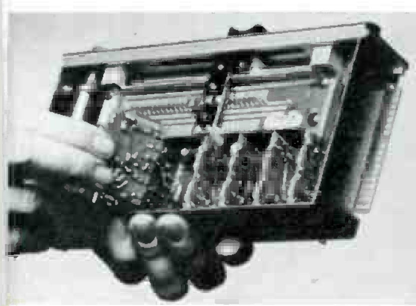
MODULAR CONSOLE



● The recent NAB convention was the place at which this company introduced its building-block concept of their new Moduline console. A total reliance on integrated circuitry is said to set a new standard in reliability. The console is built up of plug-in sub-modules that each become a part of their mother board. These mother boards may form input controls, equalizers, sub-master selectors, monitor controls, etc. The mother-board modules then plug together in the desired combinations to form a complete channel control unit. Up to 30 different channels with from one to eight simultaneous composite outputs are possible. A descriptive brochure is available.
Mfr.: McCurdy Radio Industries
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REVERB AMPLIFIER

● Though designed for listening systems, the model SR-202 lends itself to other reverb requirements. It is a stereo solid-state double-scatter unit with adjustable reverb in its two channels. A light panel, with variable pattern is coupled to the manually adjustable reverb control, supplying both aural and visual control of reverb. Input signal can be up to 3 volts and gain is approximately unity. Total harmonic distortion is less than 0.2 per cent at 1 kHz, with an output level of 330 mV and with reverb time at a minimum. Under these conditions the frequency response is ±2 dB, 20 Hz to 35 kHz.
Mfr.: Pioneer Electronics U.S.A. Corp.
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People, Places, Happenings


Morrison

● **Robert K. Morrison**, whose voice has graced **Ampex** test tapes, has resigned his position with that company to purchase and operate **Standard Tape Laboratory** as a division of **Taber Manufacturing and Engineering Co.** This new position will involve production of all types of test tapes designed for use in testing and adjusting magnetic tape recorders. Plans call for new facilities employing the latest techniques for manufacturing precision tapes to serve the broadcasting, recording, and motion-picture industries. Mr. Morrison has also found time to be the author of many technical articles which have appeared in this publication, and others.

● **Arthur D. Gaines** has been promoted to general manager of marketing and sales for **Superscope Inc.**, according to **Fred C. Tushinsky**, Superscope vice president-sales and marketing.

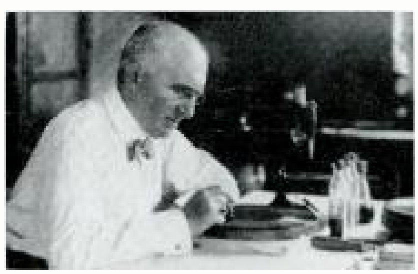
Mr. Gaines was previously marketing manager for Marantz, manufacturer of quality stereo components.

"The move is part of Superscope's efforts to strengthen and expand its management team," Tushinsky said.

Also promoted were **Steven Teachout** and **Dave Oren.** Teachout was moved up from Superscope sales-technical coordinator to marketing manager for both Superscope and Marantz. Oren was promoted from assistant sales manager for Marantz to manager of Superscope's newly-formed premium department.

● **Sterling Electronics Corp.** based in Houston, Texas has acquired the industrial division of **Radio Shack,** a division of **Tandy Corp.** The purchase was jointly announced by **Morrie K. Abramson,** executive vice-president of Sterling and **Lewis F. Kornfeld,** vice-president Radio Shack. This marks Sterling's first venture into the highly industrial northeast territory, though they presently serve the east coast with facilities in Connecticut, New York, New Jersey, Pennsylvania, Maryland, Delaware, and Virginia. The new acquisition brings their outlets to a total of sixty-four.

● Forty years ago, August 3, 1929, **N.B.C. radio** observed moments of silence over the entire network to herald the passing of one of broadcasts greatest benefactors — **Emile Berliner** — inventor of the microphone, the disc record and record player, the telephone-transmitter battery-transformer system,



the method of mass-producing disc records from a single master, the creator of the **His Master's Voice** trade mark, and the man who coined the word gramophone. Berliner was also a reknowned humanitarian and was instrumental in the passage of pure-milk laws at the nation's capitol. He also did some of the first productive experiments with helicopters. The acquisition of his patent on a microphone precluded **Western Electric's** entry into the telephone business and paved the way towards the **Bell System** becoming today's giant corporation. His word gramophone is still widely used in Europe to connote what we call a phonograph. He founded the now giant **Deutsche Grammophon Gesellschaft,** the tiny **Berliner Gramophone Company** is now **RCA Victor.**

● The first Ampex MM-1000-16 to go to Chicago has arrived at **Universal Recording Studios,** according to an announcement by **A. B. Clapper,** Universal manager. The new equipment is being used to record masters for radio and television commercials, film production, pop singles, and lp's. The **American Breed** will be one of the first pop groups to use this equipment.

● A blare of brass issues from the right and left balconies, an electronic pulse beats out a spasmodic rhythm from above and behind the stage, echoes of percussion oscillate from main floor alcoves, and electronic thunder resonates from the rear balcony.

The Tyrone Guthrie Theatre's new 4-channel sound system, designed and built by **Sound 80, Inc.,** of Minneapolis, Minnesota, offers the opportunity for all these sounds, and more, all at once, one at a time, or in any combination. This specially designed system consists of the most advanced electronic equipment on the market. What could not be purchased on the open market was built to plan by Sound 80.

The system incorporates a **Scully 280** four-track recorder which is programmed through a nine-input, ten-output control console. Five **Crown D-40** stereo monitor amplifiers feed any of ten **Altec 9844** speakers.

The multi-channel system makes it possible to move the sound around the theatre by programming various prerecorded channels of the four-track playback unit to any combination of amplifiers. For one sound cue, percussion may be programmed to main floor speakers, backstage, or to all simultaneously. A total of 90 combinations are possible.

It's all part of a specially-designed total sound system which Sound 80 technician **Scott Rivard,** working with **Herb Pilhofer, Tom Jung** and **Gary Erickson,** created and built.

As one of the most advanced sound systems in any theatre in the country, it combines maximum sound reinforcement and flexibility with minimum noise. An **Audio Designs** console, which will be expandable to sixteen output channels, is planned for future installation, using Audio Designs modules in conjunction with Audex solid-state switching.

"The Dolby System effectively reduces print-through in our spoken word recordings,"

say Marianne Mantell and Barbara Holdridge, co-founders of Caedmon Records.

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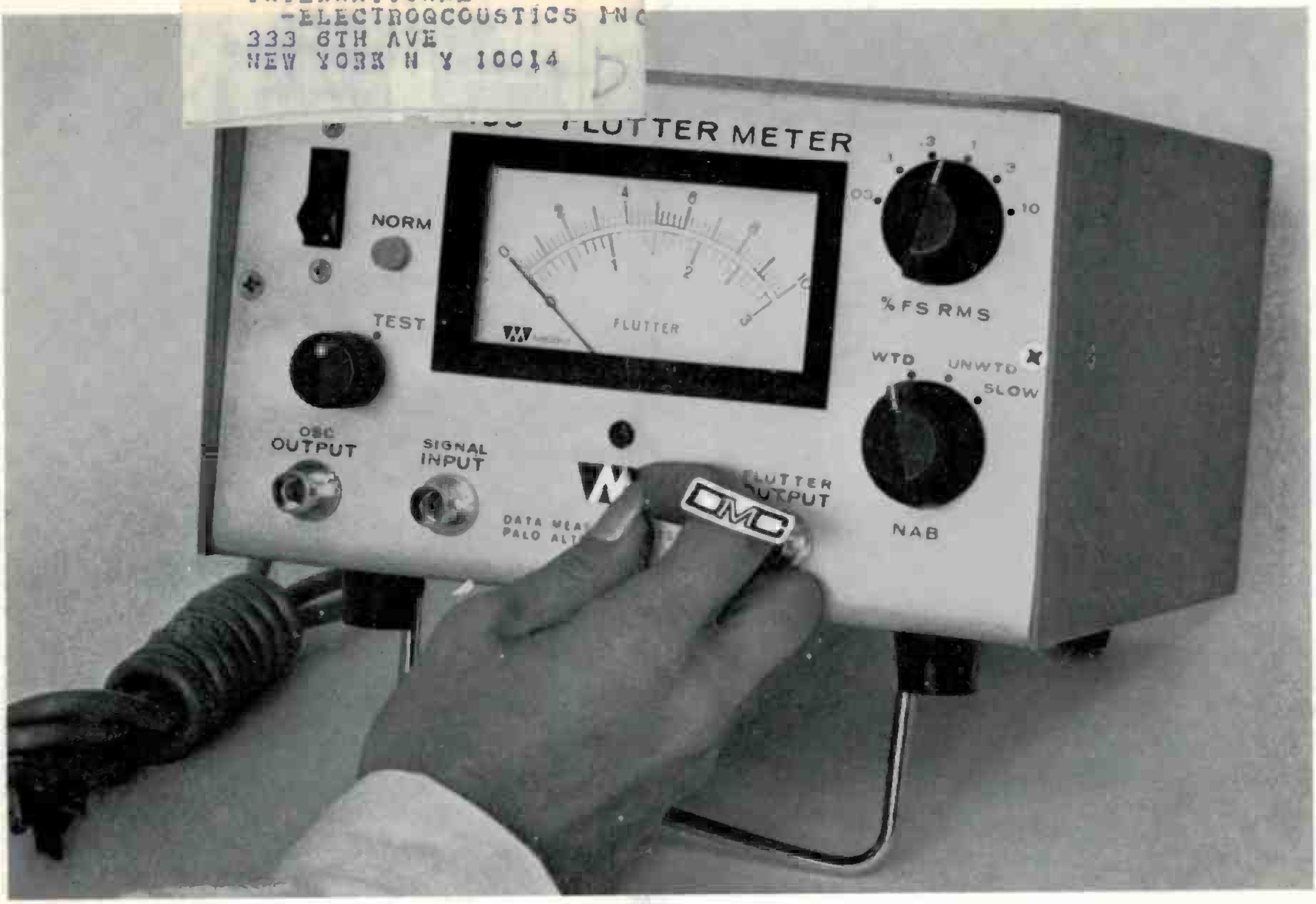

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So when you need high-performance, professional quality measurement instruments, don't call Micom, call DMC. We're still at the same location.

**You might be particularly interested in one of DMC's newest instruments. The one getting its name changed in the photo above is the Model 8155 flutter meter. It provides precise flutter measurements to NAB and DIN standards, is specifically designed for use in radio, television and high-fidelity applications – and costs only $450.*

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