1st January 1887. The idea occurred to me that it was possible to devise an instrument which should do for the eye what the phonograph did for the ear, and that by a combination of the two all motion and sound could be recorded and reproduced simultaneously. This idea, the germ of which came from the little toy called the Zoetrope, and the work of Maybridge, Marie, and others, has now been accomplished, so that every change of facial expression can be recorded and reproduced life-size. The Kinetoscope is only a small model illustrating the present stage of progress, but with each succeeding month new possibilities are brought into view.

I believe that in coming years, by my own work and that of others, Maybridge, Marie, and others who will doubtless enter the field, that grand opera can be given at the Metropolitan Opera House at New York with no material change from the original, and with artists and musicians long since dead.

The following article, which gives an able and reliable account of the invention, has my entire endorsement.

The contributors are positively well qualified for their task from a literary standpoint and the opportunity which Mr. Dickinson has had in the course of his work

[Signature]

Thomas A. Edison
AMAZING TOWER TEST PROVES SUPERIORITY OF SCOTT FET DESIGN!

NEW 342 RECEIVER HAS GREATER SENSITIVITY, BETTER SELECTIVITY, LESS DRIFT, AND EXCEPTIONAL FREEDOM FROM CROSS MODULATION.

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UNTIL DEVELOPMENT OF FIELD-EFFECT CIRCUITRY BY SCOTT ENGINEERS, IT WAS IMPOSSIBLE FOR AN ALL-SOLID-STATE FM RECEIVER TO PROVIDE THE LISTENER WITH BOTH HIGH SENSITIVITY AND FREEDOM FROM ANNOYING CROSS MODULATION. THIS TEST STRIKINGLY DEMONSTRATES ACHIEVEMENT OF BOTH DESIRED RESULTS. CROSS MODULATION REJECTION IS AT LEAST 20 DB BETTER THAN CONVENTIONAL DESIGNS . . . AND THERE IS NO SACRIFICE OF SENSITIVITY.

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CONTROLS INCLUDE TAPE MONITOR, SPEAKER SWITCHING, STEREO BALANCE, BASS, TREBLE, AND VOLUME, AUTOMATIC STEREO SWITCHING, AND FRONT PANEL STEREO HEADPHONE OUTPUT.

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WRITE FOR SCOTT'S INFORMATIVE NEW BOOKLET ON FIELD-EFFECT TRANSISTORS.

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February, 1966 Vol. 50, No. 2

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AUDIO • FEBRUARY, 1966
COMING

Articles

A Solid-State Flutter Meter, by Arthur Gladfelter. A home-construction project resulting in an instrument useful to all tape recording enthusiasts, and resulting in measurements in three frequency bands. In Two Parts — Part 1 in March.

Warning for Wives in Stereophonic Sound, by Carolyn Howard Johnson. Amusingly written by a typical Hi-Fi Widow.

High Input Resistance with Stability by L. D. Smithey. The theory behind methods employed to get a desired result. Plus all of the regular features and a section on the U.S. Department of Commerce Hi-Fi Show in London.

Profiles

ADC Six Hundred Receiver
Uher 9000 Tape Recorder
Grado Type “B” cartridge
Heathkit AR-14 Receiver Kit

In the March Issue
On the newsstands, at your favorite audio dealer’s, or in your own mailbox.

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
Joseph Giovanelli
29-37 Newkirk, Ave.
Brooklyn, N. Y.
Include stamped, self-addressed envelope.

Unbalance in a Stereo System

Q. I have a problem with my equipment which apparently defies logic and which may soon deprive me of music. I hope that you can offer some help.

I have a complete music system (stereo) consisting of two monophonic preamps, a stereo adapter, and two power amplifiers. The two preamps are operated from a common power supply.

I recently had the preamps and the power supply serviced and subsequently discovered that the left channel had decidedly weaker output. By a process of substitution, I determined that the problem lay in the left-channel preamp, which I returned for re-servicing. The service agency checked it out, told me it was fine and met factory specs. But when I got home, the same problem existed. The output was so low that I had to turn the volume up to achieve a normal listening level.

Again I brought the preamp back to the repair shop. They very kindly connected them up to another amplifier, phonograph, and speaker system. They worked fine, and had all the output I’d ever want. But again, on my return home, the output was as low as before.

Thinking it might be caused by a problem in the power supply, I switched the connections between the preamps and power supply several times, without any change in performance of one preamp over the other. The left channel always remained as weak in output as it has been described above.

If this, per se, were the only problem, I would not mind. I could simply set the two preamp gain controls at different settings, so that the output from each would be the same. However, the fact that I have to turn the volume up to minimum means that a great deal of hum and hiss appear at this level. Can you think of any possible reasons for this problem? Max Prola, Jack- son Heights, New York.

A. I really cannot give you a complete answer to this problem until I have more information.

First of all, I wonder if the trouble is really in the preamps. Maybe it is in the power amplifier feeding the left speaker.

To prove this, reverse the leads feeding the two power amplifiers. If the trouble is the preamp, the right channel will have as much output as the left channel, the reverse of the condition of which you are now writing. If the condition does not change, that is to say, the left channel is still lower in output than the right channel, the trouble would appear to be in the left channel power amplifier or its associated leads.

If the condition does not change, perhaps the trouble is in the preamp after all. Does this trouble occur on all input sources or just in the phono position?

Maybe your cartridge is to blame. You can determine this by the same procedure, reversing the leads from the phonograph to see whether the cartridge’s two channels are indeed equal in output.

Follow-Up

Q. Before writing to you the first time, I checked out the possibility of the source of the unequal outputs as being in other components. However, since then, by careful checking over a period of time, I have come to the following conclusions.

You may recall that the preamps functioned normally at the repair shop, but not at home. I have since discovered that at times, the output from the preamp is extremely low. It is comfortably audible at full output on the volume control. At other times it is louder, so that it becomes possible to balance the two channels by means of the balance control on the amplifier.

From this, I concluded that there is reduced output in one channel and that the degree of reduced output can vary from one extreme which required maximum gain to achieve normal listening levels, to another, though still lower than the other channel, is within tolerable limits. The problem is, therefore, an intermittent one.

I checked the input levels and the reduced output was evident on both phonograph and tuner.

I then decided to investigate the possibility that the volume control in the pre-amplifier might be at fault. I hooked up the stereo control with the preamp so that the tape output of the preamp was fed to the stereo control and then to the amplifier. In this way, the volume control and the tone controls of the preamps were rendered inoperative; the signal from tuner or cartridge bypassed these controls.

With the equipment hooked up this way, I found that the volume in the problem preamp was still lower, but it is at a level which can be matched with the other preamp; it never gets as low as it did previously. It would seem, then, that the
This is the Lab 80. Add up the galaxy of innovations which Garrard has developed and engineered into it...including built-in cueing...variable anti-skating compensation...ultra-sensitive magnetic tripping... and you will begin to visualize why this superbly performing automatic has revolutionized the turntable industry.

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The Enduring Ferrograph

THE FERROGRAPH CO. LTD. 84. Blackfriars Road, London, S.E.I. England

Circle 105 on Reader Service Card

If the volume control might be at fault, you were on the track in terms of the method by which the checks were made. However, what you were checking was not the volume control alone, but also the remainder of the preamp's circuitry following the selector switch. The trouble in your preamp lies anywhere from the input of the volume control onward.

You also indicated that you observed some difference in level between the two preamps at the tape output. If a tuner were connected to the inputs of both preamps and led to the tape-output terminals, there would be no loss of level because there is no circuitry there except the selector switch — at least that is true for the majority of preamps. If you did not make your check in that way, you really do not know as yet just why the output from your two tape outputs differ from one another.

If you used a recording, you can find several factors coming into play there. First of all, the cartridge may not have equal output from one channel to the other. This is a common occurrence. Secondly, the phono stages in the preamp may have differing amounts of gain. Only a test signal from an oscillator can be used to determine this.

In fact, the oscillator is the best method for feeding signals into a circuit when checking balance. Feed the oscillator into both inputs at once and then trace through the preamps with a VTVM till you find the place or places where one preamp has less gain than the other. You then can check that particular stage for other troubles.

Mistracking of the gain control in your stereo adaptor can result in an apparent imbalance between channels. To check this, feed a signal simultaneously into the two inputs of the stereo adaptor. Measure the voltage at the output of each channel with various settings of the volume control. If the pot is tracking properly, the two channels will be within a dB of each other at all settings of the pot.

If the stereo adaptor shows channel imbalance even with the pots open, then you should check into the remainder of the circuitry of the unit. Perhaps there is a dirty switch or oxidation in a connector somewhere in the adaptor or anywhere in your preamp chain for that matter.

Check all audio cables for partial shorts or opens.

Check to see if the two power amplifiers have equal gain by feeding equal signal into both and measuring their respective output voltages. They should be very nearly the same. When making this check, be sure to have a load across the speaker terminals of the amplifiers and to disconnect the speakers.

Does this sound sensible?

How can I correct it? Max Frula, Jackson Heights, New York.
RECENT PROFESSIONAL INSTALLATIONS
OF AR SPEAKERS

AR-2x
($89-$102, depending on finish)

Aeolian-Skinner reverberation system corrects excessively dead acoustics in the chapel of Choate School, Wallingford, Connecticut. Duncan Phyfe, musical director of the school, describes the effect on live pipe organ and chorus as "so natural one is not aware of an electronic reverberation system."

Similar Aeolian-Skinner installations are operating in Christ Church, Cambridge, Massachusetts, and in St. John's Episcopal Church, Washington, D.C. AR speakers were chosen because of their lack of coloration, their undistorted, full-range bass, and their reliability.

AR-2ax
($109-$128)

Sound reinforcement system for the summer jazz concerts in the sculpture garden of New York's Museum of Modern Art. Live music had to be amplified without giving the sound an unnatural, "electronic" quality; AR speakers were chosen after testing many brands.

AR-3
($203-$225)

One of the listening rooms in the Library & Museum of the Performing Arts at Lincoln Center in New York City. AR-3's were chosen for these rooms to achieve an absolute minimum of artificial coloration.

Experimental Music Studio of the University of Illinois. Dr. Hiller (seated) writes about the AR 3's, used as monitor speakers: "I wish all our equipment were as trouble free."

AR speakers and turntables are often used professionally, but they are primarily designed for natural reproduction of music in the home. Literature is available for the asking.

ACOUSTIC RESEARCH, INC.
24 Thorndike Street, Cambridge, Massachusetts 02141

AUDIO • FEBRUARY, 1966
LETTERS

Three-Speaker Stereo Hookup

Sirs:

In the past several months I have seen in some magazine devoted to audio or hi-fi an article showing how to connect three speakers for stereo. Was this in Audio? I can't seem to locate it anywhere. If so, would you please send me a copy of the article.

RAYMOND B. BOTTOM, JR.,
Vice President, WGH,
P. O. Box 98,
New Port News, Va. 23607

(If you have a different name or address, please provide it.)

A Well Deserved Rebuke

Sirs:

I have been a subscriber since the first issue of Audio, so I feel that this and previous criticisms of "my" magazine are friendly and constructive effort.

Audio has suffered along with the sorriest proofreading of too, long, and this should be corrected. Not an issue is printed without numerous typos, grammatical errors, and technical mistakes. Sometimes, even "corrected" references list the wrong pages if they appear at all, and this is less tolerable than misprinting and errors of grammar.

I was very amused by the first letter in the December issue in which you admitted the problem, then printed "a impedance" in the reply. On page 24, you refer to "an hysteresis synchronous motor." This printed h dropping never fails to irritate me, even when used by would-be snobs in the context of "humble," "historical," and the like. Significantly, even those who use it often seem to employ it in speech.

However, even if Audio never reforms, I still like the magazine and just about everything in it, including Mr. Canby, the verbiage, non-technical Yankee, whose comments and technical dabbling livens up Audio quite pleasantly.

JEROME RUSSELL OWEN
6065 Selma Ave.
Hollywood, Calif. 90028

(We were on the verge of making a firm resolution about always using "a" in front of all words beginning with "h," like hysterical and even humble and historian, but a hour later we decided it would not be a honorable thing to do. Ed.)

HIGH FIDELITY SYSTEMS—
A User's Guide by Roy F. Allison

AR Library Vol. 1 70 pp., illus., paper $1.00

A layman's practical guide to high fidelity installation. We think that it will become a classic work for novices (and perhaps be consulted secretly by professionals). From the Bergen Evening Record: "completely basic...If this doesn't give you a roadmap into the field of hi-fi, nothing will." From The American Record Guide: "really expert guidance. I would strongly urge this book as prerequisite reading for anyone contemplating hi-fi purchases." From High Fidelity: "welcome addition to the small but growing body of serious literature on home music systems." From Electronics Illustrated: "To my mind, this is the best basic book now available on high fidelity."

REPRODUCTION OF SOUND
by Edgar Villchur

AR Library Vol. 2 93 pp., illus., paper $2.00

Vol. 2 explains how components work rather than how to use them, but it presumes no technical or mathematical background. Martin Mayer writes in Esquire: "far and away the best introduction to the subject ever written—literate, intelligent, and, of course, immensely knowledgeable." From HiFi/Stereo Review: "just the books to satisfy that intellectual itch for deeper understanding."

RADIO MAGAZINES, INC.
P. O. Box 629, Mineola, N. Y.

Please send me the following:

☐ Roy Allison's "High Fidelity Systems—A User's Guide" at $1

☐ Edgar Villchur's "Reproduction of Sound" at $2

I enclose $________ in bills, money order, or check only. (All prices postpaid.)

NAME________

ADDRESS________

AUDIO • FEBRUARY, 1966
For years since its introduction, the Dynaco preamplifier design has been generally accepted as one in which the noise and distortion are so low and the quality so high that attempts to improve it would be laboratory exercises rather than commercial enterprises. Yet we have always been questioned as to why we did not gild this lily by adding step type tone controls. The enthusiastic audiophiles who ask this tell us that they want to be sure that their tone controls are out of the circuit when not being used. Our answer has always been that continuous controls give a range of flexibility which cannot be attained with step type controls, and that the "neutral" position of our controls produces a flat response characteristic adequate for the most critical need.

However, our avowed philosophy of perfectionism has kept us working on the possibility of some improvement in the circuit—and this work has now led to the first major change in our preamplifier design since it was initiated. This development (on which patents are pending) is applicable to all continuous tone control systems and immediately makes them superior to the far more expensive step type controls. What we have accomplished is to keep the infinite resolution capability of the continuous control, but to remove all frequency and phase discriminating networks from the circuit when the control is rotated to its mechanical center. This new design is incorporated in the PAS-3X (PAS-2X, too) which is now at your dealer's at the same low price.

Further, for the nominal charge of $10.00, a conversion kit TC-3X is available to update any Dyna PAS-2 or PAS-3.

Can you hear the difference? We doubt it. The preamp was amazingly good in the past. We have improved it for the sake of improvement, not because we think it needed it. It has always surpassed every other preamp without regard to cost. And, it is superior on more than measurements—including tests prove that the Dyna preamp adds no coloration to the sound and that its inclusion in the hi-fi chain is undetectable. Partially diagrammed below is the performance you can expect from the PAS-3X—why you can never get better overall quality regardless of how much money you spend.

There are Dynakit amplifiers in all power brackets which will do justice to the perfectionist's preamplifier. All are rated for continuous power.

Stereo 70
35 watts/channel
Kit $99.95

Stereo 35
17.5 watts/channel
Kit $59.95

Complete specifications and impartial test reports are available on request.

In Europe write Audiodyne a/s, Christian X's vej 42, Aarhus, Denmark.

**Dynaco Inc.**
3912 Powelton Avenue, Philadelphia 4, PA.

Audio • February, 1966
HOW TENDER IS A HUNK OF STEEL? EXCEEDINGLY...

When you are dealing with high-permeability core laminations.

In the original state, no. You can punch it, draw it, form it, shear it, or bend it and it's only thin sheet steel. But once formed into laminations and hydrogen annealed to bring out their peculiar magnetic properties, these laminations are delicate beyond belief. Drop them three inches to a hard surface, grind them ever so lightly, or merely bend them slightly and the magic is lost back to bits of sheet steel again.

MHI performance begins with unique, sintered brass core holders so staked in place that core laminations can be formed to the final contour before heat treatment. In grinding is necessary, ever. The ultra fine grinders are hand-fed and loosely stacked. (Pinch them ever so lightly and you'll have a mediocre head.)

After inductance balancing, the assembled heads are cased, epoxied and bake-cured at 250° F. — your assurance that gaps and inductance will hold at normal environmental temperatures. A final lapping and polishing of the head face is accomplished (again without grinding techniques) to provide a finish most highly inherent, built-in performance than other heads of so-called premium quality.

MHI heads provide high-end performance second to none, a superb low end, and long trouble free service life.

All of this is our way of saying: When you buy a high fidelity tape player or recorder, MHI heads as factory equipment are not exactly cause for disappointment.

Or, when buying a replacement head for your present tape equipment, you or your dealer can obtain an MHI replacement in just about five days at only one quality. Standard MHI replacement heads in the four-track stereo type retail at only $24.50. That's less than ordinary premium heads.

If you are concerned with the manufacture or engineering of teaching equipment, tape players of any type, or instrumentation systems, write or call for details on full track, half-track and quarter track heads suited to your needs.

Circle 110 on Reader Service Card
Some Sound!

At left, the gigantic Altec A7-500 "Voice of the Theatre" speaker system, whose massive perfection in sound thunders forth in the nation's recording and broadcast studios. (Studios don't have wives concerned with room décor, but they do have a strict requirement for the best speaker system anywhere!) Hand-fitted sculptured walnut hardwood cabinet, elegantly patterned in natural wood grain. Delicate, Spanish-inspired fretwork grille, curving gently. A gracefully rounded facade for a massively rounded sound.

The Magnifique Altec A7-500W-1. For the man who won't compromise sound...and the woman who won't compromise beauty.

Altec's PLAYBACK A7-500, as used in recording and broadcast studios, and in its new, Magnifique A7-500W-1 decorator model, is a high-efficiency system with an unusually wide, smooth frequency range of 35-22,000 Hz (cps). A large cast-aluminum sectoral horn accurately reproduces frequencies above 500 Hz. Altec's famous high-efficiency 802D high-frequency driver coupled to the 511B horn achieves the cleanest, distortion-free midrange of any h.f. speaker. Low frequencies are reproduced by our 15" Model 416A bass speaker combined with a front-loaded exponential horn and full-size rear-loading reflex baffle.

Designed to operate on 8 or 16 ohms, the Magnifique A7-500W-1 has a 30-watt power-handling capacity. Dimensions: 44" H x 32" W x 25" D. Consumer net: A7-500 (the brute at left) $327; A7-500W-1 (the beauty at right) $498. Same sound! Write for complete Altec catalog, Dept. A-2.

Besides the glorification of style, you will be aware of something new in the sound from the A7-500W-1 which transcends even that which placed the earlier A7-500's at the summit of loudspeakers. Listen to the new Magnifique; or if you're French, the new Magnifique; or if you're Spanish; the new Magnifica!

ALTEC LANSING
A Division of LTV Ling Altec, Inc.
ANAHEIM, CALIFORNIA

Circle 112 on Reader Service Card
The cameras are rolling. Fill-in lights play over the principal actors to compensate for the gloomy weather. Spread out over the countryside is an army of extras dressed in boots and armor, carrying spears and crossbows. The hero is making a speech. All listen in rapt attention. There are no mishaps and the scene is chinked down as a master take. But to the uninitiated observer, quite a few things would seem to have gone wrong. While the scene was being acted, a truck had roared down a highway nearby; a plane had dived overhead; an overseas jet, invisible above the clouds had screamed in the distance, one could hear music from a transistor radio dangling from the handlebars of a passing bicycle; all this to the obtrusive sound of the wind agitating the trees. The sound engineers were on hand with their microphones, but they appeared unconcerned; they and everyone connected with this film about medieval England knew that the speech would be re-recorded out of range of twentieth-century noises and stubborn nature-made sounds.

In a studio remote from the scene of the shooting, the actor will repeat his lines as he watches himself on the screen. Later a film editor will lay in the newly recorded track hoping to achieve near-perfect lip-synchronism. When the final mix is made, every syllable will be in its proper place. But for some reason the dubbed scene will be as disturbingly unreal as if the truck, the jet plane, and the transistor radio were still there. Despite sonic montage, it will fail to convince us that the words we are hearing actually were spoken by the actor. For example, we observe the wind swaying the branches of the trees, but we don't hear the leaves rustle; we see the actor move along the rocky hillside, but his feet make no sound, as if he were floating in space. What we are hearing is a voice recorded in a dry studio where every syllable and every breath intake can be heard clearly. The illusion which the technicians attempted to preserve with such painstaking care has been shattered.

Dubbing has become a permanent feature of cinematic life. Because it is a process that demands a high degree of taste and sensitivity, we can expect to see increasingly more movies produced with the kind of visual-sonic incongruities described above. In fact, films that possess true integrity of sound and image are in danger of flickering into extinction.

In itself, dubbing is not the villain of this piece. In this sound-polluted world of ours, few outdoor scenes can be shot tree of extraneous noises. Even remote lands are not immune to the jet plane. Noise is not the only actor that calls for lip-synchronism and background dubbing. The economics of movie-making require it. Unlike stage actors, many film stars have trouble memorizing their lines. Obviously it is cheaper to re-record dialogue in a studio than out of doors with a film crew and throngs of extras standing by getting paid by the hour.

The exodus from Hollywood and the growth of international co-productions have witnessed an increase in the number of films produced with casts made up of actors of different nationalities, many of whom speak little or no English. In these cases all dialogue in and out of doors is dubbed. Language dubbing of other films of international appeal has become a major industry. In an article the lines of Marcello Mastroianni, Andrey Hephurn, Cary Grant, and so on, in everything from Finnish to Japanese.

Many movie producers take the easy way out and dub films in their entirety. I often hear the claim that the Italians, for example, have developed this technique to an amazing degree. Perhaps I haven't seen enough Italian films, but I have yet to be convinced.

Is the public aware of faulty dubbing? Hard to tell. But we do know that the great majority of movie critics are not, or else don't write about it. Only one issue aroused controversy in recent years: the use of English subtitles versus dubbed dialogue. It was a debate of limited scope that failed to grapple with the principle of dubbing, only its application to the dialogue of foreign-language films.

It took a critic outside of the ranks of screen reviewers to cope with the basic issue. In an article for the New York supplement of the Sunday Herald Tribune (September 20, 1964), Walter Kerr wrote of the introductory scenes of the film The Night of the Iguana in which "clergyman Richard Burton chases his congregation out of the church. We begin to see him coming down the aisle, shouting and hearing his stunned flock toward the doorway, head-on. We see his face, throat, and shoulders all at work as he shouts. The film then cuts to a rear view of Mr. Burton as he pushes the throng..."
Leave it to us.
The new, integrated Miracord 40A comes with its own cartridge.

Factory cartridge installation insures correct installation — optimum playback quality and lowest record wear. Distortion and tracking problems due to incorrect positioning and angling are eliminated.

It is natural that the manufacturer who built the first turntable-quality changer, and the first moving magnet stereo cartridge, should be the first to combine the two in an integrated unit.

The new Miracord 40A plays records manually or automatically, singly or in sequence, at all speeds. Its features include: heavy, one-piece, dynamically balanced 12" turntable; dynamically balanced tone arm; calibrated stylus-force dial; high-torque, 4-pole induction motor; and the famous feathertouch push buttons which help make the Miracord the most gentle of all turntables.

The new Elac 240 mono/stereo cartridge in the Miracord 40A has an 0.7 mil diamond stylus. It is distinguished by clean channel separation, low distortion and smooth, flat response. Its performance is comparable to many highly reputed, stereo-only cartridges available today.

The new Miracord 40A is priced at $89.50, complete with Elac 240 cartridge, but less base. See and hear it at your hi-fi dealer. For further details, write: Benjamin Electronic Sound Corp., Farmingdale, N.Y. 11736
DX-ing

Sometimes I get the strangest anonymous packages through the mail. Like one that came in a few months back, without the slightest warning—not even any advance publicity.

It was the size of a ladies' shoebox and it came from Norveko. Hmm, says I, I must be something to do with hi fi. Or maybe records. Or tape. So I unpacked it, not noticing the label on one end of the box, and found inside a slick-looking but moderately indescribable object, sort of like an elongated electronic shaver, or maybe a small hair dryer, made out of plastic with sort of slats for air, up at one end, and a batch of little knobs and things on the side. Controls. Not a word printed on the thing itself.

One little slider switch showed a red streak when I pushed it up. on, I guessed. I turned it on and nothing happened. An arrow on the bottom indicated a door of some sort into the inside—I finally managed to get it opened (the arrow was slightly misleading) and there was a battery. 9-volt, transistor energizer. Hmm, says I once more. What no we have here? Mysteriouser and mysteriouser. There was a cord, too. Bare wires. No plug on the end.

Well, I went back to the wastebasket and retrieved the box, which I had thrown out in my usual rapid fashion. Lo and behold—it said PROFESSIONAL MICROPHONE, modestly, on one end. And out of the inside fell a comic book.

Looked a bit like one anyhow. But it was, instead, an all-language (i.e. no-language) instruction booklet. Pictures only. And also, out fell two sheets. One was labeled ERATZIELDEBTLUNG, a mouthful that was happily translated as Parts Order. Lotta diagrams of insides, with parts numbers. The other sheet said “Microphone Specification DX11, Technical data.” The entire sheet was blank. No technical data! Hmmmm, says I. This isn’t going to be so easy. (It’s an AKG mike, from Austria.)

Pictures Only

So I dove into the no-language instruction book. It was like none you’ve ever seen. About 2 x 10 inches, and on the cover it says DX11DX11DX11. Picture-drawing, that is—of a silly wench with big you-know-whats and a hideous black-haired harlot, smiling gaily. She has a DX11 in one hand.

Page 2. Ye gal is doing a dance step. Mike is diagrammed in a box with three knobs and then to a sort of 1925 kind of auto horn. Hmm—loudspeaker. Maybe. Yep. At the other end of the page, a dizzy old gent with walrus mustaches sits on a bar stool with champagne in one hand and looks lecherously at ye gal. Love-interest begins.

He’s listening (one can guess) as well as looking. Ahh! Public address. The box is an amplifier. That’s it.

Page 3. She’s doing another dance twist, to the left of the page, and the mike now runs into an oblong taper recorder. Feels. Oversimplified, but I bet it’s a Norveko. Old man is in dressing gown now, in a plush chair, with cigar, looking benevolent. I mean listening benevolently. His eyes are closed. Natch. This isn’t videotape.

Page 4. Complications. This is really baffling. Ahh! I get it! The lady dances a step with mike in one hand, in one picture. Then she does the same no-hands in another picture. Mike is on a stand. Big fat arrow runs to diagram of an octagonal collar arrangement, with measurements. Part 13. Little man (in white smock and thick black glasses—why?) points to it, looking pleased through his walruses.

Page 5. Connections. Fat cable, enlarged in diagram. One wire is red, another is 200 ohms, and a third is common to both. Then there is the shield. Three kinds of plugs, with words (at last) attached. Nouns, though. Not verbs. Little man is now a carpenter type, with lots of pockets on overall black skull cap. He looks pleased. He’s examining a plug. I’d be pleased too. I hate connecting plugs.

Page 6. Now we come to the pay-off. Little lady is reduced to the you-know-whats and the bouffant hairdo. She’s lost her lower anatomy. Next to her—two of her—is a big, black plug. Diagram of the controls on the mike and next to that, beside the rotating knurled thing that works like a volume control, it says “LAAsa” and then, “La, li.” Across the page is a picture of the openable box for the battery, with an arrow, and 9V written inside.

Get it? What—you don’t? Now, come on! You, an expert audio man, can’t figure that one out?

Instant—

Well, I couldn’t either. And that battery had me flummoxed. As well as the funny shape of the mike; for its plastic case, tapered a bit towards the bottom. was tall, not far from ten inches, and something had to be in all that extra space, along with the battery. So I tossed the whole thing to my assistant and came back later, to find the 200-ohm wire (white) hooked into a shielded cable with a phone plug on it, ready to try to see what would happen. But I’ve forgotten to tell you about page 7. Page 7. Pure guesswork on my part, yet I figured maybe the transistor circuit on this last page might have something to do with that battery and mysterious other parts inside the mike. Little man with the moustaches has now persuaded his gal (who has her whole body back again) to come over to his side of the page and the two of them are making eyes in what looks like a flowery meadow. Flowers, anyhow. No mike in sight. Love conquers all, I, irrelevantly. Some instruction!

The diagram looks like this, anyhow:

Needless to say, you know what the DX11 is by now, but I still didn’t. So I plugged it into my Ampex 350 system, one of the mike inputs on my mixer (tailored to the broadcast and specially built for me ‘way back)—and I talked, and recorded.

Well, it sounded like a mike all right. I compared it with my regular broadcast mike, a real oldie but a beauty for its age (Western Electric cardioid) and found that it compared favorably enough. As with speakers, of course, all good mikes should sound exactly alike. These two were certainly very close first cousins.

Then I turned that little knurled volume control on the mike all the way, just to see what would happen. You know what happened. Of course! On one position, I said “La” and it came out “Li” on the recording tape. On the other hand, “Li” again (copying the comic book instructions) and the tape said back to me “LAAAaaa.” Yep, it’s an instant reverber mike. Built-in doorspring system.

Now what on God’s earth would I do with a reverber mike, right in my own home? I’m not night club owner (and the only recordings I make are informational, broadcast, speech only). (Via the mike, that is. I don’t tape records through a mike, thank you.)

I felt like a perfect idiot—all I could think of was to say “La, Li, Li” a dozen times, and then “WUmp, WOOF-WOOF” and the inevitable “TESTING, TESTING” —all of which came out duly scrambled and reverbered to a fair thexwel, WWWWWUMMMPPP WOOFVFWFVFWF, TSTN TTSTNGGG. Interesting, if true, I’m sure I must have wondered what I was supposed to do next.

No question about it, this ingenious microphone can make hash of any and all speech with the greatest of transistorized ease, in case that’s what’s on your mind.

Now I suppose that a reverber mike is real useful—once the somewhat limited stant value is run through and the kids have tried saying WUMP, WUMP into it until they’re tired)—for those who actually sing and dance on a stage, home-type or otherwise, or pro and amateur. And for all who want to add reverbered singing to their own home-style tapes, whether to home accompaniment, records or taped radio music. Fine, even if it isn’t my dish. (No point in recording with a reverbered mike for professional work. There, the reverb is added afterwards—or via a fancy built-in studio reverb system.) I can even imagine trying this mike for such serious efforts as the recording of home-style “live” music, or a chorus, or chamber group, in the too-dead acoustics of the average home or meeting room.

12

AUDIO • FEBRUARY, 1966
The new Sony Solid State 350 adds professional performance to home entertainment systems

Selecting the brilliant new Sony Solid State 350 to fulfill the stereo tape recording and playback functions of your professional component music system will also endur-
ingly compliment your impeccable taste and passion for music at its finest. With an instant connection to your other stereo components, the versatile two-speed Sony 350 places at your pleasure a full array of professional features, including: 3 heads for tape and source monitoring. Vertical or horizontal operation. Belt-free, true capstan drive. Stereo recording amplifiers and playback pre-amps. Dual V U meters. Automatic sentinel switch. Frequency response 50-15,000 cps ± 2db. S.N. ratio plus 50db. Flutter and wow under 0.15%. Richly handsome gold and black decor with luxurious walnut grained low profile base. This remarkable instrument is yours at the equally remarkable price of less than $199.50. Should you want to add portability to all this, there’s the Model 350C, mounted in handsome dark gray and satin-chrome carrying case, at less than $219.50. For information write Superscope, Inc., Sun Valley, Calif.

Audio • February, 1966

Superscope The Tapeway to Stereo

Portable Model 350C
Circle 115 on Reader Service Card
NEW THORENS TD-150AB

A superb turntable in the world-famous Thorens quality tradition. Features silent, two-speed operation (33⅓ and 45 rpm), plus integrated tone arm that incorporates latest safety lowering device with pneumatic damping action. You get everything you ever wanted in an integrated turntable, including the Thorens reputation for precision craftsmanship.

Only $99.50

OTHER FEATURES INCLUDE:
- Extra-light, low-mass aluminum plug-in shell with exclusive adjustable vertical tracking angle. Adjusts to optimum playback stylus angle for any cartridge.
- Handsome slim-line chassis.
- 12-inch, 7½ lb. precision balanced, non-magnetic platter.
- Spring-loaded suspension system to minimize vibrations.

THORENS TD-124

Series II

The Finest Transcription Turntable on the market today

A brilliant example of Swiss craftsmanship acclaimed throughout the world. Unmatched for mono- or stereo-performance. Has more outstanding features, more built-in extras, than any transcription turntable in its price range. No other instrument like it available. Illustrated with the Ortofon RMG-212 Tone Arm and Hi-Jack cueing device. Only $125

IMPORTANT

15° STYLIUS OWNERS

It is an ignored fact, that in any record changer or automatic turntable that stacks records on a turntable, the 15° stylus will have its greatest tracking error when used for single play because of the compromising angle of its tone arm.

Therefore, for correct tracking and optimum playback performance, any stylus including the 15° stylus should be used with a non-automatic turntable.

A "MUST" FOR RECORD LOVERS!

Want to get more out of your records? Reduce surface noise? Get longer record life? Learn professional secrets of record care? Get a copy of HOW TO CLEAN, MAINTAIN and PROTECT RECORDS by Cecil E. Watts, noted record care expert. Only 25c.

Available from your hi-fi dealer or order directly.

ELPA MARKETING INDUSTRIES, INC. • Dept. 110A2 • New Hyde Park, N.Y.

Might work. Might help the sound, if used with discretion.

Beyond that, I'm afraid my imagination runs to negative values. Like reverbering a dull lecturer, glamorizing his sounds into unintelligibility. (College students, I dare you . . . ) Or doing recorded dictation for the office secretary with added reverb to keep her awake in the transcribing. (That's roughly like pouring perfume on her typewriter.) What else? I dunno. Go ask Norelco.

How does the reverb sound? Well, I've had a Fisher reverb unit for some time and it sounds like that—more or less. But the Fisher Space Expander unit has two doorsprings, and longer ones, too. This mike has one, shorter and fatter. It still sounds like a doorspring. It tends to twang. And, as mounted inside a movable, bumpy mike, it is easily twanged, at that.

Gotta be careful.

Used in moderation, a spring-driven reverb system can be very helpful in certain situations, such as for a singer in a club, for example. Especially when it is set low, just barely to take the edge off a too-dry sound. But when you turn it up too far, it sounds faked. (Even the fancy pro Fairchild model can do that, if used with too free a hand.) So, all in all, I have some doubts about this DX-11 Norelco reverb—it uses or for recording—though I'm happy to admit that my opinion is sort of limited. May be just the thing for your needs whatever they are.

Dead Battery

All this was some months back. I took the mike out again, just now, to re-check it, and found the little red warning streak showing. O-oh! I'd left it on. Dead battery. Well, then, no reverb this trip. But I plugged it in, anyhow, just to try the mike itself again, minus reverb.

No go. Dead as a doorbell. Not a sound could I get.

Now wait a minute . . . A dynamic mike that runs on a battery?! You mean . . . ?

Well, I guess so. At press time, I was still trying to figure this one out (never looking, of course, at the circuit diagram—I never do) and was coming to the sad conclusion that this mike must feed through the reverb solid-state circuit in such a fashion that when the battery is dead, so is the mike. Sort of silly. I was thinking—there ought to be some way or other, in an emergency . . . just to use the dynamic unit, minus reverb. Better straight sound than none at all.

The little gal in the picture instruction book isn't telling me. She wouldn't know. Nor the man with the walrus moustache.

P.S. I got a bill from Norelco the other day, one of those memo bills. It said $130. So that's what you'll pay for your portable instant reverb. Probably well worth it—if, for you, instant reverb in the hand is worth two in the bush. Even with dead batteries.

DEMONSTRATION

I can't resist writing this—because I had such a good time. I always do, every year. You see, one of the mainstays of the entire hi-fi business, one of its Vital Factors, its crucial excuses, essential to know— (continued on page 68)
This is all that moves in the new ADC 10/E cartridge

We figure it costs you roughly $49,000 a lb.

You'll probably never buy anything man-made as costly by weight as this tiny, incredibly rugged moving stylus of the new ADC 10/E cartridge.

It reduces "moving mass" to about one-third that of the best magnetic cartridges.

Moving mass (the weight or inertia of the total moving system as felt at the stylus tip) is what your record has to push around. The groove must move it in one direction, stop it, then push it another direction—thousands of times a second.

Even a few milligrams of moving mass set up tremendous forces that the record groove yields as the stylus passes... So even on the very first play, you hear a distorted groove, not the groove that was pressed in. Now, by a major jump forward in design, the ADC 10/E reduces moving mass well below the critical point of groove yield. Result: for the first time ever, you can hear the actual record you bought... on the first play, or the 500th. (Wear is negligible.) Listen to a complex passage, piano, operatic or choral selection, and you hear the difference. You get clarity, brilliance, reality and definition never obtained before. At long last, true "cleanliness"!

How good is the new ADC 10/E? By any test, lab or listening, it is so perfect that any improvement would be pointless. For the first time it can be said: no one will ever make a cartridge that performs perceptibly better.

AUDIO DYNAMICS CORPORATION
Pickett District Rd., New Milford, Conn.

SPECIFICATIONS — ADC 10/E

Type  Induced magnet
Sensitivity  4 mv at 5.5 cms/sec recorded velocity
Channel separation  30 db, 50 to 10,000 cps
Frequency response  10 to 20,000 cps, ±2 db
Stylus tip  Elliptical Stylus
Contact radius — .0003"  Lateral radius — .0007"
Vertical tracking angle  15°
Tracking force range  1½ to 1¾ grams
I.M. distortion  Less than 1% — 400 & 4,000 cps at 14.3 cms/sec velocity
Compliance  35 × 10⁻⁴ cms/dyne
Price  $59.50
CLASSICAL BEATLES
The Baroque Beatles Book. Baroque En-
semble of the Merseyye Kammermusik-
gesellschaft, The Canby Singers, Horold
Briens, helpenother, dir. Joshua Rifkin.
Review by EK!-7306 stereo
Just in case you missed this pre-
Christmas satire, here it is. Beatle tunes
(from people known them, or have
kids who do) converted pop-jazz gen-
iously into "authentic" Bach-
Telemann-Handel Baroque by Joh-
Dom Rifkin, who once played in a
jug band and is now a budding mus-
cologist of a very authentic sort.
It takes a bit of expertise on your
part—whether Beatleish or Baroque
—but most people will find this
pretty amazing as a sheer musical
feat; for the Baroque music is ex-
cellent in its own right. It could
"very well pass for" (Gilbert &
Sullivan) the real thing in any company.
There is, first, the Royal Beatle-
works Muskele, a splendid Baroque
suite with trumpets, the overtone
bass trickily on "I Want to Hold
Your Hand," the succeeding dance
movements based on other such
tunes including the recent "Ticket
to Ride" (From "HELP!""). Then the
Epstein Variations for harpsich-
orchard solo, out of "Hold Me Tight." On
Side 2 is the full-scale cantata for
"the Third Saturday after Shoa
Stadium." on "Last Night I said"
in which my own Canby Singers do
the choral parts, rather heavily
furnished by a 15-mike pop set-up
which drowned out the choral voices
with too much trumpet et al. Also
the delightful recitative and aria
"When I was Younger" straight out
of the movie "HELP!"—it's even in
the same key as the Beatle version.
Finally (at too-high a level on the
record, after the Cantata) comes a
trio sonata, Das Kiferlein (trans).
The Little Beetle.

An interesting example, by the way,
of all-out multixt "pop's studio technique on four tracks ap-
pplied to Baroque-style classical mu-
ic. In spite of some technical weak-
nesses, as above, the overall effect is
surprisingly good for the music.

A TURN ABOUT TURNABOUT
(No. Vox's Turnabout label) was a
quick follower after Nonesus—with
the new low-cost, well packaged imported
recordings, $2.50 list, or less, mono or
stereo. Turnabout's repertory centers
so far on the Mozart-Haydn period and
later, where Nonesus has largely Baro-
que and earlier though they do over-
lap. E. T. C.

Vivoli: IV Concerti (Piccolo, Viola d'Amore,
V. d'Amore and Lute). Württemberg Chamer
Orch., Foerber.

There's not nearly as much Baroque in
the Turnabout line as on Nonesus,
but here's a good sample. Nonesus also
has the two Violin concerti. The other
two are typical of the "new" Vivali-
aldi—the many works for all sorts of
odd-ball combinations, doubtless com-
pounded for his lady students at the Ve-
necian Pietà orphanage-music-conserva-
tory where he worked for many years,
which have been newly uncovered since
World War II, in terms of musical per-
formance.

Good solos here; the Württemberg
orchestra is just a bit soggy and its
sound is enhanced by a blurry liveness.

Dittersdorf: Concerti for Double-Bass, Harp;
Sinfonia Concertante for Double-Bass and Viola.
Württemberg Ch. Orch., Foerber.

Turnabout TV 340055 stereo
This genial Mozart-period composer
with the jiffy name (Properly Karl
Ditters von Dittersdorf) wrote exquisitely
Mozartean music, for odd-ball combina-
tions even odder than those of Vivaldi.
A half century earlier. Here are two
concerti with double bass, plus one for
harp, and all of the music flows along
most easily, if wholly minus the deeper
tension that kept getting into Mozart's
music. It makes a very pleasant record
for casual listening.

Haydn: Four Flute Quartets. Camillo Wanousck;
members of the Europa quartet.

Turnabout TV 340075 stereo
Here's similar music—but from a master,
in his earlier period. The flute en-
joyed a terrific popularity in the middle
to late Eighteenth century and many a
work of this sort was turned out to meet
the big demand. The sound, one flute
and three strings, is a bit thin for our
ears today and the early-Haydn style, as of
about 1767, a quarter-century before
the familiar Haydn symphonies, is very
galant and polished, taking a bit of
listening before our ears adjust pro-
perly to its values. Still, a fine record for
anyone with a liking for the "Mozart-
Haydn" period.

Mozart: Hoffner Serenade. K. 250. Württemberg
State Orchestra, Leitner. Susanne Lautenbacher,
vl.

Turnabout TV 340135 stereo
The famed wedding serenade, written
for the same Hoffner family as the later
"Haffner" Symphony (which appears to
have been made out of another serenade
by dropping some of the movements)
gets a vigorous if slightly flowery treat-
ment here, in what seems to be the offi-
cial Württemberg manner, authoritative,
very strong, but a bit unladen in en-
sence, with a slightly flabby string tone.
I like it. And the violin concerto within
the serenade (typical of the serenade
form—and probably played by Mozart
himself originally) is nicely put forth in
the same somewhat florid style by Su-
sanne Lautenbacher.

Mozart: Three Early Symphonies. No. 25 in G
minor (K. 183), No. 23 in D (K. 181), No. 20
in D (K. 133). Mainz Chamber Orch., Keir.

Turnabout TV 340015 stereo
Here's a splendid record—for of these
three closely related early symphonies
only the "little G Minor" (K. 183) is
commonly played. The others are very
seldom heard, which is a shame. From
a lad of some sixteen years of age they are
extraordinary miracles. The sound is
much like that of the Württemberg
players, but more intimately recorded,
more suitable for these works. A florid
sound with a good deal of violin-section
vibrato, but strong and musical even so.
It's always a sobering experience, and
conducive to thought, to listen to Mo-
Zart—after a goodly dose of his contemporary Berioz goes
so very much further, even at sixteen. This
one is highly recommended if you own a
Mozart fan.

Hoffman: Mandolin Quartet in F. Guilian: Man-
dolin Quartet A. Elfriede Kunschak, Edith
Boyer-Sios, mandolins.

Turnabout TV 340165 stereo
Like the flute, the mandolin became
widely popular towards the end of the
Eighteenth century and much "popular"
music was written including it. Here
are two works, a good cross section of the
mandolin music of the time—so dif-
ferent from ours.

The Hoffman work is a very com-
pete piece, late classical, out of the
period of early Beethoven and late
Haydn, not profound but well written
and showing off the mandolin's silvery
designed tones to surprisingly good ad-
vantange. Present-day guitar buffs should
find it interesting. As for the Guilian,
though it purports (according to the
notes) to date from the early Nineteenth
century, its sound is that of the early
classical time, the 1760's or 70's, and it
is surely the emptiest example of that
sort of music presently on records! Dish-
water stuff. I'd buy the record for the
Hoffman, any time.

(P.S. There's a lute somewhere in the
ensemble; I suspect it is "arranged" in-
to the music. The Hoffman piece is listed
as arranged, from what it does not say,
by the late player, Vinzenz Haidky.)
The new Empire Grenadier is the world's most perfect speaker system. If there is any doubt in your mind, take a seat and listen...
You're on the threshold of an entirely new concept in sound, a voyage into startling reality, a sense of presence never before achieved in speaker systems.

Close your eyes, think performance only. Hear the penetrating thunder of the kettle drums... resounding clamor of the cymbals, and the soft, sweet brilliance of the reed section. This is the Empire Grenadier, the only speaker that lets you sit anywhere—hear everything. Now open your eyes. Take a close look at some of its amazing features:

A revolutionary die-cast divergent acoustic lens assures fuller frequency and separation, plus broader sound propagation (over 50% more sound dispersion of its highs and mids than conventional speakers). Exclusive dynamic reflex stop system allows you to adjust the bass and treble response to suit your individual acoustics.

A 12" woofer faces downward, close to the reflecting floor surface, feeds through a front loaded horn with full circle aperture throat. This provides 360 degree sound dispersion and prevents standing waves from developing in the room.

The world's largest (18 lbs.) speaker ceramic magnet structure, an ultra-sonic domed tweeter, full presence mid-range radiator, and complete symmetry of design with terminals concealed underneath...and the most classic looking, elegantly styled chassis 'round.

Out of sight but never out of sound—the Empire Grenadier—world's most perfect speaker system.

No less perfect than the Grenadiers are the incomparable Troubadors — complete playback systems.

The famous Empire 398 and the Empire console 498.

The Troubadors consist of the Empire 3-speed professional "silent" turntable...980 dynamically balanced arm with sensational dyna-lift...and the new Empire "Living cartridge", featuring the exclusive magnetic cone stylus. Empire has built its home around a family of quality products, years ahead in design and performance. For complete color brochure write to Empire—for a sound demo go 'round to your local Hi-Fi showroom.

Model 8000P

Outstanding Features:
1. 12" inch mass loaded woofer
2. Four inch Voice coil
3. World Largest 18 lbs. ceramic magnet structure.
4. Sound absorbent rear loading
5. Die-cast acoustic lens
6. Imported marble top
7. Ultra-Sonic domed tweeter
8. Full presence-mid range
9. Damped enclosure
10. Dynamic reflex Stop System
11. Front loaded horn
12. Complete symmetry of design with terminals concealed underneath.
Medieval and Renaissance Music for the Irish and Medieval Harps, Vièle, Recorder, and Tambourin. Elena Polonska, Guy Durant, Roger Cohé.

Turnabout TV 40195 stereo

The convolutions of international recording diplomacy these days are incredibly involved. Until recently players belonged to the "Groupe d'instruments anciens de Paris" which Capitol imports on the Pathé-EMI label. Capitol is owned by British EMI. Of course, here, they are reassigned on American Vox...

Anyhow, no spoken French here, but some sort of dialogue is audible. They are lovingly, never thumpy or rigid, always varied, for good contrast, and my only reservation is the rather pronounced roboto throughout. [Schubert dances with unmistakable Viennese Walter Hitzig.] This makes some of the music rather difficult to follow. It is good roboto, though, and, as always musical.

Schubert improvised dozens of these on end for actual dancing at the famous "Schubertinas," and wrote down only for those which he could find time. They are quite waltzy, though somewhat before the waltz limit.

Bach Cantata No. 56, "Ich will den Kreuzstab," No. 82, "Ich habe genug," Herman Frey, bar., Leipzig Gewandhaus Orch., Thomanerchor, Kurt Thomas.

Turnabout TV 340205 stereo

Here, Vox-Turnabout has the Ultimate Bach Source out of Bach's own home town of Leipzig. The Thomanerchor is Bach's own church, St. Thomas. Does prove anything necessarily—but fact is that these are lovely performances of two solo cantatas, among others, with orchestra. The choir merely sings the chorale at the end of the first cantata. (There was no room for a chorale at the end of Side 2). Could be it if you love Bach's usual lengthness and weight, and if you can take one good singer for two whole sides, you'll find this first rate. He wears a very well on the ear. So does the orchestra.

DIRECT IMPORTS

(Note. Lately, to add to the enormous number of 'demos' releases, direct imports have been coming in thick and fast, often imported by U.S. labels with foreign affiliations. Here are some samples; see C.)

Orfeo Catalá. Homenaje al Mtro. Don Luis Miller. (Catalonian Choral Society) Odeon IALP 525 mono (via Capitol)

This was an extraordinary boys' and men's choir of Spain which made records, and a world-wide reputation, back before the Spanish Civil War. For "classical," collectors, its remarkable recordings of two Bach cantatas, No. 140, Wachet auf and No. 4, Christ lag, issued on 75 in Europe and then again by Victor in the U.S.A., will bring this choir back poignantly to mind—many of us learned what a Baroque period is through those two magnificent albums I still have both of them.

Here, the famous choir sings a peculiar kind of popular Spanish music in a sort of high-Romantic classic disguise. It is amazing. Nobody sings like this today anymore. Nor this kind of music. Each piece is a long, unbroken work—maybe two 12-inch sides in the original or even more. Six of them fill up the I.P. Each is kind of Romantic choral symphony and the style of singing must be heard to be believed—such sighings and gaspings, such unctuous harmonies, such extraordinary apparent effects! It is all terribly, terribly emotional, every note a tearing at the heartstrings and one wonders how such little boys could ever learn the stuff; but, then, little boys can learn anything. They sob and weep like real trouperoms. Some of the choral tricks are so remarkable that I had to replay one evening to be sure that we didn't have a big orchestra of instruments with it. No. Only voices. Weird. In another piece, the voices seemed to be imitating a flock of sheep, like the orchestra in Strauss's Don Quixote. No explanation on the imported jacket, so I can't vouch for the story.

Nevertheless, this is impressive music of its sort. Perhaps younger listeners should stay away, unless they love luscious-Romantic stuff. But older chorus fanciers, the sort who go for the Icelandic Singers, or the Welsh, or Russian, or what-not, will find this record superb. Also, for purity, those who remember the Orfeo Catalá Bach recordings. I've often wondered whether any of these kids ever survived the Revolution which came so soon afterwards. They were on the losing side.

Frühe Musik in Italien, Frankreich, und Burgund. Studio der Frühen Musik.

Telefonken SWAT 9466 stereo (via London)

What a terrific disc! The finest of its sort I have ever heard. "Early Music of Italy, France, and Burgundy" it is longs in the "Pro Musica" category of old-record music, led so far hereabouts by the mass-production N.Y. Pro Musica, per a San Francisco Musica and, on recent Dover issues, the Ambrosian Singers under Denis Stevens. Like these and others, this one features very old music for solo voices and instruments, done up with impeccable musicalological research.

But where the other records tend to be dull, or brassy, or hard in the New York Pro Musica offerings, and the voices are often much less communicative than the old instruments, these voices are—

I can only use term—electric! Stunning. So are the instruments. These people have the musical sincerity and feeling. (Not for Sadford Cape) but, where the Belgians tend towards almost too much gentleness, these performers are as brilliant as the New York Pro Musica. Thanks to an enormously greater musical feeling to back it up. Their voices do not wobble, they are always beautifully blended, phrased, full of poetry, in rapid passages, especially the mezzo-soprano Andrea von Ramm, is astonishing. So is the French and Italian dictation ranging from easy-going English and German singers.

Whatever they touch, with their weird instruments or their electrically alive voices, these people add a musical dimension to music. And this though the music, ranging from the 1300's to near 1600, is largely before the "real" music we have all been brought up on (though we have.) Whether Italian, Burgundian, or French, it's all exciting and often most persuasive—or really funny. Nothing wrong here!

The performers are a bit of a mystery. The "Studio for Early Music" is otherwise unidentified but it includes such luminaries as Karl Herbig, Helmut Fink, as well as Don Smithers and Sterling Jones. Wonder where they hang out? Wherever it may be, DON'T MISS Andre von Ramm in particular. Also, Medieval Anna Russell, a superb musical actor.

Even the stereo sound is tops. It would be, from Germany.

Schütz: Cantiones Sacrae 1625. Dresden Kreuzchor, Maurersberger.

Telefonken SAWT 9468/70 (3) stereo (via London)

Schütz: Motets from "Cantiones Sacrae" Nie-
desdässischer Singkreis, Frederic Jones.

Noneuch H-71062 stereo

Here's a complete imported version of all 40 of these splendid short choral pieces, competing with a Noneuch import also from Germany. Noneuch, on one disc has eighteen of the forty, which takes three recordings on Telefonken.

German choral singing today is fantastically good, and especially in the alumni church choirs and singing clubs. The style is remarkably uniform, too. True, accurate, steady, the boys pure and earnest, the men somewhat gutteral in tone, the harmony-ensemble, as clean as a barbershop quartet.

These two are thus much alike, though Noneuch has some of the works unaccompanied (an optional choice in such music.) But the Telefonken group, from Dresden, turns in an inferior performance on a number of scores. Maddier, overly navel sound, for nothing. And a tendency in the singers towards plodding, or jouncing rhythm, not well phrased. Noneuch's Hannover group, on the other hand, shows a long, live phrase, better diction, and in a much clearer, cleaner acoustic surround.

Telemann: Tafelmusik Ill., Teil (Musique de Table, Third Production). Soloiots, Concerto Am-
der. Đm

Telefonken SAWT 9453/54 stereo (via London)

If you like Baroque and want an all-in-one cross section of Baroque instrumental music a la Telemann, try this! You'll find, too, why Telemann was the most respected and most original of all his time, as per his own contemporaries.

He published three "productions"—collections—of his so-called Table music, for entertainment, perhaps fancifully at banquets, each with a novel arrangement of varied works. A full-size orchestral suite (with some modifications in detail, quite startling to a Bach listener), a quartet, here for flute, violin, cello, and continuo, and a concerto, for the virtuoso trio, two for two flutes and continuo, a solo sonata, for oboe and continuo and a "conclusion," a brief, snappy or-

chordal movement, all original. All these appear on these two

(Continued on page 75)
EDITOR'S REVIEW

Back in the palmy days of early hi-fi, it used to be accepted that there was one industry show during the year—the BIG one in New York. Now there are hi-fi shows practically everywhere. The next one on the calendar is at Philadelphia—in the Benjamin Franklin Hotel—February 18, 19, and 20. This is one of the better locations in the country from the standpoint of room sizes and over-all accessibility.

Then the REAL BIG show hits the boards on March 27 at the Ambassador Hotel in Los Angeles. This is always one of the greatest shows in the U.S. in our opinion, because of the facilities. The rooms are easily accessible, rather larger than average, and being in what might be likened to a garden apartment complex, are not jammed together as to create a hodge-podge of sound. We recall one Los Angeles show on March 27, 1966, which was as well situated as the Los Angeles show is, hi-fi exhibits would hit a new peak in attendance and resultant business.

Comes next the San Francisco show, held for the first time in the new Civic Auditorium building. This one opens on April 15th, and lasts through the 25th, but not having yet attended a show in these surroundings we are unable to assess the location and facilities. However, having seen and heard shows practically everywhere in the U.S., we will wager that it will turn out to the satisfaction of exhibitors and attendees alike. They always seem to.

U.S. DEPARTMENT OF COMMERCE SHOW

In the furtherance of International Trade, the Government has got-ten into the hi-fi-show business. Beginning with Frankfurt in 1964, and following with Milan in 1965, the U.S. Department of Commerce has staged hi-fi shows in West Germany and Italy, and with rather spectacular results in terms of sales. Consequently, since there is a large and almost untapped hi-fi market in England for U.S. products, London has been chosen for this year's U.S.D.C. show, and the location is the U.S. Trade Center, 57 St. James Street, which is just off Piccadilly.

For a hi-fi show outside of the U.S., there is quite an impressive list of exhibitors—33 in all, as of this writing, in addition to Arno. The list must of necessity be limited to those manufacturers whose products are actually made in the U.S., of course, which means that some of the products which are well known and well accepted in this country but which are imported from elsewhere will not be represented. However, anyone who "happens" to be in London in that month will have an opportunity to see all the British products, as well as some of the European ones, at the International Audio Fair at the Russell Hotel in London from April 14 to 17, while the U.S.D.C. show is to be held from April 14 to 22, nearly coincidental with the San Francisco Show. Oh, well, we guess we just can't make 'em all. We've already given up on the Festival du Son in Paris, March 10-15. We're waiting for shows in Cairo, Capetown, and Canberra, to say nothing of Buenos Aires.

LATEST INTEREST FOR THE AUDIO BUFF

And now we are thinking about a natural step-up for the confirmed audio recordist, who may have exhausted his horizons on ¼-in. tape and who is now looking forward to experimenting with the ½-in. version in Video Recording. We are inclined to predict that this will be the next big boom in home entertainment equipment. Wherever there have been available so far, they have sold out, so it is not as easy to buy a VTR as a loaf of bread or a fifth of milk, but manufacture is beginning to catch up to where it can keep in step with the demand.

While admittedly—so far—not as portable as an 8-mm movie camera, the results are comparable, and portability will come. We can well remember when a personal portable radio was rarely as small as a college dictionary, but now they are smaller than a package of cigarettes. So we are fairly certain that one will be able to take his VTR anywhere an automobile can go, and still take pictures to his heart's content—and see them within minutes.

Our Sound & Sight column is busily engaged in researching all the possibilities and techniques, and will keep readers continually—and reliably—informed about this new art.

OMISSIONS

Readers who scan the "Coming" column on page 2 will note that the contents of this issue do not include everything we had anticipated. It appears that we sometimes get over-ambitious, and then space does not materialize, or the article was not completed to our satisfaction, or some similar unforeseen occurrence militated against our fulfilling our projected "Comings." In other words, we sometimes bite off more than we can chew. Anyhow, these same items will crop up again in a month or so, you may be sure.
Capture natural sound with Pickering.

From the softest flutter of the woodwinds to the floor-shaking boom of the bass drum, natural sound begins with Pickering. Right where the stylus meets the groove.

Any of the new Pickering V-15 stereo cartridges will reproduce the groove, the whole groove and nothing but the groove. That’s why a Pickering can’t help sounding natural if the record and the rest of the equipment are of equally high quality.

To assure compatibility with your stereo equipment, there are four different Pickering V-15 pickups, each designed for a specific application. The new V-15AC-2 is for conventional record changers where high output and heavier tracking forces are required. The new V-15AT-2 is for lighter tracking in high-quality automatic turntables. The even more compliant V-15AM-1 is ideal for professional-type manual turntables. And the V-15AME-1 with elliptical stylus is the choice of the technical sophisticate who demands the last word in tracking ability.

No other pickup design is quite like the Pickering V-15. The cartridge weighs next to nothing (5 grams) in order to take full advantage of low-mass tone arm systems. Pickering’s exclusive Floating Stylus and patented replaceable V-Guard stylus assembly protect both the record and the diamond. But the final payoff is in the sound. You will hear the difference.

PICKERING—for those who can hear the difference.

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Test Instruments and the Audio Buff

While the entire subject of audio measurements is a complex one, there are a number of uses to which even the most inexperienced audio enthusiast can put simple test equipment to make sure his "rig" is performing properly and to keep it in top condition throughout its life.

To the ardent audio buff the love of equipment and the love of music are inseparable. No matter how much time and money and effort he has put into his audio system, he is never quite satisfied and never quite done. He is ever window-shopping for a better phono cartridge, better speakers, a better amplifier, a better whatnot. He revisits the audio salons and avidly reads the equipment reviews. And every so often he replaces one component with another.

Considering the audio buff's travail in choosing, acquiring, and improving a system, and how he suffers when what goes wrong, it is surprising how little if anything he spends on test instruments to ensure maximum performance. It is surprising because even without technical skill the audio buff can make valuable use of these instruments. It is further surprising because such helpful items as meters, signal generators, and capacitor checkers can be purchased, at least in kit form, for about the price of a good magnetic cartridge, and even such items as distortion meters can be had for no more than the cost of a top-quality cartridge.

Perhaps the audio buff's reluctance to acquire instruments is less a question of cost than a baseless fear he is incompetent to use them. Perhaps, like the person who won't make a will because he can't contemplate death, he wants no visible evidence that anything might all his system. All the same, a few relatively inexpensive instruments whose use is easily learned can help the audio buff get the best out of his system and can save him unnecessary woe. How much fun is it to lug a heavy amplifier to and from a service shop and wait several weeks in between, only to find the fault was in a cable back home that could have been checked with an inexpensive meter?

Basic Uses

Instruments are of course essential to the expert for basic research, equipment design, modification of equipment, sophisticated alignment procedures, and solving deep audio troubles. But instruments in the hands of the amateur can also perform useful, though simpler tasks. They can be useful in the following basic ways.

1. Checking the performance of new components to make sure they come up to the manufacturer's specifications.
2. Checking the performance of old components to make sure they perform as they originally did.
3. Finding the source of trouble in equipment not working properly.
4. Aligning equipment—not everything, but at least the simpler things.
5. Checking the elements of a kit to make certain all parts are of proper value and quality.
6. Checking a kit for accurate construction.

These basic uses could easily fill several articles or books. However, we shall limit the discussion to what the audio buff might do with test instruments.

Checking Performance of Components

(New or Old)

There are many aspects of performance in audio, but the dominant triumvirate are frequency response, distortion, and signal-to-noise ratio.

Frequency Response. To check the response of a single component or the assembled system, you need an audio generator to feed signals in, and a meter to measure the signals coming out, as in Fig. 1. The generator is connected to the item under test, say an amplifier, just as a tuner would be connected to the amplifier. The meter is connected to the output of the item (amplifier) under test. Feed in a series of signals covering the audio range and perhaps beyond, and measure their relative level at the output. The input signals must be "flat"—all of equal magnitude. Some audio generators have a built-in meter for this purpose; you can adjust the level of the input signal in accordance with the meter indication. If the generator has no meter, use the setup of Fig. 2 to ensure flat input signals. Then the one meter is switched to read input and output signals alternately. These readings are in dB (decibels) rather than absolute voltage. The meter must have flat response over the frequency range used for the test.

Some special precautions are in order when checking the record-playback response of a tape recorder. To avoid saturating the tape at high frequencies and thus producing an erroneous indication of treble loss, the test signals must be at least 20 dB below maximum permissible recording level. That is, they must be 20 dB below the recording level that at 1000 Hz causes a magic eye to close or a neon lamp to ignite, or they must be 14 dB below the recording level that at 1000 Hz causes a VU meter to indicate 0 VU (a properly calibrated VU meter indicates 0 VU at a level about 6 dB below maximum permissible recording level). Before checking frequency response, clean and demagnetize the heads to

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*280 Twin Lane E., Wantagh, N.Y.

**HERMAN BURSTEIN**

Fig. 1. Checking an audio component for frequency response.

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AUDIO • FEBRUARY, 1966

23
eliminate treble loss due to dirty or magnetized heads. It should be added that it is common practice to check playback response independent of the recording function; then the source of input signals is a test tape.

Quite-adequate audio generators are available for about $40 or less in kit form, and perhaps 30 per cent more in wired form. The kits present no special construction problems. These generators start at about 10 or 20 Hz and go up to about 100,000 or 200,000 Hz, so they can check the high-end performance of almost any audio component.

The meter can be a VOM (volt-ohm-milliammeter) or a VTVM (vacuum-tube volt meter). Good meters are available for about $25 or $30 in kit form, and for about 60 per cent more in wired form. Compared with a VTVM, the VOM has the advantage of portability (because it is not powered by house current) and of being able to measure current directly (whereas a VTVM requires you to measure current indirectly by finding the voltage across a known resistance and dividing the voltage by the resistance). But a VTVM is generally preferable for measuring frequency response because of its wider and more uniform response, and because it presents a higher load resistance to the item being measured, so that it is less likely to upset the performance of this item. If you are measuring very small input and output voltages, as might be the case when making tests involving magnetic-phono pickups, tape heads, and amplifier inputs for these devices, you may need an a.c. VTVM, which can indicate differences in magnitude clearly and accurately for signals of only a few millivolts. The a.c. VTVM in kit form might cost about $35, compared with $25 or $30 for a VTVM.

Distortion. Checking harmonic distortion requires an audio generator to supply signals to the item under test, and a distortion meter connected to the output, as in Fig. 3. To check intermodulation distortion, only a single instrument is needed, as in Fig. 4; this supplies the special input signals (customarily a combination of 60 Hz and 6000 Hz in 1:1 ratio), and also measures the output distortion.

A bonus of distortion meters is that they incorporate a sensitive a.c. VTVM. This can be used independent of the distortion-checking function if desired, eliminating the need to buy a separate a.c. VTVM. In kit form, distortion checkers are available for as little as approximately $55.

A special note applies to measurement of harmonic distortion in a tape recorder. This measurement is customarily made at a mid-frequency, usually 400 Hz, and not at treble frequencies. And it is made at the maximum permissible recording level as indicated by the magic eye, neon lamp, or VU meter. (In the case of a machine with a properly calibrated VU meter, the recording level should be about 6 dB above that which causes the meter to indicate 0 VU.) At this level, the great amount of treble boost employed in recording would emphasize a high-frequency input signal (for example, 10,000 Hz) to a degree that produces appreciable tape distortion. But this would offer a misleading indication of the performance of the tape recorder. In practice, the treble boost is offset by the fact that the high-frequency content of most sounds is of substantially lower level than the mid-range.

Signal-To-Noise Ratio (S/N). To check S/N, again you need an audio generator to supply an input signal, and a meter to measure output. The input signal is usually 1000 Hz.

The first step in measuring S/N is to drive the component under test to a reference level. Ordinarily this is stated as so many volts output or so many watts output, with the component's gain control (if any) full on. Thus in the case of a power amplifier rated at 30 watts, you would feed in enough signal at 1000 Hz to drive it to 30 watts. In the case of a preamp rated at 3 volts, you would feed in enough signal at 1000 Hz to drive it to 3 volts output (with the gain control full on). In the case of a tape recorder, you would feed in enough signal at 400 Hz to drive the machine to maximum permissible recording level as indicated by the magic eye, neon lamp, or VU meter. In the case of the magnetic phono input or tape head input of an amplifier, the reference level is properly stated as a certain number of millivolts input at 1000 Hz. Customarily this is 10 mV for magnetic phono input; it might—or might not—be about 3 to 5 mV for tape head.

When the reference level has been established (that is, while feeding in a signal of required magnitude or one that produces an output signal of required magnitude), the output of the component under test is measured. Then the input signal is removed, the input terminals shorted, and the output of the component is again measured; now the output consists only of noise. The difference between the outputs expressed in dB, is the S/N ratio. The meter employed (VOM, VTVM, or wattmeter) customarily has a dB scale.

When measuring S/N of a power amplifier and establishing the reference level, you are dealing with wattage rather than voltage output, and it is desirable but not necessary to have a wattmeter (which may be incorporated in a distortion checker). But you can just as well read wattage offset on a VOM or VTVM. Load the power amplifier with a resistor equal in value to the stated output impedance of the amplifier, for example, an 8-ohm resistor connected to 8-ohm output taps. The wattage rating of the resistor (ability to dissipate heat) should be at least as great as the rated output of the amplifier, for example 40 or 50 watts. Using a VOM or VTVM, read the voltage across the load resistor, and calculate wattage by this form of Ohm's Law: P = E²/R, where P (power) is watts, E is volts, and R is resistance.

Other Tests. In addition to the basic performance checks we have described, a number of other significant tests can be performed easily, with a minimum of equipment, and inexpensive equipment at that. You might want to check sensitivity, that is, the amount of signal input required for a stated signal output. You might want to check stereo separation: how much signal appears in one channel when you feed a signal
into the other channel. You might want to check an amplifier's equalization characteristic on magnetic-phono input or on tape-head input: feed in low-level signals of equal magnitude, and measure the variation in output response. You might want to check how many volts your preamp can deliver before it reaches, say, 1 per cent intermodulation distortion. You might want to check how many millivolts signal you can feed into your amplifier's magnetic-phono input before there is appreciable distortion at the amplifier output. You might want to check the speed of your phonograph or tape recorder, in this case requiring that you equip yourself with a stroboscope disk (for phono), or a stroboscopic tape wheel or stroboscopic tape.

Trouble Shooting

If there is trouble in your system and the system has separate components (such as separate tuner, preamp, and power amplifier), the first step is to identify the defective component. This can almost always be done by intelligent deduction. For example, if the sound is fine on phono but ragged on FM, this suggests the tuner is at fault. If phono and FM are both ragged, but FM sounds fine when plugged directly into the power amplifier (bypassing the preamp), the preamp is probably the culprit. And so forth. With equipment, where it is often possible to substitute a known good channel for a suspected bad one, the detection process tends to be all the easier.

In any event, when the defective component has been identified, test instruments can help narrow the search for the cause of difficulty. If you have a schematic for the faulty component and can read it just well enough to find your way from point to point, you can try injecting a signal (from an audio generator) at various points in the component, starting at the output and working back to the input. So long as the output signal "appears good," there is no trouble between the test point and the output. You can judge whether the output signal "appears good" by listening to it, by measuring it on a VOM or VTVM, or by looking at it on an oscilloscope. (Oscilloscopes satisfactory for audio are available for as little as $55 in kit form.) When you have moved the input signal to a point in the component where the output signal is no longer satisfactory (distorted, too low, excessively noisy, intermittent, and so on), the trouble lies between the point where the signal is applied and the prior test point. Then the parts in that area—tube or transistor, capacitors, resistors, and the like—are suspect.

Tubes can be checked readily by substitution. Transistors are another matter, perhaps even if located in sockets instead of wired into the circuit. Resistors can be checked for correct value by either VOM or VTVM. A capacitor checker is needed to test capacitors for correct value, opens, shorts, or excessive leakage. This instrument can be obtained for about $25 in kit form, and for about 25 per cent more in wired form. It is often necessary to disconnect one end of a capacitor from the circuit in order to make a satisfactory check, unless you use a special type of capacitor checker that permits "in-circuit" testing.

A supplementary procedure for locating the trouble area is to measure voltages and resistances at test points specified by the manufacturer of the component. These test points are usually at the tubes and transistors, and are easily identified. Either the VOM or VTVM may be used to check resistances (with the component disconnected from the power line of course). While the VOM may be satisfactory for checking voltages, depending on the quality of the particular instrument used, it is wiser as a rule to use a VTVM, particularly when measuring relatively small voltages; the lower resistance of the VOM may affect the voltage being measured. If a voltage or resistance is considerably different from what the manufacturer says it should be, say more than 20 per cent off, the

resistors, capacitors, and other parts associated with that test point are suspect and should be checked.

Don't overlook the possibility of the trouble being in a cable that connects components. A faulty cable or one insecurely connected to the components can account for hum, noise, distortion, intermittent operation, or no operation at all. Excessive flexing or poor construction can produce an open or short in the cable. Age can build up dirt or oxidation that causes a high-resistance instead of low-resistance contact between the cable plugs and the components' jacks. On its resistance ranges, the VOM or VTVM serves as a continuity checker that enables you to identify whether a cable has an open, short, near short (finite instead of virtually infinite resistance between hot and ground leads), or near open (finite instead of virtually zero resistance between opposite ends of the same lead). We should mention that instruments for measuring capacitance can often measure resistance as well, and therefore are able to check continuity. Between the two "hot" terminals at either end of a cable, one should measure virtually zero resistance, as illustrated in Fig. 5. Similarly, there should be no noticeable resistance between the two ground terminals. But there should be virtually infinite resistance between the hot terminal and ground terminal (when
the cable is disconnected from the components).

The VOM or VTVM (or capacitor checker used as a resistance-measuring device) can serve in additional useful ways as a continuity checker. For example, a cable leading from the amplifier to a speaker may be partly hidden from view (perhaps under a rug), and you may have forgotten which lead is which—important information in order to assure correct polarity in a stereo installation. If you can get to opposite ends of each lead, the resistance check can tell you which ends belong to the same lead. Suppose that the cable goes to extension speakers in another room. You can connect a flashlight battery to the leads in one room, and you can measure d.c. voltage with your VOM or VTVM in the other room. The connection between the meter and the speaker ends will give either a positive or negative reading. If a negative reading, reverse the connections between the meter and the leads. Now identify the lead connected to the positive terminal of your meter: tie a knot in the lead or mark it with fingernail polish. Similarly identify the lead connected to the positive (center) terminal of the flashlight battery. Thus you have identified opposite ends of the same lead.

To take one more example, you might verify that you have a continuous lead to your FM or TV antenna by temporarily shorting the leads at the far end and using your meter at the near end to see whether you then have a continuous electrical path between the two leads, due to the length of the antenna lead-in, the meter reading may be a few ohms. Removing the short at the far end, you should then get a reading of virtually infinite resistance, indicating no short in the lead-in.

**Aligning Components**

While there are alignment procedures too technical for the average audio buff, others are simple enough provided the necessary instruments are at hand. For example, some tube amplifiers incorporate a bias adjustment which merely requires connecting a d.c. voltmeter at a clearly designated and readily available point, and adjusting a control so that the meter (VOM or VTVM) gives a specified indication. Then the amplifier yields optimum performance. When output tubes are replaced, this adjustment must be remade. Even if they are not replaced, the adjustment should be checked occasionally.

In balancing the two channels of a stereo system, it may be helpful to use the signal from an audio generator instead of program material (tuner, phonograph, or tape), and to use the evidence of a meter instead of one's ears. Equality between channels is achieved by adjusting input level-sets, gain controls, and balance controls.

Alignment of most FM tuners is far too technical a task for the average person. But some tuners in kit form are designed for alignment by the layman with even no instruments at all. On the other hand, a meter may facilitate the task, and perhaps make alignment somewhat more accurate than it would otherwise be.

In adjusting a tape playback head for correct azimuth, it is possible to play a recorded tape and align the head by ear for maximum treble response. But you can be more certain of best results by playing a test tape carrying a prolonged high-frequency tone, and adjusting the playback-head azimuth for maximum response as indicated by a meter connected to the output of the tape machine.

The better tape recorders include controls for adjustment of bias (which affects output level, distortion, and treble response), and the adjustments can be done in various ways. An audio generator and/or meter will generally be needed. For example, some manufacturers recommend adjusting bias by recording and playing a specified tone (such as 1000 Hz) and adjusting bias for maximum output of this tone. What is sometimes done is to consider this a preliminary adjustment and make a fine adjustment (a slight increase or decrease in bias) that improves record-playback frequency response. In other cases, the manufacturer specifies a certain voltage to be measured at a given point: or a certain amount of current flowing through the record head (measured by measuring voltage across a known resistance in series with the head). Similarly, a tape recorder, particularly a high-quality one, may include internal adjustments for record and playback level, and for calibrating the record-level indicator; these call for a signal source, a meter to measure output, and a harmonic-distortion meter—the last for the purpose of calibrating the record-level indicator.

**Kit Building**

A VOM (or VTVM) and a capacitor checker can be of great aid in the accurate construction of an audio kit. To begin, it is wise to check each resistor for proper value. For proper operation of the kit, resistors must be within a design value of design value, ranging from 20 per cent down to 1 per cent. Sometimes a pair of resistors must be virtually identical in value. Similarly, capacitors should be checked for proper value, for possible shorts or opens, and for excessive leakage. More than one kit has failed to work through no fault of the builder, but because of a defective part. Yet it is hard to blame the kit manufacturer, because it would add appreciably to the cost of the kit if the manufacturer had to check every last part. His quality control procedures are such that generally, but not always, all parts are okay.

During construction it is wise to check periodically the steps taken. For example, if you have snaked a rather long lead from one point to another, use the VOM (or VTVM) to check continuity between these points; this not only makes sure there is no break in the lead, but checks your soldering for a good electrical connection. If you have had to apply considerable heat to solder a resistor to a particular point, it is a good idea to make sure the resistor has not appreciably changed value owing to the applied heat. If you have something like three or four leads coming to a common tie point, there is always the possibility that one of these leads is floating free within the solder blob and not making good electrical connection.

(Continued on page 75)
Audio Test Equipment Compendium

On the following pages are presented several of the more useful items of audio testing equipment that the serious audio buff will want to scan thoroughly when he begins to assemble an embryonic "test lab." There are many other similar items available, but the ones listed here are offered by the manufacturers with which AUDIO readers are most familiar.

VOLTOHMMETERS

<table>
<thead>
<tr>
<th>MAKE and MODEL</th>
<th>SENSITIVITY</th>
<th>RANGES</th>
<th>COMMENTS</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EICO 536</td>
<td>d.c. = 1000 OHMS/VOLT</td>
<td>0-1, 5, 10, 50, 100, 500, and 5000 volts</td>
<td>3-in. meter. Measures d.c. V, d.c. amps, ohms</td>
<td>$14.95</td>
</tr>
<tr>
<td>EICO 566</td>
<td>d.c. = 1000 OHMS/VOLT</td>
<td>0-1, 5, 10, 50, 100, 500, and 5000 volts</td>
<td>4½-in. meter. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$16.95</td>
</tr>
<tr>
<td>EICO 565</td>
<td>d.c. = 20,000 OHMS/VOLT</td>
<td>0-2, 5, 10, 50, 250, 1000, and 5000 volts</td>
<td>4½-in. meter. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$24.95</td>
</tr>
<tr>
<td>HEATH MM-1</td>
<td>d.c. = 20,000 OHMS/VOLT</td>
<td>0-1, 5, 50, 150, 500, 1500, and 5000 volts</td>
<td>4½-in. meter. 1% resistors used throughout for maximum accuracy. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$29.95</td>
</tr>
<tr>
<td>KNIGHT KG-645</td>
<td>d.c. = 1000 OHMS/VOLT</td>
<td>0-1, 5, 10, 50, 100, 500, and 5000 volts</td>
<td>4½-in. meter. 1% resistors used for maximum accuracy. Overload protectors. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$24.95</td>
</tr>
<tr>
<td>KNIGHT 83U972MW</td>
<td>d.c. = 20,000 OHMS/VOLT</td>
<td>0-1, 5, 10, 50, 250, 1000, and 5000 volts</td>
<td>4½-in. meter. 1% resistors used for maximum accuracy. Overload protectors. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$29.95</td>
</tr>
<tr>
<td>LAFFAYETTE 99R-5004</td>
<td>d.c. = 30,000 OHMS/VOLT</td>
<td>0-2, 5, 10, 25, 100, 250, 500, and 1000 volts</td>
<td>Max. buzzer short test. Uses 1% resistors. Measures a.c. V, d.c. V, d.c. amps, ohms</td>
<td>$16.88</td>
</tr>
<tr>
<td>LAFFAYETTE 99R-5013</td>
<td>d.c. = 20,000 OHMS/VOLT</td>
<td>0-2, 5, 10, 50, 250, 1000, and 5000 volts</td>
<td>6-in. meter. 1½% resistors used. Measures a.c. V, d.c. V, d.c. amps, ohms. 50 μA full scale</td>
<td>$26.95</td>
</tr>
</tbody>
</table>
EICO 232 A general purpose ac-dc-ohms unit with a low-scale sensitivity of 3 volts full scale. A zero-center-scale feature is provided. A single multi-purpose probe is supplied for use with all measurements. Frequency response is 20 Hz to 3 mHz. Price is $37.95 as a kit and $41.95 wired.

Heath JM-11 A general purpose ac-dc-ohms VTVM with a maximum full-scale range of 1.5 volts. A single multi-purpose probe is employed. A zero-center-scale feature is provided. Rms or peak-to-peak measurements may be made. Price is $21.95 as a kit and $25.95 wired.

EICO 236 An a.c. VTVM designed particularly for audio measurement work. Maximum sensitivity is 1 mV full scale. Decibel range is -80 to +2 dB in 10-dB increments. Frequency response is ±60 Hz to ±600 kHz. A switch converts the instrument to a high-sensitivity amplifier with a maximum voltage output of 7 volts rms. Price is $49.95 as a kit and $52.95 wired. Also available is a reduced sensitivity VTVM that is also calibrated as a wattmeter. Price is $49.95 as a kit and $54.95 wired.

Heath IM-21 An a.c VTVM for audio work. Frequency response is 10 Hz to 500 kHz ±1dB. Maximum sensitivity is 10 mV full scale. Decibel ranges are -40 to +2 dB in 10-dB increments. Price as a kit is $33.95 and $35.95 wired.

Knight KG-620 A general purpose ac-dc-ohms VTVM with a maximum full-scale range of 1.5 volts. Separate probes are provided for ac and ohms or d.c. volts. The meter may be set for center-scale measurements. Rms or peak-to-peak measurements may be made. Frequency response is 30 Hz to ±50 kHz. Price as a kit is $24.95; $26.95 in the wired price.

Knight KI-625 A deluxe general purpose ac-dc-ohms VTVM. Maximum a.c. sensitivity full scale is 1.5 volts. d.c. measurements may be made down to 0.5 volts full scale. The meter has a 4" face and is equipped with a combination probe for all measurements. Rms or peak-to-peak measurements may be made, as well as a center-scale zero set. Price is $26.95 as a kit and $26.95 wired.

Lafayette 2S8 0101 A general purpose ac-dc-ohms VTVM. Maximum sensitivity full scale is 3 volts. The meter has a 6½" face. A pilot light indicates the unit is powered. A.c. peak-to-peak or rms measurements may be made from the a.c.-ohms probe. A separate probe is used for d.c. The pointer may be set for a zero center. Price is $26.95 wired only.
**AUDIO GENERATORS**

<table>
<thead>
<tr>
<th>MAKE and MODEL</th>
<th>SINE-WAVE RANGE</th>
<th>SQUARE-WAVE RANGE</th>
<th>CALIBRATION ACCURACY</th>
<th>DISTORTION</th>
<th>OUTPUT HEZ</th>
<th>ATTENUATOR TYPE</th>
<th>PRICE</th>
<th>WIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARKER &amp; WILHAUSON 210</td>
<td>10 Hz-100 kHz</td>
<td>-</td>
<td>not given</td>
<td>0 2%</td>
<td>5 volts</td>
<td>single continuous</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EICO 377</td>
<td>20 Hz-200 kHz</td>
<td>0-1 kHz</td>
<td>±3%</td>
<td>10%</td>
<td>14 volts</td>
<td>step-type and continuous</td>
<td>$37.95</td>
<td>$54.95</td>
</tr>
<tr>
<td>KNIGHT KG-653</td>
<td>20 Hz-1 kHz</td>
<td>-</td>
<td>not given</td>
<td>0 3%</td>
<td>10 volts</td>
<td>step-type and continuous</td>
<td>$39.95</td>
<td>-</td>
</tr>
<tr>
<td>HEATH KG-72</td>
<td>10 Hz-100 kHz</td>
<td>-</td>
<td>±5%</td>
<td>0 4%</td>
<td>10 volts</td>
<td>6-position step-type and continuous</td>
<td>$41.95</td>
<td>$64.95</td>
</tr>
<tr>
<td>HEATH KG-82</td>
<td>20 Hz-1 kHz</td>
<td>-</td>
<td>not given</td>
<td>0 25%</td>
<td>50-100V square 10V split</td>
<td>step-type and continuous</td>
<td>$51.95</td>
<td>$94.00</td>
</tr>
<tr>
<td>LAFAYETTE 99R-5014</td>
<td>20 Hz-200 kHz</td>
<td>20 Hz-25 kHz</td>
<td>±3%</td>
<td>2%</td>
<td>7 volts</td>
<td>single continuous</td>
<td>-</td>
<td>$35.95</td>
</tr>
</tbody>
</table>

* This unit has step-type frequency selectors for accurate readability. It also has a volt- and dB-calibrated output meter.

**OSCILLOSCOPES**

**EICO 439** A general purpose scope with a vertical response from 2 Hz to 500 kHz + 1 Hz. Has a three-inch face. Sweep range is from 10 Hz to 100 kHz and sync is automatic. Sensitivity in the vertical channel is 25 mV/cm, rms. Price is $89.95 as a kit and $98.95 wired.

**EICO 427** A highly sensitive d.c. scope with a five-inch face, well suited to audio measurements. Vertical sensitivity is 2.5 mV/cm, rms, and frequency response is d.c. to 500 kHz + 1 Hz. Sweep range is from 10 Hz to 100 kHz and sync is automatic. Price is $89.95 as a kit and $108.95 wired.

**EICO 415** A wideband d.c. scope with a three-inch face. Vertical response is from d.c. to 4.5 kHz + 1 Hz. Sweep range is from 10 Hz to 1 MHz plus a TV vertical and TV horizontal. Sensitivity is 18 mV/cm, rms. Price is $99.95 as a kit and $149.95 wired.
HEATHKIT 10-21 A general purpose compact scope. Has a 3" tube face. Features identical vertical and horizontal amplifiers with 20 Hz to 200 kHz ± 2 dB response. Sweep generator range is 20 Hz to 100 kHz and sensitivity is 0.25 volts/inch, rms. Price is $54.95 as a kit only.

HEATHKIT 10-10 A 3" a.c.-d.c. scope specifically suited to audio measurements. Features identical vertical and horizontal amplifiers with a d.c. to 200 kHz response at the -2 dB point. Sweep is available from 2 Hz (lower with an external capacitor) to 50 kHz. Sensitivity is 0.1 V/inch, peak-to-peak. The phase shift between channels is less than 5 deg. Price is $89.95 as a kit only.

HEATHKIT IO-12 A lab-type scope suited to a wide range of uses. Has a 5" face with standard camera-mount connectors. A.c. range of the vertical amplifier is from 3 Hz to 5 mHz, ±1.5, -5 dB. 10 Hz to 500 kHz sweep range. Sensitivity is 0.025 volts/inch, rms. and rise time is 0.08 microseconds. Synchronizing is automatic. Price is $76.95 as a kit; $126.95 factory wired.

KNIGHT KG-630 A wideband scope with a 5" face. Vertical frequency response is d.c. to 5.2 mHz ± 1.5 dB. Rise time is 70 nanoseconds. Sweep is available from 10 Hz to 500 kHz and is semi-automatic with a level control. Vertical sensitivity is 17 mV/inch, rms. Price as a kit is $99.95 and wired at $149.95.

KNIGHT KG-630 A wideband scope with a 5" face. Response is 5 Hz to 5 mHz ± 3 dB. Vertical sensitivity is 20 mV/in. rms., inch. Sweep is from 15 Hz to 600 kHz. Synchronization can be locked in as high as 5 mHz. Price is $74.95 as a kit; $99.95 wired.

KNIGHT KG-2000 A wideband 5" d.c. scope that easily exhibits the greatest versatility of all scopes listed. Vertical bandwidth is d.c. to 5 mHz, -3 dB. Vertical sensitivity is 0.05 volts/cm, p-p, d.c. coupled, and 0.005 volts/cm, p-p a.c. coupled with a d.c. rise time of 85 nanoseconds. Time-base sweep ranges are from 0.05 sec/cm to 200 nsec/cm in 16 ranges. Sweep timing accuracy is within 3 per cent, and is fully automatic. Vertical input is by a shielded BNC connector. Camera mount studs are provided and a 5X horizontal expansion position is provided. Price is $199.95 as a kit and $299.95 wired.

(Continued on page 73)
If the Electro-Voice Model 664 picks up sound here...

The holes in the top, sides and rear of the Electro-Voice Model 664 make it one of the finest dynamic cardioid microphones you can buy. These holes reduce sound pickup at the sides, and practically cancel sound arriving from the rear. Only an Electro-Voice Variable-D® microphone has them.

Behind the slots on each side is a tiny acoustic "window" that leads directly to the back of the 664 Acoustaloy® diaphragm. The route is short, small, and designed to let only highs get through. The path is so arranged that when highs from the back of the 664 arrive, they are cut in loudness by almost 20 db. Highs arriving from the front aren't affected. Why two "windows"? So that sound rejection is uniform and symmetrical regardless of microphone placement.

The hole on top is for the mid-range. It works the same, but with a longer path and added filters to affect only the mid-frequencies. And near the rear is another hole for the lows, with an even longer path and more filtering that delays only the bass sounds, again providing almost 20 db of cancellation of sounds arriving from the rear. This "three-way" system of ports insures that the cancellation of sound from the back is just as uniform as the pickup of sound from the front—without any loss of sensitivity. The result is uniform cardioid effectiveness at every frequency for outstanding noise and feedback control.

Most other cardioid-type microphones have a single cancellation port for all frequencies. At best, this is a compromise, and indeed, many of these "single-hole" cardioids are actually omnidirectional at one frequency or another!

In addition to high sensitivity to shock and wind noises, single-port cardioid microphones also suffer from proximity effect. As you get ultra-close, bass response rises. There's nothing you can do about this varying bass response except use a Variable-D microphone with multi-port design that eliminates this problem completely.

Because it works better, the E-V 664 Dynamic Cardioid is one of the most popular directional microphones on the market. It has both high and low impedance outputs available at the plug. Frequency range is peak-free from 40 to 15,000 Hz (cps). Output is —58 db. To learn more about Variable-D microphones, write for our free booklet, "The Directional Microphone Story." Then see and try the E-V 664 at your nearby Electro-Voice microphone headquarters. Just $85.00 in satin chrome or non-reflecting gray, or $90.00 in gold finish (list prices less normal trade discounts).

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ELECTRO-VOICE, INC., Dept. 262A
602 Cecil Street, Buchanan, Michigan 49107

Circle 121 on Reader Service Card

What are all these other holes for?
Edison’s Invention of the Kineto-Phonograph

Account of the Invention

We reprint this rare article from the June, 1894, issue of Century Magazine describing Thomas A. Edison’s invention of motion pictures. It was one of the best contemporary accounts of Edison’s invention and as such should be of interest to anyone concerned with the modern version of this invention—the Video Tape Recorder.

The synchronous attachment of photography to the phonograph was early contemplated by Mr. Edison, in order to record and give back the impressions to the eye as well as to the ear.

The comprehensive term for this invention is the kineto-phonograph. The dual “talking-machine” is the phono-kinetograph, and the reproducing-machine the phono-kinetoscope, in contradistinction to the kinetograph and the kinetoscope, which relate respectively to the taking and reproduction of moving but soundless objects.

The initial experiments took the form of microscopic pin-point photographs, placed on a cylindrical shell, corresponding in size to the ordinary phonograph cylinder. These two cylinders were then placed side by side on a shaft, and the sound record was taken as nearly as possible in synchronism with the photographic image impressed on the sensitive surface of the shell. The photographic portion of the undertaking was seriously hampered by the defects of the materials at hand, which, however excellent in themselves, offered no substance sufficiently sensitive. How to secure clear-cut outlines, or indeed any outlines at all together with phenomenal speed, was the problem which puzzled the experimenters. The Daguerre, albumen, and kindred processes met the first requirements, but failed when subjected to the test of speed. These methods were therefore regretfully abandoned, a certain precipitate of knowledge being retained, and a bold leap was made to the Maddox gelatine bromide-of-silver emulsion, with which the cylinders were coated. This process gave rise to a new and serious difficulty. The bromide-of-silver haloids, held in suspension with the emulsion, showed themselves in an exaggerated coarseness when it became a question of enlarging the pin-point photographs to the dignity of one eighth of an inch, projecting them upon a screen, or viewing them through a binocular microscope. Each accession of size augmented the difficulty, and it was resolved to abandon that line of experiment, and to revolutionize the whole nature of the proceedings by discarding these small photographs and substituting a series of larger impressions allied to the outer edge of a swiftly rotating wheel, or disk, and supplied with a number of pins, so arranged as to project under the center of each picture. On the rear of the disk, upon a stand, was placed a Geissler tube, connected with an induction coil, the primary wire of which, operated by the pins, produced a rupture of primary current, which, in turn, through the medium of the secondary current, lighted up the Geissler tube at the precise moment when a picture crossed its range of view. This electrical discharge was performed in such an inappreciable fraction of time, the succession of pictures was so rapid, and the whole mechanism so nearly perfect, that the goal of the inventor seemed almost reached.

Then followed some experiments with drums upon which sheets of sensitized celluloid film were drawn, the edges being pressed into a narrow slot in the surface, similar in construction to the old tin-foil phonograph. A starting and stopping device very similar to the one now in use was also applied. The pictures were then taken spirally to the number of two hundred or so, but were limited in size, owing to the roundness of surface, which brought only the center of the picture into focus. The sheet of celluloid was then developed, fixed, etc., and placed upon a transparent drum bristling at its outer edge with brass pins. When the drum was turned rapidly, these came in contact with the primary current of an induction coil, and each image was lighted up in the same manner as described in the previous disk experiment, with this difference only, that the inside of the drum was illuminated.

The next step was the adoption of a highly sensitized strip of half-inch-wide celluloid, which proved unsatisfactory because of inadequate size. One-inch pictures on a band one and a-half inches wide were next substituted, the additional width being required for the perforations on the outer edge. These perforations occur at close and regular intervals, in order to enable the teeth of a locking-device to hold the film steady for nine tenths of 1/46 of a second, when a shutter opens rapidly and admits a beam of light, causing an image or phase in the movement of the subject. The film is then jerked forward in the remaining tenth of 1/46 second, and held at rest while the shutter has again made it round, admitting another circle of light, and so on until forty-six impressions are taken per second, or 2760 a minute. This speed yields 165,000 pictures in an hour, an amount amply sufficient for an evening’s entertainment, when unreel before the
eye. By connecting the two ends of the strip, and thus forming a continuous band, the pictures can be indefinitely multiplied. In this connection it is interesting to note that were the spasmodic motions added up by themselves, exclusive of arrests, on the same principle that a train record is computed independent of stoppages, the incredible speed of twenty-six miles an hour would be shown.

The advantage of this system over a continuous band, and of a slotted shutter forming widely spaced bands of the film, would be that in the latter only the fractional degree of light comprised in the 1/2720 part of a second is allowed to penetrate to the film at a complete sacrifice of all detail, whereas, in the present system of stopping and starting, each picture gets one hundredth part of a second's exposure, with a lens but slightly stopped down—time amply sufficient, as any photographer knows, for the attainment of excellent detail even in an ordinarily good light. It must be understood that only one camera is used for taking these strips, and not a battery of cameras, as in Mr. Muybridge's photographs of "The Horse in Motion."

The next step, after making the negative band, is to form a positive or finished series of reproductions from the negative, which is passed through a machine for the purpose, in conjunction with a blank strip of film, which, after development and general treatment, is replaced in the kinetoscope or phonokinetoscope, as the case may be. When a phonograph record has been taken simultaneously with such a strip, the two are started together by the use of a simple but effective device, and kept so all through, the phonograph record being in perfect accord with the strip. In this conjunction, the tiny holes with which the edge of the celluloid film is perforated correspond exactly with the phonographic records, and the several devices of the camera, such as the shifting of the film and the operation of the shutter, are so regulated as to keep pace with the indentation made by the stylus upon the phonographic wax cylinder, one motor serving as a source of common energy to camera and phonograph, when they are electrically and mechanically linked together.

**Synchronization**

The establishment of harmonious relations between kinetoscope and phonograph was a harrowing task, and would have broken the spirit of inventors less insured to hardship and discouragement than Edison's veterans. The experiments have borne their legitimate fruit, and the most scrupulous nicety of adjustment has been achieved, with the resultant effects of realistic life, audibly and visually expressed.

**Fig. 2** A front view of the kinetograph taken from the same article and illustrating the film strip and shutter arrangement employed. Both drawings were made from sketches furnished the authors by Mr. Edison.

The process of "taking" is variously performed; by artificial light in the photographic department, or by daylight under the improved conditions of the new theater, of which we shall speak. The actors, when more than one in number, are kept as close together as possible, and exposed either to the glare of the sun, to the blinding light of four parabolic magnesium lamps, or to the light of twenty arc-lamps, provided with highly actinic carbons and applied with powerful reflectors equal to about 50,000 candlepower. This radiation is concentrated upon the performers while the kinetograph and phonograph are hard at work storing up records and impressions for future reproduction.

A popular and inexpensive adaptation of kinetoscopic methods is in the form of the well-known nickel-in-the-slot, a machine consisting of a cabinet containing an electrical motor and batteries for operating the mechanism which actuates as the impelling power to the film. The film is in the shape of an endless band fifty feet in length, which is passed through the field of a magnifying-glass perpendicularly placed. The photographic impressions pass before the eye at the rate of forty-six per second, through the medium of a rotating, slotted disc, the slot exposing a picture at each revolution, and separating the fractional gradations of pose. Projected against a screen, or viewed through a magnifying-glass, the pictures are eminently lifelike, for the reason that the enlargement need not be more than ten times the original size. On exhibition evenings the projecting-room, which is situated in the upper story of the photographic department, is hinged with black, in order to prevent any reflection from the circle of light emanating from the screen at the other end, the projector being placed behind a curtain, also of black, and provided with a single peep-hole for the accommodation of the lens. The effect of these somber draperies, and the weird accompanying monotone of the electric motor attached to the projector are horribly impressive, and one's sense of the supernatural is heightened when a figure suddenly springs into his path, acting and talking with a vigor which leaves him totally unprepared for its mysterious vanishing. Projected stereoscopically, the results are even more realistic, as those acquainted with that class of phenomena may imagine, and a pleasing roundness is apparent, which, in ordinary photographic displays, is conspicuous by its absence.

Nothing more vivid or more natural could be imagined than these breathing, audible forms, with their tricks of familiar gesture and speech. The inconceivable swiftness of the photographic successions, and the exquisite synchronism of the phonographic attachment, have removed the last trace of automatic action, and the illusion is complete. The organ-grinder's monkey jumps upon his shoulder to the accompaniment of a strain from "Norma." The rich strains of a tenor or soprano are heard, set in their appropriate dramatic situation, and the blacksmith is seen swinging his ponderous hammer, exactly as in life, and the clanging of the anvil keeps pace with his symmetrical movements, along with the rhythmical measures of the dancer go her soft-sounding footfalls, the wrestlers and fencers ply their intricate game, guarding, parrying, attacking, thrusting, and throwing, while the quick flash of the eye, the tension of the mouth, the dilated nostrils, and the strong, deep breathing give evidence of the potentialities within.

The photographic rooms, with their singular completeness of appointment, have been the birthplace and nursery of the invention; and the more important processes connected with the preparation and development of the film, together with other mechanical and scientific devices, are still carried on in this department. The exigencies of natural lighting incident to the better "taking" of the subjects, and the lack of a suitable theatrical stage, however, necessitated the construction of a special building which stands in the center of that cluster of auxiliary houses which forms the suburbs of the laboratory, and which is of so peculiar an appearance as to challenge the attention of the most superficial observer. It obeys no architectural rules, embraces no conventional materials, and follows no accepted scheme of color. Its shape is an irregular oblong, rising abruptly in the center, at which point a movable roof is attached, which is easily raised or lowered at the will of a single manipulator. Its color is a grim and forbidding black, enlivened by the dull luster of many hundred metallic points; its material is paper, covered with pitch and profusely studded with tin nails. With its flappin
sail-like roof and ebon hue, it has a weird and semi-nautical appearance, and the uncanny effect is not lessened when, at an imperceptible signal, the great building swings slowly around upon a girdered center, presenting any given angle to the rays of the sun, and rendering the operators independent of diurnal variations. The movable principle of this building is identical with that of our river swinging bridges, the ends being suspended by iron rods from raised center-posts. This building is known as the Kinetographic Theatre, otherwise the “Black Maria.” Entering, we are confronted by a system of lights and shades so sharply differentiated as to pain the eye, accustomed to the uniform radiance of the outer air. Later we find that the contrasts are effected by the total exclusion of light from the lower end of the hall, heightened by draperies of impenetrable black, against which stands out in sharp relief the central stage, on which are placed the kinetographic subjects, bathed in the full power of the solar rays pouring down from the movable roof. This distribution of light and shade is productive of the happiest effects in the films, as the different figures are thrown into the broadest relief against the black background, and a distinctness of outline is achieved that would be impossible under ordinary conditions.

At the other end of the hall is a cell, indicated by an ordinary door and an extraordinary window, glazed in panes of lurid hue, which gives the finishing touch to the Rembrandtesque character of the picture. The compartment is devoted to the purpose of changing the film from the dark box to the kinetographic camera, being provided with a special track, running from the mysterious recesses at the back of the stage to its own special precincts, where fresh films are substituted for the ones already employed. The processes of development, etc., are performed in the main photographic building.

The *dramatis personae* of this stage are recruited from every characteristic section of social, artistic, and industrial life, and from many a phase of animal existence. One day chronicled the engagement of a troupe of trained bears and their Hungarian leaders. The bears were divided between surly discontent and a comfortable desire to follow the bent of their own inclinations. It was only after much persuasion that they could be induced to observe the interests of science. One furious monster waddled up a telegraph-pole, to the soliloquy of his own indignant growls, another settled himself comfortably in a deep arm-chair, with the air of a post-graduate in social science; a third rose solemnly on his hind legs and described the measures of some dance, to the weird strains of his keeper’s music. Another licked his master’s swarthy face, another accepted his keeper’s challenge, and engaged with him in a wrestling-match, struggling, hugging, and rolling on the ground.

Of human subjects we have a superfluity, although the utmost discrimination is essential in the selection of themes. The records embrace pugilistic encounters, trapeze and cane exercises, dancing, wrestling, fencing, singing, the playing of instruments, speech-making, the motions involved in the different crafts, horseshoeing, equestrianism, gardening, and many others.

We have yet to speak of the microscopical subjects, a class of special interest, as living outside of the unaided vision of man. In the treatment of these infinitesimal types, much difficulty was experienced in obtaining a perfect adjustment so as to reproduce the breathing of insects, the circulation of blood in a frog’s leg, and other similar processes of nature. The enlargement of animal-cules in a drop of stagnant water proved a most exacting task, but by the aid of a powerful lime-light, concentrated on the water, by the interposition of alumin cells for the interception of most of the heat rays, and by the use of a quick shutter and kindred contrivances, the obstacles were overcome, and the final results were as fully to compensate for the expenditure of time and trouble. We will suppose that the operator has at last been successful in imprisoning the tricky water-goblins on the sensitive film, in developing the positive strip, and placing it in the projector. A series of inch-large shapes then springs into view, magnified stereoptically to nearly three feet each, gruesome beyond power of expression, and exhibiting an indescribable celerity and rage. Monsters close upon one another in a blind and indiscriminate attack, limbs are dismembered, gory globules are tapped, whole battalions disappear from view. Before the ruthless completeness of these martial antics the Kilkeny cats fade into insignificance. A curious feature of the performance is the passing of these creatures in and out of focus, appearing sometimes as huge and distorted shadows then springing into the reality of their own size and proportions.

Hitherto we have limited ourselves to the delineation of detached subjects, but we shall now touch very briefly upon one of our most ambitious schemes, of which these scattered impersonations are but the heralds. Preparations have long been on foot to extend the number of actors and to increase the stage facilities, with a view to the presentation of an entire play, set in its appropriate frame.

This line of thought may be indefinitely pursued with application to any given phase of outdoor or indoor life which it is desired to reproduce. Our methods point to ultimate success, and every day adds to the security and the celerity of the undertaking. No scene, however animated and extensive, but will eventually be within reproductive power. Martial evolutions, naval exercises, processions, and countless kindred exhibitions will be recorded for the leisurely gratification of those who are debarred from attendance, or who desire to recall them. The invalid, the isolated country recluse, and the harassed business man can indulge in needed recreation, without undue expenditure, without fear of weather, and without the sacrifice of health or important engagements. Not only our own resources but those of the entire world will be at our command. The advantages to students and historians will be immeasurable. Instead of dry and misleading accounts tinged with the exaggerations of the chroniclers’ minds, our archives will be enriched by the vitalized pictures of great national scenes, instinct with all the glowing personalities which characterized them. (Antonia and W. K. L. Dickson)
SONY®
for home
video tape
recording

VIDEOCORDER®
SONY's Home Videocorder®

Important programs may be seen time and time again.

What is the Videocorder? The Videocorder is an instrument which records both picture and sound on tape, much in the same manner as an ordinary tape recorder records sound only. Professional video tape recorders have been in use for several years in many fields, notably television, where programs are recorded on tape for later broadcasting.

Now, SONY becomes the leader with a low priced home video tape recorder, called the SONY Videocorder®. Its operation is similar to that of an ordinary tape recorder. With the flip of a switch, you may either transcribe an uncopyrighted television program on tape for later viewing or play back a recorded tape. By the use of the Videocorder, important programs can be recorded on tape in your absence. Also, if two important programs are telecast simultaneously, one may be taped on the Videocorder while the other is viewed on a second TV set.

With the use of SONY's Video Camera Kit, a new era of enriched home entertainment has truly begun. Using the simple-to-operate SONY Video Camera and Microphone, anyone may easily record family events, or even their own sports activities for study and improvement. It is easy to see the tremendous advantages of video tape recording. Any recording may be viewed immediately without waiting for developing or processing. You may build a home tape library of these events for later viewing.

Sony's home use Videocorder, the newest major breakthrough in magnetic recording techniques, compact in size and low in cost, makes it possible for all to enjoy the excitement of video recording in their own home!
Video Camera gives you an easy way to record family events for immediate playback.

For more versatile usage of the Videocorder, Sony has developed its video camera which is included in the VCK-2000 Video Camera Kit. Using this Kit, any event can be taped with sound for immediate replay on the Videocorder screen. Therefore, a home tape library of important events can be built; Athletes, actors, singers or musicians can record their own performances and study them for improvement. Parades, celebrations and other public events can be recorded on tape for showing at any time in the home. Any family activity such as parties, anniversaries, or weddings can be permanently recorded and stored in the home tape library.

**Video Camera Kit**
- Comes complete with camera, standard lens, camera cable, microphone, tripod, AC cord and extension cord—all in one portable case.
- Operation of the camera is simple.
- Camera is compact in size.
- Telephoto and wide angle lenses can be used.
- Videocorder screen can be used as a monitor when recording.
- Camera is solid state—maintenance free.
- Operates on regular household AC current.

**Complete Camera Kit**
VCK-2000, $350.00

The Videocorder is not to be used to record copyrighted works.
Videocorder TCV-2010 features
- Simple operation, similar to ordinary tape recorders.
- Slow speed recording—Sony’s special feature
  - Tape speed is only $7\frac{1}{2}$ inches per second.
  - Tape is only $\frac{1}{2}$" wide.
  - Uses only $7\frac{1}{2}$" reels for one full hour of continuous recording.
  - Tape consumption is low.
  - Tape breakage is minimal.
  - Mechanical durability is assured.
- Solid state circuitry further assures durability.
- Tapes can be erased for new recordings.
- Videocorder screen can be used as a normal TV receiver.
- Operates on regular household AC current.
- Has carrying handles for easy portability.

Videocorder Model TCV-2010, $995.00

Videocorder TCV-2020 features
The Videocorder model TCV-2020 has all the features of the TCV-2010 except for the carrying handles. In addition:
- Housed in a beautiful walnut cabinet.
- Has timing device which may be preset to record programs while you are away from home.

Videocorder Model TCV-2020, $1250.00

<table>
<thead>
<tr>
<th>Type</th>
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VIDEO TAPE RECORDING caused a major revolution in television broadcasting! We believe the recent introduction of a video recorder for less than one thousand dollars will greatly expand the use of this medium and that it will create the same impact in many other fields.

It was in 1951 that Crosby Enterprises, now the Min-com Division of 3M Company, amazed the television industry by announcing that they had perfected a method of recording both sound and pictures on magnetic tape and demonstrated the first video recorder. This was shortly followed by RCA's announcement of their video tape recorder. Both units operated on essentially the same principle and employed the longitudinal technique of recording. This method is similar to that used in modern audio tape recorders. As illustrated at (A) in Fig. 1, the tape moved across the record/playback heads, which were stationary. The signals were recorded parallel to the tape path, as shown. The one-inch tape in the Crosby recorder moved at a speed of 100 inches per second and provided a bandwidth of 2.5 megacycles. The video signal was separated into eleven different components which were recorded on as many parallel tracks. A fourteen-inch reel of tape was required to obtain a 15-minute video recording. While this bandwidth did not provide any great improvement in quality over the Kinescope (film) recording process then in use (motion pictures were photographed from the screen of the station monitor), the Crosby video tape recorder did offer many other advantages. Most important at the time was the fact that the Kinescope recordings were expensive; the cost of raw film and developing alone was about $1000 for a one-hour show.

The RCA system, with its one-half-inch tape moved over three times as fast (360 inches per second) and recorded the video signal on a single track and required a seventeen-inch reel of tape for four minutes of programming.

However, this system provided a greater bandwidth and in consequence a picture superior to the Kinescope recordings.

Meanwhile another company, Ampex, had perfected a video recorder which operated on a different principle. It was not until April, 1956, when the television industry was gathered at a convention in Chicago, that their first video tape recorder was demonstrated and became available.

Instead of moving the tape across a single stationary record/playback head, as in the earlier systems, the four record/playback heads employed, as well as the tape, were moved. A drum incorporating the four heads rotated crosswise to the tape motion, as illustrated at (B) in Fig. 1; as the four record/playback heads revolved each recorded a single track. While the forward motion of the two-inch tape was only fifteen inches per second, the effective tape-to-head speed was 1500 inches per second. This technique, called transverse recording, provided a still greater bandwidth and a picture demonstrably superior to the Kinescope recordings. In addition, a 12½-in. reel of video tape would provide a one-hour recording.

In November, 1956, CBS began the first regularly scheduled video tape news program with "Douglas Edwards and the News." Before video tape, programs of this nature were repeated four times each evening, once for each time zone. Kinescope recordings were impractical because of the time required for film processing, and their prohibitive cost.

As deliveries of video recorders increased and they were put into use, other advantages soon became apparent. The quality of the video tape telecasts was now such that they could not be distinguished from the "live" broadcasts by the viewers. This is quite simple to understand when we stop to realize that when video tape is employed there are only three transfer stages. The electronic signals are converted to magnetic impulses and stored on tape. Upon playback the stored magnetic impulses are simply converted back to video signals. Conversely, a Kinescope recording must pass through twelve transfer stages losing some quality at each as it is transferred from the electronic to the optical, to chemicals, to optical and back to electronic again.

Perhaps the most important advantage to the early users of video tape recording was the fact that the cost for a one-hour show was only a few dollars as opposed to the thousand or more for

![Fig. 1. (A) The longitudinal method of video recording employed by Crosby enterprises. (B) The transverse method of video recording later developed by Ampex.](image-url)
a Kinescope recording, since the video tape could be erased after use and reused many times. As word of the new medium spread, the government and educators quickly realized its tremendous potential as a teaching and training aid. The use of video recorders was, of course, still limited by their high cost ($50,000 each). Initially, only large universities, the TV networks, and the government could afford them.

In September 1959, the Japanese firm of Toshiba announced and demonstrated a single-head video recorder employing a radically new concept. The helical scan technique of video recording, as it came to be called, employed a single record/playback head mounted on a disc within a cylinder, as illustrated in Fig. 2. The two-inch tape was wound and moved in a helical loop around the cylinder at the broadcast standard speed of fifteen inches per second. As the record/playback head revolved it recorded a long slanting track. The track started at the bottom of the tape and rose diagonally to the top as the head revolved inside the helical loop. The head then immediately contacted the bottom of the tape again; however, due to the forward motion of the tape, the following track was recorded a fraction of an inch further along the tape, as illustrated.

The helical scan technique, by eliminating three record/playback heads, the head switching system, and three amplifiers (four were required with the transverse system), was able to provide excellent quality at a price substantially less than others available at the time.

In November, 1959, a grant from the Ford Foundation permitted the National Educational Television Network (which is to educational television stations what national commercial networks are to their member stations) to install video tape recorders in its duplicating center at Ann Arbor, Michigan. The hope was that these recordings would provide a means of copying tapes and erasing them for re-use eliminating the necessity of making copies of Kinescope films which had been found to lose value after the initial showing at a station. Video tape would make it possible, it was hoped, to distribute to schools and colleges programs of current events, or special "one-shot" programs which previously had been prohibitively costly to duplicate on film. The Foundation's fondest expectations were realized; the video recorders were highly successful. In consequence the Ford Foundation made a second grant to NET in 1960 permitting twenty-five additional stations to be equipped for video tape. By 1961 NET numbered 58 affiliates, all with video tape facilities.

In the spring of 1961, Ampex demonstrated a single-head recorder which operated on essentially the same principle as Toshiba's. The tape was moved at a speed of 75 ips, which was to become the standard for non-broadcast applications, instead of the 15 ips employed by Toshiba.

In October of 1962, a helical scan recorder priced at the $10,000 level—a substantial reduction from the previous prices—was introduced by the Japanese Sony Corporation. This company had started in 1948 by building audio tape recorders for educational purposes. In 1955 they manufactured the world's first miniaturized transistor radio. In 1960 they had begun the manufacture of the world's first miniature transistorized television receivers. Little did Mr. Ibuka and Mr. Morita, the founders of Sony, realize that each of these developments, noteworthy by itself, was merely another step toward an end which would be as important as the invention by Gutenberg of movable type. This comparatively low, price further expanded the use of video recording.

Smaller schools, colleges, and universities could now afford them. Video tape recorders were quickly incorporated into many closed-circuit educational TV systems. Now specialists in various fields could be recorded when they were available and events could be recorded as they occurred, and shown when a particular phase of a course called for the information. The smaller TV stations also expand their use of video tape recorders.

Soon Hollywood became interested in the new medium and the possibilities of combining the video recorder with a motion picture camera. It was discovered that the video recorder could provide many advantages in this field too! Rehearsal time could be greatly reduced. The director could now view the scene on the monitor without the film camera operating. There was no longer any guesswork about composition, and possible omissions. The number of "takes" could be reduced; the director could now follow the scene on the video monitor as it was being shot. There was no longer any problem as to whether or not a given "take" was satisfactory. The video tape preview could be found to be of tremendous value in rehearsing the cast. The fact that the actors and crew could see the scene as it was played back was found to be extremely valuable in shooting. The combination of the video camera and recorder and the motion picture camera had streamlined production procedures, provided economies, and increased the quality of the ultimate film. In 1964, the Mitchell Camera Corporation, who had been working with the Sony Corporation introduced their "System S," and created a new film making tool. This was the first commercially available combination of the video camera and recorder with the motion picture camera, as illustrated in Fig. 3. It was subsequently discovered that when this combination system was properly employed it could cut the cost of filming by at least 25 per cent, and it also permitted a substantial saving in time.

During this time North American Philips, RCA, and others had also developed a number of excellent video recorders at competitive prices. Video

Figure 2 The single-head, helical-scan system of video recording invented by Tokyo Shibaura Electric Co. Ltd. (Toshiba).
recording, because of the consequent price reductions again expanded from its earlier applications to new ones in science, commerce, medicine, research, and religion.

During the year 1965 video recorders in the three-thousand-dollar price category were introduced and thereby began the same revolution in other fields which video tape had caused in television broadcasting.

It was also during this year that Sony Corporation's long experience with precision motors, miniaturized electronic components, television receivers and monitors, and video recorders were combined to create a major breakthrough in the art of video recording by introducing the first instrument to sell for under $1000, thus removing the one limitation which had precluded the use of video recording by many prospective buyers. It is now well within the budgets of even the smallest organizations. Almost complete automation in recording and viewing make it possible for anyone to produce excellent video tape recordings.

The combination of moving pictures and sound is today recognized by business, science, education, government, industry, and religion as the most effective means of transmitting information. The effectiveness of video recording in any of the varied tasks which were assigned to it had been proven. It could be employed to analyze, to report, to educate, to persuade, and to sell.

There is a tremendous number of applications in which video recording permits the user to accomplish his ends more efficiently and less expensively than any other medium. There are even more in which video recording opens up entirely new possibilities. We will attempt to outline a few in the hope that they will stimulate the imagination of the reader into suggesting others applicable to his particular field of endeavor.

The video recorder can be of tremendous advantage in the pre-production testing of prototype machinery, aircraft, ships, and automobiles. The video camera can be attached to, or close by, any point of interest where the use of a direct observer is impossible because of safety, space, or other considerations. The effectiveness of test runs can be greatly increased since a video recording can provide more accurate and detailed information than the memory of any observer. A video recording can be played back as often as required by the engineer, or any other, department.

In the medical field, video recording has many valuable applications. The study of X-ray pictures can be greatly facilitated since the image from a video recording can be made much brighter than the same image would appear on an X-ray screen, thus providing improved detail recognition.

Video recordings may be made of the behavior of mentally disturbed patients, then played back and studied at the convenience of the staff psychiatrist eliminating the necessity of calling him for personal observation while he may be otherwise occupied.

For biological research the microscope may be combined with a video camera and recorder to create a research tool of fantastic power—an "electronic-recording microscope." This new scientific instrument will greatly facilitate study by reducing the viewing fatigue commonly experienced when looking at the microscope field directly through the eyepiece for prolonged periods. Perhaps the most important contribution the "electronic-recording microscope" makes to biological research is its ability to repeat the original observations as often as is required to check a particularly important or interesting stage. There is no processing delay encountered as when film is employed—the cost of the record is considerably less since when the observation is unsatisfactory or has served its purpose, the video tape may be instantly erased and reused. The addition of ultra-violet and infrared illumination and/or the substitution of the vidicon tubes now available for these wavelengths can further extend the application of the "electronic-recording microscope" in many fields.

While on the subject of infrared light, we should mention that a video recording will prove extremely valuable to naturalists and zoologists. Both amateur and professional can greatly extend the areas of their research by employing a video camera and recorder fitted with an infrared sensitive vidicon tube to observe nocturnal birds, insects, and small mammals when the eye could not see them at all. The phenomena can be recorded for later and more convenient study and analysis.

A video camera and recorder combined with a telescope can provide many advantages to the amateur or professional astronomer. The video chain can increase the basic sensitivity of the telescope almost six times. Phenomena of particular interest may be recorded and instantly played back as often as is required to a group audience.

We could continue with many other applications for the video recorder, however, the lack of space permits only one. The field of home entertainment will benefit greatly by its introduction.

We believe one of its most interesting applications will be the creation of "home video movies" which can compare favorably with the professional travelogues and documentaries shown on commercial television such as the fascinating NBC release "Spanish Arinca" produced by George Vease. In this documentary, "live" action, slides, film clips, and "still"s taken from books and paintings were combined to create a superb television program. With a video recorder, vacation pictures can be combined with purchased slides of the same area, "the shots you missed" for one reason or another. Interesting facts from books or travel folders can be employed as the "script" for your narration. A complete sound and sight "video movie" can be created in your home.

We have mentioned only a few of the possible applications of video recording in order to acquaint our readers with the tremendous potential of this medium.

In future "Sound and Sight" articles we will cite actual examples of the various applications and provide detailed information on the techniques employed—the "tricks of the trade" so to speak.
Some Comments on the RIAA Tape Standard

HERMAN BURSTEIN

"With regard to our standards generally, I think you ought to be aware that the Association does not arbitrarily legislate standards and exact mandatory compliance on the part of members of the industry. Adherence to these standards is completely voluntary and in order to win as much compliance as possible the standards endeavor to cover not only the theoretical aspects of the question but also its practical applications. At times this involves a compromise between conflicting points of view and between theoretical desirability and practical attainment."

Equalization

Figure 1 shows the playback equalization curves recommended by RIAA for 7.5 and 3.75 ips. Standard 9.1 states, "This is exclusive of any modifications to the characteristics required to correct for head losses." In other words the playback equalization in Fig. 1 can be altered (less treble cut and/or additional bass boost) to compensate for frequency losses of the playback head. Because the above quotation appears in a section titled "Reproducing Characteristic," it must be interpreted as applying only to the playback head.

The RIAA standard says nothing about record equalization. But logic and precedent (such as the NAB standard for 15 ips) tell us that record equalization shall be such that, in conjunction with standard playback equalization, it achieves read-playback response which is flat within desirable and practical limits (determined in large part by tape speed).

Happily the RIAA playback curve for 7.5 ips is the same as NAB equalization. The NAB curve has long been official for 15 ips, and in the past 10 years has come into increasing use for 7.5 ips as well. For a number of years all or nearly all 7.5-ips recorded tapes have incorporated NAB equalization; that is, they produce flat response when played back with the 7.5-ips curve in Fig. 1. It is to be hoped that these tape recorder manufacturers who do not yet provide RIAA (same as NAB) equalization at 7.5 ips will be prompted by the new standard to fall in line.

On the other hand, the RIAA 3.75 ips curve gives us cause for reflection. In net it appears a good choice, but there are problems, no matter what other choice might have been made, there would still have been problems.

To approach these problems, it is first necessary to appreciate that the whole question of tape equalization doesn’t really revolve about frequency per se but about recorded wavelength. Within the audio range of 20 to 20,000 Hz, modern, well-constructed tape heads exhibit significant frequency losses. What we are up against essentially are losses on the tape, which increase as recorded wavelength decreases. At a given tape speed, recorded wavelength decreases with rising frequency. At a given frequency, recorded wavelength decreases in proportion to a decrease in tape speed. A playback equalization characteristic is chosen to achieve optimum performance in view of tape losses at various wavelengths. Optimum performance means the best combination of extended treble response, low distortion, and high signal-to-noise ratio. When we translate a wavelength characteristic into frequency, we must take tape speed into account. If the optimum playback equalization thus translated gives us a bass-boost curve with 50-µsec equalization (3150-Hz turnover) at 7.5 ips, then it gives us 100-µsec equalization (1590-Hz turnover) at 3.75 ips.

In short, if 50-µsec equalization is satisfactory at 7.5 ips, 100-µsec equalization should be equally satisfactory at 3.75 ips. The RIAA (or NAB) curve for 3.75 ips is a 50-µsec curve. But the RIAA curve for 3.75 ips is 90 instead of 100 µsec. Why 90 µsec? I don’t know, but here are two guesses.

1. Ninety µsec may be closer to optimum than 100 µsec at 3.75 ips. (If so, by the same token 43 µsec is closer to optimum than 50 µsec at 7.5 ips. But since 50-µsec equalization is in widespread use at 7.5 ips, RIAA wisely decided to make the 50-µsec curve standard.) Although 100 µsec might have been closest to optimum until recently, continued improvements in tape heads, tape machine electronics, and tapes (better treble response, less noise, and more head room—ability to withstand more applied signal before saturating) have probably made it feasible to go somewhat below 100-µsec equalization, say to 90 µsec. It should be understood that reducing playback equalization in terms of the time constant (or increasing it in terms of the turnover frequency means a larger amount of bass boost and, conversely, a greater amount of treble cut in playback). The treble cut in playback is feasible if the tape’s treble performance has been improved and if it is possible to apply increased treble boost to the tape before.

FIG. 1. Reproducing characteristics for magnetic tape records as provided by the RIAA Tape Standards. Reference frequency, 400 Hz; Tolerance, ±2 dB.
excessive distortion sets in. Altogether, if the RIAA found 90-msec equalization optimum for 3.75 ips, and if it were not confronted by some other prevailing equalization practice at this speed, it had good reason to designate 90 msec as the standard.

2. If you study Fig. 1, you'll see that the curves for 7.5 and 3.75 ips are at most 5 dB apart at the high end. An intermediate curve, with 70-msec turnover, would be within 2.5 dB of being correct for either 7.5 or 3.75 ips. Hence a moderately priced tape machine could save money by providing only one playback characteristic for both 7.5 and 3.75 ips, and yet be within 2.5 dB of correct equalization at each speed. A 2.5-dB error is barely, if at all, audible, and easily corrected by a slight touchup of the treble control in one's audio system. It should be noted in Fig. 1 that the standard permits 2 dB tolerance for the playback curve. A deviation of 2.5 dB instead of 2 dB from the nominal curve is unforgivable.

Thus in itself the RIAA 3.75-ips curve makes sense. But it does raise a problem in view of playback equalization practices at this speed on the part of some tape recorder manufacturers. In the previous absence of a standard applicable to this speed, various equalization practices have sprung up. Some machines employ as high as 200-msec equalization. Others use 100-msec—observing the wavelength relationship, which calls for 100 msec at 3.75 ips if 50 msec is right for 7.5 ips. Still others may be using 120 msec equalization, as suggested by MRIA several years ago. The difference between 90- and 100-msec equalization is insignificant, involving about 1 dB of treble exaggeration if 100 msec is used when playing a tape called for 90 msec. The difference between 90 and 120 msec is on the border of significance, involving about 2.5 dB treble exaggeration. But the difference between 90 and 200 msec equalization is serious, involving almost 7 dB of treble exaggeration. Recorded tapes operating at 3.75 ips are coming into vogue, and if they require a 90-msec playback curve, a machine with a 200-msec playback curve will produce noticeable treble emphasis.

The owner of such a machine might make the effort to have its playback equalization network changed, and this will require a corresponding change (more treble boost) in the record equalization. But what then of the tapes he has previously recorded at 3.75 ips? It appears his best course is to leave the equalization network alone, and use the treble control of his audio system to supply the required treble cut if and when he plays recorded 3.75-ips tapes requiring 90 msec equalization.

**Tape Tracks**

Until now we have understood that the quarter-track format is essentially that of 90-msec playback equalization may have two explanations. In the United States, at one time 50-msec was considered suitable only for 5 ips. Proportionately, therefore, 200-msec was considered appropriate for 3.75 ips. In Europe, the CCIR curve uses 100-msec equalization at 7.5 ips. Proportionately, therefore, 200-msec is called for at 3.75 ips.

Fig. 2. Basic quarter-track tape format.

Fig. 2, whether used for four-way mono or two-way stereo. Each of the four tracks is shown as 43 mils wide, and each of the three islands is shown as 25 mils wide, adding to a total of 247 mils (thousands of an inch). The nominal width of so-called "quarter-inch" tape is actually 246 mils (instead of 250 mils, which would exactly equal one-quarter inch), with a plus and minus tolerance of 2 mils. In brief, the tape may be between 244 and 248 mils wide. If it is less than 247 mils, a very slight amount of the upper gap of a stereo tape head may project above the tape, resulting in tracks 1 and 4 being slightly too narrow. But the loss in recorded signal on tracks 1 and 4 is inconsequential. At most, when the tape is 244 mils wide, 1.5 mils out of 45 mils would be lost on each track, reducing the signal by only 0.3 dB. Alternatively, a stereo tape head can be aligned with reference to the tape so there is no track loss. What happens then is that the middle island (between tracks 2 and 3) is slightly wider than 25 mils, while the other two islands are slightly narrower than 25 mils. This is illustrated in Fig. 3, which shows how the gaps might be positioned with reference to a tape 244 mils wide. Note that each gap has the same height (43 mils) as in Fig. 2, and the distance between the two gaps (93 mils) is the same as in Fig. 2. If we think of tracks 1 and 3 as remaining stationary, what has happened is that tracks 2 and 4 have been moved up 3 mils with respect to tracks 1 and 3.

With this background, we can turn to the RIAA standard, which basically conforms to Fig. 2 but makes the tracks fit the tape and the tape heads in use. Standard 8.2.3 states:

"The four tracks shall each have a recorded track width of 0.043 ± 0.004 in. and be equally disposed across the width of the tape so that the distance between the center lines of tracks 1 and 3, and 2 and 4 will be 0.134 inches to 0.136 inches. Tracks 1 and 4 should be positioned so that the distance between their outer edges does not exceed the minimum tape width of 0.244 inches."

Spelled out, this says:

1. The total space occupied by the tracks and the islands between them shall not exceed 244 mils, thereby fitting onto a tape of minimum standard width.

2. All four tracks shall be equally wide. (Continued on page 77)
Evaluation of Artificial Reverberation to Conventional Sound Installations

GEORGE S. LEHSTEN*

While artificial reverberation is far from being a cure-all for recordings made originally in a "dead" hall, it does have some advantages and if the user understands the limitations, he can often improve the over-all result. The author calls attention to some salient features.

During the past several years, the introduction of several different types of equipment for the purpose of providing artificial reverberation to existing recordings has been made. With few exceptions the majority of these ventures proved unacceptable chiefly because of a lack of experience in the proper use of such equipment. Admittedly, some units also added undesirable amount of distortion.

Extensive evaluation of a large percentage of these designs has led to the belief that improper use constituted the biggest source of distortion rather than the equipment itself. Specifically, four major types of reverberation equipment have been evaluated for their individual usefulness both for the purpose of adding a reverberation signal to a properly set up reproducing system and adding reverberation signals to existing recordings.

To evaluate the apparent quality of such equipment a reference must be at hand for a comparison. Consequently, a rather extensive study of various music studios and halls was made. While the results obtained did not point out any superior hall qualifications, they did point out that an "average" reverberation characteristic would not yield an acceptable pattern for the design of such a device. To this end, a more detailed study of Carnegie Hall in New York was made. It is based on the results of this study that the specifications for the application of a reverberation signal to existing stereophonic systems has been attempted. This is not meant to be an endorsement of the acoustical properties of Carnegie Hall or any other hall for that matter, but rather a basis for the development of an effective system for the application of such signals to existing equipment.

Types of Equipment

Of the general classes of equipment for this purpose, four main types are available—(1), the electro-mechanical systems employing electronic assemblies for the necessary amplifying considerations and mechanical devices such as springs or rods for the delay networks; (2), the electro-acoustical systems which are similar to the first type except that they employ acoustic chambers for the necessary delay qualifications; (3), the electronic recording techniques of recording the signal on an endless tape and combining, by rather intricate means, the signals from a number of reproduce heads spaced at varying increasing distance from the record head; and (4), the all-electronic systems employing electronic logic circuits to provide the necessary delay characteristics. To evaluate which of these systems could be considered the better design approach to the task at hand requires a highly imaginative line of reasoning to the desired end result.

The chief disadvantage with all of these systems, in varying degrees, is that the signal that controls or initiates the reverberation signal is the same that the listener hears from the main channels of the existing system. In actual practice however, it has been found that a certain percentage of the reverberation in the original hall presentation is derived from acoustical effects that are not picked up by normal microphone placement procedures. In some specific cases of intentionally recording the reverberation signal on a separate track the best over-all signal was captured when the reverberation microphones were located to the rear of the hall. When these tapes are compared on a point-to-point basis, by means of a sound spectrograph, to the tapes made for the normal A and B channels, discrepancies as to the original notes and sounds are apparent.

Applications

In setting up a system employing artificial reverberation the first approach is to in part remove by means of a series of sharp filters a frequency spectrum that is representative of the acoustic dimensions of the original recording hall. The differential level of this bandwidth has to be maintained, however, so that the listener does not become aware that a portion of the reproduced signal is missing from his "A" and "B" channels. The actual level of the resultant of the reverberated signal added acoustically to the remaining level of sound from the "A" and "B" channel has to be exactly the same as before the removal of the reverberation signals. As an example, if the original program material had, during one specific passage, a note of 1000 Hz at an acoustical level of 0.5 watts when reproduced, we would remove the equivalent of 0.1 watts of this 1000-Hz signal from the A and B channels, process it by way of our delay networks and subsequently reproduce it by another speaker at such a level that the listener is still aware of the 1000-Hz note at a level of 0.5 acoustical watts. It should be apparent at this point that the application of any device that merely takes a portion of the A and B signals, delays it by some figure and reproduces it without any form of compensation of the original A- and B-channel levels, is adding to the acoustical level of the listening area this small bandwidth of frequencies placing them out of perspective with the original program material. (Continued on page 71)

*480 Teaneck Road, Teaneck, N.J. 07666
President, Perfectone Sound Laboratories
Chief Engineer, Alpine Geophysical Asso-ociation, Inc.

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NEW 90-WATT SOLID STATE FM MULTIPLEX STEREO RECEIVER
MODEL SX-1000T
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Circle 122 on Reader Service Card

Audio • February, 1966
A few months ago, the author had occasion to change a head on an Uber 4000-S tape recorder (Audio, October, 1965) and needed some sort of alignment-indicating tape to make sure that the new head, a Nortronics 1202, was in the correct location. Such a tape is commercially available from RCA under the designation 12-5-64T, and can be obtained from RCA Victor Record Division, 6800 E. 30th St., Indianapolis, Ind., we have since learned, but at the time we were unaware of it.

However, in talks with our associate, Larry Zidel, we came up with a tape which most anyone with two properly head-positioned tape recorders can make for himself, provided one of the recorders is full-track and the other quarter track, with three heads.

The whole idea is borrowed from movie practice, in which an optical track was used for the same purpose. This track consisted of an area which was unmodulated in the proper position for the sound projector light slit, and the remainder of the track was modulated with a "buzz," essentially a low-frequency square wave. When the film was played on a properly aligned projector, nothing was heard. If there was any misalignment, you heard the buzz.

We decided upon a track which would have 1000-Hz modulation on the proper track positions, and a 150-Hz square wave on the balance of the tape. To produce such a tape, we first recorded the 150-Hz square wave on a full-track machine, thus giving us the "buzz"-track background. The next step was to record 1000 Hz on both channels of a four-track stereo recorder, with the normal erase head "cleaning off" the 150-Hz square wave prior to the recording of the 1000 Hz.

While this did exactly what we thought it would, we had overlooked the fact that the erase-head track is about 8 mils wider than the recorded track, so it left a clear space on each side of the 1000 Hz, as shown in Fig. 1, which is a simulated reproduction of the final result. This resulted in a playback of the 1000 Hz in a satisfactory manner, but permitted a slight deviation from the correct position before the error became noticeable. Obviously, the tape could weave some 4 mils either way before the background buzz was heard.

The next step, logically, was to disconnect the erase head and connect the record head to the erase oscillator, using the record head as the erase head and thus cleaning off only the area properly occupied by the desired track position. A second pass through the machine with the record head connected in the normal manner and the erase head still disconnected gave a similar result to that in Fig. 1 but without the spaces between the 1000 Hz and the 150-Hz buzz.

Reversing the tape and making two more passes through the machine, repeating the last two steps, will provide the result shown in Fig. 2. This we have a test tape which will reproduce only 1000 Hz when the heads are in the correct position, but any deviation will show up as a buzz superimposed over the 1000 Hz.

Modifications

While it may be argued that for the single purpose of track positioning the test tape could have accomplished the same objective if we had only erased the 150-Hz buzz track, with the record head serving as the erase head, and leaving the track position completely blank. This would undoubtedly have been preferable since it would be easier to hear the buzz in the absence of the 1000-Hz tone. However, this would have eliminated a second benefit of the test tape—that of checking the balance between the two tracks and the associated amplifiers.

The tape described offers the experimenter a simple and workable means of checking the head position after a change, and can be made on any standard four-track recorder in which the erase head may be disconnected and the record head used temporarily as the erase head.

In this latter connection, it is likely that the erase/bias oscillator may not furnish sufficient bias to the record head to erase the buzz without some adjustment, but some recorders have this facility. It is usual for the record head to have higher inductance than the erase head, and more erase current may be required than the erase oscillator can furnish. This can be remedied by interposing an amplifier between the oscillator and the record head. Then monitor on the play head and gradually increase the erase current until the track is silent. This does require a machine with three heads, but the typically ingenious tape enthusiast should have no trouble in obtaining the desired result.
"Well Articulated...Musically Balanced...Eminently Honest"

- High Fidelity

What makes Bozak's Symphony No. 1, Model B-4000, the largest selling full-sized, full-voiced speaker system in the world?

For one thing, it is specifically designed for stereo. To achieve the broad, uniform distribution of high frequencies needed for stereo realism, the eight treble speakers in the B-4000 are arranged in a loaded vertical column array. That's the same arrangement we designed for the outdoor sound reinforcement systems used by the New York Philharmonic and the Metropolitan Opera.

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If there's a certain indefinable something missing from your own music at home, perhaps you should listen to the Bozak Symphony No. 1. Your dealer will gladly demonstrate.

Or, if you'd like the opinion of an unbiased expert, we'll gladly send you a reprint of High Fidelity's review.

Bozak

Box 1166, Darien, Connecticut

Circle 123 on Reader Service Card
HEATHKIT MODEL IG-112 FM STEREO GENERATOR

It is particularly appropriate that we report on this piece of test gear in this issue, centered as it is upon useful audio test equipment. The FM Stereo generator is, in fact, a newcomer to the test field. There are, at this writing, few enough service agencies that possess one. Part of the reason is that FM Stereo generators have been expensive. $500 is the figure quoted for several of the lower priced ones. So, how can Heath deliver a unit of quality at $100 (admittedly as a kit)? We shall see.

It might be logical to ask, first off, if this is the sort of instrument that is needed by the average audio buff. Certainly it is not the first instrument that a budding hip requires. But if you take your FM Stereo seriously and want to maintain your tuner in best possible operating condition, this generator will pave the way toward that goal.

This is a good alignment tool for any FM tuner, mono or multiple. In a single package of compact dimensions is contained a multi-frequency audio generator, a multiplex signal generator, and a 100-mHz FM signal generator. Three in one, as it were.

The IG-112 thus provides an audio modulated FM Stereo signal that can feed directly either a multiplex adapter (or the input to the multiplex section of a tuner or receiver) or the antenna terminals of a tuner.

The FM output is centered at 100 mHz with an adjustment for ± 2 mHz. Deviation is continuously adjustable to a maximum of 75 kHz with a sweep rate of 60 Hz. For 'scope alignment of a tuner, the sweep width is adjustable to 750 kHz. Output is moderately high, certainly enough for the most insensitive tuner. Conversely, there are three step-switches that each give the FM signal 20 dB of attenuation.

Audio modulation is switch selectable at 400, 1000, or 5000 Hz. In addition, you may elect 19 kHz, 38 kHz, and SCA (65 or 67 kHz). Output is selectable at the composite signal output for left- or right-hand phase. You can also pick any of the available audio frequencies directly if you wish.

If it is a complete tuner to be aligned, the IG-112 will also provide FM markers (crystal generated) at 10.7 mHz, 90.95 mHz, 96.3 mHz, 101.65 mHz, and 107 mHz. A 5.35-mHz crystal is employed.

The controls are self-explanatory regarding function of the unit. There are five front-panel knobs. In the center is the function switch. This places the mode of operation at R. F. Sweep/1. F. Marker: Audio and Mono FM, Phase Test (Left plus Right in Phase); Left Channel, Right Channel. To the left of this switch is the 19-kHz pilot-level control that also includes the power on/off switch. To the right is a control with the wordly label: Deviation - Sweep Width - Composite Level - Audio Level. Obviously, it doesn't do that all at once but depends rather on the mode of operation.

Along the lower portion of the front are to be found the Frequency Selector, Composite Signal/Audio-Output connector, 1. F. Marker Output connector, the three R. F. Attenuators, (slide switches), and the Center R. F. Frequency control.

On the rear apron is the only additional operating control: a slide-switch selector for the SCA signal of 65 or 67 kHz.

Construction

Heath stoutly maintains itself as the leader of the paper-bag-pack concept of kit packaging. There is nothing fancy about the way the kit comes. All the capacitors in one bag, all the capacitors in another. Once everything is sorted out, you set to.

One thing we discovered pretty quickly was that good quality parts are used throughout. Heath has not stinted on hardware, either. There were left-overs in all screw sizes.

A bit over ten hours had the job done. Heath's book is magnificent. Illustrations are excellent and sufficiently detailed. Frankly, we expected that there would be several errors along the way since no addendum sheet came with the kit. And we did find two: page 23 the book has you threading a wire from a lug of tube V6 through the center post and out to another terminal. The special ceramic socket provided for that position has no center post. Then in the alignment instructions (this procedure takes another hour or more) we spent a bit of time looking for L5 to adjust. There was none. A check of the schematics revealed that what was screened L5 on the chassis is, in fact, L5. Those were the errors. Frankly, we have found less perfect books when there have been addenda.

Well, it was finished and we plugged it in. Tubes lit, nothing smoked, so we went on to the alignment. It wasn't long ere we discovered that all was not right in the multiplex section. Audio was fine, but no multiplex generation. It was a couple of hours later before we discovered the joint that solder hadn't quite reached (Not Heath's fault—ours.) Alignment incidentally requires both a scope and an a. c. VTVM.

Once alignment was finished we had on hand a worthwhile tool. Scope observa-
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an excellent 4-speed manual record playing unit with high fidelity features. This compact, efficient player is recommended for basic music systems and quality audio-visual applications.

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tions showed as good a signal as one could want. We used it to check the alignment of a tuner that had just had a going over with equipment listing at ten times the cost. The results were the same.

We are not running the usual circuit description (it is given in considerable detail in the construction manual) relying instead on publication of the block diagram. Fig. 2. The only comment necessary is that both the 19-kHz and 5.35-mHz oscillators are Pierce crystal-controlled circuits for maximum stability and accuracy at these critical points.

This generator is a tool of considerable merit for its qualities and versatility. If we feel that it could be further improved by the addition of an input for an audio oscillator or music signal and a position that provided only 19 kHz (instead of including signal) at the level it is mixed with signal (10 per cent) then we are hint picking. This is a fine instrument; one that does a thoroughly professional job at considerably less than a professional price. For this, even had there been nothing else, Heath is to be congratulated.

Circle 310

REVOX G-36 TAPE RECORDER

Tape recording has come a long way in the last few years. It seems only yesterday that it was an extraordinary machine indeed that could break the 12-kHz barrier. (And, not much earlier, it was a rule of thumb that top frequency response equaled the speed in inches-per-second multiplied by one kHz.)

Now it is commonplace for a recorder to provide 30,000-Hz response at 7½ ips. And, at low distortion. Where standard 0 VU was often specified at a 2- or 3-per-cent point, 0 VU now is expected to be under 1 per cent. And it is often half a per cent or less.

This ReVox G-36 is a prime example of what we mean. Although a recent arrival in this country, the Swiss firm has been on the European scene for a while. The G-36 is identical to the ReVox 736 that has been described in recent British periodicals, with one important difference: the equalization standard in Europe is the CCIR curve, materially different from our NAB curve. The G-36 is, of course, supplied with NAB equalization. The accuracy of that curve reproduced is shown in Fig. 4. This is derived from Amperex Test Tape 81321-01. The bass rise shown is, for the most part, the tape and not the ReVox.

At $500, the G-36 is the lowest-priced unit we know that has the capability of handling 10%-inch reels. And, it is admirably qualified to handle these reels, too.

By way of explanation, the G-36 is a three-motor machine. Capstan drive is from an oversized Papst hysterisisynchronous motor. Each reel hub is an extension of a shaft from a separate Papst motor. Hold-back tension for tape transport is achieved by applying reverse torque to the supply motor. Since the 10%-inch reels have an average circumference (with tape) that is larger than the usual 7-inch reel, greater pull is required for these large reels. This is achieved by a cleverly arranged knurled ring switch located at the apex of the head cover. In the small-reel position, an arm is extended from the cover and prevents the placement of large reels until a tension change is made by pushing the arm back into the cover.

It is hard to imagine that controls could be placed more logically and practically than they are here. The four knobs shown are actually all coaxials. The two on the left are for the play circuits, the two on the right for the record. The coax rings on the two left knobs control power on/off and playback mode respectively. The two on the right are identical. Each selects one of three possible inputs for each channel. This pair also allows sound-on-sound with an extra position each that transfers sound from one stereo channel to the other.

The small knobs are all control pots. On the right, they control respective channel record volume. On the left, one is for play volume through the built-in mono speaker; the other applies bass boost to playback through that speaker.

A pair of standard-ballistic VU meters are provided for record monitoring. They are stilled in playback. Playback, incidentally, is either through a single built-in monitor speaker and six-watt amplifier or, via fixed-output cathode followers (to a stereo amplifier).

Since there are three separate quarter-track head and separate record and play preamplifiers, off-the-tape record monitoring is possible. This may be done on the machine, affecting only the sound that comes from the internal speaker. Or, it can be achieved on any standard amplifier/control that has a tape monitor facility.

All tape motion is controlled by four of the five piano-type keys. These are electrically keyed to the operation they control. The capstan pinch-roller, assembled on a heavy casting that is part of the over-all head assembly, is solenoid controlled as are the mechanical brakes. These brakes, incidentally, are of fail-safe operation. That is, when power is removed, the brakes are applied. Thus, a pull through high-speed rewind will safely stop the tape with nary a loose turn. If the tape should run out or break, thus releasing a pressure switch, the brakes will also be applied and the capstan released.

The Circuit

The entire electronics section is reached by removing the bottom cover of the unit. Layout is exemplary— all straight line and lovely-to-look-at (and to service if need be). Circuitry is straightforward enough using the common varieties of twin-triode tube. In all, twelve tubes, three silicon diodes, and three selenium rectifiers are used.

Each of the stages is not only single purpose, but relatively unusual in a recorder is the use of completely passive frequency compensation and equalization. Less unusual perhaps, but equally desirable, is the d. c. heating of all early preampl stages. Each record stage has a total of five triode stages. Each pair employs feedback to reduce distortion and noise. Three triode
As of now, practically everything you’ve heard about solid-state receivers is out of date—including how much you should pay

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Six Hundred
all solid-state
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And got that independent top rating for a major advance in speakers...

The ADC Brentwood 303A Speaker solves the old problem of “cone break-up” not with complicating capacitors or inductors, but by a simplifying design and production advance. In the independent ratings that count most, the 303A scored top!

A receiver like this is the heart of your music system. It has to perform very, very well. This one does. And truth to tell, so do several other fine American makes, priced from about $285 on up.

From there on out, this ADC Six Hundred is so different it starts a new generation. ADC never made tube units. This is no adaptation of a tube circuit, or tube parts, or tube assembly line. It's pure solid-state from the concept on.

As we did in cartridges and speakers, we created this advanced receiver with an approach we call Integrated Production Design. The usual method in the industry is to design the unit, then figure out how to produce it. Instead, we work out design and production together. Good ideas flow both ways. So when we go into production, no compromises are necessary—and we have a simpler, sturdier, better functioning piece of equipment. And a lot of the old "rules" are apt to go out the window.

For example, you may have heard that each transistor needs a big, complicated "heat sink". Nonsense! We use a simple aluminum extrusion that dissipates the heat through the chassis. It's more efficient and less costly. You've been warned that turning on the unit with a speaker lead loose could blow the transistors? Stop worrying; this one can't. No special protectors, just better design. You've been told all transistors have to be silicon? That's from the past. We use two types, each where it functions best, each totally damage-proof.

Our Integrated Production Design also makes this a "permanent" unit you can probably hand down to your son, and maybe grandson. The electronics is wholly free of wires and tube-style assembly. The rugged etched circuit boards and solid, bonded modules could go on a moontrip. And note the size (a tip-off to newness)—yet inside it is strikingly uncrowded and uncluttered. Peek in and admire.

Now as to price. As you know, transistor unit prices have crept down year by year as technology advanced. With this ADC development, they really crack. Compare. This beautiful, trouble-free, foolproof, soul-satisfying unit leaves from about $60 to $150 more in your pocket. Should you buy a semi-obsolete model and pay more for it? Silly question! See the new ADC Six Hundred (and the companion ADC Sixty Amplifier) at your dealer.

SPECIFICATIONS—ADC Six Hundred RECEIVER

List price, $280.00.


AMPLIFIER SECTION: Power output (IHFM), 60 watts at 8 ohms. (Provides full output with any conventional speakers regardless of impedances) □ Power per channel, 22 watts RMS □ Full, independent control on front panel for 2 pairs of speakers □ Separate fuses for each channel prevent shorting □ Headphone jack □ Full tape and monitoring provisions □ Automatic contour □ Total harmonic distortion at rated power, 0.5% □ Intermodulation distortion, 0.8% □ Power band width at rated distortion, 20-20,000 cps. □ Frequency response, ± 2 db., 10-100,000 cps. □ True bookshelf size, only 8½" deep in finely crafted walnut cabinet (extra, optional).

The ADC Sixty AMPLIFIER has identical power (60 watts at all impedances) and same features as Amplifier Section of the Six Hundred Receiver. Also available in walnut cabinet (extra, optional). List price, $149.50.

AUDIO DYNAMICS CORPORATION
Pickett District Road, New Milford, Conn.
stages, two amplifiers, and a cathode-follower output form the play circuits. These stages just quoted do not count the push-pull oscillator (70 kHz) or the cathode-follower isolators between the record amplifiers and the VU meters.

The built-in mono power-amplifier is of a completely standard three-stage push-pull design. It will deliver a legitimate 6 watts into an 8-ohm load.

Test Results

Figure 4 shows the over-all frequency response measured on Scotch 202 tape. Levels were run at 10 dB below indicated 0 VU. Between 18 and 20 kHz we detected some audible beat tones between the input signal and the bias. However, it should be noted that the normal energy content of music at these frequencies is well below the 10-dB mark, so this will never be an audible problem in recording.

0 VU as indicated on the meters was within one dB of standard 0 VU. In fact each channel was within one dB of its mate at all times so our graph has only one channel shown.

Input dynamic range capacity is enormous. In the microphone input, sensitivity is 1.2 mV for 0 VU. Strange, however, was the fact that distinctly non-standard back-panel RCA-type phono jacks were provided.

Tuner input sensitivity is 0.018 volts. Any (labeled with the British radio term "Diode") has a 2.7 mV sensitivity. There are a pair of input attenuators in this function that reduce voltage before the first stage so that the volume control can be used at a convenient middle position. Otherwise, it would be hardly needed. With that 2.7 mV input sensitivity it takes 0.8 volt before overload distortion sets in.

Signal-to-noise measurements were arrived at by erasing a 0-VU signal from the tape and measuring the residue. It was a respectable -45 dB level and -43 dB right channel. These are unweighted figures.

That big drive motor and careful attention to tape-handling details resulted in exceptionally low flutter and wow. At the 7½-inch speed our meter needle just hung a bit over the zero mark. This is below 0.015 per cent total flutter and wow, extraordinarily good! At 3½ ips we could, at least, reliably measure flutter. Total combined wow and flutter was 0.12 per cent; still better than we have measured on some units at 7½!

Finally, if you are in a hurry to rewind a tape, the ReVox will zip 1200 feet through in 45 seconds. With a tight, smooth wind.

We can't close without stating something about the plastic cover that comes with the recorder. It is of flexible Tenite-like plastic. Granted it is strong enough to support my 180-odd pounds without so much as a shudder, but its appearance isn't up to the rest of the machine.

So you see, nothing is perfect. (Oh, would that everything was so imperfect.) Some where along the line we trust that you have reached the conclusion that we are enamored of this machine. Because we are.

Circle 211

HARTLEY 220MS HOLTON SR. SPEAKER SYSTEM

Recently arrived is the latest in a series of 220 speaker systems from Hartley Products. These share the commonness of being full-range single ten-inch drivers. The Holton Sr. designation is indicative of the type of enclosure provided—a floor standing unit of modest but larger than "bookshelf" size.

The MS designation stands for Magnetic Suspension, a device consisting of a ferrous ring beyond the voice coil that acts as a movement damper on the cone. The result is a crisp clarity indicative of excellent transient response capabilities.

This latest version has removed the "whizzer" dome that graces earlier 220-MS's. In its place is a coaxial cone connected to the main cone only by a flexible surround. The manufacturer states that separate voice coils drive each section; this cannot be seen by visual inspection.

This, then, is a coaxial system employing a ten-inch, long-throw woofer and, at its apex, a small tweeter sub-assembly. The mechanism is sold separately (no cabinet) for $135. In the cabinet, which is fully loaded with a roll of kim-sound insulation, it is $245. From which price a quality product should be deduced. And, that is indeed what this is.

This is a full-range system. If you want to hear what 20 Hz sounds like listen to this system. It is capable of bass response that needs take a back seat to nothing.

Actually, it is a lack of bass that is most impressive at first hearing. There is no doubling at any normal levels. The solid transients reveal a driver that will not make bass when the music has none.

But one cannot eat of bass alone. This unit will do equal justice to the rest of the model, this 220MS delivers a mid-range that is both easy to listen to and full and rich.

Highs in appropriate abundance are here, too. Response extends smoothly up to the limits of audibility. Microphone checks indicate that those limits are beyond the average range of human hearing.

So it is safe to deduce that musical balance is secure with this speaker. And so it is. Still, extensive listening tests do reveal a characteristic color. This is not a neutral speaker. (What speaker is?) The best adjective is "warmth." Or, to juxtapose, there is no sterile coldness to the sound of this system. Warmth must not be interpreted to mean muddiness. That is certainly not the case. The bass transient capability already alluded to extends over the entire spectrum of sound. Instrumental separation is good. (Don't confuse instrumental separation with stereo separation. We mean the ability of the speaker to separate the voices of the orchestra or chorus.)

Human voice is served well by these qualities. There is only a handful of speakers that share this ability to make a male voice not sound as if it comes from a barrel.

All of these qualities are bought, apparently, at the cost of efficiency. While this is not the lowest-efficiency system around by any means, it is one that will do best with a moderate to high-powered amplifier. Certainly, 20 watts per channel is a minimum needed.

This system will not prove to be everyone's cup of tea. Perhaps no speaker is or will ever be, but if you want a speaker to complement top-grade components, one that sounds musically valid and has more than adequate dispersion so that highs do not hit you between the eyes, then by all means audition this Hartley.

Circle 212

Figure 5. The Hartley Holton Sr. speaker system.
Engineer Edward Wille depends on Rek-O-Kut turntables, as he has for over a decade to deliver the finest in recorded sound for his disc jockey shows. Hundreds of radio stations use Rek-O-Kut turntables. They operate with the same clock-like precision for many years. Owning a Rek-O-Kut is a long-term love affair.

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Audio Measurements Course

NORMAN H. CROWHURST*

In Five Parts, Part 2

In this installment we learn why it is important to make sure that the signal we are measuring is actually the one we want, and we learn the relation of impedance to gain measurements if our results are to be accurate and repeatable.

Before starting to answer the questions we left open at the end of the first installment, we want to emphasize a procedure that should always be used in making audio measurements, in one way or another: look at what you are measuring; one thing we said might have alerted you to the value of doing this—the piece about possibly overloading on hum or noise. By looking at what you’re reading, with a ‘scope as well as a meter, you won’t be misled by a false answer of this kind. But don’t feel bad if the idea didn’t occur to you; many audio men have made the same mistake!

A vital piece of equipment for audio measurements is an oscilloscope. Without checking to see what you are looking at, your measurements may be absolutely meaningless, because the figures you read on meters may not be what you think they are at all! Meters are usually preferred for obtaining the final information, because they give numbers convenient to write down. But these numbers may be anything but the quantity you think the meter is indicating, if you don’t also look at the quantity with a scope.

Using a Scope

As we proceed, we will give more details on the proper use of a ‘scope for various measurements and the way to interpret what it displays, but at the outset we will briefly describe how to identify an “unknown” reading with it. Suppose you have found that the reading isn’t what you thought it was and you want to find out what it is.

Assume that you have checked the input waveform with a ‘scope to be a sine wave, and now, when you connect the ‘scope to the output, it is just a mass of traces that don’t mean anything: how do you identify what it is? You may have some ideas, so you check accordingly, until you know:

If it is a high-frequency oscillation, you may find the frequency by changing the time-base frequency, until you get a trace of the ultrasonic frequency on the screen. If this doesn’t work, then you have something else.

Is it hum, or something hum-related? Switch to the line sweep. If it is 60 Hz, or if 60 Hz is present with something else, the trace will be either a sloping line or a loop, or one of these with something superimposed on it (Fig. 2-1, A through D). If it is a multiple of 60 Hz, such as an adequately smoothed full-wave rectification, or a radiated hum field with dominant third harmonic, then an appropriate multiple loop or curved line will appear, possibly with something else superimposed (Fig. 2-2).

Then perhaps it may be signal-related. For example, a heavy oscillation could be triggered at some certain point on the waveform, so the ‘scope does not sync properly on the signal, as it did with the pure sine wave. Connect the input to horizontal input and the output to vertical input of the ‘scope and switch to external sweep. Now the trace (when you’ve adjusted amplitude to get it “on screen”) should be a straight line at an angle (which can conveniently be adjusted, by means of horizontal and vertical gain controls, to a 45°-deg. angle). If it has bursts superimposed on it (Fig. 2-3), you know what the trouble is.

So much in general for using a ‘scope with audio measurements, now get to the specifics.

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Fig. 2-1. Traces seen on a ‘scope, using line sweep, when there is a component of line frequency present: (A) and (B), pure line frequency; (C) and (D), with noise or some other signal component.

Fig. 2-2. Traces due to 120 Hz, also using line sweep, introduced from supply ripple: (A), (B), and (C), different forms of ripple; (D), with noise or other signal.

Fig. 2-3. Vertical/horizontal display of output vs. input sometimes helps: a, where both have the same waveform; b, where output has bursts of high frequency oscillation at parts of its waveform.
Introducing S-10

SOLID STATE / CONDENSER MICROPHONE

Cardioid Pattern / Self Contained with Lifetime Polarization
WHY CONDENSER ... ?

Many dynamic microphones entering the market in recent years appear to have all the qualities of condensers. In some cases their frequency curves show linear responses from 30 to 18,000 Hz. They also claim performance comparable to condensers due to new diaphragm materials. Why is it then that professional recording studios are filled with condenser microphones? Why is it that the condenser microphone is used as a standard measuring tool against which all other types are compared? Why is there such a startling difference between the condenser and other types in A-B comparisons?

Much of the answer lies in the microphone's response to transients — the attack of a bow on a string, the strike of a drum, the nuances of a human voice.

A dynamic microphone diaphragm must be massive in order to achieve a low enough resonant frequency to reproduce the lower end of the audio range. This is true for all magnetically operated microphones, including ribbons. The ribbon type achieves its low resonant frequency by its great compliance which results in a fragility too great for many applications.

Condenser types, on the other hand, have resonant frequencies well above the audio spectrum, permitting the lowest possible diaphragm mass. The condenser's diaphragm is not required to move a voice coil as in the dynamic nor is it surrounded by a large magnetic structure as in the ribbon, it is free to follow the sharpest audio transients.

THE DIFFERENCE

In order to measure the transient response of a microphone, it is necessary to subject it to the severest of all acoustic transients — the shock wave, in this case produced by an electrical discharge. The acoustic transient produced has a risetime of less than one micro-second. By observing the output of a microphone subjected to such a shock wave, its transient response can be determined.

In order to portray this shock wave as accurately as possible a special pressure condenser microphone was built using an extremely small, light diaphragm with linear frequency response well beyond 200,000 Hz. Figure 1 shows the characteristics of the shock wave as measured by this special microphone in an anechoic chamber.

Figure 2 is a dual beam presentation of the response of two microphones to the same shock wave at the same instant. The upper trace shows the response of the new SYNCRØN S-10 condenser microphone. It shows a risetime of 15 micro-seconds and an insignificant amount of ringing and overshoot. The lower trace shows the response of a leading cardioid dynamic microphone at the same instant. The risetime is 40 micro-seconds and a significant amount of ringing and overshoot is evident.

Comparisons of the S-10 with virtually all leading dynamic microphones have produced essentially the same results as shown here — graphic proof that frequency response curves do not tell the whole story...

UNIPOLAR RESPONSE

The S-10's on-axis frequency response shows all the smoothness and wide range expected of condenser microphones. Just as important, the frequency response for off-axis sounds is very linear. The polar pattern pictured here indicates a deviation of no more than 2 dB. from the on-axis response for frequencies of up to 10 kHz. These curves were produced by an actual S-10 microphone in an anechoic chamber and are not artists' conceptions. Each S-10 microphone produced is tested under identical conditions and an individual response curve is furnished with it. For a nominal charge, S-10 owners may return their microphones to SYNCRØN at any time for verification of this performance.
SYNCRON’s employment of the latest semiconductor and battery technology obsoletes elaborate condenser microphone “systems”. The external power supply is eliminated, enabling the S-10 to be used with the ease of a dynamic microphone. The condenser element is permanently polarized at a potential of 62 volts. Electronic circuitry is powered by a single inexpensive mercury battery encased in the microphone body. Battery life is 1,000 hours minimum with simple insert replacement. The S-10 can be used with assurance on critical “no second chance” pickups. There’s no tube filament to suddenly burn out. The end of battery life is signaled by a slight increase in distortion, giving the user several hours advance warning at replacement time.

THE SOUND

The first and final analysis of microphone quality concerns sound. The clear superiority of condensers has been proven through the years with their universal use by recording centers, film studios, broadcast operations, orchestras, vocalists, and everyone sensitive to highest fidelity. The S-10 fulfills the really important requirements: superiority in the lab and superiority in the studio.

SOLID STATE

The S-10 Field Effect Transistor circuitry has noise performance superior to tubes — and the obvious solid state advantages of longevity, small size, and low power consumption without the necessity of resorting to complicated RF circuits. Microphonics and heat generation are entirely eliminated. In addition, the inherent linearity of the FET makes possible a dynamic range unequalled by tubes or transistorized RF circuits, thus eliminating the need for costly overload protection devices. The S-10 is not encumbered by over-design or trick circuits. The emphasis is on simplicity, quality, and reliability.

CONVENIENCE

Battery replacement is accomplished easily in a matter of seconds without the use of tools. The single mercury battery — Mallory TR-126 or equivalent — is easily obtained locally. Substitution of a three-wire shielded cable adapts the S-10 for remote on-off switching, and the addition of an S-104 battery bypass enables operation via an external source of 8-9 volts when inaccessibility or continuous service are factors.
S-10 Microphone SPECIFICATIONS

Type: Pressure gradient, condenser

Frequency Response: 40 — 20,000 Hz ± 3db

Capsule Capacitance: 60 pf

Diaphragm: Mylar

Directional Characteristic: Cardioid at all frequencies, 20 db front-to-back ratio

Overload Protection: None needed

Total harmonic distortion: Less than 0.5% to 124 db SPL at all frequencies

Output Level, 200 ohm load: −53 dbm re 10 dyne/cm²

Noise: Less than 27 phon, (DIN 45405)

Output Impedance: 200 ohms nominal, characteristics unaffected by any load from 30 ohms to ∞

Amplifier: Field Effect Transistor

Microphone Connector: 4 pin XLR type (serves as on-off switch)

Cable: 2 wire shielded, stripped and tinned, 20 feet

Power Supply: Single TR126 mercury battery, life — 1000 hours

Mount: 5/8" — 27 swivel stand mount

Finish: Satin nickel

Dimensions: 7/8" diameter x 7 3/8" long

Weight: 9 oz. with battery

Price: $240.00 complete with battery, carrying case, swivel mount, and cable

SYNCRN AND THE FIELD EFFECT TRANSISTOR

Syncron Corporation was formed by a group of young engineers from broadcasting, recording, and acoustical instrumentation fields with a common primary interest — quality condenser microphones. With all the fast-breaking developments of the space age, somewhere they felt, in the melange of power supplies, tubes, fuses, cables, expensive foreign connectors and high price tags, there must be a better way.

With the United States' active leadership in Field Effect Transistor technology it was only natural that an American company would be the first to use the Field Effect Transistor successfully in a condenser microphone. Upon the introduction of commercial FETs in early 1963, Syncron built the first condenser microphones to use such devices. The cost of the FET's that would meet Syncron's rigid requirements was extremely high, so the microphones remained in the laboratory where they were subjected to nearly a year of intensive field-testing. The inevitable price break came in 1964 whereupon Syncron introduced its FET condenser microphone — the first commercial product to employ a Field Effect Transistor in any form. Syncron engineers have continually worked to perfect the use of the Field Effect Transistor in condenser microphones. The Syncron S-10 is the result of this clear leadership in modern condenser microphone development.

ACCESSORIES

S-101 WINDSCREEN

Prevents wind noise and effectively reduces plosive speech sounds without affecting microphone characteristics. 100% nylon construction. Weight: 1/2 oz. Diameter: 2 inches.

Price: $14.95

S-102 DESK STAND

A heavy brass casting provides maximum stability on three padded legs. Unique swivel band permits finger-tip positioning — 360° horizontally, 150° vertically. Rich textured vinyl finish. 4 3/4" high, 10 1/2" long, 7 3/4" wide. Weight: 1 1/4 lbs.

Price: $19.95

S-103 SUSPENSION


Price: $29.95
Amplification

A complete set-up for taking frequency response is shown at Fig. 2-4. This differs from Fig. 1-11 for reasons we will discuss shortly. You could switch the 'scope to external sweep and set it for a 45-deg. line at a mid-frequency and then interpret the result for other frequencies by the way the line deviates from 45 deg. This is a good method, provided you know (a) that the 'scope amplifiers are accurate throughout the frequency range used and (b) that the coupling that could influence particularly the high-frequency response.

The best method is to use the 'scope with its conventional time base, merely to verify that you are measuring what you think you are. Use the same meter to measure input and output (Fig. 2-5) by switching and preferably use it at the same setting. This means that the gain measurement will be independent of the meter's accuracy. If it has a slight high-frequency loss, or inaccuracy in reading, using the same setting eliminates both forms of error from the measurement.

To do this, you need a calibrated attenuator. These come in various forms, either rotary or key type, and at various impedances. The procedure is to adjust the attenuator setting at each frequency of measurement, so input and output indications on the meter are both the same. Use the 'scope to verify that the output reading is in fact amplified input. With the attenuation, it will have the same amplitude as output, so both traces shall be sensibly identical.

If you intend to make use of the connection from 'scope horizontal to the input metering point, verify that connecting it does not make any more difference to higher frequencies than it does at low frequencies. The effect of connecting the 'scope horizontal input should be negligible at all frequencies. If it isn't, disconnect this link, except for when you need it for the check described in the previous section.

So taking a frequency response involves making connections and adjusting at each frequency to get the same reading at input and output when the meter is switched. Then the setting of the attenuator is noted as being the amplifier gain at that frequency.

Terminating impedances

We limited at the end of the first installment that input and output impedances must be correct. The output load impedance must be of the correct value, and capable of dissipating whatever power level is used for making the test, without materially changing in value. This means the wattage rating of the output load resistors needs to be several times the maximum power they will receive, so they run relatively cool at all times, and also their value should be checked, preferably on a resistance bridge. An ohmmeter does not give a sufficiently precise reading for checking output load values.

Input source impedance is another quantity about which there is often mis-

understanding as to correct use. Looking back from the amplifier input, the impedance "seen" must be correct. With modern feedback amplifiers, this is sometimes important to ensure the stability of the amplifier. But in almost every amplifier, changing the source impedance affects either gain or frequency response in some way. More sophisticated tests will explore this in detail. A simple frequency-response measurement should be made with the correct value connected.

Gain

Now comes the question of where the input should be metered. Gain is usually defined, somewhat vaguely, as the increase in level from the input terminals to the output terminals of the amplifier. A "standard" definition used for a long while was designated "insertion gain," which was described as the amount by which level is raised or lowered (in the latter case, it is a loss, not a gain) by inserting the amplifier between the input and output terminals.

A difficulty about that definition is that input and output impedances are seldom identical. The only case where they are is in a line amplifier. In all other cases, connecting the input directly to the output will result in a mismatch and its corresponding loss. If the input is other than the vague "high impedance" which, in tube amplifiers, means it connects directly to the grid of the first stage, then a realistic reference for insertion gain can be the substitution of a hypothetically perfect transformer to match input and output impedances.

In short, the gain relates output power to input power. But this vague "high impedance" does not readily lend itself to an expression of input level in terms of power. In this case, input is essentially a voltage. So we must refer to voltage gain, or else hybrid the

Fig. 2.4. Complete input/output method, using attenuator to match levels and calculate gain.

Fig. 2.5. Using a single audio voltmeter to eliminate possible errors due to voltmeter calibration error or response deficiency.
measurement by referring to power output for voltage input.

Regardless of whether voltage or power is used as reference for calculating expressed results, the voltage measured to determine input level must be at the input end of the source resistance. If, as is the usual method, attenuation is used so the same meter indication can be applied at both ends, then the attenuator also comes between the input measurement point and the amplifier input.

The input source resistance, if different from the working impedance of the attenuator, must be achieved in such a way as to terminate the attenuator correctly, while presenting the correct source impedance to the amplifier. An appropriate calculation can include the effect of this matching procedure into the gain figures. A few examples will illustrate.

First suppose that the input is "high impedance" and the recommended maximum source resistance is 100,000 ohms, and that the attenuator is 50 ohms. The attenuator should be terminated with 500 ohms (usually there is a key to provide this termination internally) and a resistance of 100,000 ohms should be inserted between the attenuator termination and the amplifier input (Fig. 2-6). As gain will always be referred to voltage in these circumstances, merely read the attenuator setting when input and output readings are the same.

Now suppose the input impedance is 50 ohms: you need two resistors to terminate for the attenuator, such that the attenuator is correctly terminated with 500 ohms, while the amplifier gets its source resistance of 50 ohms. It is well to check whether the attenuator is supposed to provide a load approximating 50 ohms, or what, although with a 10:1 impedance-matching ratio this is not as important as it would be with closer ratios.

If the attenuator is supposed also to present a load of 50 ohms, then a series resistor of about 475 ohms with a shunt resistor of 52.5 ohms will present a load of 500 ohms to the attenuator (including the 50-ohm amplifier input) and a source of 50 ohms to the amplifier. This conclusion is arrived at by paralleling the 52.5 ohms and 50 ohms in series with 475 ohms, to make very close to 500 ohms, while 975 ohms (don't forget the attenuator's source, as well as the external 475 ohms) in parallel with 52.5 ohms makes 50 ohms.

Now to calculate gain. First there is the setting of the attenuator, which will deliver the input power, divided by the attenuator setting, into the total 500-ohm termination. Of this, only about 25/500 appears across the amplifier input, which represents a power loss of 13 dB (current is not changed, but voltage is).

Now the current is divided between the 52.5-ohm shunt resistor and the amplifier input, which is a further 3 dB power loss (same voltage, half current). But this is part of the normal transfer loss between equal, matched impedances. In effect, omitting this from the calculation does the same thing as measuring the voltage at the "front end" of the input resistor, except that here we are using current dividing, instead of voltage division, for matching, as a matter of convenience. So you may merely add 13 dB to the attenuator setting to get the insertion gain of the amplifier.

Now suppose the input is rated for 50 ohms source, but the amplifier's own internal input impedance is higher—say 2000 ohms. Here a series resistor of 450 ohms, with a shunt of 52.2 ohms will come close. The 2000 ohms in parallel with 52.5 ohms produces about 51 ohms, which added to 450 ohms makes up the required 500 ohms, within an ohm, to terminate the attenuator. And 950 ohms in parallel with 52.5 ohms produces the required 50 ohms source for the amplifier.

Now the voltage division is 50/500, or 1/10th. So you need to add only 10 dB to the attenuator setting. There will be less than 3 dB loss due to the shunting effect of the amplifier, but this is because the usual mismatch does not occur. The amplifier is working more like a bridging amplifier.

If the output impedance of the amplifier is 16 ohms, you have another correction to make for the change from 50 ohms (input) to 16 ohms (output). As the same voltage across 16 ohms represents a little more than 3 times the current it does in 50 ohms, this is a further gain increase of 5 dB, so the total to be added to the attenuator setting is 18 dB or 15 dB, as the case may be, to get the insertion gain figure.

Now suppose the output is 500 ohms, still with a 50-ohm input, using the...
same input matching method. As a voltage across 500 ohms is accompanied by only 1/10th the current it will produce in 50 ohms, this represents a 10-dB loss for the impedance change. So the net amount to add to the attenuator setting would be 3 dB for the first case or no change for the second.

Next suppose the input impedance is 10,000 ohms. The result will be close enough if you terminate the attenuator of 500 ohms and then put a series resistor of 10,000 ohms. With the amplifier presenting another 10,000 ohms (we assume) there will be an additional shunt on the attenuator of 20,000 ohms, which makes the actual termination for the attenuator about 487 ohms instead of 500 ohms, which is a small fraction of a dB mismatch. Now you divide the current between 500 ohms and 20,000 ohms, which is a ratio of 40:1 or 16 dB, to add to the attenuator setting.

That assumes the output is also 10,000 ohms. If it is actually 500 ohms, for example, the same voltage will produce 20 times the current, requiring another addition of 13 dB, to make a total of 29 dB to add to the attenuator setting, so the result is insertion gain.

These are just typical examples to illustrate a method of calculating. Practical possibilities are virtually unlimited, but can be as readily calculated by following the same principles through.

**Frequency Response**

So much for determining gain according to recognized procedure. Now we proceed to take frequency response, which is merely making the same gain measurement at lots of frequencies and plotting the results out. If you don't have any better way to do it, you'll have to do just that. The usual way to express the result is to extract the mid-band gain as a constant factor, usually at 1000 Hz, and then plot the response in dB + or - from this mid-band gain.

If you have much frequency-response taking to do, it is obviously desirable to automate the procedure a bit. Not only will this speed up the process, it will enable virtually all frequencies to be read, from 20 Hz to 20,000 Hz, if those are the limits used.

Earlier attempts at automatic curveplotting equipment used a very carefully compensated input circuit, adjusted to hold the input voltage as close to constant as ingenuity could achieve, and then used a recording voltmeter to read the output. The output meter often used a logarithmic rectifier, or a rectifier with a logarithmic shunt, to produce a record chart calibrated directly in a reasonable facsimile of dB.

By also carefully engineering an audio oscillator with a frequency dial close to logarithmic, a suitable frequency scale could be used as well (Fig. 2-7).

But logarithmic rectifiers have a habit of changing with age, and the old type of oscillator with logarithmic frequency scale used a beatnote type, which needed careful zero adjustment to stay in calibration, particularly at the low frequency end. Hewlett-Packard changed the latter situation by developing an R/C oscillator (their type 207-A) that covers the whole audio range in one turn of the frequency dial, and that has an extension shaft at the rear to facilitate coupling to a recorder. Its scale is also close to logarithmic.

The automated method can incorporate all the accuracies of the adjustable attenuator method of spot by spot plotting, by using a recorder with a servo drive mechanism (Fig. 2-8). In this arrangement, the input and output are each fed to identical rectifiers and the outputs are balanced one against the other. The difference is d.c.-amplified to drive a servo motor that moves two things at once: the setting of the calibrated rotary attenuator, so as to make the two voltages equal before the motor stops, and the recording pen, which thus automatically records the position of the attenuator at which balance is achieved.

The rotary attenuator is usually a plug-in unit, so different attenuation ranges can be inserted, with corresponding changes in the density of the dB scale on the chart. With this set-up, automated response taking is achieved with all the accuracy of the basic method, in a fraction of the time and with full-frequency coverage.

Now suppose you want a rough check, and you don't have the calibrated attenuator, or the automated recording system, at hand. The same basic method is good (Fig. 2-9). Calculate the input network to attenuate by a known factor, so the input and output voltages are as near the same as possible, and so correct matching is...
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Is the Result Valid?

Whatever method you use, always check what you are doing, over on the scope the whole frequency range before you start making measurements, either by hand or by recorder. In particular, check that distortion does not occur (in measurable or noticeable degree) at any frequency, and that noise does not invalidate the result at any frequency. If either occurs, you have to adjust your method, or the level, to improve matters.

In any event, always make, right on the chart, a record of the level and other details at which you made the response measurement (Fig. 2-10). Frequency response often changes with different levels, quite apart from the introduction of non-linear distortion, so the ability to reproduce your results, or to recheck them, may depend on knowing at what level they were taken.

If you want to get really sophisticated, a further test is to check response at different levels for comparison, and make comparative plots, to show how level affects response (Fig. 2-11).

That's enough about frequency response for the time being, as applied to basic amplifiers. Next we'll turn to distortion and power measurements. For these we have a choice of instrumentation: the so-called harmonic-distortion meter eliminates fundamental and measures everything left, as distortion; the wave-analyzer type of instrument measures each component frequency in the output individually, from which the total distortion can be computed. Which is better, or is there another way that might have some advantages? When you've thought about this, see what our answer in the panel says. AE

(To Be Continued)

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- **Professional Dynamic Microphone.** An effective built-in windscreen which virtually eliminates wind noise and explosive breath sounds is a primary feature of this dynamic microphone of omnidirectional characteristic. Called the Model RM65, the unit is a probe type of rugged construction, yet is lightweight and thus suited to hand-held use as well as stand operation. Shure Brothers' Professional Products Division is the manufacturer. Important specifications include: a smooth response from 40 to 15,000 Hz with slight tailoring to provide an increase in the speech intelligibility. Range output is either 30-56 ohms or 150-250 ohms. Level at either impedance is ±5.0 dB (6 dB equals 1 millivolt with 10 microbars). Artists that prefer to vocalize close into a microphone will find that this unit is designed to suppress "P" popping at such distances. Finish is an inconspicuous textured dark gray enamel. A twenty-foot two-conductor shielded cable fitted with a Cannon XLR-3-11C connector is supplied. Also supplied is a 90-degree swivel slip-in case that fits any stand equipped with 5/8"-27 threads. List price is $125.00. **Circle 201**

- **Nutdriver Sets.** Constructors and kit hobbyists will want to know about these new Excelite nut driver sets. Set No. 77 contains seven solid-shaft nut drivers with hex openings from 3/16" through 3/8". Sockets are all case-hardened with polished and plated shafts. The handles are shockproof (UL) and breakproof plastic. Set Number HS-18 contains ten hollow-shaft nut drivers with hex openings from 3/16" through 9/16", otherwise specifications remain the same. Either kit is packed in a snap-lock-lid case of compact dimension. **Circle 202**

- **Public Address Amplifier.** Model PA-615 from Lafayette Radio Electronics is a 45-watt-average unit. Ideal for medium-sized applications such as dance halls or ice rinks. Power output is to 8-, 10-, or 15-ohm speakers, or to lines of 25 or 70.7 volts. Frequency response is 30 to 20,000 Hz ± 3 dB. Inputs are provided for two microphone and two high-level sources. Mixing of microphones with one auxiliary input is possible. All inputs are under the control of a master gain pot. Connections are by Amphenol 75 MC1F connectors and phone plugs. Weight is 36 lbs. power consumption 110 watts. The tube complement includes 2-T22AT, 1-6V4, 2-6166G, and a 2AX4 rectifier. List price is $94.95. **Circle 203**

- **Solid-State Tuner.** A new stereo tuner featuring an all-silicon IF section has been announced by H. H. Scott. Designated as Model 312S, the unit sells for a suggested list of less than $50.00. FM, mono or stereo, with the latter being automatically switched, is offered. In the stereo mode a panel light indicates that the unit is switched. An unusual tuner feature is the combination of signal strength and center tuning in a single meter—a front-panel switch selects the needed function. Maximum sensitivity is 1.6 µV; signal-to-noise ratio is 65 dB; distortion, under 0.8 per cent: drift, less than 0.62 per cent. Stereo frequency response, ± 1 dB, 30 to 15,000 Hz; capture ratio is 4:1; selectivity is 45 dB; cross-modulation rejection is 30 dB, and stereo separation is 35 dB. The silver-plated four-nutvisor front end feature of Scott tuners is retained. **Circle 204**

- **Compact Speaker.** This latest unit in a long line of Wharfdales is the W-30. It is a true bookshelf speaker measuring 15" by 6" by 9" with an integrated unit system with a high-compliance eighinch woofer and separate small cone tweeter. A unique feature of this system is its Acoustic Compensation Circuit. This is a two-position switch that is unlike the usual tweeter control usually found on two-way systems. The switch serves to alter the normal response by reducing the presence range together with a controlled amount of tweeter. The result is a change in the character of sound from full-bodied to mellow. This can be used to advantage for both room and personal-taste compensation. Efficiency of the system is high; a 10 to 15-watt amplifier is suggested. List price in walnut is $69.95. **Circle 205**

- **RCA's Lightest and Smallest Microphone.** A new subminiature, lavaliere dynamic microphone has recently been unveiled by RCA Electronic Components and Devices. The RCA RK-12A weighs less than 3/8 of an ounce and measures 1 inch in length and 3/8 of an inch in diameter. This microphone has been designed for excellent speech balance for use in TV interviews and public address applications. Frequency response covers the range of 60 to 18,000 Hz. Pickup characteristics are non-directional. The microphone comes equipped with lavaliere and tie-clip holders. Other features include: a line-impedance voice coil that permits its use with any microphone and the range of 30 to 500 ohms, gold plating on accessory, and a micro-singed, stainless steel meshed acoustic screen that effectively filters out dirt and moisture. On the spot repairs may be made by the use of available complete replacement cartridges. Installation features of this system is its compactness. **Circle 206**

66

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our vast system going, is the yearly dealer wingding that each of our major companies must put on to keep its regional dealership happy and well informed. Well, er . . . happy, anyhow. Some of these wingdings, oh-so-happily, are open to select members of the press.

Now I don't get to many of these affairs—I'd never get any work done if I did. But I always grab at the chance when one comes my way, because I like to be happy too. It's all one big happy hi fi family for me. And the one I grab at most quickly is Jensen's, from Chicago. That is, the New York Jensen wingding. It's something. (I have also hugely enjoyed some of the others, including several by General Electric, one of which beat any repast I ever ate for sheer gourmandizing.)

Parts Show

First, of course, these dealer get-togethers must be equipped properly. There must, naturally, be a one-company Parts Show, like at the Hi-Fi Shows but three times as big. And so first of all, the Company picks a big room at some hotel and laboriously sets up an enormous display of Company Products, all around the edges. Switching panels, colored lights, piles of literature, music galore. Very instructive, to put it mildly. A lot of work goes into that sort of display, I tell you.

Well, finally, comes the Great Day. All the Company Brass is in attendance, the bugs have been got out of the Display, to the tune of hours of tuning-up (we hope they're out) and all is ready. An exhausting ordeal for those involved, but the guests, quite naturally, will be oblivious of all that and couldn't care less, which is as it should be.

So you arrive. But before you even see the Display you are likely to encounter a real live bunny. Or a more modest equivalent (Jensen). She checks you in, nuzzles your coat and hat away from you, pins on your badge and then, with a big smile, presents you with a GIFT. Good one, too. Off to a splendid start! Jensen's to me was a lovely blue ball point pen, fixed up so that each time you click it in and out a different Jensen ad appears in a magnifying window. I didn't catch onto this until halfway through the banquet . . .

But first, as I say, there is the Display, which is to be seen in all its glory as you enter the party room. It occupies everybody's mind for at least ten full seconds. What comes next, needless to say, is the bar, where things are being dispensed with a fine freedom and a total absence of cash, to the delight of all including yours truly. In no time at all, the cocktail party is buzzing at its liveliest—you never saw such an Old Home Week! The display now serves handily for leaning against, in animated conversation, or putting down a drink for a moment, or for cigarette trays.

Nothing rowdy—far from it. Just, to coin a new word, loundy. Such a roar of pleased conversation you never heard. (This was a big party, mind you.) A rousing good time, as friends meet friends, circles form and dissolve, dealers whoop to dealers over other peoples' shoulders. Terrific. And the only sufferers are those unlucky minor officials who are stuck with running the exhibits in the Display. They did a thriving business at Jensen, as a matter of fact, but it had to be carried on in a hoarse shout, mouth to ear. Wearing with one accord, most of the guests ignored them. They were much too busy having fun.

Moment of Truth

But sooner or later, must come the Moment of Truth. The official Demonstration. No company can throw an affair like this without at least a gesture towards audible

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The party went along, better than ever. The boys were having their good time and why bother them, I thought to myself. That's the whole idea, isn't it? Now, Mister V.P., you don't really think you're going to get our undivided interest for your Demonstration now, at such a happy moment as this? 

Nevertheless, the Vice President (or whoever he was) kept at it, mildly, calling for our attention. And after awhile, a good long while, there occurred a sort of half-hull, a slightly detectable lowering of the conversational dB. Some of the dealers, probably old hands, pretended not to notice. Others, slightly more dutiful to Mother Jensen's command, turned half away from their conversations and canapés—not giving them up, mind you, just re- volverng their persons a bit in the general direction of where things were to happen. And so the Annual Demonstration began, and wended its way, still gently persuasive, all smiles, through a gradually rising tide of renewed cheerful noise until it finally just plain disappeared, completely engulfed, without an audible trace! It had to be seen to be believed. Seen, because you really couldn't hear it. Not much, anyhow.

I figured, myself, that most of the Jensen dealers already knew a lot about the models on display and so could afford to lend their ears to other matters more con
divial. Jensen must have known it too. The amiable gent who ran the Demonstration, straight through the barrage of noise, didn't seem to be a bit annoyed. If he was, he manfully didn't show it. He beamed vocally through the mike, right in tune with the rest of us. We all made noise, all at once.

I tried to take a few notes on him (with the blue Jensen ball point), as the proceedings went on and as each of the Company's splendid stereo speaker systems was played in turn, via the switching and the colored lights. But my second martini kept getting in the way, and all I can make out now of what I wrote down, on a program book, is a cryptic statement that says "replacements—I think it was replacement." I'm afraid I can't interpret that to you at this late date. But I did, with my unerring musical ear, recognize a very familiar tune, over and over again, which my accompanying lady friend, with her unerring memory, instantly identified as "Jealousy," a tango. We heard "Jealousy" through each of Jensen's systems, but I'm
What makes it different?
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Almeida plays a lead instrument of some sort in each selection, three of which happen to be his own compositions. In the themes from "The Reward" and "Zorba the Greek," his lead instrument is the tiple. This small item has four sets of double strings and is similar to the mandolin in appearance. Other instruments involved in the background: a cavaquinho, a treble Brazilian guitar about the size of a ukulele and, to complete the ensemble, there is a twelve string guitar, a Fender bass guitar, a variety of more conventional guitars, drums, and percussion. Not exactly a group you'd expect to meet coming down the street every day in the week but one capable of lending sonic variety to show music that can certainly use it.

REVERBERATION
(from page 44)

An interesting parallel occurs in geophysical echo-sounding techniques. In these applications the desired signal for recording is the bandwidth that is removed from the original. The remaining full bandwidth is not used except for reference purposes. In later applications the removed signals are again combined with the original data. In this manner, one is able to a marked degree, to salvage a much weaker echo that is located under a multiple bottom reflection.

Conclusion
While the addition of artificial reverberation to an existing sound system does not make a great hall out of a small listening room, it does aid in establishing the proper depth to the program. It aids materially in acoustically removing the speakers from the room and in adding the much needed feeling of size. If these signals are correctly applied to the original program material, the affect is one step closer to the ideal of high fidelity: that of reproduction as close as possible to the original.

Echo sounding techniques make use of the fact that different layers of material such as water, sand, rock, clay, and so on, reflect signals of different frequencies in the audio-frequency range. Thus, if a reflected signal from additional layers below the ocean floor is received, the frequency containing the largest energy level would be different from the signal reflected from the ocean floor itself. Suitable filters enable the operator of such equipment to reject to varying degrees the multiple bottom echo and yet retain the reflected signal from these additional layers below the bottom even though this signal is considerably more attenuated.
Two new releases on two different American jazz labels have a common and somewhat extraordinary purpose. They serve to commemorate overseas visits by two German jazz groups. Both visits were sponsored by the German Goethe Institute, and if one can judge from the product on these two labels, we have the same kind of competition in the jazz field that we have encountered with our manufactured goods in overseas markets. It has been our smug habit to assume that we have one cultural export with which no other nation could compete. Whenever the Stu's were sent over to put on a goodwill tour that was uniquely American, all it had to do was get Louis Armstrong or Benny Goodman. But it was a patently designed gimmick shrewdly designed for winning friends and overcoming language barriers. Now it looks as if the patent rights have expired. In the future it would be wise for us to recognize that we will be obliged to engage in vigorous competition if we don't want to find ourselves frozen out by high-quality foreign imitations.

It's particularly serious because we're up against a very interesting gimmick shrewdly designed to cement even closer friendships than can be stuck together by a simple concert tour. The gimmick may not be particularly new, but it is effective: combine your own jazz style with the music of the countries you're visiting. Dave Brubeck has clumsily attempted to employ this technique in visits to Germany and Japan, but the framework has been too large for his talents. Either these two Germans are less self-conscious than Mr. Brubeck or they are more skillful in merging their own personalities into their music. In any event, they have found an effective technique for blending European jazz with the music of other continents.

Albert Mangelsdorff: Now, Jazz Ramwong
Pacific Jazz Stereo ST-20093

The ramwong is a popular Siamese folk dance and according to the liner notes on this platter, the new version from which this disc derives its title received acclaim from press and public when it was presented in Bangkok in January, 1964. The disc was recorded at Walldorf Tonstudio, Frankfurt-am-Main, for CBS Records of Holland after the Mangelsdorff Quintet returned from a 10-week Asian tour that stretched from Turkey to Japan and was commissioned by the Goethe Institute. The group gave 50 concerts in 65 days, and they were accorded what must by now be considered the traditional welcome for all jazz musicians in Thailand—a jam session at the royal palace in which King Bhumiphol participated. The quintet is composed of Albert Mangelsdorff, trombone, Günter Kronberg, alto, Heinz Sauer, tenor, Günter Lenz, bass, and Ralf Hübner, drums. They turn in polished performances throughout, but it is the title tune and Three Jazz Moods or Theme from Pather Panchali that provide the most interest and originality. Indefatigable performers, the group has appeared at the important European jazz festivals in France, Poland, Switzerland, and Yugoslavia, and Mangelsdorff was a soloist at the Newport Festival in 1965.

Klaus Doldinger Quartet: Doldinger in South America
Emarcy Stereo SRE 66009

This recording is an impressive document of the strong impact that South America made on one of Europe's leading jazz quartets. Following a 37-concert tour from Rio to Mexico that made a big impression on the Latin Americans, Doldinger's group returned to Europe and discovered that the Latins had also made quite an impression on them. Together with guitarist Attila Zoller, they have recorded their impressions in a sophisticated collection of atmospheric jazz with pronounced bossa nova inflections. Control, rather than freedom, is at the core of these performances, and there is just a bit of conscious contrivance in some of the arrangements, but it's all handled with impeccable taste, and the results make for easy, satisfying listening.

J. J. Johnson: Goodies
RCA Victor Stereo LSP-3458

Good sound, a large orchestra, and a chorus have all been lavished on this production, and as might be expected, the results are inflated and a trifle vulgar. Jay Jay is given ample opportunity to solo, but he has no serious competition to play against. Consequently he doesn't rise to the heights of which he is so capable when the sides are more evenly matched. One Johnson sings a couple of tunes with lots of energy, and Mariene Ver Planck scats through another pair of numbers. The sound is great: lots of spread, contrasting rhythms from left and right speakers, a solid center. The only thing missing is the kind of music we expect from a musician of the caliber of J. J. Johnson.

JERRY MULLIGAN: IF YOU CAN'T BEAT 'EM, JOIN 'EM
Limelight Stereo 15 66021

With the assistance of Pete Jolly, piano, Johnny Gray, drums, Jimmy Bond, bass, and Hal Blaine, drums, Mulligan makes a conscientious obeisance to nine of the great hit tunes of the last three years. "King of the Road," "Englewood No. 9," "Hush, Hush Sweet Charlotte," "I Know a Place," "Can't Buy Me Love," "A Hard Day's Night," "If I Fell," "Downtown," and "Tambourine" are agreeable performances that are planned to retain the melodic interest of these pop favorites intact. It's well below Mulligan's creative level, but it is a deft rendition of music that can benefit from a more low-keyed treatment than is found in the classic versions. The album in which Limelight presents this set is a graphic triumph. Designed by Daniel Czubak, it features a pop-up center and a handsome booklet written by Gene Lees.

Paul Butterfield Blues Band
Elektra Stereo EKS-7294

"We suggest that you play this record at the highest possible volume and with your hi-fi turned on at its greatest sensitivity to fully appreciate the sound of the Paul Butterfield Blues Band." That's the legend carried in a box on the jacket liner of this potential legendary album. Anyone whose sound system is capable of more than moderate volume should approach this disc with caution for Elektra has managed to engrave a fantastic amount of clean, high-level sound on the grooves of this lively swinging collection by a 23-year-old white アゴシージャンク with a direct, highly personal blues style. Butterfield sings, plays the harmonica, and creates much of his own material. Accompanying his band consisting of two electric guitars, electric bass, electric organ, and drums, he presents a vigorous, almost violent, approach to the blues that is very different from the usual introspective blues manner but one which is just as valid. This is a remarkably fine record, even when played at moderate levels. At full output you had better chain yourself to the speakers, or you'll be blasted right through your walls. If you're really adventurous, and your neighbors are touchy, it also sounds great on earphones.

Mr. 12 String Guitar
World Pacific Stereo 21835

Having explored the sound of the twelve-string guitar in more traditional material in previous albums, World Pacific now offers us a more folk-oriented edition. Seven of the platter's dozen tunes are from the pen of Bob Dylan, and only three guitars are used. They are augmented by two electric organ, drums, bass, and fender bass. The remarkably clear recording that has always been a feature of this series is present once again, but for me, there is more of a detached, perforatory quality to these performances than to the earlier records in the series. The series' editorial considerations are not likely to affect seriously the popularity of this new release. Dylan is the reigning king of this folkrock movement, and tastefully arranged versions of some of his most popular songs include "Blowin' in the Wind," Mr. Tambourine Man, "Like a Rolling Stone," and "It Ain't Me Babe."
TEST EQUIPMENT
(from page 30)

DISTORTION ANALYZERS

EICO 902 A combination harmonic and intermediate distortion analyzer, this unit also functions as a high sensitivity a.c. VTVM. Measures distortion over frequency range from 20-20,000 Hz with a minimum input of 0.7 volts. Scale ranges of 0.1, 0.3, 1, 3, 10, 30, and 100 per cent are available for either THD or IM analysis. As an a.c. VTVM full scale settings of 0.1, 0.3, 1, 3, 10, 30, 100, and 300 volts are usable. Frequency response is 16,000,000 Hz ±3 dB. A test signal of 60 and 1600 Hz at either 4:1 or 1:1 ratios is available for IM use or external signals may be substituted. Price is $250, wired only.

Heath IM-12 A harmonic distortion analyzer that will show THD over a range of 20-20,000 Hz. Full-scale ranges of 0.1, 0.3, 1, 3, 10, 30, and 100 per cent are available for either THD or IM analysis. Minimum input voltage for distortion measurements is 0.3 volts. This unit also serves as an a.c. VTVM with a maximum sensitivity of 1 volt full scale. It will measure noise levels down to 60 dBm. Price in kit form is $49.95.

Heath IM-22 Audio Analyzer This instrument is for measurement of inter-modulation distortion in accordance with SMPTE standards. It provides its own signals of 60 and 6000 Hz which may be mixed as required. Other frequencies may be applied externally if desired. Built-in 25-watt loads of 4, 8, 16, or 600 ohms may be used in terminations. The IM-22 also functions as a directly calibrated watt-meter and high-sensitivity a.c. VTVM with a maximum full-scale sensitivity of 10 MV. Full-scale distortion ranges are 0.1, 0.3, 1, 3, 10, 30, and 100 per cent. There is an input level set. Frequency response as an a.c. VTVM is 10 to 100,000 Hz ±3 dB. Decibel calibration in dBm is from -35 to -152 dBm. Price in kit form is $16.95.

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- Colorful Stereo Guide. H. H. Scott is offering the latest edition of his Guide to Custom Stereo. This 80-page brochure, illustrated in full color, features photographs, descriptions, and specifications of all Scott component kits, kits and speakers. But it is also a valuable source of information. In simple language it explains how stereo works, and how to choose the components most suited to individual acoustic and budgetary requirements. Many of the color photos show the components in room decor conditions. The brochure is free of charge. Circle 221

- PA Literature. This latest catalog describes the Commander series of Harman-Kardon components. When fully opened, the catalog doubles as a wall chart and ready reference of complete, easy-to-read specifications. Two handy tables indicate which accessories are used with each amplifier, tuner, or receiver. A new guide to the POWRICOM intercom system makes it easy to understand how this most valuable unit may be integrated into any PA installation. A basic, two-channel/two-channel system black diagram further illustrates the facility of the complete project. List prices are included in this free catalog. Circle 222

- Hobby Manual. Kit and do-it-yourself constructors will enjoy this new book from General Electric. It is a 200-page digest of projects for entertainment, home, camp and workshop. Included are a light that dims gradually at a pre-determined time, an electronic organ, the size of a typewriter that plugs into your music system, an airport receiver that lets you eavesdrop on conversations between pilot and control tower and an electronic car ignition system. Four-color pages of the manual are devoted to a layman's explanation of the fundamental operation of the wide range of components used in these systems. All in all, there are thirty-five projects, none of them requiring deep electronic experience. Cost is $1.50 and the Hobby Manual is available through GE electronic component dealers or direct from Circle 223

- Piezoelectric Data Book. Electronic device, circuit and system designers will find value in this 45-page technical manual on piezoelectric technology. The book progresses from the fundamental descriptions of characteristics and principal applications of piezoelectric crystals and elements to coverage of piezoelectric components and the piezoelectric properties of ceramics. There is also a brief discussion of equivalent circuits and their applications to flexing, sandwich-type electric elements known as "Bimorphs" and "Multimorphs" as well as an outline of the properties of special ceramic shapes and tubes. The book, "Piezoelectric Electronic Technology," is published by the Clevite Corporation. It contains forty figures and seven tables. Eight pages are devoted to conversion charts designed to facilitate converting published piezoelectric measures between U.S. and metric units. Circle 224

AUDIO • FEBRUARY, 1966
When you have completed an audio kit, the instructions may call for you to make certain resistance checks (for example at the d.c. power supply) before turning the component on. If the component doesn't work properly, the kit manufacturer will have a number of trouble-shooting suggestions, some of which call for measuring resistances and voltages.

Conclusion

If you want your audio components to yield full potential performance and stay that way, you may well give serious thought to acquiring a few basic test instruments at relatively low cost. No one thinks it strange for a car owner to delve deep under the hood of his automobile. Why shouldn't the audio buff have similar technical familiarity with his audio equipment?

Getting started in something new is always a problem. Start in a simple way. A good VOM might be your best initial acquisition. It is really quite inexpensive, yet very useful. As you gain familiarity with your first piece of test equipment, you'll find that the notion of using instruments is not so foreign as once seemed, and you'll be emboldened to go on to such things as an capacitor checker, audio generator, distortion meter, etc.

At the same time, recognize your limitations. There are service problems and alignments that require the skill and experience of the expert, and quite possibly require test instruments better than those sold at popular prices. When you probe inside a component, be careful not to disturb the arrangement of parts and leads. If you have to disconnect a part (for example a capacitor) in order to check it, first make a drawing that shows where the leads go, so that you'll be sure to reconnect this part or its replacement properly. If you are testing inside a component with the power on, keep in mind that small amounts of current passing through your body can hurt badly or can even kill. The rule is one hand for the test and one for yourself (behind your back). This is not meant to frighten you from using test instruments. It is simply meant to put you on respectful terms with them and their use.

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**TEST INSTRUMENTS FOR THE AUDIO BUFF**

(from page 29)

When you have completed an audio kit, the instructions may call for you to make certain resistance checks (for example at the d.c. power supply) before turning the component on. If the component doesn't work properly, the kit manufacturer will have a number of trouble-shooting suggestions, some of which call for measuring resistances and voltages.

Conclusion

If you want your audio components to yield full potential performance and stay that way, you may well give serious thought to acquiring a few basic test instruments at relatively low cost. No one thinks it strange for a car owner to delve deep under the hood of his automobile. Why shouldn't the audio buff have similar technical familiarity with his audio equipment?

Getting started in something new is always a problem. Start in a simple way. A good VOM might be your best initial acquisition. It is really quite inexpensive, yet very useful. As you gain familiarity with your first piece of test equipment, you'll find that the notion of using instruments is not so foreign as once seemed, and you'll be emboldened to go on to such things as a capacitor checker, audio generator, distortion meter, etc.

At the same time, recognize your limitations. There are service problems and alignments that require the skill and experience of the expert, and quite possibly require test instruments better than those sold at popular prices. When you probe inside a component, be careful not to disturb the arrangement of parts and leads. If you have to disconnect a part (for example a capacitor) in order to check it, first make a drawing that shows where the leads go, so that you'll be sure to reconnect this part or its replacement properly. If you are testing inside a component with the power on, keep in mind that small amounts of current passing through your body can hurt badly or can even kill. The rule is one hand for the test and one for yourself (behind your back). This is not meant to frighten you from using test instruments. It is simply meant to put you on respectful terms with them and their use.

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**RECORD REVUE**

(from page 19)

records, enough to keep you in solid Baroque for weeks.

Performance is crisp and vigorous, through with a peculiar lunging quality that is a bit confusing at first. (It could be partly the recording—which is called "Roysound" and is calculated by computer, like Dynagroove.) The performers are Dutch, their playing subtly different from the standard German Baroque style. English notes included.

Les anciens vous présentent leurs instruments de musique: le Groupe d'Instruments Anciens de Paris.

Pathé EMI DTB 335 stereo (via Copirol)

Gotta know some French for this one. If you do, you'll find it a good sonic exposition of old musical instruments, with excellent examples and spoken comment (French) by two voices, in stereo, plus an excellent illustrated booklet (French). Even without French you might enjoy it.

Tricky procedure. The main narrator, in one stereo speaker, carries on the informative line of thought. (Excellent dictation, slow enough to follow easily.)

A second voice, in the other speaker and a bit in background (probably for contrast in the mono version) quotes from contemporary accounts concerning the various instruments. The musical illustrations are very nicely managed, never nudge brief nor cut off un-musically, and well played, too. There's the expected emphasis on French musical history, natch—the French have the naive idea that most important things originate in France (as we do of our own self-centered country!) and they don't mind saying so (nor do we). Won't bother you a bit here.

You'll listen to several types of old harp, old flutes, oboes, recorders, serpent, cromorne (Krummhorn)—perhaps the original for our word "crummy"—the rackett, a handful of wooden bottle with a bloowing-tube and a crackly bass voice, plus harpsi-chords, clavichords, and a brief sampling of very early piano sound. Like to have heard more of that. And lots of fiddles. viola, viols—a real musical zoo. Every instrument, though, is played with musical feeling and reasonable skill, as well as respect. All in all a model for this sort of recording.
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The track width may vary between 39 and 43 mils. 3. The three islands between tracks shall be of equal width. 4. The tracks as a group shall be symmetrically positioned with respect to the tape, so that the top of track 1 and the bottom of track 4 are equidistant from the tape edges. 5. A track plus its adjacent island shall occupy between 67 and 68 mils. 6. The distance between the center lines of tracks 1 and 3, or of 2 and 4, is given as 134 to 136 mils. 7. Going from the center of track 1 to the center of track 3 sequentially covers half of track 1, island 1-2, all of track 2, island 2-3, and half of track 3—a total of two tracks and two islands. If 2 tracks plus 2 islands shall cover 134 to 136 mils, then 1 track plus 1 island shall cover half as much, namely 67 to 68 mils.

If the minimum track width of 39 mils is used, then the islands must be between 28 and 29 mils in width, so that a track plus adjacent island will cover between 67 and 68 mils. Then the total space occupied by tracks plus island is between 240 and 243 mils (4 tracks of 39 mils plus 3 islands of 28 mils add up to 240

mils; 4 tracks of 39 mils plus 3 islands of 29 mils add up to 243 mils). At the other extreme, if the maximum track width of 43 mils is used, then the islands can only be 24 mils wide (instead of 25 mils as in Fig. 2). Four tracks of 43 mils plus 3 islands of 24 mils add up to the maximum permissible total width of 244 mils. If the tracks are of intermediate width, namely between 39 and 43 mils, the islands will range between 24 and 29 mils.

Assuming that a tape head manufacturer elects track 135 mils as the distance between center lines of tracks 1 and 3 (and of tracks 2 and 4), Fig. 4 shows the maximum and minimum space covered by each track, and the corresponding island width, under the RIAA standard. (Figure 4 is not necessary to scale.) Note that whether the track width is 43 mils, 39 mils, or in between, each track's center line remains in the same place with respect to the tape, provided the distance between center lines of alternate tracks (of tracks 1 and 3, or 2 and 4) remains 135 mils. If the distance between center lines changes, the tracks shift position. But this shift can only be very slight, because the distance between center lines may vary only 1 mil above or below 135 mils. There is no danger that a tape recorded on one machine will play back improperly on another machine because their track widths (gap heights) are different or because their distances between center lines are different.

One may wonder why the track width is permitted to vary between 39 and 43 mils (producing a variation of about 1 dB in recorded signal) instead of being fixed at 43 mils as in Fig. 2. Similarly one may wonder why the distance between center lines is permitted to vary between 134 and 136 mils. Two reasons come to mind:

1. To avoid excessive manufacturing and processing costs, reasonable tolerances are permitted.

Fig. 4. Track widths per RIAA Standard if the distance between alternate center lines is 135 mils.

NOTE: THIS FIGURE IS NOT EXACTLY TO SCALE.
THE Turntable of the Tape-Age
807

Industry Notes...

- That Magnecord Contest. Do you remember that contest that Magnecord ran recently to find the oldest living PT-6 recorder? University of Illinois University, Decatur, Illinois had it. Paul E. Weisser, head of broadcasting and broadcasting professor turned in the winning information. The University had purchased the PT-6 in the late 1940's when they were setting up a radio studio. The recorder has been in continuous use since that time, and was, at contest time, employed in the speech department. In accordance with the contest rules (revised per a suggestion that appeared in this column) the University was given a new PT-6 in exchange for their veteran unit. Professor Weisser received a new model 1028 Magnecord plans to overhaul the old unit completely and "gold plate" it for exhibition purposes.

- JBL News. No less than three JBL releases have crossed our desk recently. The first informs one and all that James R. Lansing Sound, Inc. is the recipient of the Los Angeles Chamber of Commerce 1965 Industrial Design Award of Excellence. The company is honored with the JBL 90 watt Stereo Power Energizer. This second consecutive year that JBL has received recognition in this contest. Last year the JBL SC50 Graphic Crossover was honored.

Next release. William H. Thomas, president of JBL Sound, Inc. has been elected to the Board of Governors of the Audio Engineering Society. Mr. Thomas is the first 1966 Western Chapter of the AES in Los Angeles and has previously served the organization as Western Vice President in 1962. The final release announces that Mr. Eugene Hawkins, a staff artist at JBL, was recently named a John Hay Whitney Fellowship winner for 1965-1966. He was selected on the basis of his oils, lithographs, and woodcuts, which were submitted to the Whitney judges earlier this year. Eugene Edwards has been with JBL for several years. His posters advertising the 1962 Los Angeles High-Fidelity Show were selected by the IHE for promotion that year. He is also the recipient of the Foundation for Freedom Award. At JBL, Mr. Hawkins’ work includes all graphic design for literature, including dealer aids, sales promotion collateral material and dealer advertisements.

Views at Concertone. Al Barsimanto has recently been appointed Vice President of Concertone, division of Astro-Science Corporation. He is responsible for Concertone’s product development and expansion program. In making the announcement, J. E. Harding, Concertone President, indicated that A1 Barsimanto’s background as former National Sales Manager of Roberts and West Coast Sales Manager for Concertone will serve him well in his new capacity. Mr. Barsimanto has always been active in marketing and product development projects and a consultant to the photographic and musical fields prior to joining Concertone.

- Connector Source. Switchcraft, Inc. has been appointed as American Distributors of the German Phono line. Phono is ranked as one of the largest manufacturers of high-quality audio and microphone connectors. Under terms of the agreement recently signed, Switchcraft will assemble and market Phono products under the Switchcraft label. Over 100 types of audio receptacles and connectors for broadcast and professional applications as public address, communications equipment, tape and phone equipment, precision recording equipment and scientific test measurement devices, are now available under the combination.

- Transistors on the Move. At the NTEEM Show in Boston, the 15th annual audio output transistor manufacturing by Security Devices, Inc. has been honored by Mr. Herman H. Scott, President of the company’s Lebanon, New Hampshire. The presentation was made by James Harrison, Director of Marketing for Temperature-Sensitive Device Division. The award was based on the fact that H. H. Scott, Inc. was the first manufacturer of stereo receivers to employ silicon transistors. More than one-quarter million of these devices have been used in H. H. Scott stereo components and consoles.

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ABOUT MUSIC
(from page 10)

along, and his voice continues to harmonize the congregation at precisely the same level. But nothing is going on in his shoulders or in the musculature at the base of his neck.

"We are instantly aware that this is not only an inserted shot—photographing pieces of a scene separately is of course legitimate film-making, provided it does not give its own secret away—but that the insert was shot silently, with sound added later. Mr. Burton’s body is not engaged in the emotion announced on the sound track. It is ‘walking through’ the sequence, uninvolved. The discrepancy between the two mismatched pieces of film is at once obvious; illusion jars to a stop as though someone had pulled the emergency cord on a subway train."

(To director John Huston’s credit, it should be stated that most of this film seemed to have been recorded live—to the extent that a microphone bonn was seen being lowered momentarily into camera view during a Burton monologue. The scene was retained presumably because the director preferred the take over others.)

Even with expert post-recording of dialogue, however, illusion crumbles when other “seen” sounds cannot be heard. In an attempt to reconstruct a scene in aural terms, sound engineers usually isolate one effect and underscore the dialogue with it. A night scene, for instance, may feature the creaking of crickets. In interior scenes, we will hear obvious sounds such as the shutting of a door, the clicking of a cigarette lighter, the chatter of conversation in the background. What is missing in most dubbed scenes are ambient sounds that have no specific dramatic significance, as well as a reasonable acoustical recreation of the place we see. It is the absence of these sounds and the mismatch of acoustical properties that produce what Walter Kerr calls a “spooky” feeling.

Movies will continue to be spooky, or disembodied, as long as film directors and their mixers and dubbers remain insensitive to the need to make sound correspond to sight.
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It's a good deal longer than it used to be, ten or twenty or thirty years ago. And it gets longer every day, thanks in large part to medical research. Over a million men and women are alive today, cured of cancer. Research helped find the answers that saved their lives. Research takes time. And money. The American Cancer Society spent over $12,000,000 last year alone, to find still more of the answers. Yet $2,000,000 in research applications, approved by the Society, could not be financed for lack of funds. Your dollars are desperately needed to help speed the day of victory over this dread disease. Send your check today to CANCER, c/o Postmaster.
In this unretouched photograph, the long, black hair of the brush built into the new Stanton 581 is shown in action on a rather dusty record. Note that all the loose lint, fuzz and dust are kept out of the groove and away from the stylus. That’s why the Longhair is the ideal stereo cartridge for your Gesualdo madrigals and Frescobaldi toccatas. Its protective action is completely automatic, every time you play the record, without extra gadgets or accessories.

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