the authoritative magazine about high-fidelity

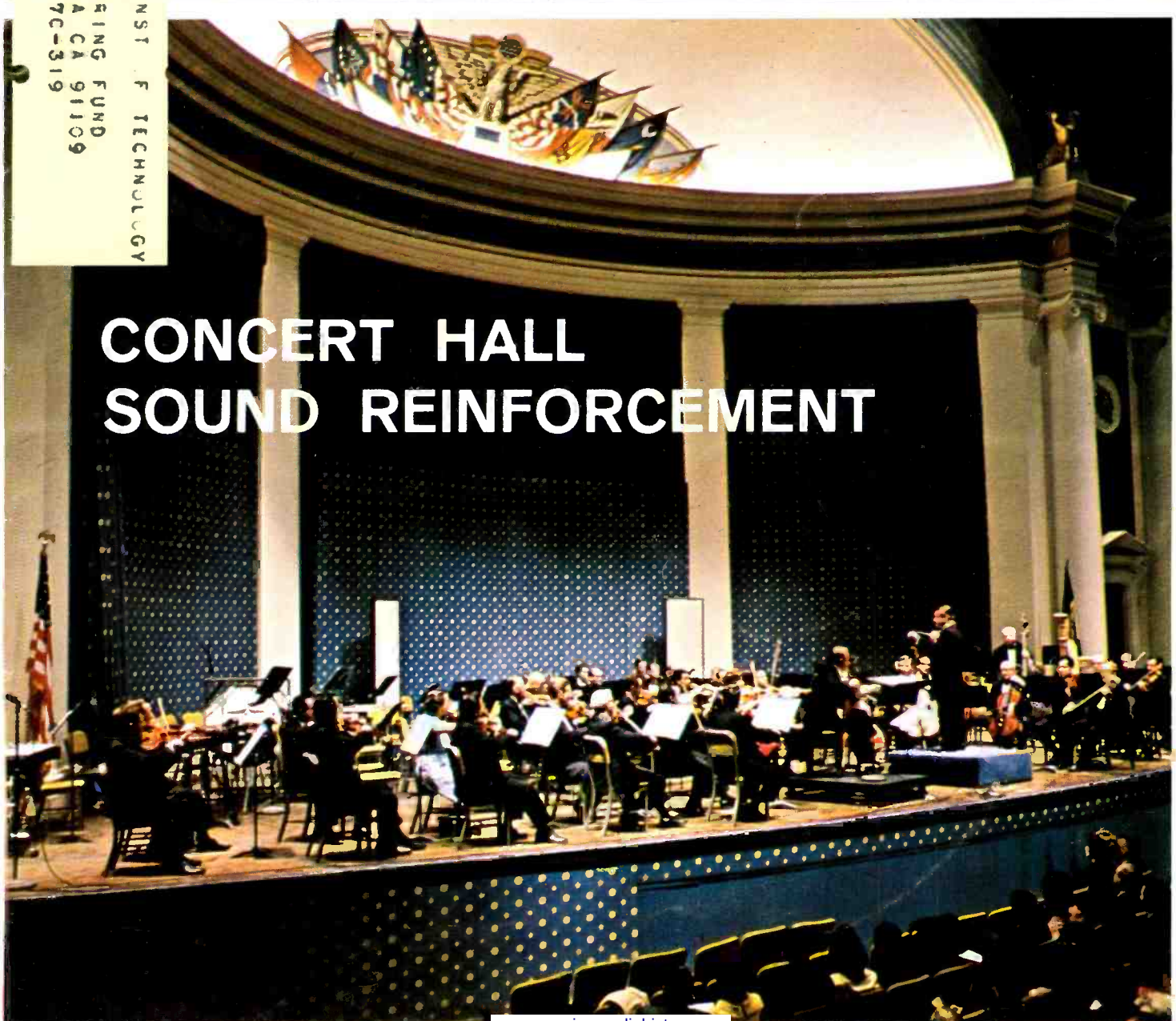
ON SALE SEPTEMBER

1967 60¢

AUDIO

BUILD A LIMITER TO IMPROVE TAPE RECORDING QUALITY

EQUIPMENT REVIEWS: ORTOFON SL15T PHONO CARTRIDGE, CERTONE 770 TAPE RECORDER, MIRACORD PW50H TURNTABLE



New Scott 344C- more power, more features.

(THERE'S A SOUND REASON.)

Scott's 344 series receivers have led the medium-price field in popularity since their introduction, and the all-new 344C is sure to be no exception! 90 Watts of usable power give exceptional performance from a whisper to a roar. The 344C even sounds better between stations . . . annoying hiss has been wiped out by Scott's muting control.

Want speakers in several rooms? It's a cinch with the 344C. You can even switch off all speakers and listen in privacy through stereo earphones. And the 344C's new pushbutton panel includes special controls so you can monitor off-the-air taping, with professional results.

If your listening isn't complete without AM, tune in with Scott's new 384 . . . basically a 344C in AM/FM form. Both the 384 and the 344C include Field-Effect Transistors, Integrated Circuits, and all-silicon output. Both offer you an entry into high-price features and performance . . . at medium price.

344C/384 Control Features Dual Bass, Treble, and Loudness controls; Volume compensation; Noise filter; Interstation muting; Tape monitor; Dual speaker switches; Dual microphone inputs; Professional tuning meter; Front panel headphone output.
344C/384 Specifications Music Power Rating, 90 Watts @ 4 ohms; Harmonic distortion, 0.8%; Frequency response, 15-30,000 Hz ± 1 dB; Cross modulation rejection, 90 dB; Usable sensitivity, 1.9 μV; Selectivity, 46 dB; Tuner stereo separation, 36 dB; Capture ratio, 2.2 dB; Signal/Noise ratio, 65 dB; **Price: 344C, $399.95; 384, $439.95.**

Scott . . . where innovation is a tradition

SCOTT®

For complete information on the all-new 1968 Scott line, write: Dept. 35-09, H.H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. 01754, Export: Scott International, Maynard, Mass.

FOR SCOTT'S ALL-NEW 1968 GUIDE TO CUSTOM STEREO, CIRCLE READER SERVICE NUMBER 100.

September, 1967 Vol. 51, No. 9

AUDIO

Successor to RADIO, Est. 1917

AUDIO ARTICLES

AUDIO REVIEWS

AUDIO PROFILES

AUDIO IN GENERAL

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Coming in October

Special Hi-Fi Show Issue

THE '68 HOT ONES—Audio's special New York High Fidelity Music Show Issue shows you the outstanding, new hi-fi components and systems to be presented to the public.

If you live in the N. Y. metropolitan area, this issue will serve as a show-goer's guide to **what** to see at the show. And an exhibitor's guide will show you **where** to see it.

For readers who cannot attend, the issue will point out what's new on your local dealers' shelves or what you can expect them to have shortly.

Other feature articles will include:

THE SKATING-FORCE PHENOMENA—Jim Kogen has written the most definitive article on skating force that we've seen to date. Here are the inside facts on what it is, how it's measured, and how it influences performance of modern, lightweight phono cartridges.

FM TUNER MEASUREMENTS—Ever wonder what all those FM specifications **really** mean? Here, in a detailed article by Leonard Feldman, are the step-by-step measuring methods used to arrive at the bewildering assortment of values that spell out an FM tuner's capabilities, plus what they mean to you in terms of fidelity.

PLUS: Audioclinic, Tape Guide, Record Reviews, Equipment Profiles, and more.

ABOUT THE COVER: Electronic sound reinforcement of musical instruments plays an increasingly important role in concert halls. The reason is simple: Big halls are needed to hold larger audiences who are, in turn, required to meet rising costs. The upshot is that subtle instrumental nuances simply don't reach numbers of people in the audience unless the sound is strengthened electronically. If you look closely at our cover photo, you will observe two electrostatic speaker systems in the background bolstering a guitarist's musical output. For further details, turn to page 30.

AUDIOCLINIC

JOSEPH GIOVANELLI

If you have a problem or question on audio, write to Mr. Joseph Giovanelli at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.

Note

From time to time many of you have taken the trouble to write me, shedding additional light on some problem dealt with in an *Audioclinic* column. I have found such letters to be both interesting and helpful.

It occurred to me the other day that you might like to share these letters with me. Occasionally, therefore, at least some portion of my column will be devoted to such material.

Hearing Losses

"I have waited month by month for some audio engineer or audiologist to enlighten correspondent David A. Taylor about the problem of decreased sound level at 4,000 cycles per second. (Professor Hertz's proponents have not yet invaded medical circles.) In a very human reaction, Mr. Taylor immediately assumed that his equipment was faulty.

"Mr. Taylor's problem, in all probability, actually is a hearing loss for tones of about 4,000 cps. This so-called '4,000-cycle notch' is well known in industrial medical practice. It is found fairly frequently in adult males in industry, but only if a complete ear examination, including a pure-tone audiometric examination is done. Hearing loss involving mainly 4,000 cps may be produced in a number of ways such as certain infections, poisons, and rare neurological diseases, but most commonly it is the earliest manifestation of a noise-induced hearing loss. This condition results when an individual is exposed to high noise levels day after day, week after week, while at work in industry, in the Armed Forces, or in some noisy hobby such as drag racing or high fidelity sound reproduction.

"Continued exposure to excessive noise can lead to progressive losses in perception of frequencies adjacent to 4,000 cps—the end result being a rather marked deafness as exemplified by the well-known 'boiler maker's ear.'

"Since the hearing loss results from actual destruction of auditory nerve fibers, treatment is ineffective. Removal of the individual from the noisy environment or protection of the ears with muffs or well-fitting earplugs will stop the progression of this condition. The ideal preventive measure, of course, is to keep the noise level down to reasonable figures.

"It would not surprise me to find that many audio enthusiasts had a mild, noise-induced 4,000 cps hearing loss, in view of the high levels at which many hi-fi rigs are continuously operated. No distinction is made by our nerve fibers between noise and music. The distinction is a subjective and aesthetic one. Music levels above 90 db (0 dB = 10^{-16} acoustical watts) will produce auditory nerve destruction just as surely as any other noise.

"Wives of high fidelity sound reproduction zealots may welcome a legitimate reason for turning down the family's hi-fi to a dull roar. Reasonable sound levels today will preserve our ears for the music of the future. In view of present trends in music, this sacrifice may be hardly worthwhile."—H. J. Van Valzah, M.D., Grosse Ile, Michigan

Connecting a Portable Radio to a Preamplifier

Q. I am considering using the earphone output jack of my 10-transistor portable radio to feed my preamplifier. I am sure that the resulting sound quality will not be good. Is there any possibility of damage to the transistors in the portable?—Fred J. Petzinger, Jr., Jr., Portsmouth, Va.

A. Your radio will not be damaged by connecting its speaker leads, or headphone jack, to the input of your preamplifier. Some radios, however, become unstable when presented with high impedance loads of this sort. You may find it necessary, therefore, to load down the phone jack with a resistor of about 8 Ohms. This will stabilize any feedback which might be present in your radio.

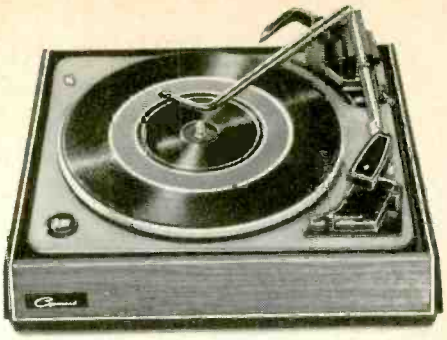
Transistor portables are often designed with small coupling capacitors. The effect of this is to reduce the low-frequency response of the output stage. The speakers of such radios are small. Hence, the loss of bass will not be noticed. Further, the fact that the amplifier in the radio does not need to produce sufficient bass response results in a saving in battery power.

What this all means is: it would be

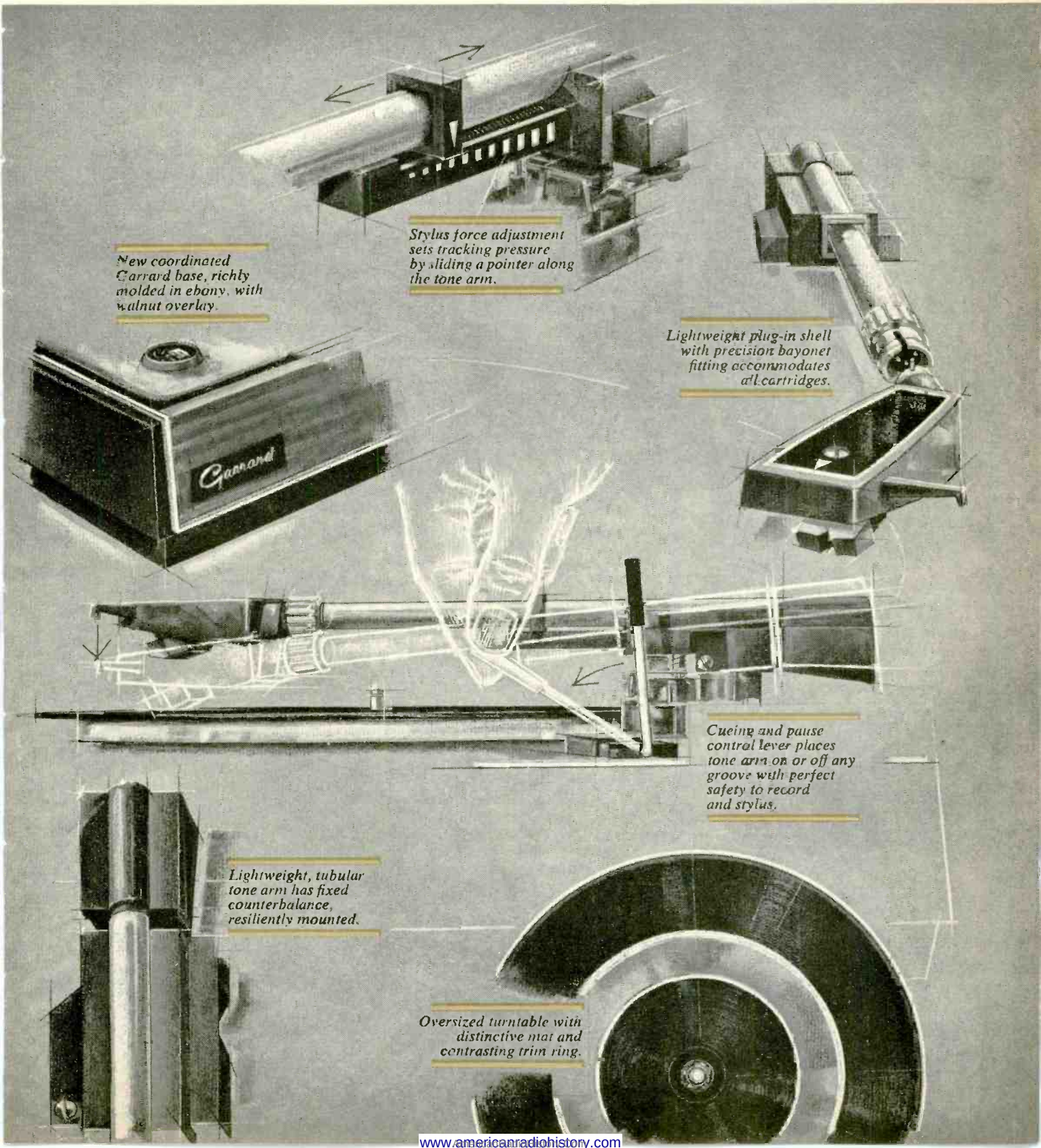
Check No. 3 on Reader Service Card →

GARRARD'S 50 MARK II

A NEW COMPACT AUTOMATIC TURNTABLE WITH HIGH PERFORMANCE FEATURES AT ONLY $54.50



Far from being keyed to the level of budget or even medium priced music systems, the 50 Mark II deserves comparison with the finest and most expensive automatic turntables. Its dramatic impact begins with styling . . . functional, handsome and beautifully coordinated. Operating features are equally impressive . . . encompassing the latest advances in convenience and performance. The 50 Mark II is one of five new Garrard Automatic Turntables. For complimentary Comparator Guide describing each model, write: Dept. AM-1, Garrard, Westbury, N. Y. 11590.



better if you could obtain your signal from the detector terminals of the receiver. Signal is often obtainable from the volume control terminals just as is possible with vacuum tube radio receivers. The quality will be better when this procedure is followed than is likely to result when the output stage is used to feed your preamplifier.

You may need to use a coupling capacitor between the radio and the preamplifier to avoid applying d.c. to the preamplifier's input circuit.

Planning a Speaker System

Q. I have just finished building a Klipschorn enclosure, i.e., the bass section of the EV-Georgian of old fame, and intend to use this as a "super woofer" up to about 100 Hz, beyond which my AR3's will take over. The K-horn will be driven with an A plus B signal from the center-channel output of my preamplifier by way of a third power amplifier and crossover network. In the above application, do I have to use a complete crossover network and use a resistor in the high-frequency branch to replace the tweeter or would a low-pass filter be sufficient?—Josef Roesmer, Pittsburgh, Pa.

A. You do not require a full crossover network. All you need now is the low-pass filter.

You mentioned, however, that this woofer is merely the first step to a new loudspeaker system. It just might be that at a later date you will need the remaining portion of your crossover network. Therefore, I suggest that you plan your future installation now. If you discover that you do not need the complete network, all well and good. If you do require it, however, you should build it now and it will then be ready for later use.

The center-channel signal can be derived by the use of a summing transformer rather than by the use of a separate power amplifier. Of course, if space is no object, you can use the center-channel amplifier as you have already planned to do. A summing transformer is available commercially. They come complete with instructions for this and other applications.

Headphones

Q. I am a music teacher and part-time symphony musician, who is, perhaps unfortunately, more interested in listening to music than in the technical aspects of high fidelity.

I wish to use headphones for a number of reasons, but headphones have improved in the last five years. I seek your advice on an improved set because shopping in person is impossible. Examination of AUDIO's August issue discloses that the Beyer DT-48, Koss Pro-4 and Telex Serenata headsets appear to have the best frequency response and/or distortion figures. Your comments on the strengths and weaknesses of each would be appreciated.

That leads directly to a more fundamental question. Just how big an amplifier is needed to drive a pair of headphones? At low signal levels probably any amplifier made would suffice, but how much reserve power is needed for that effortless reproduction of a sweeping orchestral crescendo of an oratorio, or electronic music? I am primarily interested in clear, uncolored sound with low distortion and hum, styling and gadgets being irrelevant. Dyna seems to enjoy a reputation for quality equipment at a modest cost, but would it be imprudent in terms of efficiency and cost to use a Dyna Stereo 70 or 35 to drive a pair of headphones? If so, what other quality amplifier would you recommend?—John S. Lyon, Monrovia, Liberia

A. I really must beg off commenting on specific products. I understand that you cannot shop in person for the phones. However, I always prefer to deal with fundamentals rather than questions about product information and evaluation. For this kind of material, may I suggest you consult our "Equipment Profile" section. In my column I try to be as objective as possible. I do not believe it would be possible for me to appear objective when discussing the relative merits of product A versus product B. What I prefer as a specific headset or whatever might well be disappointing to you in terms of performance.

If you only wish to use headphones, almost any amplifier will work nicely. In fact, all you require is a small unit capable of one or two watts output. If you do much traveling, this virtue will be welcomed by you because low power can be packaged in a very compact form indeed.

The reason headphones require so little driving power is that they are designed with light elements. Higher powers will destroy their voice coils from overheating and stressing. Further, power requirements are reduced due to the tight coupling of the phones into the ear canal. When the seal between the phones and the ear is complete, all sounds propagated by the earphones enter the ear. This is a very efficient arrangement.

While it is true that Dynaco equipment does perform well, it is unnecessary to use this kind of equipment unless your installation includes loudspeakers.

Check No. 5 on Reader Service Card →

Some people will never be "in." Their fancies run high and they are fanatically loyal to logic, imported beer and aged cheese. The outcrowder is long-haired, bald, herring-bone suited, and clad in dungarees with turtleneck sweater.

The conversation is endless. Probing the profound, he will discourse on drugs, Stendahl, the Kennedys, DeGaulle, Art, Love and Be-Ins.

His taste in music can run the gamut of Beatle fad, Bach fugue and Ravi Shankar.

The one thing that is most common is a demand for great performance.

His ear is attuned to the subtleties of delicate instrumentation.

When the conversation becomes subdued and the mood softens to a "listen" the cartridge used is the ADC 10E-MkII.

Top-rated, this mini cartridge is almost human in its instinct. It brings out the brilliance, from the lowest bass to the highest treble.

Its channel separation, supreme, as it feels and caresses every groove, bringing out each little nuance of the recording.

Using a unique "induced magnet" principle, it reduces the mass of the moving system to a minimal value and significantly increases stylus compliance. This allows the stylus to accurately follow the intricate modulation of the record groove.

There is less distortion and minimum record wear.

The miniscule, geometrically designed, elliptical diamond (lateral radius of .7 mil and contact radius of .3 mil) contributes to a more superior tracking ability.

These elements, carefully opinionated features, result in a genuine effortless reproduction that carries the listener to the edge of his seat.

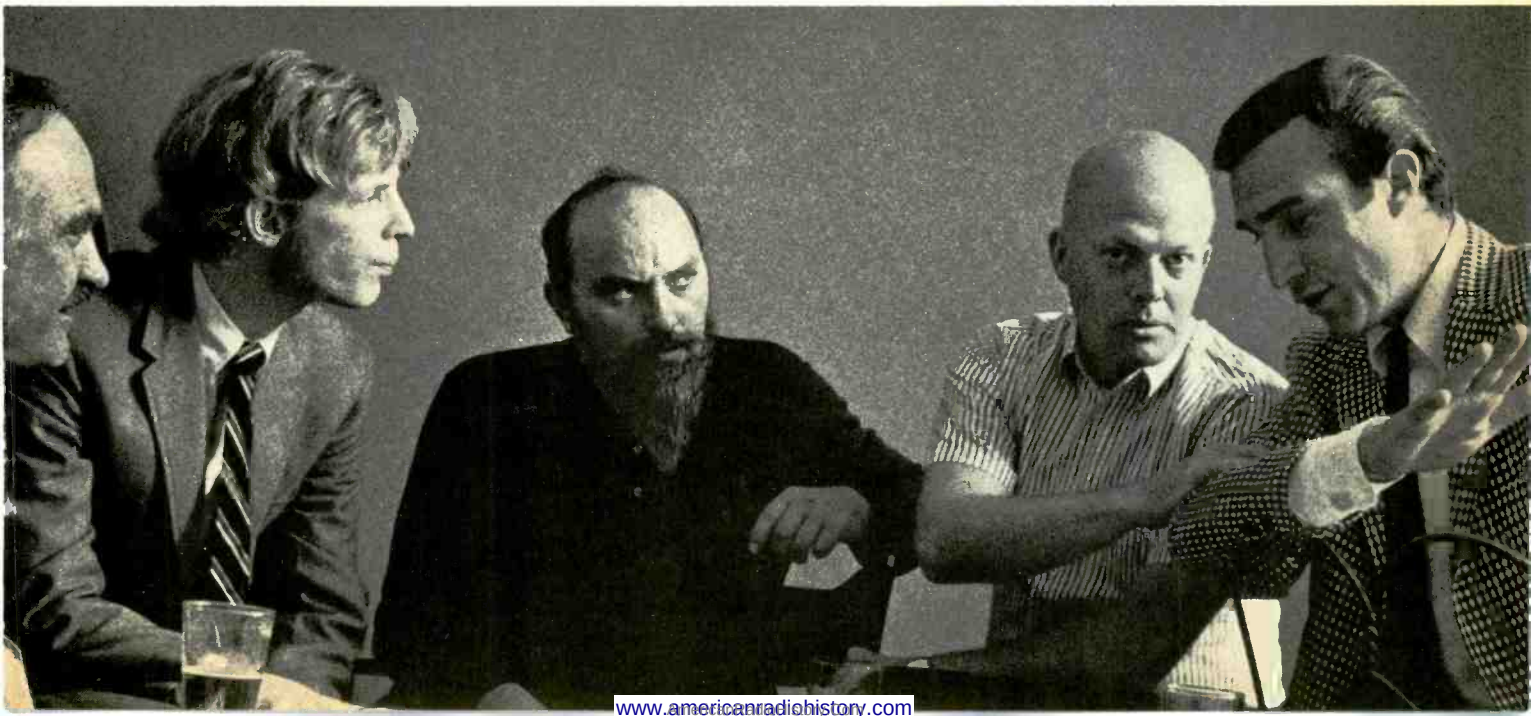
HiFi Stereo Review in an independent survey made these claims, "... its ability to trace highly modulated grooves at only 1 gram, is a feat achieved by few cartridges in our experience." And, "... it would track the HF/SR test record at 0.5 gram, lower than any other cartridge tested."

The cost is high. Just a breath under sixty dollars. But understandably so. Our appeal is to a small "out" crowd.

ADC

AUDIO DYNAMICS CORPORATION
New Milford, Connecticut 06776

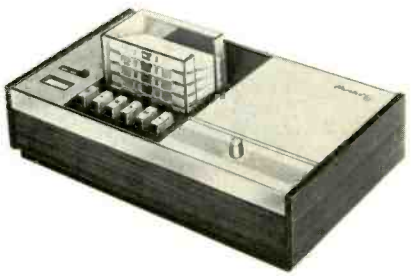
The "Out-Crowd Pleaser."



What's New in Audio

The "Automatics" are here!

Tape recorders which provide automatic changing of playback material, that is. It has been tried before with tape cartridges, of course (3M Wollensak and RCA Victor, for example), but with limited success. But now there's an automatic for tape cassettes, one of the hottest mass-market, recorded-tape formats today. Norelco broke the ice by announcing its Model 2502 auto-



matic stereo-cassette changer playback deck. The industry's first cassette changer accommodates up to six cassettes, providing up to 4½ hours of continuous music.

The cassettes, stacked in a removable sleeve, are successively deposited into play position and, as completed, are stored inside the cabinet. Naturally, the unit automatically shuts off when the last cassette has been played. Features include: pushbutton controls for fast forward and rewind, start, stop, and pause; digital counter, and volume, tone and balance controls. The 2502's low-profile cabinet is teak and brushed chrome. Frequency response is said to be 60 Hz to 10 kHz. Price is about $100. Check 74

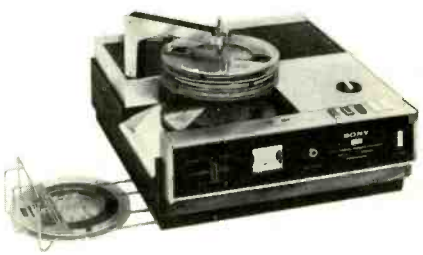
* * *

Automatic changing of cassettes might be considered to be a natural evolution. But an automatic *reel*-changing system isn't. And that's what Superscope revealed recently—a new Sony tape recorder with automatic reel-changing (up to five reels of prerecorded tape).

The new product, Sony Model 760, incorporates a number of engineering innovations: reel-changing mechanism, automatic reel threading, automatic reel reversing, and ejection of the completed reel after both sides have been played. The four-track deck (another model will feature record and playback functions) can handle tape reels from three to seven inches. In addition, reels of different diameter may be intermixed. There are three speeds: 7½, 3¾ and 1⅞ ips.

As you can see in the photo, the 760 bears some family resemblance to an automatic record changer. It's the spindle that does it, allowing up to five reels to be stacked on it. For automatic operation, you merely press one of the unit's solenoid pushbutton controls. The first reel is released from the spindle, automatically threaded, and reversed automatically. The latter facility is accomplished with Sony's E.S.P. electronic sensing system, which does not require metallic sensing tape or recorded subsonic signals on the tape.

During a demonstration, we were mesmerized by the mechanical action that followed completion of a tape. An ejector mechanism slowly rose from



the deck panel, lifting the reel from the playing spindle, tilting it so that it slid gently down a "sliding pond" into a tray built into the side of the recorder. The reel ejector then dropped back into the deck panel, the next reel fell

← Check No. 6 on Reader Service Card

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Our new low-noise tape... is all surprises!

From surprisingly soft to surprisingly loud—new Ampex 404 Series low-noise tape can capture more audio reality than low-noise tapes of the past.

Its new small-particle oxide meets or surpasses the most demanding low-noise specifications. Holds inherent tape noise ("hiss") far below the level of your most delicate musical passage. Yet from this same quiet tape comes *greater high frequency response* and *broader undistorted dynamic range* —qualities previously sacrificed in low-noise tapes. So the silence has more silence. The flute sounds sweeter. *And* the cymbals crash louder, without distortion — on Ampex 404 Series low-noise tape.

Buy the full range of Ampex professional tapes for extra quality: New Ampex 404 Series low-noise tapes for mastering and duplicating. 600 Series for general purpose professional recording. 681 Series lubricated tapes for endless loop cartridges. 291 Series tapes for a/v. Plus others. Send the coupon for up-to-date information.

To: Ampex Corporation, Room 7-14A, Redwood City, California 94063

☐ Send me literature on the full line of Ampex professional tapes, including new 404 Series low-noise tape, for

- ☐ Professional
- ☐ Master
- ☐ Duplicating
- ☐ Other: _____

NAME _____

ORGANIZATION _____

ADDRESS _____

CITY/STATE/ZIP _____

Career opportunities? Write Box D, Redwood City, Calif. 94064.

AMPEX

into position, and the whole sequence started again. Price of the deck is expected to be around $400. Check 75

Wharfedale changes designs

The 1968 line of speaker systems from the Wharfedale Div. of British Industries Corp. has a new appearance. Each model is fashioned as a fine piece of furniture with rich grille cloths and handsome cabinets. Obviously, blending speakers with home decor has become increasingly important as the hi-fi market expands beyond aficionados to the housewife. Removable grilles on each of the six new Achromatic speaker systems to facilitate fabric changes should therefore warm m'lady's heart.

The top model in the new line is the W90D, which divides bass between two 12½ in. woofers, each with a 9½ lb. magnet assembly. One woofer, with a flat polystyrene radiator, couples low bass energy into the room, while the other, with a conical-shaped diaphragm, reproduces upper bass and lower mid-range. Both woofers operate in an acoustic suspension-type enclosure. A pair of 5-in. mid-range speakers and two omnidirectional, mylar-dome pressure tweeters take care of the remainder of the musical spectrum. It's noteworthy that these speakers are acoustically isolated from the bass compartment, and the cabinet employs sand-filled panel construction to dampen enclosure vibration. $294 in oiled-walnut finish; $315 in polished walnut; $279 in sanded birch, the utility model. Check 77

Hallicrafters enters home stereo market

Ask any "ham" and he'll tell you that the Hallicrafters Co. has been specializing in AM and FM communications equipment for years and years. Now, however, they have taken a step into the home entertainment arena with a transistorized stereo FM-AM-Short Wave receiver, Model CR-3000.

The new six-band receiver features an output power rating of 30 Watts (IHF), FM stereo separation of 30 dB minimum. Controls include bass, treble, volume, and balance, a function switch, and a "fine tuning" control for short wave. Other features are: stereo headphone jack, FM stereo indicator lamp, and input jacks for phono (magnetic and ceramic cartridges) and tape. $269; with RSP-1 speaker systems, $389.85. Check 76

New VU-meter panels from Altec Lansing

Three new VU-meter panels for use in sound systems, audio consoles, and recording studios, have been announced by Altec Lansing. They are designed to measure and visually indicate in volume units the input power of an electrical signal made up of speech, music or other complex tones, to a transmitter or transmission line. They employ a zero reference level of one milliwatt.

The Model 9708A panel has one VU meter, 9709A, two VU meters; 9710A, three VU meters. In the 9709A and 9710A panels, controls are ganged together so that all meters will read at the same level. The VU meters feature

very high sensitivity. With 3,600 Ohms series resistance, and 1.228 Volts applied, the VU meter will indicate zero VU or 100%. This represents 4 dB above one milliwatt in 600 Ohms. Check 78

Marantz components are too good for most people.

Are you one of the exceptions? For the most astonishing set of specifications you've ever read, write "Exceptions," Marantz, Inc., 37-04 57th St., Woodside, New York 11377, Department A-17.

marantz
A SUBSIDIARY OF SUPERSCOPE, INC.

The Marantz components illustrated, top to bottom: SLT-12 Straight-Line Tracking Playback System • Model 15 solid-state 120-watt Stereo Power Amplifier • Model 7T solid-state Stereo Pre-amplifier Console • Model 10B Stereo FM Tuner

Tape Guide

HERMAN BURSTEIN

Tape output feed

Q. Can improved results be expected by feeding the signal from a tape playback head directly to the preamplifier of an audio system, rather than from the tape machine's own preamplifier to the audio equipment which follows it? This question presupposes that the preamplifier of the hi-fi system will be of high quality and that the equalization of the preamp tape-head input is correct; and that the connecting cable from the tape head to the preamp is short and avoids hum pickup. My thought is that the less the number of electronic stages involved, the less the noise, distortion, and so on.

A. Whether you go directly from the tape head into the external preamp, or from the tape amplifier into the external preamp, you will be going (ordinarily) through the same number of electronic stages. In the first case, you go from the tape head into a *low-level* input of the external amplifier, which puts the signal through extra stages of amplification (and equalization). In the other case, you go from the tape amplifier into a *high-level* input of the external amplifier, which bypasses extra stages of amplification. Therefore the question boils down to whether the first couple of stages are of higher quality (lower noise and distortion, and more accurate equalization) in the tape amplifier or in the external amplifier. And this of course depends upon the particular tape machine and the particular external amplifier that you have.

Confused by equalization

Q. I am trying to understand the concept of equalization. What is meant by 50-μsec or 100-μsec equalization? What is their relationship to turnover frequency?

A. When a capacitance is charged through a resistance, the time constant is the time in seconds required for the voltage across the capacitance to reach 63.2 per cent of its final value. This time is R in Ohms multiplied by C in Farads, (or R in megohms and C in μF), or simply RC. If C is stated in microfarads (and R in Ohms), the time constant RC is specified in microseconds (μsec).

In an equalization circuit involving a capacitance and a resistance (as is usually the case in audio), the frequency at which there is a significant change in frequency response (bass rise or drop; treble rise or drop) is called the turnover frequency. At this point there is equal voltage across the capacitance and resistance, and frequency response has changed approximately 3 dB. In the first octave beyond the turnover frequency (at twice the frequency if we are talking about treble rise or drop, or at half the frequency if we are talking about bass rise or drop), frequency response changes about 4 dB; in the second octave, about 5 dB; and about 6 dB-per-octave thereafter. Thus the nature of a simple equalization circuit, involving a resistance and a capacitance, can be specified in terms of the turnover frequency.

In this turnover frequency, f is given by the formula $f = 1/(2\ RC)$. Note the appearance of the time constant RC in the formula. If we state C *in* μF and taking π as 3.1416, the formula becomes $f = 159{,}155/(RC)$. Transposing, we can also write: $RC = 159{,}155/f$. Keep in mind that in the last two formulas C is in μF and the time constant is in μsec.

Frequently, the equalization characteristic is stated in terms of the time constant instead of the turnover frequency. To illustrate, we may be told that the bass-boost curve has a time constant of 50 μsec (as in the case of NAB tape playback equalization at 7.5 and 15 ips). To calculate the turnover frequency: $f = 159{,}155/50 = 3180$ *Hz*. Or if we are told that the bass boost has a turnover frequency of *1590* Hz, we can calculate the time constant: $RC = 159{,}155/1590 = 100$ *μsec*.

Now suppose we are told that a bass boost curve has not only a time constant of 50-μsec but also a second time constant of 3180 μsec. This signifies that bass boost does not continue indefinitely as frequency declines, but that bass boost levels out at a second turnover frequency; at this second turnover the bass boost is 3 dB below the maximum boost eventually attained. To calculate the second turnover frequency: $f = 159{,}155/3180 = 50$ *Hz* (as in the case of NAB tape playback equalization).

An equalization curve can have more than two turnover frequencies. Thus the RIAA phono playback curve specifies time constants of 3180, 318, and 75 μsec, corresponding respectively to turnover frequencies of 50, 500, and 2122 Hz. This means that playback equalization consists of bass boost commencing (3 dB up) at 500 Hz and leveling out (3 dB below maximum) at 50 Hz; and of treble drop commencing (3 dB down) at 2122 Hz.

An equalization curve may have just one turnover frequency, provided that the curve consists of a drop (bass or treble). Thus the playback characteristic of an FM receiver is specified as a 75-μsec time constant, or as a turnover frequency of 2122 Hz. That is, the signal originally delivered by the detector of the tuner is subject to a decline reaching 3 dB at 2122 Hz, about 7 dB at 4244 Hz, about 12 dB at 8488 Hz, and so on. (The signal of the FM transmitter is subject to a corresponding *rise;* however, this rise does not continue forever but levels out above the audio range.)

Head life

Q. To extend the life of the heads on my tape recorder, I am contemplating getting a separate transport for playing tapes, and using my present machine only for recording. Would this degrade the sound?

A. Usually the requirements for playback are more exacting than those for recording. Head wear and resultant widening of the gap have a much more disastrous effect in playback (treble loss). Audible noise is produced mostly in playback. Accordingly, if you are not going to use tape machines of equal quality for recording and playback, it may be wisest to use the better machine for playback. (In some machines, however, poor oscillator waveform may produce appreciable noise in recording.)

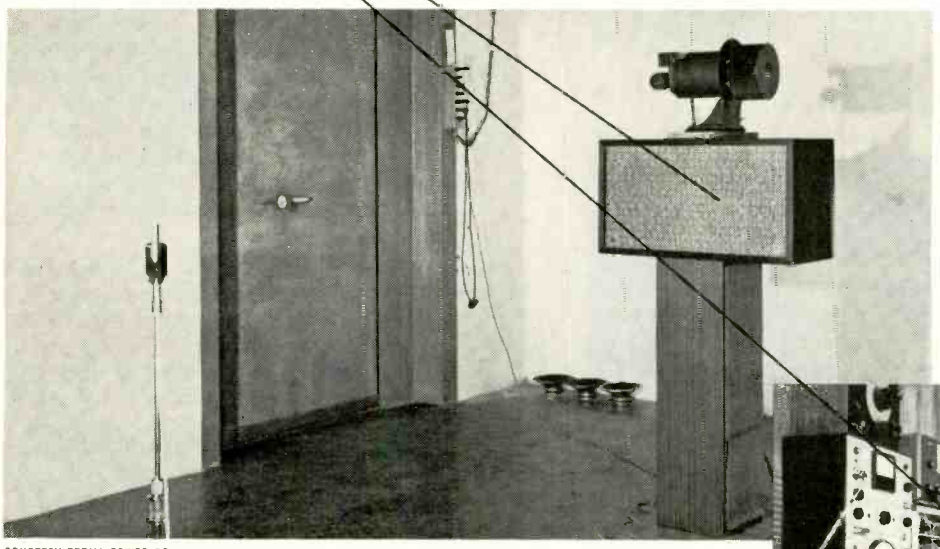
Transistors vs. tubes

Q. Do you believe that, at their present state of development, transistors will give the same performance in tape recorders as do tubes? Since some transistors are notorious for their poor overload characteristics, can they do an adequate job in a tape preamp?

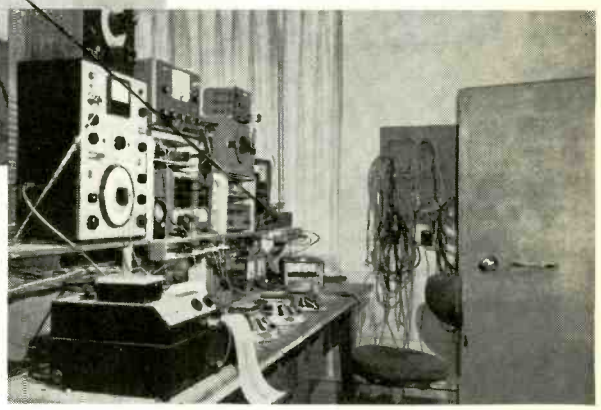
A. Audio transistors finally appear to have arrived at the stage where they give as good performance as tubes, and generally with greater reliability. According to the most recent reviews, transistors may have already outdistanced tubes in terms of low distortion and low noise. On the other hand, if you have to replace a transistor, this is still more of an effort than replacing a tube. There is the problem of obtaining the correct transistor from a store or the manufacturer (perhaps with an appreciable wait in the latter case), and there is the problem of putting it into the circuit (soldering may be required).

(Continued on page 12)

AR INC. *speakers and turntables are used as laboratory measurement standards–*



COURTESY PERMA-POWER CO.



Reverberant test chamber and associated laboratory test bench of the Perma-Power Company of Chicago, manufacturer of instrument amplifiers and sound-reinforcement systems. The AR-2a× speaker on the pedestal is used as a distortion standard to calibrate chamber characteristics. This test facility, described in a recent paper by Daniel Queen in the **Journal of the AES**, employs only laboratory-grade equipment. (Note the AR turntable on the test bench.)

but they were designed for music.

COURTESY WABC-FM

Offices of the Vice President and General Manager, and of the Program Director of radio station WABC-FM in New York City. AR-2a× speakers and AR turntables are used throughout WABC's offices to monitor broadcasts and to check records. WABC executives must hear an accurate version of their broadcast signal; they cannot afford to use reproducing equipment that adds coloration of its own.

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

Check No. 11 on Reader Service Card

3 motors better than 1?

Q. I would appreciate any advice you can give on a machine in the $500 to $700 price range with respect to the advantages of three motors or one motor.

A. In the case of machines intended for home use, it is difficult to state a preference for three motors, two, or one. The dominating factors are quality of design and quality of parts, rather than the number of motors. In machines of professional character, three motors are desirable for greater durability, simplicity, flexibility, and ease of editing; also for faster forward and reverse wind.

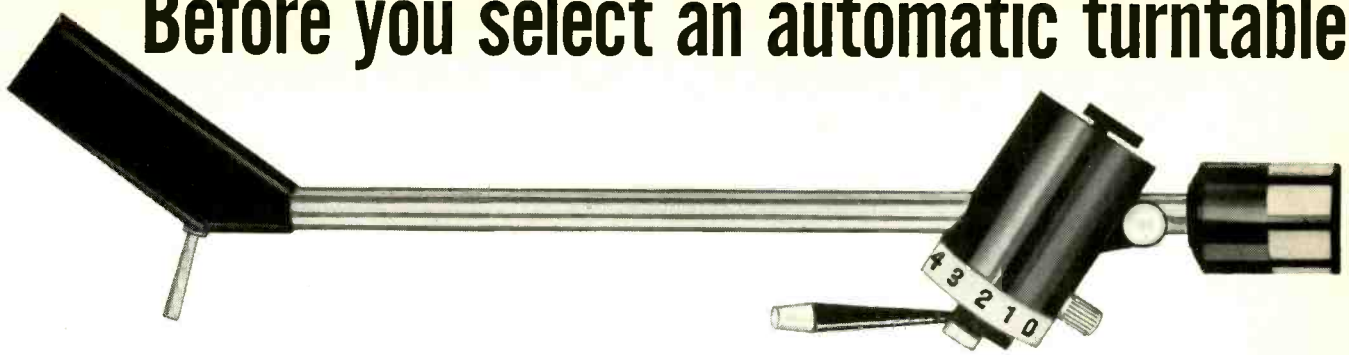
Bird songs

Q. I wonder if you could give me some advice on recording tape. I started recording bird songs in the field about 3 years ago, using 1½-mil low-print-through tape. I changed to ½-mil tensilized tape when a university lab advised this. In March, 1964, I started using 1½-mil high-output-tape. I believe my results have been very good with this tape. Now that low-noise tape is available (1 mil), I wonder if I could get as good results with it or better, compared with the 1½-mil high-output tape.

A professional naturalist advises me that he now uses low-print tapes in the field. My editing is done one to 24 months after recording. I wrote (to one of the tape manufacturers) four weeks ago, but received no answer. I am trying to line up a tape balanced for high output and low print-through. I can stick with 1½-mil tape, but for an air trip, where space could be a factor, the 1-mil tape would be an advantage. Fewer boxes of tape might also be an advantage in going through customs.

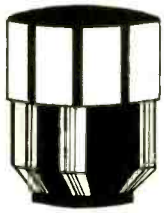
A. The only advice I can offer you is to try different types and brands of tape until you find the one best suited to your special needs. You should take into account that high-output and low print-through—everything else being the same—tend to be conflicting requirements. That is, an improvement in one characteristic tends to entail a sacrifice in the other. I have heard good reports on the new low-noise tapes, and suggest that you try these. In view of the fact that you propose to use 1-mil tape and edit it as much as 24 months later, and taking account of the fact that 1-mil tape tends to have greater print-through than 1½-mil tape, I suggest that to reduce print-through you rewind the tape once or twice before playing it.

Before you select an automatic turntable

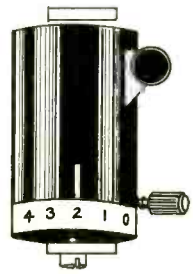


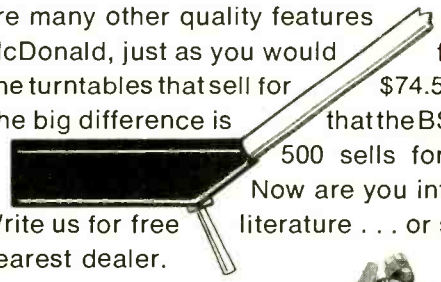
let us arm you with the facts.

Probably the most critical way to evaluate the quality of any changer is by closely inspecting the tone arm and its capabilities. Let's examine



the tone arm of the BSR McDonald 500 automatic turntable. This is the resiliently mounted coarse and fine vernier adjustable counterweight. It counter-balances the tone arm both horizontally and vertically and assures sensitive and accurate tracking. Here you see the micrometer stylus pressure adjustment that permits ⅓ gram settings all the way from 0 to 6 grams. This assures perfect stylus pressure in accordance with cartridge specifications. Here's another unique and valuable feature . . . the cueing and pause control lever that lets you select the exact band on the record, without fear of ever damaging the record or the cartridge. It even permits pausing at any point and then gently floats the tone arm down into the very same groove! Whenever the turntable is in the "off" position the arm automatically returns and securely locks in this cradle to protect it and keep it from movement. This is the low-mass tubular aluminum pick-up arm . . . perfectly counter-balanced both horizontally and vertically to make it less susceptible to external shock. Of course, there are many other quality features on the BSR McDonald, just as you would find on other fine turntables that sell for $74.50 and higher. The big difference is that the BSR McDonald 500 sells for much less. Now are you interested? . . . Write us for free literature . . . or see it at your nearest dealer.





BSR McDONALD 500

Precision crafted in Great Britain
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AUDIO ETC.

EDWARD TATNALL CANBY

LAST MONTH WE wrote about Mr. Cristofv, the man who added the interesting information that we human animals thrive in this outdoor positive electrical environment. Might have guessed it. We also thrive in the atmosphere's special range of pressure, temperature and blend of gases, oxygen much diluted in nitrogen. Evolution at work, obviously. The animal adapts itself, over millennia, to its special environment. Including positive air charges.

It's not surprising, then (if you follow me), that as Cristofv first pointed out, abnormal charges in the air seriously bother us. Shouldn't they, after all? Just as an abnormal stuffiness in an enclosed room, an excess of carbon dioxide and a diminishing supply of oxygen, cause us to run to open a window and let in the pure, normal, life-promoting outside air. (Pollution? Let's by-pass *that* problem.)

With the influx of fresh air, we can now suppose, comes a lively supply of positive charge in the form of ionized gas particles. Health giving! That's how it feels, doesn't it? You are invigorated by the outside air. Now you know a better reason why.

Now here we come to an electrical crux. Enclosed spaces, especially metallic ones like the insides of cars, planes, even steel buildings, tend to develop separate air-charges of their own. That's because they are Faraday cages.

Faraday

Remember? Faraday found that an electrical charge, however strong, tends to remain on the outer surface of a conductor, solid or hollow. (Communications note: the coaxial cable. Also the r.f. waveguide, an oddly similar principle.) If you are inside, and surrounded, your insulation is complete. A plane or a car may be charged by lightning or a fallen power line to fabulous levels; as long as you stay inside your Faraday cage you are OK. Stick a finger outside and you're fried. A charge busts loose via finger.

As a matter of fact, if I remember rightly, this general principle had been discovered long before in connection with static charges using such electrical oddities as wooden cubes. A hollow oaken cube was proved to act identically with a solid cube of the same size with respect to electrical behaviour. (Note that the high-voltage, very low-amperage discharge currents of those days could be handled by all sorts of odd media. "Wires" were often of twine or wood, charge holders were of glass, wood, resin, etc., all excellent non-conductors.)

Next. Inside a car body, or a plane, inside steel framed building, there tends to develop a *negative* charge, neatly separated from the outside positive charge by the Faraday cage principle. The outside charge goes 'round and 'round and can't get in.

People inside these cages thus tend to operate poorly. Since we live in cages most of the time, this is serious. And since we not only live but must *perform* inside them, things are even more serious. Worst of all—we must *fight* inside Faraday cages. Military significance. It was there that M. Cristofv's theory really took off. In Germany.

Fortunately, the war was over before anything came of it. Not long afterwards, about when the German V-2 engineers were coming over here, Mr. Cristofv came too. Now, he was on our side, just in time to get down to work. . . .

Why a *negative* charge inside these cages? A blank in my mind is partially filled up by the explanation that it gets there due to the old-fashioned static generation process, rubbing of one material against another. Say a plastic seat cover against a cloth-covered human bottom. In the Seventeenth century they already knew that some rubbed materials produce one kind of electricity, others produce a different kind; the *other* kind. Do we always generate *negative* charges in our enclosed air spaces? Well, so it seems. Too often for comfort.

Uh-uh. More trouble. Remember that to "generate" a charge actually means to *separate* charges, pushing them electrically apart, storing one in a capacitor, drawing off another, perhaps, to ground. (Just try two Vandegraff charge machines working oppositely and see how nicely you can *separate* charges, up to enormous opposite voltages.) Now if you develop a negative charge in your enclosed space, where does the positive go? Gotta go somewhere. Otherwise how would you have that excess of negative ions (free electrons)? There you are, say, sitting on your backside in your car and charging things up. I ask you, what happens to the separated positive ions of your fanny-charge? This for the moment has me stumped.

Anyhow, theory or no theory, it does happen. Serious negative charges do build up in the inside air. And Faraday keeps the outside positive charge away. Hence, poor concentration, low spirits, quick fatigue for the human inhabitants.

How can we create a positive charge, instead? That's obviously what Cristofv had in mind from the beginning. He worked on the problem for a good long while—for us, luckily.

Black Box

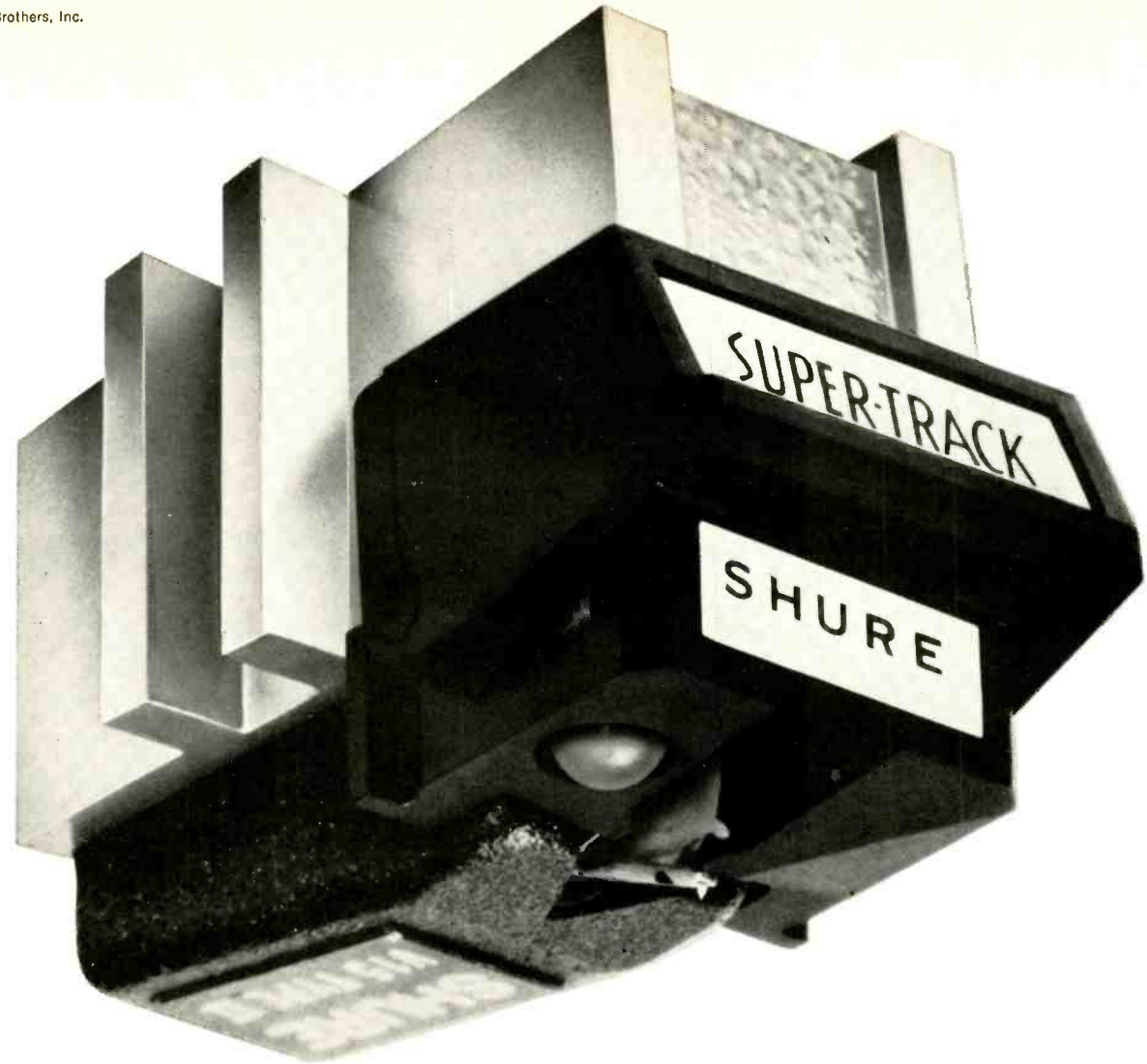
Let's skip. Since the late 1950s Cristofv has had his black box. Plug it in and out pours a cloud of positive charge, i.e., ionized air. (The box sends the negative ions back down the power line.) It was the answer! That black box has been used for years, secretly, in our military planes and elsewhere in enclosed military spaces. Get that, my friends! That's where the security came in. Though no longer. The box also went up with a couple of astronauts. Dunno if it invigorated them or not, but it could have.

Eventually, the big secret lost potential, until it was no longer worth secreting. Now, the black box is on the civilian market in Europe, manufactured in, you guessed it, Germany. It's soon going to be on sale here in the U. S. too, since the security wraps are now put away and, more important, Cristofv has got his U. S. patent firmly in hand. All this just recently, and you've probably read about it in the news media. So, one of these days, you'll plug in a black box of your own and start accentuating the positive in your private Faraday cage.

It'll cost you more than a hundred dollars for that little stream of positive ions, but it could be worth it to you, especially in a business, a school, or a laboratory, where productiveness depends on human efficiency.

I'm not clear as to whether a battery-

(Continued on page 16)



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World-wide, critics say that all of your recordings will sound better and last longer when played with the revolutionary Shure V-15 Type II Super-Trackability phono cartridge.

Independent testing organizations say it is alone in its ability to track passages which have been cut at a sufficiently high recording velocity to insure precise and definitive intonation, full dynamic range, and optimum signal-to-noise ratio . . . at one gram (or less) force!

WRITE FOR COMPLETE LITERATURE, or send $3.95 for the definitive Shure trackability test record "An Audio Obstacle Course". (Record is free with a V-15 Type II.) Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Illinois 60204.

AUDIO ETC.

(Continued from page 14)

powered model is in the offing for cars, but it'd be a pretty fancy kind of positive charge to acquire when all you have to do is open the ventilator and let in a blast of free charge from the outside air. (Except, of course, just before a thunderstorm, when the air tends to go violently negative in charge. Ever notice how unhappy and restless you feel at such moments?)

How does the Cristofv black box operate? Well, of course, it separates charges, and drains off the negative part, releasing a gentle waft of positive-charged air. It's just a little box, too, and it will charge up a surprisingly big space, they say.

Alpha, Beta, Gamma

The principle is quite easy to follow, now that we have gone into this ion biz. You start with a bit of radioactive material (it lasts for years), giving off assorted radiations in a small way. Obviously nothing large-scale. You project these through a negatively charged grid or screen.

Now see if I can get this right. Alpha particles are helium protons, the positive half of that noble gas. So the alpha radiation is picked up by the charged screen. Good bye. (They neutralize some bit of negative power back in the public utility powerhouse, causing a mite of current flow and a bit more oil to be burnt up, and an oil tanker, somewhere, to move forward a billionth of an inch on its way to refuel the powerhouse tanks.)

Gamma radiation isn't particles at all; it's electromagnetic radiation pure and simple. Being of short wavelength and, we presume, not very potent here, it is dissipated quickly within a brief distance, presumably separating a few particles and charges here and there on a sub-atomic scale. Transfer of energy.

Beta radiation is negative. This radiation (very high voltage, I suppose) bangs into neutral air molecules and, er . . . separates the charges. The negative halves, lightweight free electrons, zoom up to a charged positive anode somewhere in the room and depart from the scene. (They by-pass that negative screen, I gather, because they aren't created until after the negative betas have got safely past it.)

The positive halves, much heavier gas ions, remain in the air as an excess positive charge. Happy days!

(I still can't quite see why the negative ions that were hanging around in the first place, and caused all the trouble, shouldn't just drain away via this same positive anode without all this fancy radiation stuff. But then I always was a bit dense on these matters and I must be wrong. Or else Cristofv and the U.S. Army are wrong.)

Ion Tweeter

Loudspeaker? Oh yes, that.

My original article, 'way back, was about a fabulous tweeter without solid moving parts, its sound created entirely via an ionized-gas discharge of signal voltage through excited air, the sound coming directly from the motion of the air itself. No cones, domes, diaphragms, no electrofoils. Just air. Because it had no moving solid mass, this tweeter—other things being equal—produced the very finest sound of all, virtually perfect. The sound waves were electrically induced in the air itself, straight from the signal. A marvelous idea, I thought, and readers' comments have confirmed me, on and off, over the last years.

That tweeter was the well-known Ionovac, introduced in the U.S. by DuKane and, if I am right, now no longer in production though some brand-new units evidently are still being sold. The Ionovac, I learned, derived from a European patent structure, the original inventor being a M. Siegfried Klein of Paris, France (nice old French name, that one). Via a British patent, the same tweeter is made in England by Fane Acoustics, Ltd. under the name Ionofane. The Ionofane is now being actively imported into the U.S. by Ercona Corp. of New York (Leak, et al.)—so we're back in business.

I didn't even know of the Ionofane until this article was under way. By the looks of it, the British tweeter is the Ionovac under another name, or vice versa. In principle, anyway.

However, I toss this official info into the pot just to keep you up to date and, maybe, more confused than ever. The Ionofane-Ionovac operates via a 27 mHz oscillator-produced high-voltage circuit across an air gap in a quartz cell. (The cell wears out in time. Guarantee or warranty is 1200 hours or 1 year, whichever comes first. Sort of a take-off on Detroit's goings-on.) The oscillator output is signal-modulated. The signal varies, "causing the volume of ionisation (British spelling) to vary in exact proportion" within the air gap. This, it says, causes pressure waves which "are converted into sound by an exponential horn."

Uh-uh. Please, Mister Ionofane, tell us how it really is. Did you ever hear of a horn that *converts pressure waves*

(Continued on page 18)

Letters from Readers

Hungarian broadcaster worked for Edison

■ Your article on *Musical Broadcasting in the 19th Century* brought nostalgic feelings to me.

I lived in Budapest, Hungary in the 1920's and was well acquainted with the Telefón-Hirmondó at that time. It brought to our home daily news, live transmissions of the National Theatre and State Opera with performances by such artists as Amelita Galli-Curci (unfortunately she did not make a hit with the sophisticated Hungarian public and she cancelled the rest of her intended come-back concert tour of Europe), Caruso, Beniamino Gigli, Richard Tauber and many other artists as well. These performances had to be listened to with earphones. I remember the thrill my family and, needless to say, I got when as a teen-ager I built one of my first amplifiers and hooked up the output to a loudspeaker. Most Hungarians had never heard at that time a wireless broadcast, nor had they experience with amplifiers and loudspeakers. My latch-up, while definitely against the law, was quite a sensation among our friends who would invite themselves to our home to hear this unique set-up.

I want to make a small correction in the spelling of the name of the originator of this system. You have him as Theodore Buschgasch, whereas his name is really spelled Puskás (pronounced Pooshkosh). He worked under Edison for a while and then came back to Budapest to start his news-telling (Hirmondó) station.

ROBERT AUGENFELD, M.D.
College Point, N. Y.

Listening room dimensions

■ I read a few years ago that the ideal dimensions for a listening room are L = 1.6 of the height and W = 1.25 of the height. Have you any experience in this area? I am thinking of adding on a family room.

JERRY D. SWEARINGEN
Gainesville, Fla.

Resonances are most evenly distributed when room dimensions approximate the ratios mentioned.—Ed.

Ten reasons why Altec shouldn't sell its new condenser microphone systems for $198.00...

1. Your choice: AC or DC, Cardioid or Omnidirectional—Order the system you need now and expand by adding the appropriate extra mike or supply at any later time. Get any combination by simply switching microphones and/or power supplies. Model designations: M49—AC/cardioid; M50—DC/cardioid; M51—AC/omnidirectional; M52—DC/omnidirectional.

2. Frequency response from 20 to 20,000 Hz—This is with an essentially flat curve. Output level is—53 dBm re 10 dynes/cm², with balanced system output.

3. Extremely small diaphragm—Under 0.5" in diameter. HF dropoff for sound waves arriving at random, non-perpendicular angles of incidence will occur only at frequencies above 20,000 Hz. All Altec condenser microphones contain diaphragms small enough to insure that HF dropoff does not occur within the usable frequency range.

4. 100% solid-state circuitry—The 195A base utilizes an FET as an emitter follower and also contains a 3-pin XLR-12 connector. No RF or balanced-bridge critical adjustments are used. The FET drops the extremely high impedance of the microphone to an impedance suitable for connection to a shielded 2-conductor standard cable. Power is simplexed over this same cable. The separate power supply provides balanced outputs for standard 150/250-ohm microphone preamp inputs.

5. Small, light power supply—About the size of two back-to-back packs of cigarettes, both the DC and the AC supplies provide ruggedness for long-term heavy duty combined with small size and light weight for new ease in handling. Finish is hard chrome.

6. Long-life DC battery operation—Two mercury batteries provide 2500 operational hours, up to a year in normal use. A convenient meter on the supply shows battery condition. Battery drain is prevented when system is not in use by unplugging the 195A base or by operating a recessed switch on the supply housing.

7. Many accessories are standard—With each system a wind/pop screen; microphone holder; and a 25-foot, 2-wire, shielded cable are provided at no additional cost. Connectors and mounting hardware are attached.

8. High-temperature ambient permissible — The systems will operate in an ambient up to 55° maximum (131°F).

9. Exclusive Altec exchange policy—After expiration of the normal full year guarantee, Altec will accept an inoperative microphone in exchange for a comparable new unit at a fraction of original cost. This policy is unique in the industry.

10. Microphone is unusually small and light—This feature—microphone and base are 3½" L x ¾" Diam.; weight 2.2 oz.—designed as a means of eliminating the cumbersome size, bulky shape, and heavy weight of older style microphones.

* Extra High Sensitivity Models: Extremely high sensitivity (45 dBm re 10 dynes/cm²) with unusually high signal-to-noise ratio. Designed specifically for use where microphone must be placed at some distance from performers (such as suspended over stage, orchestra pit, or audience, or in footlights). Identical to M51 and M52 systems in other respects, the M251 is for AC operation; M252 for DC. Both are omnidirectional. Price per system: $216.

And one reason why it can.

How Altec can offer you these superb systems at only $198 per—Part of the reason is that they're entirely American-made at our Anaheim plant. No import duties or importer profits to pay. Another part is that we know how to build studio mikes. We should—we've been doing it for nearly 30 years! (For example, remember the 21B and M-11?)

Send your inquiry today for complete technical information. We'll include a recent article on the values of big vs. little condenser microphones written by Alex Badmaieff, our chief engineer of transducers. Also our colorful new 1967 Stereo Components Catalog, just in case you're interested.

ALTEC LANSING

A Division of LTV Ling Altec, Inc., Anaheim, California

AUDIO ETC.

(Continued from page 16)

in air into sound? The pressure waves already *are* sound. The horn just couples the pressure waves to the outside air with maximum efficiency and thereby propagates the signal to your listening ears. Yes? (Boy, do people get into trouble easily in this kind of write-up! Me, too, most likely.) Let's keep our transducers in the right places if we can.

But let all this pass for the moment. What in Heaven's name has this got to do with Cristjo Cristofv and the black box that . . . *Wow! Of course!*

Ionized air. Now you see where my nasty little mind began, 'way back in that earlier article. How about an ion *health* tweeter? Ah, but what type of ions does the tweeter produce? Positive or negative? That stopped me. I didn't know, nor could anyone tell me. Wouldn't it be sad if this tweeter produced the wrong kind? A health hazard indeed.

Well, now I know. First, a high-voltage electric potential ionizes a gas—any gas—by stripping off outer electrons. The gas then conducts, the electrons flow. An ion lacking an electron is thus positive in charge. One correspondent on this subject went to his library for me and looked it all up; yes, he writes, the books say that *all* gas discharges produce positive ionization. Of course! The negative part is the current itself. Flowing electrons.

So, then, the fabulous ionized-gas tweeter *must* produce positive ions. It's a Cristofv-type health tweeter, by golly. Heavenly days! Just plug it in and enjoy a double stream of bliss—super-hi-fi sound and a soothing envigorating bath of ions. The right kind of ions.

Turn the idea around, maybe, and feed your hi-fi signal line into a Cristofv black box—maybe to that negatively charged screen. Then Mr. Cristofv, to his utter surprise, will find himself in the hi-fi business.

You know, I keep having uneasy dreams about those ions. I mutter away to myself—positive, negative, positive, negative, *which was it?* And I seem to think, in my dream, that, of course, the *negative* ions are the healthy ones.

Now wouldn't it be dreadful if this were actually so. If my dream were right, then this article would be horribly, horribly wrong. But then again, so would *Business Week.*

Wake up, Canby! I said it was positive, POSITIVE. I'm absolutely positive about it.

* * *

The Ionofane tweeter arrived for my inspection, conveniently shipped to me as part of a full-range speaker system in a handsome cabinet. Alas, just then, Mother Nature decided it was time for my Annual Virus. So my hi-fi enthusiasm dropped 95 percent and my ears heard no tweeters at all, for days. When I summoned the energy to heft that cabinet onto the back seat of my VW to take out to my country listening place it was almost the day before yesterday. And my Best Assistant had gone away out of town. I needed him.

Even so, with all my fifteen thumbs, I did hear the Ionofane sound, even though it took me an unconscionable and disgraceful amount of time before I had plowed through the preliminaries and got the Ionofane rolling. I am dense when it comes to simple instructions, I guess.

Anyhow, the thing works—blue glow and all—and then some. Super-quality sound does indeed materialize, loudly, out of nothing but thin, blue air, conducting air, modulated air, producing its own vibrations without diaphragm, cone, dome or any other solid moving part. Amazing! And apparently it transduces highs (3,500 upwards) with, to my ears, virtually no distortion. 3 kcs to 50 kcs ±2 dB, says the literature.

My trouble was that the Model 604 Ionofane, rushed to me as a courtesy, is not precisely one of the models now being imported into this country by Ercona of New York, though it is only mildly different. (It was of a size that would fit into my VW. Good reason.) Ercona has a bigger full-range unit with a 15-inch woofer (mine is 12-inch) called the Model 603, all ready for you. And there's a handy mid-range-plus-tweeter system in a small cabinet, too, with a three-way crossover built in, neatly designed to go with an existing bass system. That's the Model 602. And of course there's the basic Ionofane tweeter itself, available separately as the Model 601. Three excellent choices for the U. S. market. Ercona supplies plans for building a system patterned from the Model 604, however.

Now these are all basically the same, varying only in associated cabinetry and speakery, and my Model 604 was merely one more variant. But as a non-import model, it came to me with the original British layout and instructions, though properly equipped with U. S. plug, for 110 volts, 60 Hz. The instructions were English—I mean British. So were the assorted knobs, screws, bumps, protuberances, etc., all British-style and unfamiliar to me. In no time I was confused.

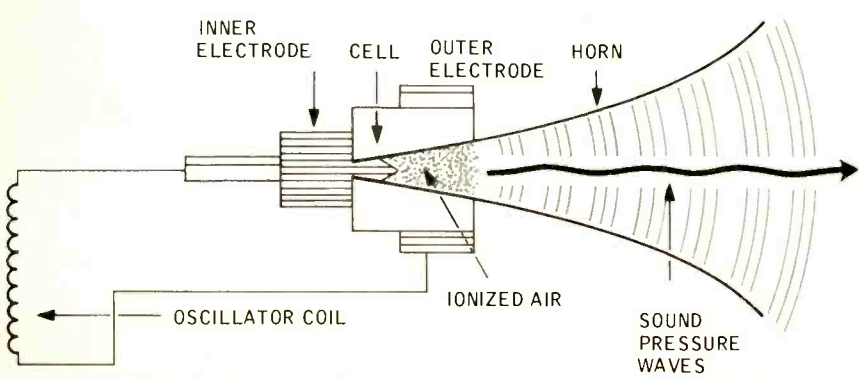
I'd like to recount for you exactly how I flubbed my way through, so you'll appreciate the sort of minor but vital problems we face when we start importing goods for domestication hereabouts. Many an importer will know what I mean! Frustrating, sometimes.

Light Bulb Test

Well, first, there was the power supply. The Ionofane has one, for the oscillator-modulator circuit. I started right away to plug it into the wall socket, just to see that famous blue glow begin—but my wary eye fell on a ground wire, protruding from the plug. Instantly dozens of bright red flags went up in my head. STOP! Some readers may recall that on two occasions I have managed to burn up expensive equipment merely by plugging it in wrong way 'round. 117 volts, full line a.c. on the chassis, and on the "ground" lead of the signal cables. It can happen, though it shouldn't.

So I got out my neon test light, plugged in the Ionofane and gingerly tried that ground wire through it, touching the center screw on my dual wall socket. Phew! Bright red light.

Drawing illustrates how ionic speaker operates.



(Continued on page 21)

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(Continued from page 18)

Lucky I tried. I reversed the plug and there was only an intermittent flicker in the neon, a minor leakage. O.K. But before going further and hooking myself and the Ionofane into my general system (of many chassis) right way around, I got out my little voltmeter, just to see what was what. Wow! When the plug was in wrong there was indeed 117 volts on the ground wire. That looked bad—but I was off the beam again. I tried my Ultimate Test (and a good one): an electric light bulb. If that bulb were to light up, we would have real trouble. A hot ground.

The bulb didn't light. The 117 volts went right through it, still reading full strength on the meter. So all was O.K. Ionofane *was* isolated, just as I thought it really must be. Still — very much worth a try. In fact, I recommend this sort of grounding test for *all* new equipment in your system, just to be absolutely sure.

So, marking the plug with tape for correct polarization, I boldly plugged it in and fastened the ground wire to the wall socket screw. (The directions said *"Ensure that the Earth lead of the Ionofane mains cable is connected to the earth lead of the mains supply."*) All well. No fireworks. I felt a bit silly. John D. Public at his most cautious.

It takes a half minute for the air to ionise (British spelling) in the tweeter and there's supposed to be a slight "singing noise" for a few moments. My stopped-up ears missed it. Supersonic. However, there was a fat, healthy 60 Hz power supply hum that told me the thing was on, and a pleasant warmth began to exude. Lo and behold—suddenly the purple-blue glow appeared. I could see it right through the grille cloth and in the rear as well. Now to apply the signal. A few minor matters to clear up on the way, though.

Impedance. My other speaker was 4 ohms. My stereo amplifier adjusted for either 4 or 8 ohms. The Ionofane asked for 15 ohms, Resistive. Ah well, a minor mismatch, maybe. International-type. So I set things for 8 ohms and hoped it would be O.K. with Ionofane. It seemed so.

Phasing. That was easy. I pulled out my still-useful extension phasing switch, permanently attached to my speaker line, and walked out to the center of my listening area, where I switched back and forth. I had guessed wrong, natch. Easily fixed; just reverse the leads. But one item in the instructions made me jump: *". . . The phasing of the Ionofane with the bass speaker is of no importance when using a cross-over of 3,500 c.p.s."* Is that right? Complex phasing thoughts rushed through my head for a moment, then I made a mental note to check this with Ben Bauer of CBS Laboratories, a super phasing expert. No importance in stereo? Could be. Maybe they're right.

So—with signal feeding in, I was off. Splendid! The Ionofane puts out a remarkably potent sound, diaphragm or no diaphragm. Really loud, and nicely spread out sidewise.

Too loud, in fact. The over-all balance with my other speaker was fine, but the Ionofane tweeter was very much louder than those in my companion speaker (high and mid-range), even turned up to their maximum. Have to cut it down. Ought to be simple; the Ionofane, it said in the instructions, is provided with the proper control. *"Adjust the sensitivity control on the power pack to balance the sensitivity of the Ionofane with the sensitivity of your bass speaker and to compensate for room acoustics."* Clear enough, if linguistically a bit redundant. Now was when I began to flounder.

Level Set

First, I looked at the photo in the Directions, shhowing the tweeter unit standing next to the small power supply box. No level set in sight. There was a black knob on the side. A fuse? Plus two screws on a black plate, looking very much like signal connections. That was all.

I took off the back panel, and there was the box all right; but it wasn't quite the same. *Three* thingumajigs on the black plate. Two holes and another small knob. And various unidentified screws here and there on the top—not in the photo. Heavens—there must be a volume control somewhere?

I turned the second knob, the first looking fuse-like. It unscrewed, quite a way, then there was a bit of a flash—oops! I get it. That's the European voltage-choice system. You screw the little knob into the hole marked for the right voltage. 110, 125, 220. Mine was in the 110 position. (There were markings, partially hidden by the case.)

So I tried a prominent screw on top that looked as if it might be one of those adjustable screwdriver level sets. But no. It screwed, too. Clockwise a half turn and the blue glow switched off. No sound. Counter-clockwise and it came back on; but there was no diminution of the sound. Still loud.

Now what had I gone and done? The "sensitivity" control must be somewhere on the darned thing. Was I blind? So, getting agitated, I tried the knob that looked like a fuse. I turned it gingerly. It unscrewed. (Our fuses are bayonet-type, and larger.) I kept unscrewing, counter-clockwise. Suddenly, out fell *half* of a very small glass fuse, obviously blown. The metal cap from one end was still inside the knob in my hand. I almost fell over. Because the Ionofane was still playing! Loud and clear. Just as loud as ever. Was I hearing ghosts?

So I put the broken fuse back in—why not?—and tried a few more screws. Then the Ionofane tweeter quit. Blue light sputtered as I rocked it a bit (it was slightly loose in its mounting) and then went out. Power supply still on, and humming. Woofer was well. No sound in the tweeter. This was getting nutty. I decided it was time to quit this Saturday-night fantasy world and get some rest. I shut up shop and went to bed.

Sunday Morning

Hah! A fine Sunday morning and I felt much better. The virus was cowed and I was on the mend at last. So I went back to work, plugged the polarized plug back in again and started to re-connect that ground wire.

The tweeter was still silent. And this time the power supply wasn't humming either. Dead. Only the woofer woofed.

Well of course, what did I expect—in the broad light of day? After all, there was a blown fuse in there. But why had the thing operated fuseless the night before? *Or had it?* I began to wonder just how sick I'd been with that virus.

* * * *

Well, I can't replace the fuse now, since it's the wrong kind, British-type. And I haven't yet got the nerve to stick in a piece of solder. So I guess I'll wait for my Best Assistant to come back, in a day or so. And I know exactly what will happen.

In thirty seconds flat he'll say, look, you Dope (he's not exactly tactful), here's the level-set, right under your nose. Just turn it, like this, see? And out will pour the loveliest highs you ever can imagine, perfectly balanced against those of my other speaker in gorgeous, absolutely undistorted stereo. I'm looking forward to it. I can take it. I often have. John D. Public himself.

Hey, better rush out and get yourself a Model 603, or a 602, or a 601, all fixed up for the American market. You can't get my 604. Æ

EDITOR'S REVIEW

Consumer Reports Strikes Again

Consumer Reports holds great power. It reaches millions of people, many of whom look upon it as the arbiter of what to buy and what not to buy. So a report on high-fidelity component equipment in its pages (July issue) was of great interest. We cannot agree or disagree with the comparative ratings of 18 stereo receivers covered in the report. In the past, however, *CR* reports have been found to be erratic. Judged by specialists, some were on-the-head, others were beyond comprehension. Findings have been vociferously disputed.

Comparing one product with another always introduces the possibility of errors due to personal judgements, not to mention arbitrary test procedures (nowadays *CR* lists some test procedures used to examine hi-fi equipment).

Without being picayune, we detect some serious shortcomings in *CR*'s reports on hi-fi equipment. For example, we can quickly count 10 hi-fi manufacturers whose products were not represented in the tests; similarly, countless models were omitted. Further, prices of receivers examined ranged from $219.95 to $499, with a mean average of $309. Isn't it unreasonable to compare a very limited number of models, in widely divergent price categories? Following this approach, *CR* would rate Ford Falcons, Chrysler New Yorkers and Volkswagens against each other, while ignoring Chevrolets, Cadillacs, and other automobiles. Naturally, they don't follow this practice when it comes to automobiles.

CR admits to heavily weighting amplifier frequency response over other characteristics. "We gave a heavy weight to smoothness in frequency response in evaluating amplifiers, because we believe that this characteristic has a primary effect on the tone quality," *CR* says. Yet they kept their test signal low enough to produce only ⅛-Watt amplifier output "to avoid any disturbing effects from distortion . . ."

CR believes that the Institute of High Fidelity (IHF) measurement of power "using transient signals that don't stress the power supply, is misleading because a lot of music is steady state. . . ."

For *Consumer Report's* information, the IHF standard of measurement for audio amplifiers clearly calls for dynamic *and* continuous output tests: ". . . Measurements of continuous output and dynamic output of each channel of amplification shall be made as per sections 3.1.1 and 3.1.2. . . . The results of the sets of measurements resulting in the lowest output per channel shall be rated output. . . ." And supply voltages *are* taken into account, as any careful reader of the IHF standard (introduced in 1966) is quick to learn.

No standard of measurement should be insulated beyond criticism, of course. But *CR* is hardly the one to toss stones in light of the questionable test methods they practice; methods that, by their own admission, allow for personal decisions concerning points at which distortion becomes irritating.

Dolby Move Over

The audio noise-reduction system developed by Dolby Laboratories doesn't have the field to itself. There's some stiff competition around. For example, the West German EMT organization has had a noise-reduction system which operates with automatic electronic circuitry for a few years. And Ampex has developed a process called, EX+, which is said to substantially reduce background noise during tape playback. As much as 50%, it is claimed. In fact, they have announced an initial production of 15 recorded tapes which use the EX+ process, including the following labels: Archive, D. G. G., London, Mercury, Philips, and Vanguard. So the race is on.

Cartridge Tape Sales Grow Like Topsy

Cartridge tapes for automobile and home use are expected to account for approximately 65% of the stereo tape business in 1967, says Don Hall of Ampex Stereo. In an estimated $100 million market, that's quite a slice of the pie for the resurgent medium. Four-track cartridge tapes have been around for many years, of course, with Viking believed to be the first equipment producer. Muntz' promotional efforts in recent years, however, pushed the tapes and playback equipment into the winner's circle. And now eight-track cartridge tapes, getting the nod from auto manufacturers and recording companies, promise to exceed four-track cartridge tape sales. Add to this the mushrooming cassette business and we can well believe the forecast.

Examining titles of cartridge tape albums produced this year, we find classical music notable by its relative absence. Pop is king here, it seems. Even reel-to-reel recorded tapes appear to have risen to the challenge by producing more and more popular music in contrast to less classical releases.

Fortunately for audio buffs, classical music can always be recorded from hi-fi stereo FM tuners, supplementing whatever is missing in recorded tape catalogs.

A.P.S.

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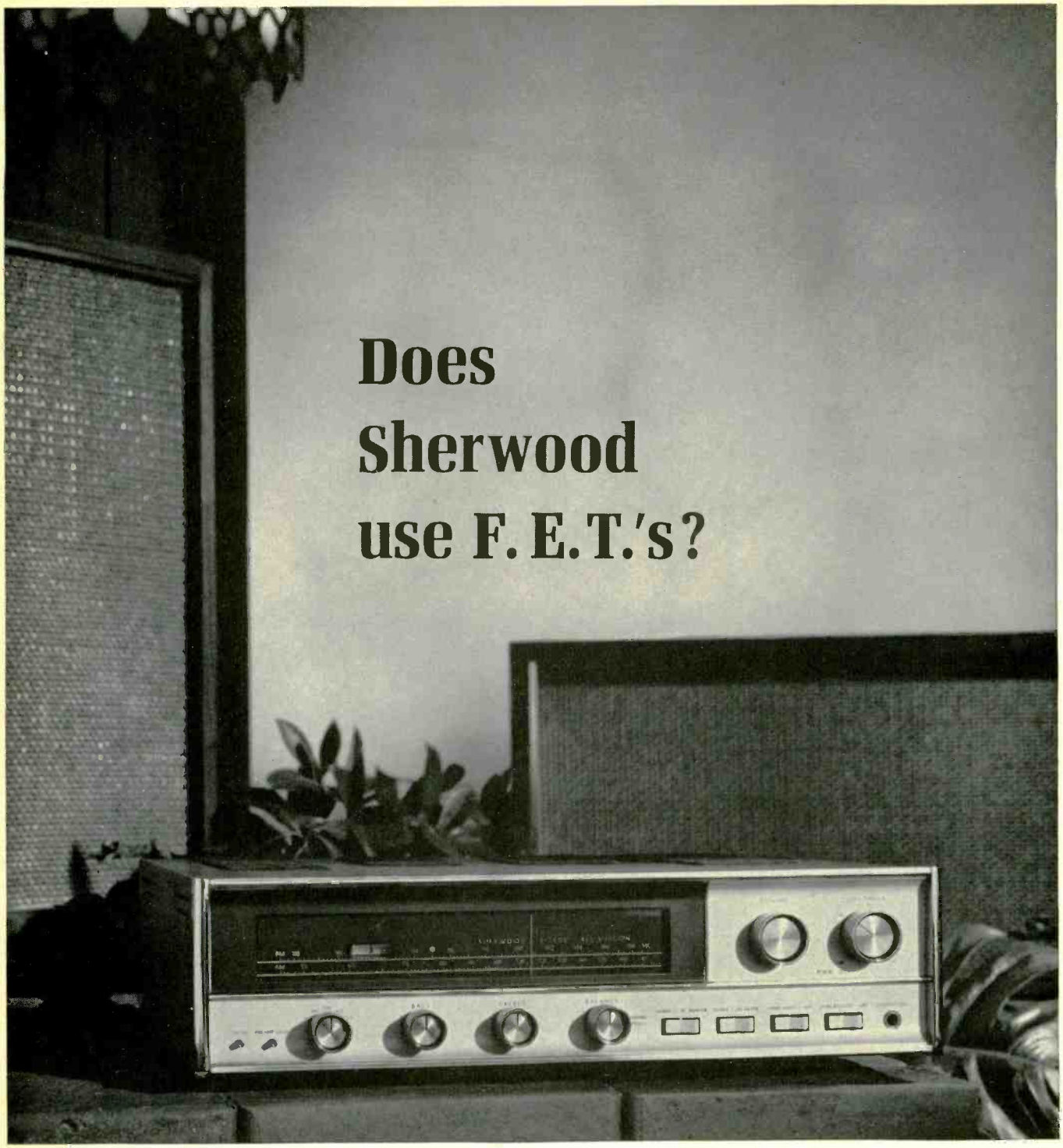

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Sherwood

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Improve tape recording quality with the transistorized limiter described here. Full construction plans plus details on how the device works are included.

Build a Solid-State Stereo Limiter

WAYNE B. DENNY

IF YOU'VE DONE any serious "live" tape recording, you know that it is best to record at the highest level possible before distortion occurs. In this way, you achieve your best signal-to-noise ratio.

But watching your VU meter or "magic eye" to avoid sustained or momentary peaks which can drive an amplifier and/or magnetic tape into distortion is often an unrewarding job. An easier way is to employ a limiter amplifier to do the task efficiently and accurately.

As the name implies, a limiter simply limits the amount of signal going to a recorder's inputs. An outboard limiter, the construction project we will discuss in this article, is placed between microphone(s) and a recorder's input(s), as shown in *Fig.* 1. Here, it acts to clip an excessively strong signal peak, symmetrically, to avoid overdriving an amplifier or otherwise causing distortion.

The stereo limiter discussed here is shown, completed, in *Fig.* 2.

The "heart" of the limiter to be described is a Raytheon "Rayistor." This device (two are used for stereophonic purposes) is a combination light source and photo-resistive element packaged in a transistor-sized capsule. The more current coursing through the light source, the *lower* the resistance of the photo-sensitive element. Looking at the simplified drawing in *Fig.* 3, note that increased current (stronger signal) will result in more current fed back

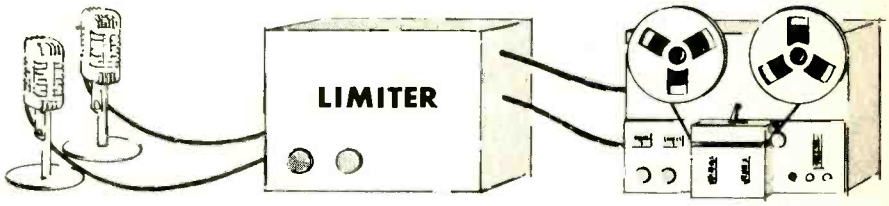


Fig. 1—Limiter setup during tape recording session.

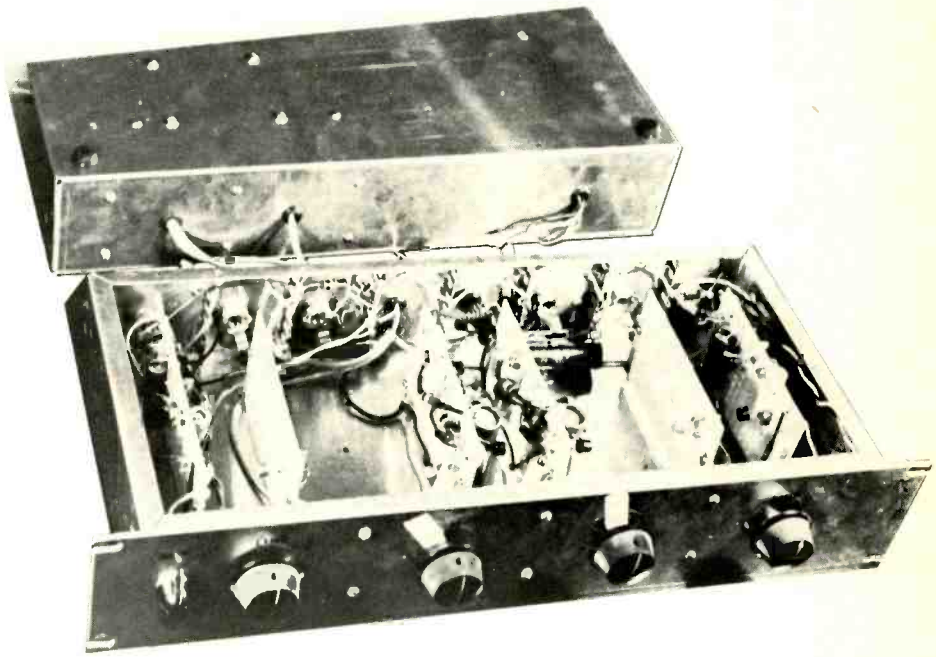


Fig. 2—Solid-state limiter built by author. Removing cover plate reveals audio amplifier circuit boards. Audio circuits are contained in the lower compartment; batteries and "lamp-driver" amplifiers are mounted above.

to the Rayistor which, in turn, will exhibit decreased resistance. As a result, more of the incoming signal to amplifier A_3, the output amplifier, will be shunted to ground. In practice, it should normally require a peak signal, one that would generally cause distortion, to lower the resistance of the Rayistor to the point where it would clip the signal. Thus, most of the dynamic range recorded would be preserved.

Preliminary work on the application of "Rayistors" to simple volume limiters has already been reported in AUDIO.[1] Recently, a completely portable and battery-operated limiter has been developed and tested. Its purpose is to help the amateur recordist reduce the number and severity of over-recording "accidents" which might otherwise occur when working with non-professional performers under less-than-optimum conditions. It is *not* intended to replace the skill of the recordist.

The general circuit arrangement is shown in *Fig.* 4. A_1 and A_2 are microphone amplifiers which bring the signal voltage up to a level of approximately one quarter of a volt. Following gain and mixing controls, the shunt-resistor element of the Rayistor (CK1114) acts as a supplemental volume control to reduce peak signals. A_3 and A_4 provide sufficient additional gain to drive conventional "high level" inputs found in the usual tape recorder. A_5 and A_6 further amplify the signal and produce sufficient power to actuate the lamp element in the Rayistors.

[1] James Young and Wayne B. Denny, "Solid-state limiter for tape recording," AUDIO, September, 1965, p. 30.

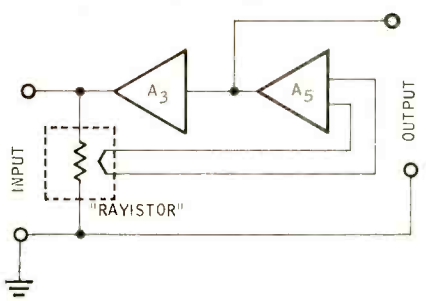


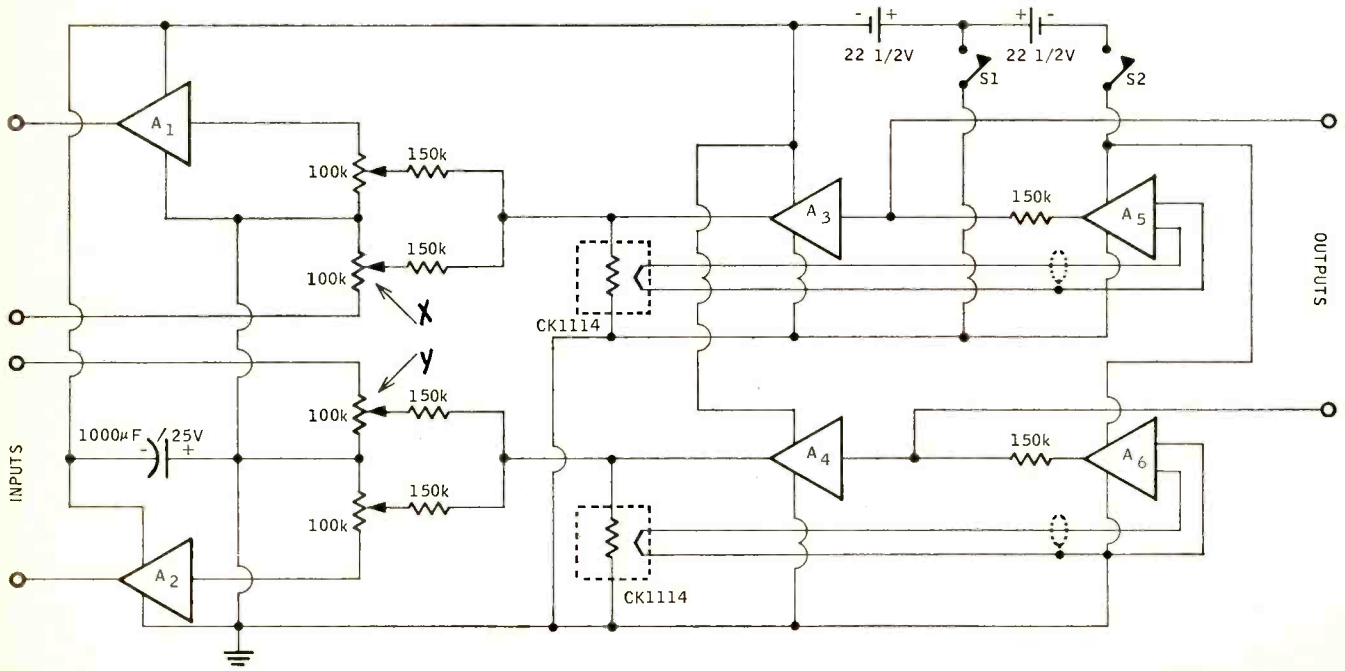
Fig. 3 – Simplified schematic illustrates feedback used with limiter.

Operation with a recorder

In comparison with commercially-available limiters, this device is quite unsophisticated. The operator has no control over the signal level at which limiting will occur; nor can he change attack and release times of the control circuits. In practice, the outputs from the limiter are patched to the high-level inputs of the tape recorder. The gain controls of the recorder are then adjusted until signals which start to limit give approximately a "zero-level" indication on the recorder VU meters. Input levels are then controlled by the potentiometers in the limiter, with the hope that peaks which might ordinarily "pin" the meters will merely put the needle into the "red." The exact settings of the recorder gain controls must be based on some trial magnetic tapes made at rehearsals. Once these controls are set, the recordist should "forget" the limiting action and act as though the limiter doesn't exist.

Experience has shown that a slower release time might be beneficial, but this would greatly compli-

Fig. 4–Six similar modular amplifiers are used in this two-channel limiter. Provision is made for both low-level and high-level input signals.



cate the circuit. Suitable circuits require rectification of the driving signals, and control of attack and release times by "RC" time constants. They can be built readily enough but it might be better to purchase them. The circuits shown in this article are more modest performers, and the user should be aware of their limitations.

Circuit details

The six amplifiers used in this device are all based on circuits suggested in the *General Electric Transistor Manual*. All transistors are 2N508A's. Six separate (but similar) amplifiers were built and tested before any modifications were made. Using unselected transistors and "10%" components, the amplifiers were identical within a decibel.

The preamplifiers, used with a Bang and Olufsen (B&O) Model 200 double-ribbon stereo microphone, do *not* require matching transformers. In this application, high gain and relatively low input impedance are required. The final circuit for the pre-amplifiers is shown in *Fig.* 5, where C_1 has a value of 500 μF. Under these conditions the voltage gain is about 700. If a matching transformer is used, C_1 can be omitted. The pre-amplifier will then have a gain of about 50 and an input impedance of about 0.1 megohm over most of the audio range. Two additional mixing potentiometers are provided for high-level inputs.

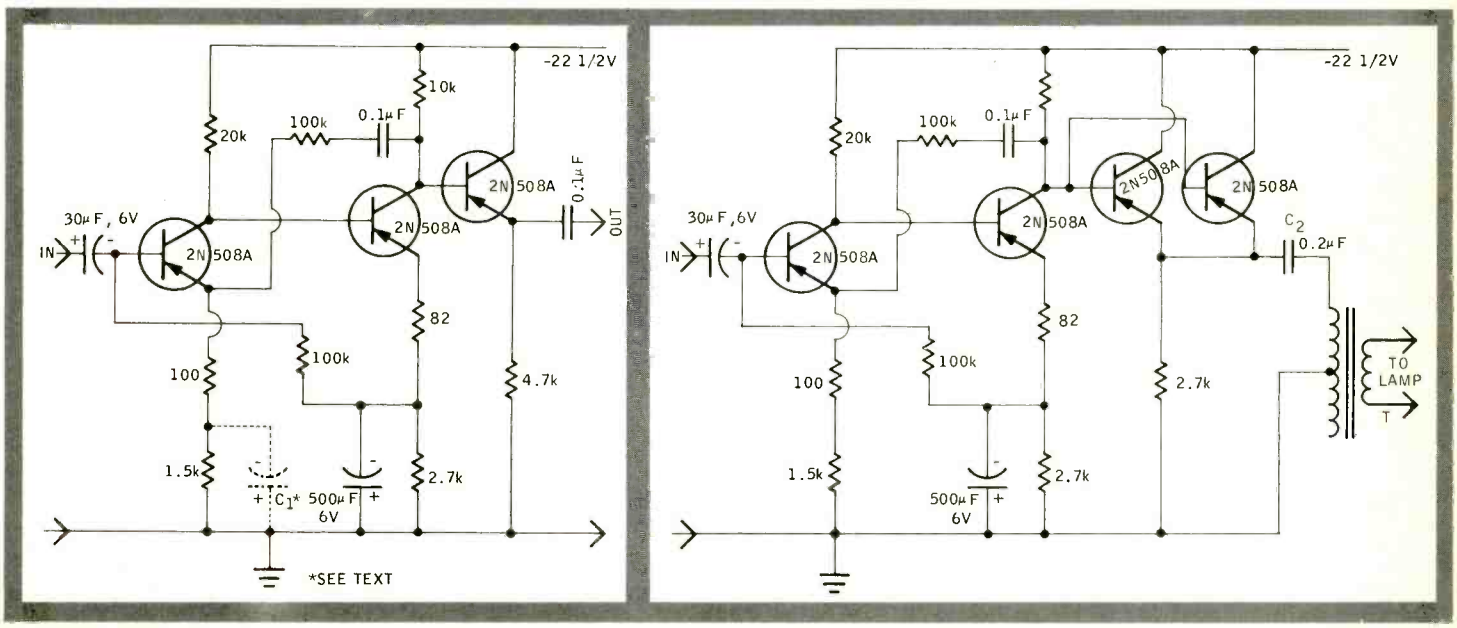
A_3 and A_4 use the circuit of *Fig.* 5 with C_1 omitted. This assures that the input impedance of these amplifiers is high enough to avoid shunting the Rayistors too severely.

The circuit for the *lamp-driving* amplifiers, A_5 and A_6, is given in *Fig.* 6, again with C_1 omitted. Major modifications are shown in the output emitter-follower stage. Two transistors in parallel are used to provide sufficient power to drive the lamps. The output transistors are coupled to the Rayistor lamps by capacitors, C_2, and audio output transformers, T. Several available transformers were tried and the best ones appeared to be *Stancor* 3830 units. These are universal output units. Best performance was obtained using only half of the primary winding and *all* the secondary winding (taps 1 and 6). Capacitor C_2 (0.2 μF) was chosen to give uniform gain at the lowest possible frequencies. The combination functions at all frequencies down to about 200 Hz when used with the CK1114.

Circuit operation

The effectiveness of the circuit is shown in *Fig.* 7. With the lamp-drivers inoperative, the input-output characteristic is the usual 45-deg. line when both input and output are plotted logarithmically. The input voltage was measured at points X and Y. *Fig.* 4. Overload occurs at about 5½ volts rms: the signal is clipped symmetrically at that value. With the lamp-drivers in operation, input-output linearity no longer occurs above about ⅓ volt, and a maximum compression of nearly 20 dB occurs. Finally, the lamp drivers saturate. Thus increasing the signal further will not increase the power available in the lamp circuit. In this region, the shunt-resistor section of the CK1114 Rayistor acts as a *fixed* resistor and the input-output char-

Figs. 5 and 6—With relatively minor modifications, the same basic amplifier circuit shown in Fig. 4 is suitable for use as a preamplifier, output amplifier, or Rayistor lamp-driver, as illustrated at left. Value of C_1 is discussed in the text. The circuit at right is used in conjunction with Rayistor lamp-drivers, which require high power output at relatively low output impedance. Two 2N508A transistors in the output stage provide the necessary power, while the transformer has the needed low Z.



acteristic is again linear and inclined at 45 deg. Of course, the device is not intended to operate in this region, but the data were taken to ensure that the circuit behaves as predicted at *all* signal levels.

The internal impedance of small 22½-volt batteries is sufficiently high to require a shunt capacitor if a single battery is used to power A_1 operating in tandem with A_3, and A_2 operating in tandem with A_4. Otherwise, oscillations can be expected at high-gain settings of the mixing potentiometers. No attempt was made to power A_5 and A_6 from the same battery used for the other amplifiers; a separate battery is required.

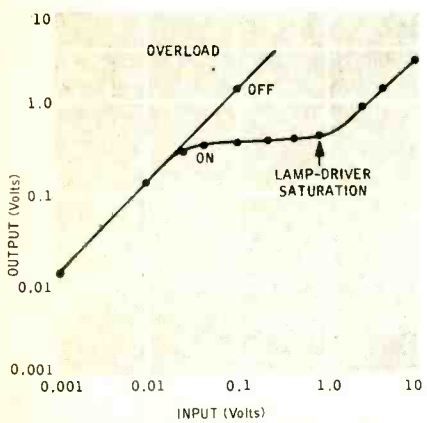
Although the input impedance of A_1 and A_2 is quite low, it was found that spurious oscillations usually occurred when A_5 and A_6 were enclosed in the same metal cabinet with the other amplifiers. Accordingly, the lamp drivers, A_5 and A_6, were completely shielded from the rest of the circuit. Also, shielded wire was used to couple the transformer secondary windings to the Rayistor lamp elements; the shield was grounded near the lamp-drivers. All input and output jacks were located on the rear panel and actual chassis "grounds" made only near the input jacks.

The signal level at which the lamp-driver starts to function depends on the resistors in series with the inputs to A_5 and A_6. Values of 150k Ohms give the characteristics shown on the graph of *Fig.* 7. Greater sensitivity can be obtained by reducing these resistors but, naturally, there is a limit. With the lamp drivers inoperative, the input transistors of these amplifiers act like low-resistance diodes with extremely non-linear characteristics. This input resistance can affect the output circuit of the limiter, causing distortion, unless the series resistor is kept reasonably high.

It was pointed out earlier that the coupling between the output transistors of A_5 and A_6 and their respective Rayistors was effective only at frequencies above about 200 Hz. It must be emphasized that the transformers are not being used as they were intended to be used. Other transformers may provide better impedance matches with correspondingly greater power to the Rayistors. The arrangement used in *Fig.* 4 has one advantage, however: it is impossible to overdrive the Rayistors unless the amplifiers are self-oscillating. In order to check the stability of the unit, it is suggested that 100-Ohm resistors be substituted for the lamps *before* the Rayistors are installed. If the oscilloscope shows no instability at all volume settings *with input devices connected,* it is safe to connect the Rayistors. (Failure to follow his own advice cost the writer approximately $16!)

Although the frequency limitation imposed by the capacitor-transformer combination may give less than ideal results, the unit seems to operate quite satisfactorily in practice. Most signals have appreciable content in the "above 200-Hz region" so that the limiter is an effective unit. As used with the specified B&O microphone, the limiter provides very quiet and clean signals. In general, the tapes that result are cleaner than those made without using the limiter. And that's what counts. *Æ*

Fig. 7—Gain characteristics of the device are shown with and without limiting. With the limiter in operation, voltage gain decreases when the input signal voltage (measured at points X and Y in Fig. 4) exceeds about ⅓ Volt. This "non-linearity" is not accompanied by an appreciable increase in waveform distortion, as shown by an oscilloscope trace.



PARTS LIST

FOR FIG. 4

2 Rayistors, CK1114
4 100k Ohm Pots
1 1000μF, 25V Electrolytic
2 Rayistors, CK1114
4 100k-Ohm Potentiometers
6 150k-Ohm Resistors
2 Single pole-single throw Switches
2 22½V Batteries
Appropriate metal case, binding posts, knobs, etc.

FOR FIG. 5
(Amplifiers A1, A2, A3, A4)

8 2N508A Transistors

Capacitors

4 30μF, V Electrolytic
6 500μF, 6V Electrolytic
8 0.1μF Paper

Resistors

4 100 Ohm
4 1.5k Ohm
8 100k Ohm
4 20k Ohm
4 10k Ohm
4 2.7k Ohm
4 4.7k Ohm

FOR FIG. 6
(Amplifiers A5, A6)

8 2N508A Transistors
2 Stancor 3830 Transformers

Capacitors

2 30μF, 6V Electrolytic
2 500μF, 6V Electrolytic
2 0.1μF Paper
2 0.2μF Paper

Resistors

2 100 Ohm
2 1.5k Ohm
4 100k Ohm
2 20k Ohm
2 10k Ohm
2 82 Ohm
4 2.7k Ohm
2 4.7k Ohm

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Fri., Sept. 22, 6:30–7:30 PM—Novice Symposium (same as Thurs.). . . . 7:30–8:30 PM—"Cartridges, Turntables, and Changers". . . . 8:30–9:30 PM—Decor Group—Albert Herbert.

Sat., Sept. 23, 2:00–3:00 PM—"The Pop Scene"*. . . . 3:00–4:00 PM—"Amplifiers and Tuners". . . . 4:00–5:00 PM—Decor Group—Bill Leonard. . . . 6:30–7:30 PM—Novice Symposium (same as Thurs.). . . . 7:30–8:30 PM—"Stereo and the Listener". . . . 8:30–9:30 PM—"The Successful Recordings."*

Sun., Sept. 24, 2:00–3:00 PM—Decor Group—Vladimir Kagan. . . . 3:00–4:00 PM—Novice Symposium (Same as Thurs.). . . . 4:00–5:00 PM—"The Jazz Recording Scene."*

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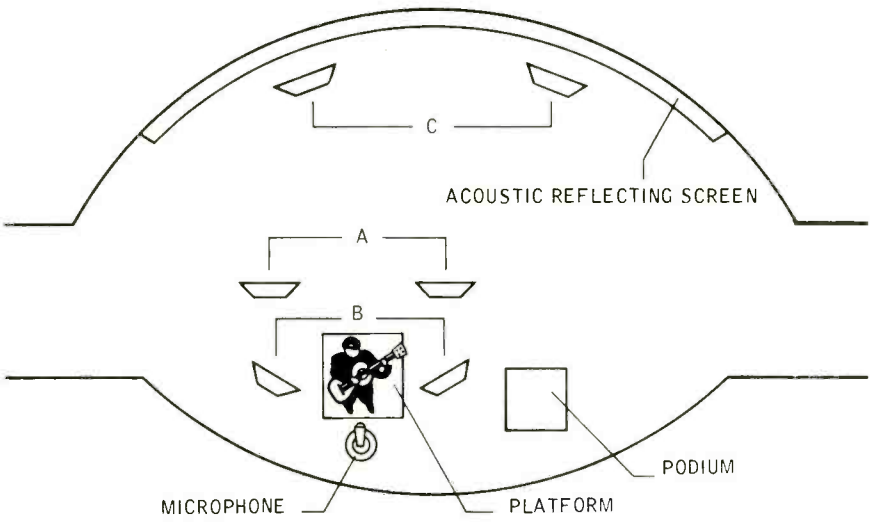
SOUND REINFORCEMENT IN CONCERT HALLS

MARTIN L. BORISH*

Fig. 1—Electrostatic panels, placed on risers behind the National Symphony Orchestra, reinforce sound from the guitar soloist.

Fig. 2—Speakers used during this performance were effective in all three positions noted. However, Position "C" was used to avoid obstructing the view of the conductor.



THE PROBLEM OF AMPLIFYING a sound of limited output so it can be heard by a large number of people is not a recent problem. Until the development of electronic amplifiers and supporting equipment, the only solution was to design instruments and train voices for maximum projection.

The evolvement of our present-day musical instruments can partially be traced to the need for reaching specific size audiences. Horns, trumpets, and bugles had many uses where sound had to carry over great distances. On the other hand, strings, woodwinds, and keyboard instruments such as the harpsichord were used to delight nobility in small salons or, at most, in intimate concert halls.

As the halls got larger, the orchestras grew in size, too. The harpsichord became a pianoforte, which ultimately became a concert grand. The technique of singing faced challenges as audiences expanded. One wonders if the brilliant virtuosos of the 18th century could shake the rafters of the 3800-seat Metropolitan Opera like a Corelli or Nilsson.

Then along came the vacuum tube, the microphone, the loudspeaker. The politician could forget how to project. Crooners could put down their megaphones and pick up a microphone. Broadway theaters became wired wonderlands with mikes and horns hanging on the whispered sounds of today's voiceless stars. Yet, despite the prolifera-

*Acoustech, Inc., Milwaukee, Wisconsin.

Fig. 3—Constitution Hall as viewed from the stage. A great amount of sound energy must be generated to reach 3,811 listeners in this one-million cubic-foot auditorium.

Fig. 4—Photographs taken during the performance show Laurindo Almeida, guitarist, accompanied by the National Symphony Orchestra. Note position of the condensor microphone.

tion of public address systems, the concert hall remained aloof until recent years.

Now the cost of putting on a concert hall performance is so enormous that room for more concert-goers must be found, hang the acoustics. So, if a 1500-seat auditorium is considered good size in Europe, 3000 is marginal here. In fact, 4000- and 5000-seat auditoriums are becoming more commonplace. To help balance deficits, our major orchestras are going out into the parks to play for tens of thousands.

The jazz groups are climbing out of the speakeasies and into the big auditoriums. The folksingers are right there with them. The long-playing record has introduced to thousands the beauties of the baroque. The harpsichord, the classic guitar have both become "in."

What happens to our hi-fi enthusiast when he attends a live concert? Too often he is disappointed. The sound is faint, indistinct, weak. A cough covers a chord. The live sound is sometimes a "let down" compared to the clarity of a home music system!

To meet the challenge of larger areas to be covered by sound, concert managers and producers are now looking at electronic sound reinforcement as a solution. And to reproduce the original sound source with as little coloration as possible, many have turned to products familiar to high fidelity salons.

The hall already had a fine amplification system at the time this concert was to be given. Though ideal for voice, however, it was not deemed suitabile for some soloists scheduled to perform at Constitution Hall, namely a guitarist and a harpsichordist. This is what induced the National Symphony Orchestra's conductor, Howard Mitchell, and manager, M. Robert Rogers, to employ a different sound system. A full-range stereo electrostatic loudspeaker/solid-state amplifier system —the Acoustech Ten—was loaned to the orchestra by a local hi-fi dealer for this purpose.

To achieve proper placement, a "dry run" was made with a local, Sophocles Papas, standing in for the actual soloist, Brazilian guitarist Laurindo Almeida.

Sound reinforcement at Constitution Hall

This example of how sound reinforcement enhanced a concert hall performance was observed at Washington, D. C.'s Constitution Hall not too long ago.

Constitution Hall is one of the larger concert halls in the country (over one million cubic feet of space) with seating for 3,811 listeners. The National Symphony Orchestra of Washington, D. C., Howard Mitchell, music director, performs here in an acoustically-live environment (reverberation time: 1.9 seconds). The hall is designed without overhanging balconies; the balcony is a horseshoe surrounding the orchestra seats which are in the arena below, the stage being at the open end of the horseshoe.

To preserve the illusion that the sound was coming only from the soloist, the speaker panels were placed first in Position A and then in Position B (Fig. 2). As electrostatic panels radiate as much sound to the rear as they do to the front, the orchestral musicians had an opportunity to hear the soloist, not usually possible with a guitar soloist.

Acoustic feedback was minimal for a number of reasons. The Ten system, for example, incorporates a bass contour which permits the low frequencies to be tailored for optimum bass response with minimum feedback. And placement of an Altec condenser mike directly in front of the guitar made use of the instrument's shielding effect to further reduce feedback possibilities.

The next day's orchestral rehearsal with Almeida introduced several problems. The orchestra sitting behind the panels heard the guitar so clearly that they misjudged the volume of sound they needed to produce. As a result, the orchestra started by playing too loudly. Lloyd Geisler, the orchestra's associate conductor and conductor of this concert, effectively remedied that problem. The second difficulty required more drastic action. To facilitate moving the panels off and on stage, they had been placed on dollies. As they stand six feet high to start with, this raised them to a height where they interfered with the sight lines from musicians to conductor.

Ironically, the radiators used in

Fig. 5—Washington, D. C. guitarist, Sophocles Papas, participated in testing the sound enhancement system on stage at Constitution Hall before arrival of featured soloist, Laurindo Almeida.

the panels are only 9″ by 12″ and can be mounted in any configuration. The panels could be low, square, curved — any way desired. Unfortunately, in the time available, the standard home model had to be used.

The only solution was to move the panels behind the orchestra and about 30 inches in front of a new acoustic screen along the back of the stage. They were placed about 25 feet apart and about 30 feet behind the soloist. (Position C in Fig. 2.) The sound from the back of the speakers hit the screen and was reflected out to the audience. The one disadvantage of this position was the possibility that those sitting close to the stage would notice sound coming from the back of the stage apart from that coming from the soloist.

The concert proved these fears groundless. Charles Crowder, music critic of the *Washington Post*, reported as follows:

"... An extraordinary innovation in guitar playing was displayed last night at Constitution Hall when the National Symphony brought Laurindo Almeida to play the Villa-Lobos Concerto for that instrument.

* * *

"Guitarists are the rage nowadays, but until last night a guitar recital in Constitution Hall with its 3811 seats was unthinkable. During the first two movements of the Concerto, my ears picked up the intimate, resonant sounds of the instrument from my seat, rather close to the stage. There is nothing unusual about that, for I was sitting close enough to claim the vantage point of a rather large living room.

"For the third movement, I moved to the extreme rear and the sound remained the same. Guitarists, gear your sights on the big halls. . . ."

The audience reaction was equally enthusiastic. Almeida was called upon to perform five encores, a reflection not only of his virtuosity but also on the ability of the listeners to hear distinctly what he was playing.

An interesting observation was made by Crowder in his review concerning the first two movements of the concerto. At this point he was sitting about 50 feet from the soloist and thought that what he heard must be coming from the performer, not the speakers. However, in rehearsal, the sound had been checked at a point not far from his seat. With the reinforcement turned off, the guitar was inaudible!

Before the concerto began, Rogers spoke to the audience about the novel experiment they were going to witness. He concluded his remarks with the observation that the sound system was to operate like a well-designed brassiere. "It should enhance, not replace." Æ

Inside an Electrostatic Speaker

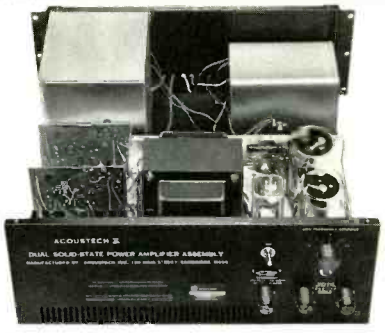


Fig. 1—Power pack used with Acoustech-Ten full-range speaker.

Electrostatic speakers, sometimes called condenser speakers, have captured the imagination of audio buffs from time to time. Today there are at least three full-range electrostatic speaker systems, not to mention a number of electrostatic tweeters, on the market.

Low mass and having the ability to be driven uniformly over the entire diaphragm doubtlessly contributes to its appeal. Sales deterrents for the masses (as opposed to the cognoscenti), however, include Shoji-screen size (for full-range units), more stringent amplifier requirements than for dynamic speakers, and relatively high cost. Nonetheless, sound quality from electrostatics has been lauded by many people. So it is particularly interesting to observe its use in the concert hall, and to examine the innards of the type used.

Construction

An Acoustech Ten electrostatic speaker panel (the type utilized at the Washington, D. C., concert described in this issue) incorporates 13 electrostatic radiators. One is for high frequencies, the other twelve cover the middle and low frequencies. The size, resonance, and choice of diaphragm material differ, but the construction and design of

(Continued on page 34)

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(Continued from page 32)

the two types have broad similarities. (Whereas electrostatic tweeters are used in conjunction with dynamic woofers in many contemporary systems, the electrostatic woofer and midrange is unusual.)

When thinking of an electrostatic radiator, think of a sandwich. Two plastic flat molds on the outside represent the slices of bread. Inside, instead of ham (or corned beef) is a thin plastic diaphragm. A fixed d.c. bias is applied to the diaphragm. The audio signal is carried on the two outside forms, causing the diaphragm to move forward and backward in accordance with the signal. The movement is very small; it is the large surface that provides sufficient air movement to reproduce low frequencies.

While it sounds simple in theory, building a full-range electrostatic is anything but simple. Much research and experimentation has gone into perfecting the chemical compounds used to coat the elements. Empirical data based on years of use has been significant.

A plastic molded frame (one of the slices of bread) is 9″ by 12″ in size. The size and number of holes has a direct bearing on performance. Actually, every part of the assembly is critical. One side is silk-screened with a conductive compound, the principal ingredient being carbon. When dry, a protective insulated coat is screened over this. Then various terminals and mounting contacts (silver conductive paint is used) are mounted. On the inside of the frame, a ribbon of conductive paint is carefully applied.

The frame is then placed on a custom-built machine which looks suspiciously like a Rube Goldberg invention (Fig. 2). Contact cement is placed around the edges of the mold; the plastic diaphragm is stretched across the frame and tightened. At the proper tension, the machine stops and firms the diaphragm down on the frame. A deviation of a few cycles on the diaphragm resonance can seriously affect results. The exposed surface of the diaphragm is then coated with another specially prepared compound to make the surface conductive but with a high degree of resistance. Not only is the formula important, but the thickness of the coat is equally so.

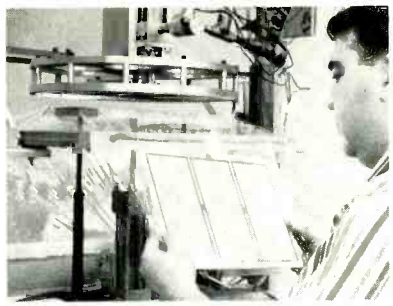

Fig. 2—Custom-built machine stretches and mounts diaphragm material to molded frame.

The radiator is now in the form of an open-faced sandwich. To complete the assembly another silk-screened frame (but without a diaphragm) is attached (Fig. 3). Nylon rods hold the entire device together.

How, you may ask, does the d.c. bias (over 6000 Volts) reach the plastic diaphragm inside the sandwich? On the outside of the mold is a silver contact point. The contact point connects to the ribbon of conductive paint on the inside of the frame. The ribbon, in turn, is in direct contact with the surface of the diaphragm, thus carrying the bias voltage to its destination.

Though construction involves great precision and care, the finished radiators are astoundingly rugged and trouble-free.

The radiators are mounted on a wooden frame, terminals connected together, and the assembled panel appears as in Fig. 4. The panel is placed in a calibrated reverberation room. A series of tests, using pink noise primarily, are performed. Final panels are so similar that matching for stereo systems is unnecessary.

Fig. 3—Twelve woofer-midrange and one tweeter radiators are mounted on a wooden frame to create a complete full-range electrostatic speaker system.

Separate coupling transformers are provided in this system for the tweeter and the woofer. Each transformer is directly coupled to its own solid-state power amplifier. The separation of high and low frequencies is accomplished electronically ahead of the amplifiers.

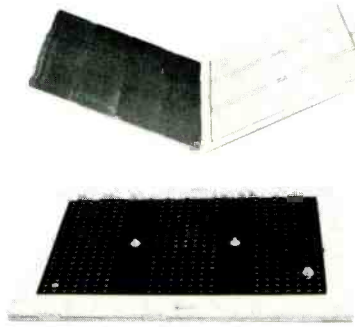

Fig. 4—The electrostatic radiator resembles a sandwich. The stretched diaphragm, coated with conductive material, is situated between the two plastic frames. The black, silk-screened area in the center of the assembled radiator (foreground) accepts audio signals, causing the diaphragm to move forward and back.

Theoretically, the amplifier/speaker system can operate with signal from any preamplifier or tuner. However, as the system is separated from the preamplifier by a distance of 10 to 200 feet, it is desirable for the output impedance of the preamplifier to be quite low (200 Ohms is a good figure).

Customizing a system for professional application is simple. The small radiators can be mounted in many ways, in many locations, in unlimited combinations, and by adding more tweeters or less woofers as desired. It is even possible to mount them in the wall (allowing extra units to compensate for the loss of the back radiation).

Where maximum sound level with minimum power input is desired, the electrostatic is not the answer. Next to an electrostatic, all speakers are efficient. For this reason, over 500 Watts of transient power is provided in the four amplifiers built into the Ten system. The forte of the system, says its manufacturer, is minimum coloration of sound. AE

When engineers get together, the conversation turns to pickups.

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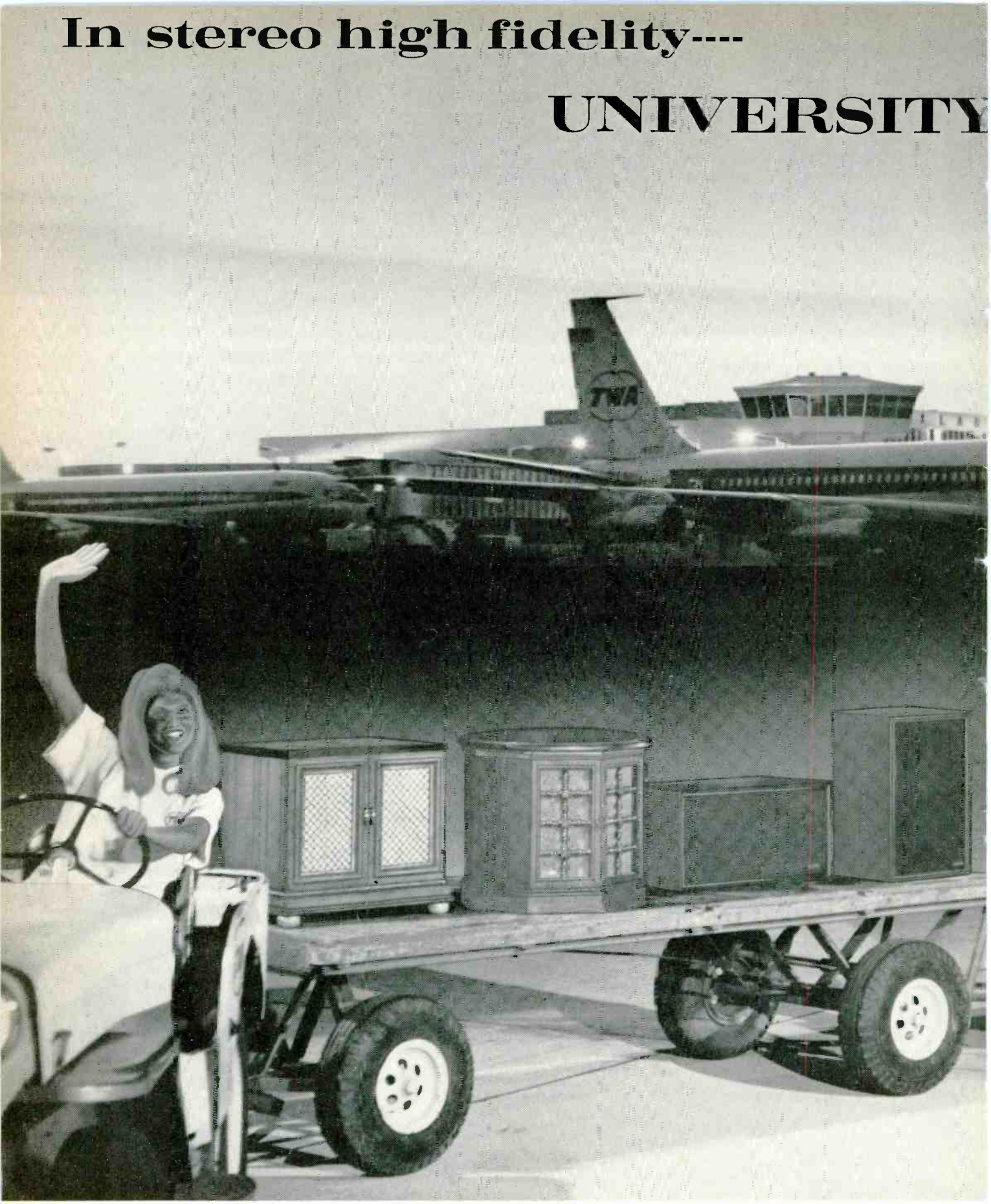

Left to right: *Sorrento II:* Three-speaker — four-way — acoustic suspension system in Spanish modern styling — Seville blue with slate top — $289 — matching mirror optional at extra cost ☐ *Mediterranean:* Three-speaker high compliance system with a graceful Mediterranean flair — in antique butternut — $269.50 ☐ *Estoril:* Four-way aerodynamic bass energized system — oiled walnut finish in contemporary styling — $164.50 ☐ *Laredo:* Three-speaker — four-way — multi-chamber system — dramatic Moorish styling — hand-rubbed walnut finish — $109.50 ☐ *Cantada:* Three-speaker radiation resistance loaded system — styled in the continental manner — oiled walnut finish — $145. ☐ *Debonaire:* Three-speaker radiation resistance loaded system — contemporary American styling — oiled walnut finish — $124.95 ☐ *Ultra-D:* Three-speaker high

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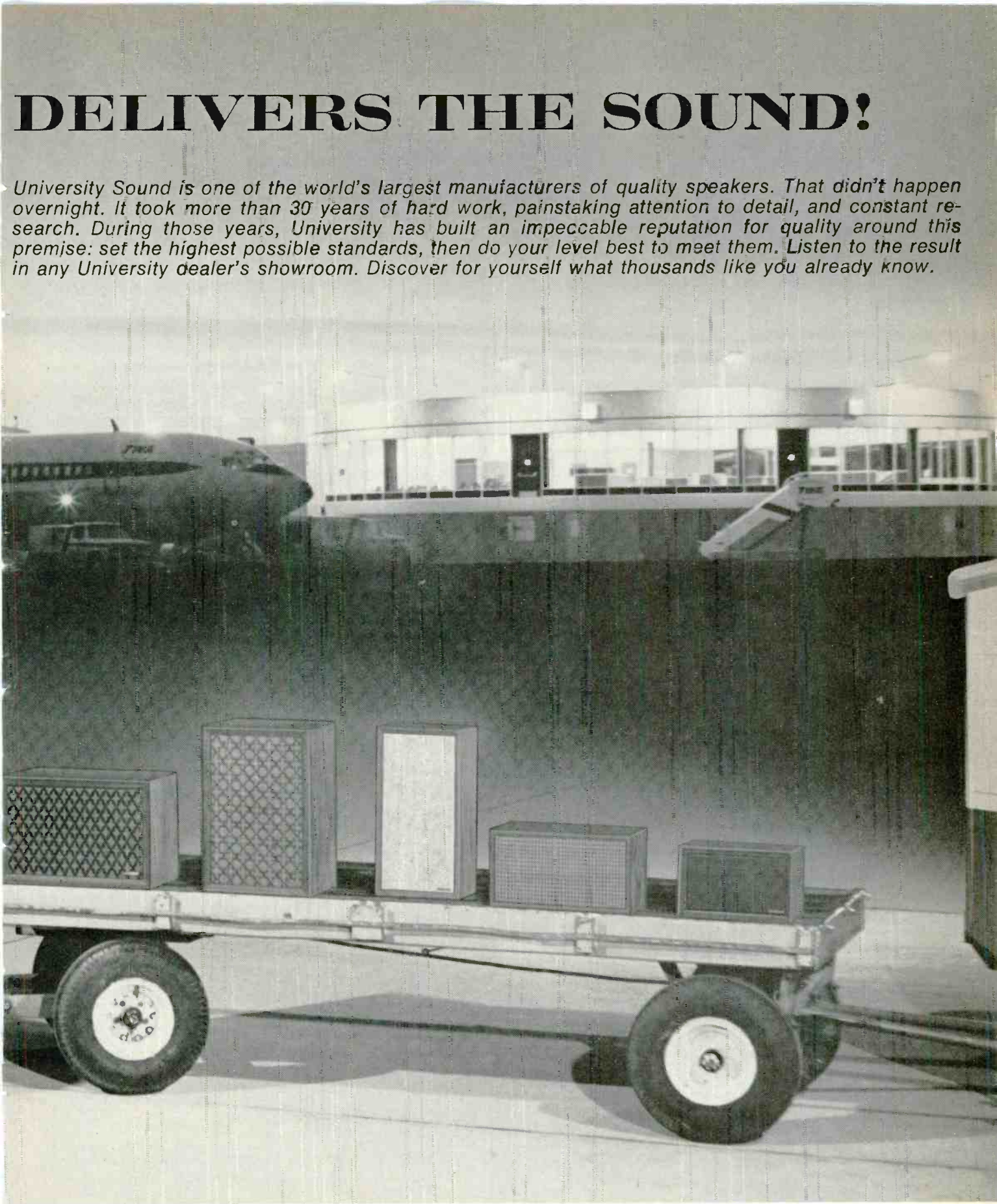

efficiency acoustic suspension system — contemporary Scandanavian styling — oiled walnut finish — $69.95 ☐ *UR-4:* Two-speaker high compliance system in hackberry with oiled walnut finish — $58.95 ☐ *Mini-ette:* Two-speaker high efficiency acoustic suspension system — contemporary Scandanavian styling — oiled walnut finish — $49.50 ☐

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The New NAB Magnetic Tape Standards

HERMAN BURSTEIN

Playback, record, and frequency response characteristics are examined in this installment

PART 3

THE NAB PLAYBACK characteristic is largely but not entirely an equalization curve provided by the playback amplifier. Rather, it is the combination of such a curve plus frequency irregularities (treble losses and bass losses or gains) that a particular playback head exhibits (as heads in general do). This *combination* must achieve a specified playback response with respect to constant flux on the tape. If there were an ideal head—with no response irregularities—the playback equalization and the playback characteristic would be identical.

In practice, with high quality heads, equalization provided by a playback amplifier comes within a few dB of the total playback characteristic specified by NAB.

One playback characteristic is specified for 7½ and 15 ips. A second characteristic is specified for 3¾ and 1⅞ ips.

For 7½ and 15 ips, the playback characteristic is in effect: bass boost commencing (3 dB up) at 3180 Hz, rising 6 dB per octave as frequency declines, and leveling out (3 dB below maximum boost) at 50 Hz. In microseconds, the specified turnovers are 50 and 3180 μsec.

For 3¾ and 1⅞ ips, the playback characteristic is in effect: bass boost commencing at 1770 Hz, rising 6 dB per octave as frequency declines, and leveling out at 50 Hz. The specified turnovers are 90 and 3180 μsec.

The 1953 NAB standard provided a playback characteristic only for 15 ips, and this was the same as the present characteristic for 7½ and 15 ips. The RIAA standard provides playback characteristics only for 7½ and 3¾ ips, and these are the same as the NAB ones. Inasmuch as the NAB standard does not show the playback characteristics in the manner we have described, whereas the RIAA standard does, we present here RIAA Fig. 1. Note, however, that the NAB tolerances, which we shall describe later, are somewhat different and on the whole tighter, than the RIAA tolerance of ± 2 dB.

The NAB playback characteristics, while *equivalent* to our description and to RIAA (Fig. 1) and to NAB in the 1953 standard, are *actually* presented as shown in Fig. 2. There are two reasons for the new form of presentation: (1) It helps get away from the misconception that the playback characteristic is merely a specific equalization curve in the playback amplifier without regard for response irregularities of the playback head. (2) It serves to show how the flux recorded on the

(Continued on page 38)

Fig. 1—RIAA reproducing characteristics for magnetic tape.

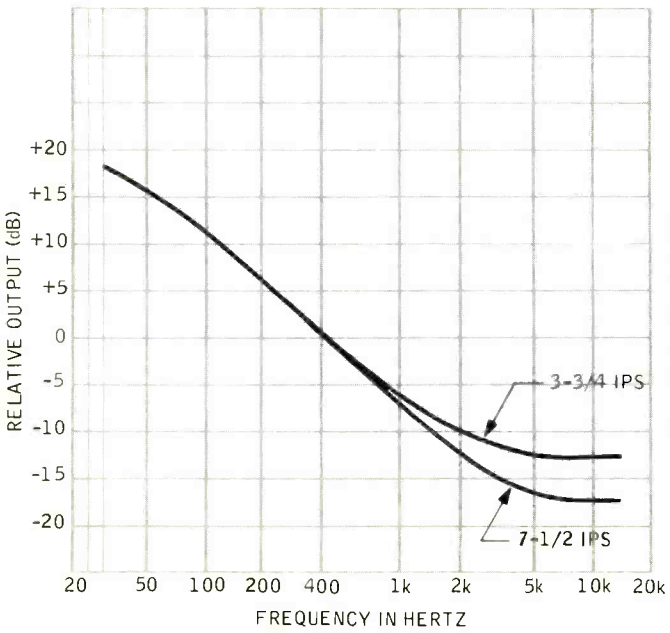
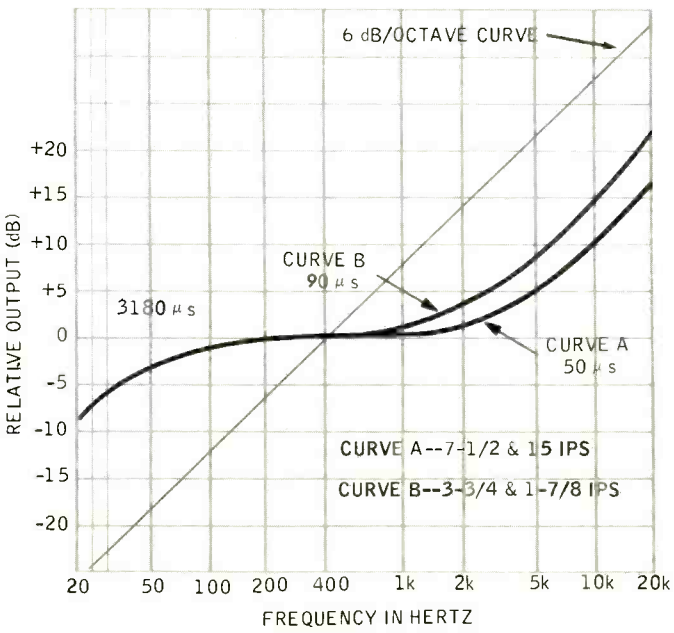


Fig. 2—NAB reproducing characteristics for magnetic tape.



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The New NAB Standards

(Continued from page 34)

tape should vary with frequency.

Fig. 2 assumes an ideal playback head and constant flux in the core of this head, in which case the combined response of the head and playback amplifier should have the response characteristic of Curve A (for 7½ and 15 ips) or Curve B (for 3¾ and 1⅞ ips).

However, with constant flux in its core, the voltage output of the ideal playback head actually rises 6 dB per octave, as shown by the line we have added to the NAB curves in Fig. 2. Given this steadily rising input, the amplifier must be equalized to produce, say, Curve A. Therefore, the actual equalization curve inside the difference (for an ideal head) is the *difference* between the 6 dB/octave curve and Curve A. It may be seen that, using the 6 dB/octave line as a reference, Curve A rises steadily as one goes from the high to the low frequencies. Thus Curve A is equivalent to a bass boost characteristic, such as we have already described. At 20,000 Hz, Curve A is 18 dB below the reference line, and at 20 Hz it is 17.3 dB above this line—a total bass boost of 35.3 dB in the 20-20,000 Hz range.

Curve A (and similarly Curve B) shows that for constant flux on the tape and, therefore, in the core of the playback head (the two are nearly the same), output of the playback amplifier should rise with frequency. But since the ultimate objective is flat response, the rising output of the playback amplifier must imply a corresponding drop in the recorded flux on the tape.

The NAB standard does not say what kind of tape should be used in making the record-playback measurement. However, the specification of "normal operating bias" suggests that a tape machine's bias should be adjusted for the kind of tape being used. Thus, with appropriate bias adjustments, a machine would produce the same record-playback response with special-purpose tape (high-output, low-noise, low-print-through, etc.) as with conventional tape.

At the time this was written, the NAB Test Tapes were not yet readily available. In the meantime, therefore, one would have to rely on other test tapes, such as the Ampex test tapes widely used.

[John G. McKnight, Ampex staff engineer who was on the NAB Committee that formulated the new tape standards, comments on this and the preceding section: "Your section on Measuring Frequency Response is generally O.K., but I would have preferred a positive approach to the direct method using Test Tape, rather than the present reference to its being an indirect method. Perhaps it might be better to say that since the frequency and wavelength responses of practical heads are not known factors, the reproducing flux characteristic of a tape machine cannot be measured by measuring only the equalization of the reproducing amplifier.

["The NAB Committee's philosophy on frequency response measurement was this: The field user of recorders and reproducers can play tapes easily; on the other hand, he has absolutely no means of independently calibrating a reproducing head (determining deviations from ideal) and, in general, is probably not even too anxious to open cabinets, unplug head cables, build special adaptors, pads, etc., and measure the reproducing amplifier response. Therefore, from a *user's* (broadcaster's) standpoint, the use of the Reproducer Test Tape is the *direct* approach, and the basic flux measurement would be an *indirect* approach. . . . The whole purpose of writing the NAB reproducer response as it is, is to allow the simple measurement of a reproducer by means of a Test Tape.

["I would therefore have preferred that you *started out* with this concept, and get into the complication of practical equipment design considerations later on. We (the Committee) were aiming at the following concepts (although we had not arrived at this degree of sim-

(Continued on page 54)

Fig. 3—NAB standard reproducing response limits.

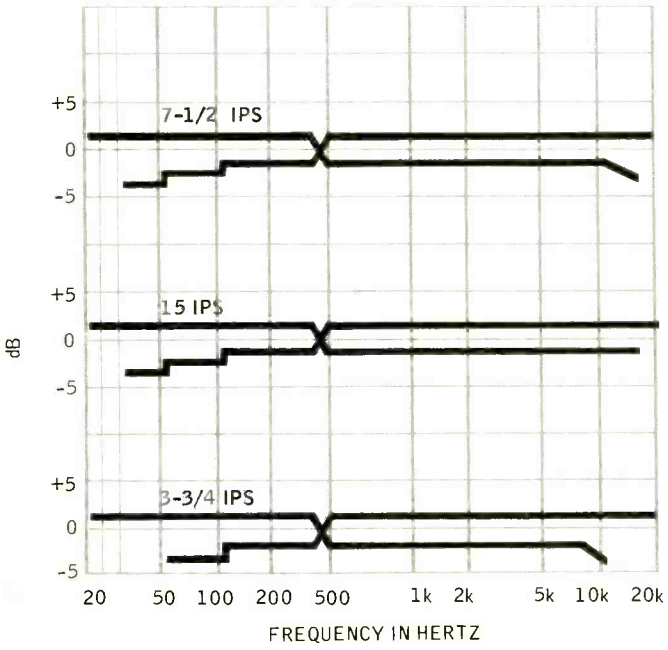
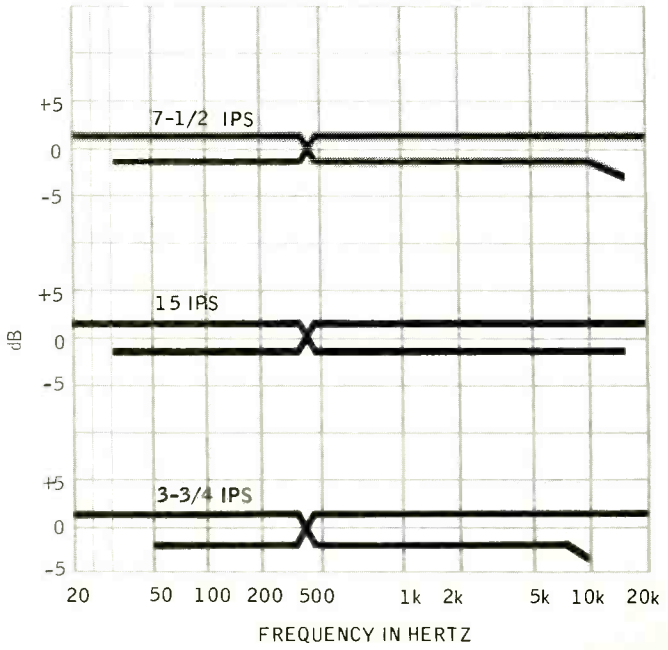


Fig. 4—NAB standard recorded response limits.



Build a world of your own on "Scotch" Brand Dynarange® Tape.

Great moments in music . . . happy times at home and away—capture whatever sound you want to save on "Scotch" Brand "Dynarange" Recording Tape. "Dynarange" delivers true, clear, faithful reproduction across the entire sound range. Makes all music come clearer . . . cuts background noise . . . gives you fidelity you didn't know your recorder had.

And "Dynarange" saves you money, too! Delivers the same full fidelity at a slow 3¾ speed that you ordinarily expect only at 7½ ips. The result: You record twice the music per foot . . . use half as much tape . . . save 25% or more in tape costs! Lifetime silicone lubrication protects against head wear, assures smooth tape travel and extends tape life. Isn't it time you built your own private world of sound on "Scotch" Brand "Dynarange" Recording Tape?

Magnetic Products Division 3M COMPANY

"SCOTCH", "DYNARANGE" AND THE PLAID DESIGN ARE REGISTERED TRADEMARKS OF 3M CO

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Extravagantly priced to some; a bargain to the audio perfectionist—the new Sony three-way electronic-crossover stereo system. All components and all transistors are Sony-made, Sony-engineered.

Three solid-state stereo power amplifiers are used —one for each channel. They deliver more than 300 watts of audio power with distortion low enough to be virtually immeasurable. The solid-state electronic crossover component operates between the stereo preamplifier section and the six power-amplifier sections, where it can perform its task of frequency separation without degrading the potential response of either the speakers or the power amplifiers. (Conventional passive capacitance/inductance crossovers commonly used between the amplifier and speakers can affect damping and stability; cause phase shifts and impedance variations.)

Each amplifier following the electronic crossover is connected to an individual driver in the speaker system. There is actually a separate woofer amplifier, a mid-range amplifier, and a tweeter amplifier for each stereo channel. Because each amplifier handles a relatively narrow band of frequencies, IM distortion is reduced to the vanishing point. The critical crossover frequency between the woofer and mid-range units can be switch-selected to 150, 250, 400 or 600 Hz; between mid and high ranges to 3, 4, 5, or 6.5 kHz. Bass-turnover and bass-boost controls contour the response of the woofers to match both room acoustics and the overall response of the mid-range and tweeter. Output-level controls for low, mid and high ranges are provided for each stereo channel. A pair of full-size Sony 3-way speaker systems, driven (and precisely controlled) by the six amplifier channels, deliver a smooth distortion-free, wide-range frequency response.

Two program sources are included: an FM stereo tuner so sensitive that it pulls in the weakest stations, yet is absolutely insensitive to overload by strong local signals. The servo-control manual-play turntable is rated by High Fidelity magazine as having *"the lowest rumble figure yet measured (–77 db)."* The stable, precision-engineered arm with moving-coil cartridge is professional in every respect.

This Sony system is for the audio perfectionist. For those who wish to upgrade their system or start from scratch, these Sony components are available individually. For a delightful experience ask your Sony hi-fi dealer to demonstrate the $2574.50 system. Free literature describes the system in detail. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

The Sony $2574.50 system—TA-1120 integrated stereo amplifier, $399.50; two TA-3120 stereo power amplifiers, $249.50 each; TA-4300, 3-way electronic crossover, $199.50; ST-5000W FM stereo tuner, $399.50; TTS-3000 turntable, $149.50; PUA-237 12-inch tone arm, $85; VC-8E cartridge, $65; two SS-3300 3-way speaker systems, $349.50 each. Walnut cabinets for TA-1120 and ST-5000W, $24.50 each; turntable base $29.50. Prices suggested list.

Only $2574.50 (Only?)

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EQUIPMENT PROFILES

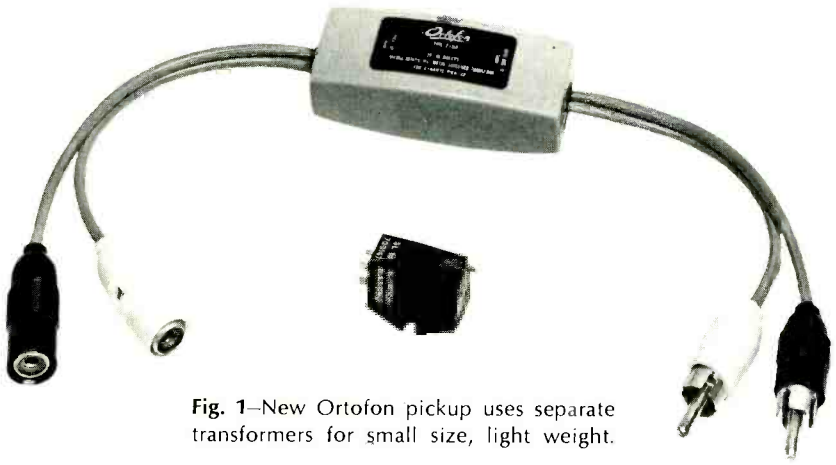


Fig. 1—New Ortofon pickup uses separate transformers for small size, light weight.

ORTOFON SL15T STEREO CARTRIDGE

MANUFACTURER'S SPECIFICATIONS—Frequency response: 10-40,000 Hz. Static compliance. 20 × 10^{-6} cm/dyne. Channel separation: 20-30 dB at 1 kHz. Stylus: 0.7-mil × 0.3-mil elliptical diamond. 15 deg. tracking angle. Weight of cartridge: 7 grams. Output impedance: 2 ohms. Recommended load impedance per channel: 1.5 ohms. Equivalent mass (at stylus point): 0.9 mg. Recommended stylus force: 1-2 grams. Output (without transformers, loaded): 0.04 mV. External transformer primary impedance: 1-5 ohms. Secondary impedance: 2100 ohms. Recommended load impedance: 10 to 50k Ohms. Frequency response: 10-40,000 Hz.

Of the four modus operandi of commercially-available phono pickups, the moving coil has significant theoretical advantages. If its magnetic field can be made linear, the output will then be strictly a function of the coil velocity. But the theoretical advantages only become real after good use is made of the operating principles in the design and manufacture of the cartridge.

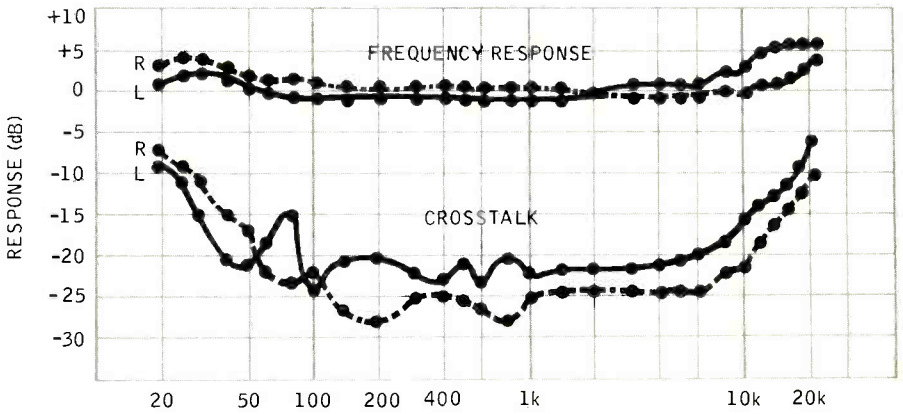
To get lots of Gauss for a superior signal-to-noise ratio, and good linearity for low distortion, the magnetic field has to be made linear and large. A more difficult problem still, is in making an efficient coil and stylus support system which stands up to the abuse of an all-thumbs operator. Most manufacturers have refrained from tangling with these problems by leaning toward different operating principles which employ simpler stylus suspensions and related tolerances. There used to be ESL, Fairchild, Neumann, Grado, and Ortofon not so long ago. Today only Ortofon and, just recently, Sony, are the only two available suppliers of moving-coil cartridges.

The Ortofon SL15T is a variation of the excellent S15T cartridge which preceded it. The S15T cartridge has built-in transformers, as you might know. Separating the transformers from the cartridge was an inevitable step because some of the latest tone arms are too small in either mass or size to cope with the S15T. So here we have the SL15T—a 7-gram peanut which will fit any tone arm, including those on automatic turntables.

The stylus assembly consists of an aluminum-tube cantilever which has a highly polished, square-shanked diamond mounted to its tip. The stylus, when viewed under a high-power microscope, looks smooth and clear, resembling glass. Since friction causes both record and stylus wear, and a smooth stylus cuts down on friction, this stylus should last longer and cause less record wear than many styli we've examined. The cantilever has a smooth tube surrounding it, a protective device which comes into contact with the record if excess downward force is accidentally applied. The cartridge body is only ⅞ in. long, and mounts on standard half-inch centers.

The SL15T does not feature a replace-it-yourself stylus. If the stylus should require replacement or realignment, it would have to be returned to the distributor. No doubt this is a distinct bother, but a redeeming feature is that the need to do this is less likely

Fig. 2—Frequency response and cross-talk curves for right and left channels are shown below. Design induces deliberate peaks above 8 kHz to counter loss of high frequencies due to tracing in inner record grooves.



"MATERNITÉ" by Renoir.
An original lithograph signed in stone. Catalog Delteil #50. From the collection of James B. Lansing Sound, Inc.

Art as a component of perception.

Solid objects broken down into component elements of light, shade, and texture, combining to create an undistorted mosaic of reality; fleeting visual impressions captured and recorded with uncompromising lucidity of style. "Impressionism" was a technique of discovery, an examination and portrayal of the components of perception.

True perception of sound results from the exact portrayal of each element of its composition.

The quality of sound reproduced by high fidelity equipment depends on the sensitivity of the loudspeakers and other component parts. Engineers and craftsmen at James B. Lansing Sound, Inc., have developed the world's finest loudspeakers and electronic components through uncompromising dedication to the ultimate expression of sound.

JBL

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EQUIPMENT PROFILES

(Continued from page 44)

to occur than with many other cartridges due to the fine diamond tip of the SL15T and its protective device.

Performance

The transformer assembly, shown in *Fig.* 1, accepts RCA-type plugs from the tone arm as its input, and its short cables plug into the magnetic inputs of preamps, leaving the transformer to hang close to the preamp.

After orienting the assembly properly, the signal-to-noise ratio of the SL15T cartridge through the transformers and a tube-type wide-band RIAA preamp was 50 dB referred to 3.4 cm/sec at 1000 Hz. This is certainly an acceptable figure. Hum was inaudible at listening levels. With transistorized preamps, an even lower hum level, and therefore a better signal-to-noise ratio, would probably be obtained.

For our tests, the cartridge was mounted in a 16-in. SME Series II tone arm. A tracking force of 1.5 grams was found to be optimum for low distortion and satisfactory tracking. Suffice to say that the SL15T had no difficulty tracking any commercially-made disc that we tried.

Sensitivity, using the transformers, was 6.2 mV at 1000 Hz on both channels, referred to 3.54 cm/sec rms, 45-deg. velocity. The frequency response is shown in *Fig.* 2. Channels were matched very well. Between 50 Hz and 5 kHz, the left and right channels were within 0.8 dB of each other. The response begins to rise above 8 kHz in resonant peaks, which we would normally attribute as inherent in the design. However, in a brochure issued by the distributor, the peak rise is said to be *deliberate*. This 4-dB peak was introduced, says Elpa Marketing, to counter loss of high frequencies due to tracing in inner grooves. If a slight rise is allowed at the outer grooves, only a minor drop will be evident at the inner grooves. Consequently, this gives a nearly straight frequency response over the major part of the record. The brochure goes on to say that the peaks have been reduced to 2 dB in current production units.

In listening tests, we did not find the peak rise objectionable. For all we know, this very rise may be contributing to the excellent sound quality of discs played with the SL15T. A 3-dB treble cut at the preamp will, of course, even things out a bit more. But in most cases it is not required.

We did not measure above 20 kHz in frequency, but from the graph it is evident that the response just keeps on going past 20 kHz. The relevance of response outside the audible range is a controversial subject that we shall not go into here. Crosstalk at 1000 Hz is an average 23 dB for both channels, with good separation maintained at both extremes of the frequency spectrum. So the over-all separation is excellent.

Photographs of scope traces while the cartridge tracked square waves of a CBS Labs STR-111 test record are

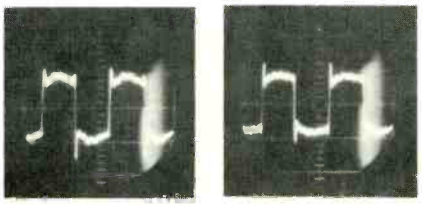

Fig. 3—Ortofon SL-15T produced above square waves at 1000 Hz. At left, the left channel tracked grooves with 3.54 cm/sec recorded velocity; Photo at right shows right channel's square-wave response to lateral cut at 5.0 cm/sec.

shown in *Fig.* 3. The square-wave response of the SL15T had one cycle of damped oscillation at the leading edge, which is due to the peak rise in frequency response above 8 kHz. The over-all waveshapes show the SL15T to be an exceptionally fine performer, with low distortion.

Listening tests confirmed this. The cartridge performed superbly with all types of record material, with stereo and mono records. The midrange sounded smooth, the bass line was solid, highs were clear and bright. (On some violin records, a 3-dB high-treble cut improved the balance.) Brass and transients reproduced particularly well. All in all, the new Ortofon SL15T is an outstanding cartridge for use in the finest stereo high fidelity systems, flawed only by some very minor installation inconveniences.

Price, with elliptical diamond stylus and separate model 2-15-K transformers, $75; without transformers, $60.

Check 46

MIRACORD PW50H AUTOMATIC TURNTABLE

MANUFACTURER'S SPECIFICATIONS—Speeds: Four. Record Sizes: 7, 10 or 12 inches. Tonearm: dynamically balanced; calibrated stylus-force dial (0 to 6½ grams) accurate to within 0.1 gram; max. tracking error, 0.5 degree/inch; lateral arm-bearing friction, less than 0.4 gram; fundamental resonance, under 8 Hz; gram-calibrated anti-skate control on deck. Turntable: dynamically balanced, one piece, 12″ in diameter. Rumble: better than −40 dB (NAB). Wow: 0.06%. Flutter: 0.02%. Speed Accuracy: better than 1%.

The PW50H is a plush one, all right. Aside from its handsome appearance, it fairly bristles with operating conveniences: manual and automatic play, pushbutton operation, illuminated speed indicator, built-in cueing device, stylus overhang adjustment (external), and power control base option, to name a few. And the $149.50 package (less optional Power Control Base, PCB-50, $22.50) is a truly smooth performer, as you would expect it to be.

The top-of-the-line Miracord came equipped with a phono cartridge for our tests. If it had not, however, we would have come face to face with a unique feature: a cartridge insert that allows the front-to-back position of the cartridge (and therefore its stylus overhang) to be adjusted after it was mounted in the tone arm by turning a

(Continued on page 48)

Fig. 4—Miracord PW50H automatic turntable with PCB-50 optional power control base.

There's Music in the Air!

Tape it with a Sony

There's a world of beautiful music waiting for you and it's yours for the taping. Let Sony-superb 4-track stereo capture every note faithfully while you relax in your easy chair. Simply connect your stereo tuner to the Sony Solid-State 230W, "Stereo Consolette," and tape your favorites off the air. And the Sony-exclusive **Stereo Control Center's** handsome front panel offers you all the versatility and convenience of the most expensive component preamplifier and power amplifier. Here is an instrument that is truly a complete home stereo sound system. Connect your stereo tuner, stereo changer or turntable to the 230 and the **Stereo Control Center** provides instant selection of musical source for listening or recording. Together with its laboratory-matched, dual speaker systems, the Sony 230W "Stereo Consolette" offers the look of elegant furniture for the most fashion-conscious home. There's pure luxury in its oiled walnut cabinet smartly trimmed in satin chrome and black, the precision, machine-turned knobs, switches that slide smoothly beneath the fingertips. Yet complete with matching Sony SS-23 dual speaker systems, two Sony F-45 cardioid dynamic microphones, the Sony 230W is priced less than $299.50.

SONY'S PROOF OF QUALITY — A FULL ONE YEAR WARRANTY

SONY® SUPERSCOPE® The Tapeway to Stereo®

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SONY Solid-State Model 230, "Stereo Compact Portable." The sensational new "230" packed for travel. Here is a complete, ready-to-go stereo tape system. Its high-compliance lid-integrated, dual speaker systems may be separated up to fifteen feet for maximum stereo effect. Handsomely encased for rugged use, yet styled for the look of high fashion. Complete with two Sony F-45 cardioid dynamic microphones, less than $249.50.

The Model 230W, pictured above, can be purchased without the SS-23 Speakers. Select your preference in speakers, or use the Sony 230W as a tape deck and preamplifier for auxiliary components in a stereo sound system with a basic amplifier of any desired higher output. Complete with two Sony F-45 cardioid dynamic microphones, less than $239.50.

EQUIPMENT PROFILES

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slotted lead-screw at the front face of the arm. A little thing, you say? Well, so are power seats on automobiles, but it's sure a pleasing refinement to have when your wife shifts the position of your seat every time she drives.

The front-to-back cartridge-position adjustment is done after the insert is slipped into the arm. A retractable pointer on the turntable deck indicates the position at which the stylus should be set. This method is decidedly more accurate and easier to use than are templates. With the offset correctly set, the arm had a maximum tracking error of just under 0.5 deg.-per-inch or radius. This figure is excellent.

To balance the tonearm, which has a square cross-section shape, a vernier drive knob is adjusted. This moves an acoustically-isolated counterweight. A direct-reading stylus force adjustment dial, an integral part of the tonearm, is graduated in ¼-gram increments (it may be set in between, as well). It was found to be quite accurate and easy to use throughout most of its range.

Near the tonearm is another dial-it-yourself knob, this one controlling the amount of anti-skating compensation applied to the arm. The design employs a rotary spring to exert an opposing force to arm motion. The force, applied to a cam beneath the arm, travels toward the center of the record, which is just what an effective anti-skating device ought to do. The numbers on the anti-skating dial correspond to numbers of the stylus-force dial. Accordingly, the anti-skating knob is simply turned to the same number as the one set for stylus force.

The tonearm has a bearing suspension with lateral friction measured at 0.5 grams throughout most of its travel, making it adequate for the most compliant cartridges available today. Furthermore, the plane of the vertical pivot is parallel to the cartridge rather than perpendicular to the arm shaft. This reduces flutter caused by the inevitable fore and aft play in the arm pivots.

An arm support with a lock position is another nice design touch. It reveals either a red or green color, denoting lock position and free-to-move position, respectively. A safety protects the changing mechanism from damage, however, should the tonearm be left accidentally in a locked position while cycling through.

With today's featherweight tracking forces, a cueing device is more than a luxury. So it's no surprise to find a built-in cueing device on the company's best turntable. The device, which permits the tonearm to be raised and lowered independent of the arm and turntable mechanism, is a pneumatically-controlled platform which elevates the arm enough to permit it to be moved across a record without touching its surface. With the stylus over the selected groove, a flip of the lever releases a silicon-damped piston which lowers the platform, gently setting the arm down for play.

The 50H turntable's 12-in. platter is a heavy (almost 5½ pounds), nonferrous metal casting. Compensating weights visible on the underside of the platter attest to factory dynamic balancing. Teflon-encased ball-bearing races are used in its support, requiring no maintenance.

The popular Papst hysteresis-synchronous motor, with a stepped pulley mounted to its shaft, drives a rubber interwheel. Speed is controlled by a conveniently-located lever which elevates the interwheel to engage any of the four pulley steps selected. The set speed is indicated in a little window that lights up, doing double duty as an "on" light, too.

A set of four pushbuttons controls the automatic operation of the changer. Pressure required to actuate one of these pushbuttons is so very low that there is no evident danger of jarring the unit. Accordingly, the user can reject a record in mid-stream without "skipping" (or even an audible pop). Or the arm can be manually positioned, in which case the turntable starts revolving as soon as the arm is removed from its rest position.

Two spindles are furnished with the unit. A shortie for manual or automatic single record play, and the "Magic Wand" spindle for stacking records and automatic multi-disc play.

Performance

The unit performed well with one through ten records on the turntable. Rumble, including vertical and lateral components, was measured at −32 dB referred to 1.4 cm/sec at 100 Hz (or 3.54 cm/sec rms 45 deg. velocity at 1000 Hz), the standard NAB method for rumble measurement. With the vertical rumble components cancelled by paralleling the cartridge outputs, rumble was −41 dB, confirming the manufacturer's claim. These figures are comparable to most non-professional manual-only turntables. At normal listening levels, rumble is noticeably absent. Most of the rumble energy was between 20 and 30 Hz.

With 10 records on the turntable, it was an insignificant 0.05% fast. With one record, it was 0.5% fast. Varying line voltage from 60 to 140 volts did not affect speed. Wow was clocked at 0.08%, and flutter was insignificant.

(Continued on page 50)

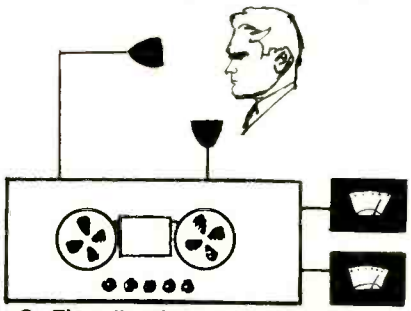
Fig. 5—Concertone 770 four-track, four-speed, stereo tape recorder

Now... the first lavalier microphone without 'lavalier sound': the MD 214 by SENNHEISER

Among the many reasons for using lavalier microphones are their constant distance from the performer (less need to 'ride gain') and unobtrusiveness. However, *ordinary* lavalier microphones have 'lavalier sound,' a muffled, noisy quality that makes them unsuitable for commercial use.

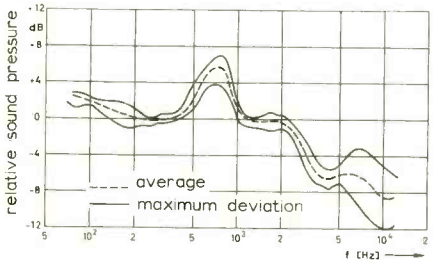
What causes 'lavalier sound'?

1. Directional sound radiation: The mouth radiates sound, especially higher frequencies, in a beam-like pattern, resulting in lower off-axis sound pressures at lower frequencies. Since lavalier microphones are always significantly off-axis, a loss of 'presence' results.



2. The vibrating chest: Extensive research has shown that the chest acts as a radiator in the region of 600-800 Hz, with peak energy radiated around 700 Hz (surprisingly, this figure varies little between the sexes). When ordinary lavalier microphones are placed in position they pick up this energy, imparting a boomy quality to speech and singing alike.

3. Noise problems: Three kinds of noise plague the ordinary lavalier microphone: mechanical noise conducted along the microphone cable, noise from friction generated when the microphone rubs against clothing, and airborne noise, such as cloth rubbing against itself.

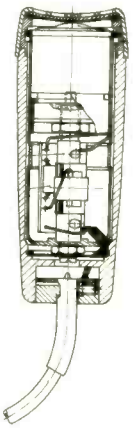


How the MD 214 eliminates these problems:

Contoured response restores lost 'presence': Sennheiser engineers conducted extensive tests, comparing the response of a microphone placed in the lavalier position with an identical one placed on-axis. Using a number of subjects, they were able to plot an average curve of difference. By judicious construction of the transducer assembly, the MD 214's response was tailored to a 'mirror-image' of the difference curve. The result: unusually flat response in the audio range.

Filtering prevents boominess: A specially-engineered filter, unique with Sennheiser, attenuates frequencies in a narrow region around 700 Hz, eliminating the hollow, muffled quality produced by pickup of chest vibrations.

Shock-isolation cuts noise: The MD 214 is built to eliminate noise from the inside out. The transducing assembly is housed in a 'case-within-a-case;' a separate assembly which is pneumatically damped and slides in a permanently-lubricated plastic gasket. This unit, which serves as a noise baffle, is in turn surrounded by a thick cast housing, which has rounded corners to reduce friction, while preventing the microphone from rolling side-to-side. The microphone cable has a flexible internal strain relief, which prevents mechanical noise from reaching the transducer via the cable.



The result of these engineering innovations is a microphone specially-created to meet the stringent pickup requirements of the film and broadcast industries. For technical data on the MD 214 or any other dynamic or condenser microphones in the Sennheiser line, please call or write:

SENNHEISER
electronic
CORPORATION (N.Y.)

500 Fifth Avenue, New York, N.Y. 10036
Telephone (212) 564-0433
(manufacturing plant, Bissendorf, Hannover, West Germany)

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EQUIPMENT PROFILES

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There were no arm resonances down to 10 Hz. And the unit mounted in the PCB-50 accessory base was not particularly sensitive to shock and vibration or acoustic feedback.

The PCB-50 base is a handsome 17 in. by 14½ in. by 4 in. walnut unit which supplies power to the PW50H changer. It also connects its built-in a.c. receptacle to the changer's on-off switch. Thus, it enables, say, an amplifier which is plugged into the base to be turned on and off automatically by the changer. Previously, it would have been ill-advised to switch large amplifier currents through a changer's switch contacts. But with transistorized units, which draw less electrical power than earlier vacuum tube units, there's no problem. Therefore, we gain a most convenient feature. An illuminated nameplate indicates that the changer is "on" whether the rear-mounted receptacle is energized or not. This base was found to be very effective and is an appropriate accessory to the PW50H automatic turntable.

In glancing between the test data and the PW50H it is obvious that a lot of good engineering must have gone into this product to have successfully incorporated so many worthwhile features while, at the same time, improving basic turntable-arm characteristics. We can only conclude that the Miracord PW50H is an outstanding performer in all respects and find that its automatic features make it a pleasure to use. Check 44

Concertone Model 770 A.C./Battery-Powered Stereo Tape Recorder

MANUFACTURER'S SPECIFICATIONS—Tape Speeds: Four. Tracks: Four, stereo or mono. Reel Size: Up to 7-in. Power Requirements: 6 standard "D"-size flashlight cells, 117 Volts a.c. Frequency Range: 30-15 kHz at 7½ ips, 30-10 kHz at 3¾ ips. Flutter and Wow: Less than 0.25% rms at 7½ ips and 3¾ ips. Power Output: 0.8 Watts per channel. Signal-to-Noise Ratio: Better than 45 dB. Dimensions: 11 13/16 in. x 13 7/8 in. x 5 5/8 in. Weight: 16 Lbs. with batteries.

Among the many questions we receive from readers every month is, "What kind of a tape recorder should I buy?" In most instances, the inquirer does not describe thoroughly just how he intends to use the tape recorder—whether just for fun, to dub old records to tape, to record musical groups, or simply as a memory device on which he can "dictate" his thoughts or ideas for later reference. And without this vital information it is practically impossible to give any valid suggestions as to the type of recorder he should buy.

One of the increasingly popular uses of tape recorders is for capturing sounds of life wherever they may occur, which makes it imperative that the machine be battery powered. To be sure, there are some very fine machines which are completely adequate for professional recording of music and which depend solely on battery power. And there is one which derives its motive transport power from a spring motor which will provide some four minutes of running with one winding. Its electronic section is battery powered. In fact there are several models which are exceptionally good for "location" recording, but most of them are relatively expensive, and it is often beyond the realm of the average budget. At the other end of the scale, of course, are the many battery-powered machines which are little more than toys—in particular, the reel-drive devices (which are in rapid decline) but which serve as long as the tape recorded on them is also played back on the same machine—or possibly on another machine of the same make, in case one makes tapes which are to serve as "letters" to a friend or relative. But these recorders have a limited use, and certainly cannot be depended on to produce a really good tape. Furthermore, most of these "toy" machines will accommodate reels no larger than 3¼ in., which severely limits their use.

Then comes the 700 series of Concertone recorders comprising three models—the 700, which is a 2-track mono unit, the 727, which is 4-track mono unit, and the 770, which is a 4-track stereo recorder. All have four speeds—7½, 3¾, 1⅞, and 15/16 ips. All are cordless, but all can also operate from a 117-volt a.c. line without adapters, requiring only the line cord. For battery operation, they require 6 standard "D" cells. All accommodate 7-in. reels, and all are simply loaded with features.

The Model 770 battery-powered machine is of particular interest to tape enthusiasts because it offers stereo record and stereo playback at a relatively low cost.

The 770, with which we are specifically concerned in this PROFILE, will record and play 4-track stereo, record and play quarter-track mono, and play two-track stereo and mono on its built-in 3 × 5½-in. speakers or on external speakers, using its own 800-mW power amplifier, or it will provide a line output ahead of the power amplifiers for feeding another amplifier system. It is equipped with a stereo headphone jack, individual microphone jacks for each channel, line input phono jacks, and a dual jack which accommodates the dictating microphone which may record on either channel, at the same time providing monitoring from the channel being recorded.

The dictating microphone is equipped with a switch which controls the motor power, enabling the user to start and stop the tape motion from the remote microphone position. Two separate, matched dynamic microphones are included for the usual recording chores.

Other features include a three-dial

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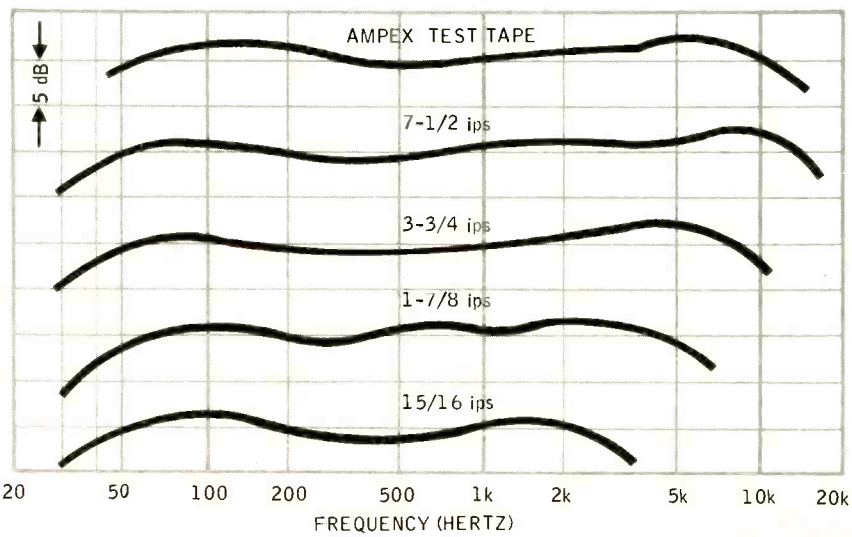
Fig. 6—Record-playback response of Concertone 770 at 4-speeds.



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digital counter with a push-to-reset button, speaker switch which cuts off the internal (and external, if these are being used) speakers in one position, and cuts off the headphone jack in the other. The power switch has two positions—a.c. and battery. When the a.c. is connected, the "off" position is battery, and vice versa. When the operating knob is in the off position, there is no current drain anyhow, so the batteries are not run down. With a 1200-ft. reel of tape on the machine, there is a current drain from the batteries of approximately 400 mA when recording on both channels. In the play mode, there is somewhat more current drain when the speakers are being driven to listenable volume. We would expect one set of batteries would last from 10 to 20 hours in normal use.

There is a fast-forward knob and an instant pause knob. One more switch controls which channel is being recorded with the dictating microphone. The line input and output phono jacks are located on the back in a recessed space, along with the a.c. input plug which mates with a receptacle on the line cord. The headphone jack is also located in this space.

The reel hubs have a spring clip which retains the reels excellently so that operation in the vertical position is possible without the need for reel retainers. A tone control is provided for each channel and it works only during playback.

Though the 770 is a three-head machine, no provision is made for monitoring from tape during recording. It is likely, therefore, that the use of an extra head is a production expedient to simplify switching.

Circuit Description

The two channels are electrically identical, and consist of two transistor stages with feedback around them to provide equalization for both recording and playback. These are followed by an amplifier stage and the driver stage, the latter having additional equalization in its emitter circuit. The driver is transformer-coupled to the two output transistors in each channel. Feed for the record head derives from the collector circuit of the driver stage. The supply voltage for all stages except the output is regulated by a transistor circuit, and two additional transistors serve as amplifiers to drive the two record-level meters. The bias/erase oscillator circuit consists of a single-ended oscillator stage followed by a push-pull amplifier stage. When recording in only one channel, a resistor is substituted

for the erase head of the unused channel to maintain correct loading on the oscillator circuit. Plugging microphones into the mic jacks cuts off the line inputs, so there is no provision for mixing inputs. Motor speed is regulated by a governor.

Performance

The curves show the frequency response of the 770 in five modes—playback from a 7½-ips standard frequency tape, and in-and-out response for the four speeds. Wow and flutter measured 0.23 at 7½ ips, 0.26 at 3¾, 0.36 at 1⅞, and 0.47 at 15/16, which is within specifications. Signal-to-noise ratio measured 46 dB, and maximum power output per channel, measured separately, was 825 mW; together, 785 mW per channel. Rewind and fast-forward modes clocked at just under 2 minutes for 1200 feet of tape.

Clearly, the 770, like most portables, is no earth-shaker when it comes to playback fidelity. The audio amplifier system is necessarily limited to keep down the weight, size, and cost. But since the 770's recording capability easily exceeds its playback performance, a discerning hi-fier can realize satisfactory fidelity by playing back the recorded tape through external amplifiers and speaker systems of high quality.

Considering that this recorder measures only 11 13/16 in. wide by 13⅞ in. high and 5⅜ in. deep and weighs only 16 pounds with batteries, it is obvious that a lot of machine is packed into a small space. (It is also apparent that portability here does not mean tuck-it-in-a-pocket versatility.) While neither 7- nor 5-in. reels can be on the machine with the cover on, 3¼-in. reels can, so that the recorder can be carried "ready-to-go," if desired, although the machine can be carried without the cover and with 7-in. reels in place. Accessories furnished with the 770 include the two dynamic microphones, the remote-control "dictating" microphone, the a.c. line cord, and two 3-ft. patch cords equipped with phono plugs on both ends. The microphone plugs are standard phone plugs; the remote-control microphone is a special dual plug, and the remote speaker jacks take standard phone plugs.

On the whole, we think this is a handy, flexible machine for the user who needs portability, plans to record stereo where an a.c. outlet is not available, and yet who cannot justify the expense of the more professional machines. The 770 is priced at "less than $289." Check 50

The New NAB Standards

(Continued from page 38)

plicity and elegance at the time of writing the NAB Standard):

["A Recorder Flux Characteristic, which is the tape flux produced by constant input voltage to the Recorder. (A concept not used by NAB.)

["A Reproducer Flux Characteristic, which is the output voltage produced by constant flux input to the Reproducer. (Fig. 2.)

["A Relative Reproducing Characteristic, which shows the deviations (or allowable deviations) of a system from the Standard Reproducing Flux Characteristic. (Fig. 3.)

["A Relative Recording Characteristic, which shows the deviations (or allowable deviations) of a system from the Standard Recording Flux Characteristic. (Fig. 4.)"]

Frequency Response Specifications

When measuring playback response in the manner previously described (by playing the NAB Standard Test Tape for a particular speed), response shall be within the following limits referred to 400 Hz: At all speeds, +1 db between 20 and 20,000 Hz. At 7½ ips, −1 db between 100 and 10,000 Hz, and dropping to −3 db at 30 and 15,000 Hz. At 15 ips, −1 db between 100 and 15,000 Hz, and dropping below this range to −3 db at 30 Hz. At 3¾ ips, −1½ db between 100 and 7500 Hz, and dropping outside this range to −3 db at 50 Hz and −4 db at 10,000 Hz.

Recorded response, measured in the manner previously described, shall be within the following limits referred to 400 Hz: At all speeds +1 db between 20 and 20,000 Hz. At 7½ ips, −1 db between 30 and 10,000 Hz, and dropping above this range to −2 db at 15,000 Hz. At 15 ips, −1 db between 30 and 15,000 Hz. At 3¾ ips, −1½ db between 50 and 7500 Hz, dropping above this range to −4 db at 10,000 Hz.

(Continued next month)

ABZ's of FM

LEONARD FELDMAN

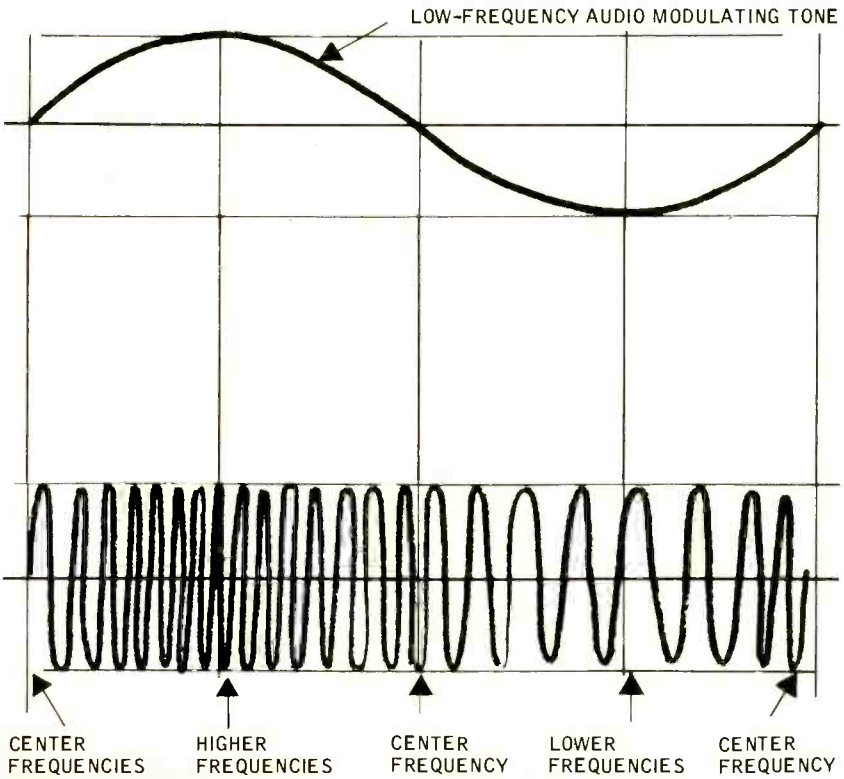
In FM, the amplitude of the r.f. carrier remains constant at all times. It's the *frequency* of the carrier that is varied by modulation, as shown in Fig. 1. Again, a low-frequency audio tone is used to modulate the carrier. As the audio tone goes positive, the frequency of the FM carrier *increases* (more alternations per second), whereas when the audio tone crosses the zero axis (and has no amplitude, instantaneously), the frequency of the carrier returns to its center or nominal value. Finally, when the audio modulating voltage goes negative, the carrier frequency *decreases* (fewer alterations per second).

The amount of carrier frequency variation about its nominal center is governed by the *amplitude* of the modulating voltage. To put it another way, a symphony orchestra playing loud passages will cause the carrier frequency to shift about its nominal center *more* than would a whispering vocalist. The frequency of the audio modulating voltage merely determines the rapidity with which the FM carrier swings above and below its center frequency.

To summarize, a *strong* audio signal (loud) will shift the carrier frequency about its nominal value to a greater extent than will a weak (soft) tone. The number of times per second that this frequency shift occurs is governed by the frequency or pitch of the modulating tone.

(Continued on page 56)

Fig. 1—Detailed examination of what happens to the frequency of an r.f. carrier when it's modulated by an audio tone. This entire sequence represents just one cycle of the modulating tone. It would be repeated 1000 times per second for a 1 kHz audio tone.



ABZ's of FM

(Continued from page 55)

From the above, you can see that the term "100% modulation" really has no specific meaning, in a physical sense or limitation, when applied to FM. Because of certain other considerations that will be discussed shortly, however, maximum allowable "deviation" (amount of departure from "center frequency") has been set by the FCC as 75 kHz above and below the carrier frequency.

To minimize any possible interaction between stations, an additional 25 kHz is allotted on either side of these extremes. Therefore, each station is assigned a "bandwidth" of 200 kHz (75 kHz + 25 kHz about the center frequency). As a practical matter, the maximum number of stations that might be assigned in a given locale would be (108 MHz − 88 MHz = 20 MHz = 20,000 kHz; 20,000/200 =) 100. Again, in actual practice, the FCC seldom assigns stations closer than 400 kHz apart in an immediate geographical area.

FM Sidebands

As was true in AM, sidebands are formed as a carrier begins to be FM-modulated. So long as the frequency deviation is held to some minimum amount, two sidebands only are developed, just as in AM.

The upper sideband will be removed in frequency by the frequency of the modulating tone above the carrier frequency and the lower sideband will be displaced below the center frequency by the same amount. So far, the situation is the same as in AM. As we increase the amplitude of the modulating tone (and therefore the frequency deviation of the carrier) beyond a minimum value, however, additional significant sidebands appear at multiples above and below the carrier. Thus, if a strong audio signal of 1000 Hz is used to modulate a carrier centered at 90MHz, sidebands will appear at 90.001 MHz, 90.002 MHz, 90.003 MHz, etc., and 89.999 MHz, 89.998 MHz, 89.997 MHz, and so on.

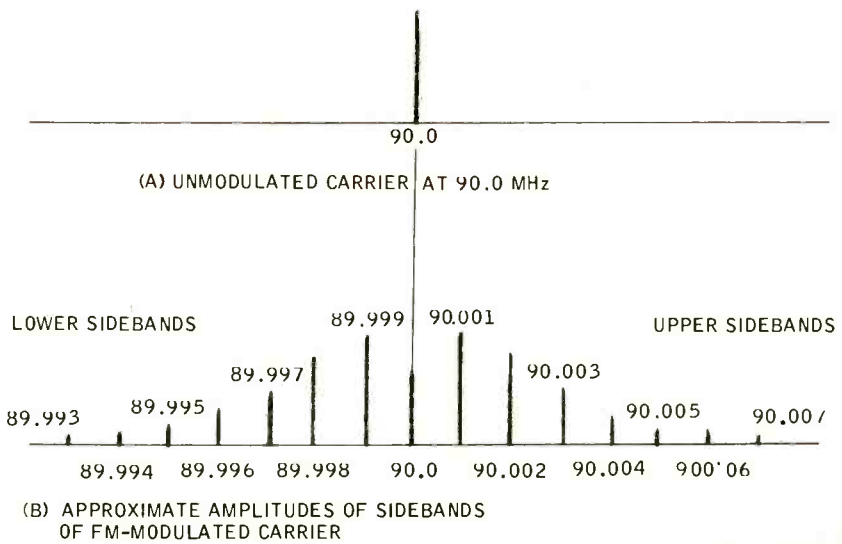
Note that we used the term *significant* sidebands. In theory, an *infinite* number of sidebands are produced. At any given modulating intensity, however, only a finite number of these have sufficient power to be of any significance.

We have seen, however, that whenever sidebands are formed, they are spaced apart by a frequency equal to the modulating tone frequency. This may be seen as shown in Fig. 2, in which the modulating frequency is 1 kHz and modulation intensity is strong enough to produce seven significant sidebands above and below the center carrier frequency.

Now suppose we wished to transmit a 15 kHz tone instead of 1 kHz and that the intensity of modulation is to be the same. Fig. 3 indicates that seven sidebands still result above and below the carrier, but since the modulating frequency is now 15 kHz instead of 1 kHz, the seventh sideband is fully 105 kHz above and below the carrier frequency.

We therefore observe that the frequency bandwidth required by a frequency-modulated carrier depends

Fig. 2—Formation of sidebands about an FM carrier when it is modulated fairly heavily by a 1000 Hz tone. All frequencies are in MHz.



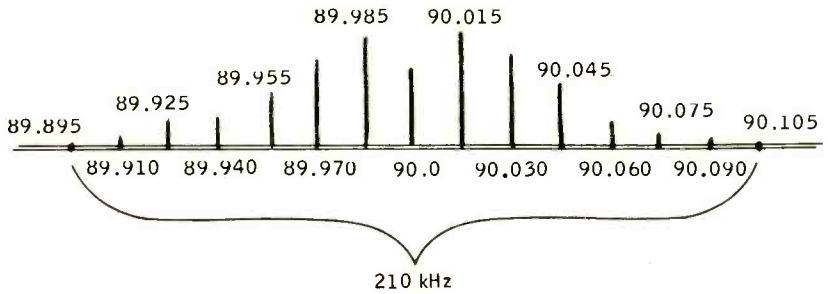


Fig. 3—The only change from Fig. 2 is the **frequency** of the modulating tone. It is now 15 kHz instead of 1 kHz, and the resultant sidebands now extend 105 kHz on either side of the carrier's center frequency.

upon two factors: *intensity* of the applied modulating audio voltage and *frequency* of this voltage. From these considerations evolve the term *modulation index*, which is defined as the ratio of FM carrier deviation to the audio frequency causing the deviation. In current U. S. practice, the maximum deviation permitted is 75 kHz and the highest audio frequency used is 15 kHz (hence the "high-fidelity" connotations for FM, as opposed to the 5 kHz limit generally imposed with AM). Thus, the modulation index for these conditions is 75 kHz/15 kHz or 5.

Complex calculations show, however, that a modulation index of 5 always produces no less than 8 significant sidebands above and below the main carrier frequency. It is always somewhat confusing to the student of FM to learn that, although the carrier frequency is never actually shifted by more than ± 75 kHz above and below the center, *sidebands* do appear beyond these limits. For example, if a 15,000 Hz tone were to fully modulate an FM carrier (Index 5) out to ± 75 kHz, we have said that 8 sidebands would be formed on either side of the carrier. The most remote of these sidebands would be 8 x 15 kHz removed from center frequency, or 120 kHz above and below the carrier center.

In actual practice, a 15 kHz note will seldom have enough intensity to deviate the transmitter to its 75 kHz limits, though in theory this condition is possible and would be within the limits set by the FCC. The FCC rules merely state that the maximum *shift* of the carrier frequency never exceed 75 kHz. Often, when the 75 kHz shift is fully utilized, significant sidebands often appear outside the 75 kHz limits. Usually, their energy contribution is quite small and, besides, the extra guardband of that additional 25 kHz helps to reduce the possibility of interstation interference.

Thus far, we have examined the nature of FM and AM modulation in relation to imparting information to an r.f. carrier. The table of comparison between the two forms of modulation shown here summarizes some of the significant facts which will help to clarify later installments. Æ

TABLE I

	AM	FM
Public Frequencies	640-1640 kHz	88-108 MHz
Carrier Amplitude	Varies from 0 to 200% of nominal	Constant
Carrier Frequency	Constant	Varies ±75 kHz from center
Audio Loudness Varies	Amplitude of carrier	Frequency of carrier
Audio Frequency Varies	Rapidity of carrier amplitude changes	Rapidity of carrier frequency changes
Sidebands Produced (Significant)	Two—upper and lower	2 to 16, depending upon modulation intensity
Highest Frequency (Audio)	5,000 Hz (with some exceptions)	15,000 Hz
Station Bandwidth	10 kHz (some exceptions)	200 kHz (including 25 kHz guardband at each extreme)

RECORD REVIEW

EDWARD TATNALL CANBY

Haydn: Concerto in F for 2 Flutes; Concerto No. 1 in D for Horn. Max Stern, Ilse Roth, fls., Ernst Stolzinger, horn; Mozart Society Players.
Pirouette JAS 19010 stereo

There's missing info on this fine record, but it's not hard to fill in. The Concerto for 2 flutes is one of several works originally written in the 1780's on commission from the zany King of Naples. He favored the lira organizzata, a stringed hurdy-gurdy played via a crank and a tiny keyboard, which also had an attached bellows and a set of tiny organ pipes. The concertos were for two of these—evidently the King needed moral support. The music was much too good to be lost and so is often played in arrangements for more practicle instruments—the flutes do just fine.

The Horn Concerto is obviously a work of the earliest Haydn period (probably 1762), not exactly profound, but it sparkles. The horn plays in the then-current "hunting" manner, a vigorous outdoor sort of music, not a bit lugubrious.

Excellent performance all around, in both works. But the sound is screetchy as well as a bit distorted. Is this one of those European-American mismatches in respect to recording curve? Likely. Just roll off the highs with your tone control, and the music comes into excellent balance. Why do they do this to us so often? E.T.C.

Two Great Organs. (Bach: Chorale Partita, "O Gott du frommer Gott"; Boyvin, Selections from First and Second Books.) Noelie Pierront, Silbermann organs at Marmoutier, Ebersmunster.
Music Guild MS 140 stereo

A French lady organist here plays Bach on one Silbermann organ, an obscure late-17th century French Baroque composer, Jacques Boyvin, on another. She manages to make both organs and composers sound remarkably French.

The Silbermann clan of organ builders came from Strasbourg and their organs are mostly in that area, which has been French and German on and off over the centuries. The Ebersmunster organ as here recorded is a tremendously brilliant instrument in an enormous and somewhat obscuring liveness—this last, of course, partly a factor of mike placement. The Boyvin works, arranged in the French-Baroque manner under titles indicating the stops used (as in Couperin), are highly ornate, with rather odd-sounding harmonies, their colorful presentation marred by the extreme confusion of reverb. Nice sound, but it's hard to follow the musical sense. The registrations are colorful to the point of fussiness, even on this old organ. Too much, I'd say.

The same thing comes out more clearly in the Bach (an early and colorful work, to be sure), as played on the somewhat more subdued Marmoutier organ. Same big, obscuring liveness, same multiplicity of color changes and the same confusion, as harmonies overlap and blend. Still—a nice sound. E.T.C.

Baroque Organ Masters (Buxtehude, Boehm, Walther). Kenneth Gilbert, Casavant organs at St-Jean and Joliette (Quebec).
Pirouette JAS 19034 stereo (via Everest)

These organs are Canadian, as is the young organist. The music is nicely laid out, on each side a Buxtehude, a Boehm, and a Walther, three interesting Baroque composers born successively in 1637, 1661, and 1684. The last, Walther, a contemporary and friend of J. S. Bach.

In contrast with the French playing of Noellie Pierront on Music Guild, Kenneth Gilbert's performances are recorded with a sound on the dry side, fairly close-up, and his playing is resolutely metrical; not a note is obscured nor a harmony blurred. The St.-Jean organ on Side One is a bit too dry for comfort, if clear in sound. The Joliette instrument is brighter, warmer, and more alive.

Though Gilbert's technique is brilliant, he is not a warm player; he seems in a hurry, gives precious little leeway to those graceful elements of drama that in this sort of Baroque music should have time to "digest" in the ear. His musical intelligence is such, however, that the sense of these worthwhile works gets through, even if in a mildly frosty manner. E.T.C.

Dvorak: Czech Suite, Op. 39; Serenade for Winds, Cellos, Basses, Op. 44. Musica Aeterna Orch., Waldman.
Decca DL 710137 stereo

This is one of those rare New York-based orchestral recordings (the Philharmonic aside). And it's a nice one. Two informal Dvorák serenades, one for a standard small "classical" orchestra, dominated by strings, and the other (better known, this one) for winds, with cellos and double-bass on the bottom.

Frederic Waldman is an old-world-type conductor who has done a lot to tame New York's somewhat undisciplined, floating population of symphonic performers, most notably with his Musica Aeterna concerts, taken up by Decca for recording. New York players are remarkably like New York taxi drivers—independent, clannish, cynical philosophers who expect the worst and usually find it. Yet, if you can scratch them hard enough, sheer sentimentalists at heart. Waldman doesn't have an outstanding collection of these high-priced performers; but he does get through to his men and they sing for him.

I've heard smoother, more intense playing of the Wind Serenade on other records; the Czech Suite could be better in ensemble. And yet the spirit in both is very bright, very real. For New York—that's something. E.T.C.

Six Sonatas for Oboe and Continuo (Handel, Boismortier, Telemann, Locatelli). Jacques Simard; K. Gilbert, hps., M. Carpenter, cello.
Pirouette JAS 19007 stereo

One of Pirouette's Canadian products, this Baroque recital of oboe sonatas is excellent of its sort. The only problem being built-in is an inevitable monotony. That is, until you manage to neutralize the oboe itself,

plus harpsichord-cello accompaniments, and thus become aware of the considerable and interesting differences between these works. Simard is French Canadian, trained in Quebec and in Paris. Michael Carpenter and Kenneth Gilbert (cello and harpsichord) are presumably Canadian colleagues.

The oboist is graceful and agile, very knowledgeable as to current Baroque-style performance. The two-man continuo accompaniments are a bit on the lumpy side, rather prominently featured in the recorded balance. (The effect would be less lumpy if the mikes had been further away.) With so much oboe to listen to, perhaps this was a deliberately chosen balance to emphasize the strong harmonies. Not a bad idea for such a recorded recital.

E.T.C.

16 Great Overtures: Scherchen, cond., 3 record set
Westminster WMS-1021 stereo

When Hermann Scherchen died last year, he left a void that has not yet been filled. He was more than an eminent conductor. He was a musicologist in the true sense of the word. He was also deeply interested and involved in the electronics of recording. He was enough of an audio buff to develop his own music-producing electronics studio to which composers, engineers, and performers were regularly invited. He placed himself in the very forefront of avant-garde musical interests.

As an interpreter, he was certainly controversial. *The New York Times* said, "As a conductor he has been described as 'precise,' 'economical,' 'strong-minded,' 'unconventional,' 'idiosyncratic.' That he had communicative powers was rarely questioned, but his interpretations raised strong opinions, both pro and con."

It is not for me to pass judgment on Scherchen. History will deal with him as it will. However, Westminster has seen fit to release this three-record set culled from their extensive library of Schercheniana. Westminster's title writers felt impelled to add the word "great" to the album's cover. I can't agree. To be sure there are sixteen overtures, but it is questionable as to how many are "great."

The overtures are—Adam: *Si J'Etais Roy;* Auber: *La Muette de Portici;* Beethoven: *Consecration of the House, and Coriolan;* Boieldieu: *La Dame Blanch;* Lalo: *Le Roi d'Ys;* Maillart: *Les Dragons de Villars;* Rossini: *Thieving Magpie, and William Tell;* Thomas: *Mignon;* and the following Weber overtures: *Abu Hassan, Euryanthe, Jubilee, Oberon, Peter Schmoll, Preziosa.* There is nothing *bad* here, but not everything is *great.*

These recordings cover a considerable period, I suspect. The Beethoven and Rossini works, all on one disc, are with the Vienna State Opera Orchestra. They represent the poorest sound and stereo in the case of the Rossini; as for the Beethoven, this is reprocessed mono-into-stereo, which, for my money, is no stereo at all.

All the remaining works are performances of the Orchestre du Theatre National de l'Opera de Paris, and sonics are satisfactory. The Weber works, all contained on the final disc of the set, represent the best sound of the lot, nearly as good as can be had.

I should point out that all the performances are recorded rather dryly. While this is not intended as a criticism, it does serve to accent the real audio fault of the album. It would seem that the re-recording engineers might have had the feeling that the masters lacked bass. So every work has something of a bathroom boom at the bass end. Not overbearingly so, the engineers were judicious, but enough to be annoying.

No, this set cannot be recommended on the basis of its interest for audio buffs. This is a collection for the person who feels that Scherchen had something important to say and that effort should be made to preserve that statement. I am one of those people.

M.R.

Performance: A *Sound:* B+ to C—

Brahms: Clarinet Quintet in B minor, Op. 115. Mozart: Duo in G Major, K. 423. Vladimir Riha, clarinet. The Smetana Quartet.
Crossroads 22160080 stereo

Brahms really discovered the clarinet late in life. His four symphonies and numerous orchestral compositions were already behind him when he came upon the renowned clarinetist, Richard Muhlfeld, who evidently so impressed Brahms that he immediately set about writing some chamber music for Muhlfeld to play. First came the Trio which blended the quality of the clarinet with the cello and piano (Op. 114). This was in 1891 when Brahms was 58. He warmed up to the task of writing for the clarinet and plunged immediately into a work of infinitely greater inspiration, the Quintet (Op. 115) for clarinet with a string quartet. This is unquestionably one of the ingratiating works Brahms produced, for which we owe Richard Muhlfeld a vote of thanks. This sudden enthusiasm for

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Tape Recording and Reproduction	Arthur E. Gruber, Consultant
Transducers	Philip B. Williams, Jensen Mfg. Div., Muter Company

AUDIO ES

the clarinet did not wane with the quintet, since two sonatas for clarinet and piano (Op. 120) were produced by the composer three years later.

Obviously, Brahms was aware of the instrument since he used it in his earliest compositions but it took an outstanding clarinet player to really demonstrate what could be done with it.

The Quintet was a success right from the first performance and the records indicate that the highlight of the piece was the second movement, the Adagio, which is an exceptionally inspired example of musical poetry. The mood and the setting is that of a gypsy campfire, where the clarinetist holds forth and sings a melancholy song, with murmuring strings behind him to complete a picture of perfect tranquility and an utterly relaxed atmosphere.

Crossroads gives us one of the more musical interpretations available on disc. This is not spectacular playing for technical effect, but simple straightforward musicianship. The Smetana quartet play with excellent blend on all four strings. All the members play with almost identical quality and unified concept which would qualify them as one of the best quartets around. The clarinetist, Vladimir Riha, takes his place as a real member of the ensemble. Even in the slow Adagio where traditionally the clarinetist takes "the bit in his teeth" and goes, Riha stays strictly to the score and leaves the effects to Brahms. The tempi used in the first and third movements are somewhat more deliberate than what is usually heard, but this is completely offset by what these musicians do with it.

The second side of the recording is filled by a Mozart Duo in G Major, performed by members of the Smetana Quartet, Jiri Novak, the first violin, and Milan Skampa, the violinist. This is a charming work, admirably performed. The musicianship is on a level with the major work on this disc and leaves little doubt that Epic Records struck gold, musically, when they arranged to release these Supraphon recordings in this country via Crossroads. The musicians are first rate, and deserve additional attention in print along with the descriptive tracts on the compositions. Recognition should be one of the rewards for superior performances. The Supraphon productions are obviously exposing us to some of the best talent in Czechoslovakia, so why stop short in producing a really outstanding service rather than just a good buy.

Technically, the recording is consistent with the ends required by the music. The balance of the ensemble is excellent throughout. The tone of the clarinet comes through beautifully round and mellow and the quality of wind and the strings are realistically warm, tonally balanced, and crystal clear.

This is not the highly individualistic style of clarinet playing found on earlier releases of the Quintet, notably such as Reginald Kell. In fact, it is refreshingly clear of all musical idiosyncracies and that is one reason I unhesitatingly recommend it. O.E.K.

Performance: A *Sound:* A

Sing to the Lord: Robert Shaw Chorale, Robert Shaw, cond.
RCA Victor LSC-2492 stereo

This splendid new recording from RCA-Victor's Robert Shaw Chorale presents sixteen early American folk hymns. There is no orchestra called out because they are all sung *a capella*. Of the sixteen, few are familiar (to me), but all are most worthy of hearing. They are—*Sing to the Lord; God Is Seen; A Charge to Keep I Have; Come, Ye That Love the Lord; How Firm a Foundation; Come Away to the Stars; Lord, What is Man; Hark, I Hear; Good Morning, Brother Pilgrim; Calvary's Mountain; Come and Taste; Teach Me the Measure; The Hebrew Children; O Happy Souls; When I Can Read My Title Clear;* and *Shout On.*

The Chorale is precision itself, with clear voices and words that can be understood. Stereo balance is excellent, and overall sound loses a straight A only because of some shatter during the loudest passages (present with several test cartridges). RCA has come a way with their Dynagroove system. This record must be counted a true contribution. The fact that full texts are included is an extra bonus.

R.L.L.

Performance: A *Sound:* B+

Mormon Tabernacle Choir: Greatest Hits. Ricard P. Condie, Director/The Philadelphia Orchestra, Ormandy, cond.
Columbia MS 6951 stereo

I am not sure why it is that whenever I hear one of these Columbia Mormon Tabernacle/Philadelphia Orchestra combinations I find the hairs on my neck rising. It must be that this combination has succeeded in creating genuine musical excitement such as is rarely found in the concert hall, let alone the grooves of a record. All the "hits" you would expect are here, even that super-pops, best-seller, *Battle Hymn of the Republic.* My favorite, though, is *This Land is Your Land,* though I cannot find fault with any of

the other selections, to wit: *God Bless America; The Lord's Prayer; When Johnny Comes Marching Home; A Mighty Fortress is Our God; Bless This House; Heavenly Father; Onward Christian Soldiers; Jesus, Joy of Man's Desiring* (Bach); *Come, Come Ye Saints; Hallelujah Chorus* from *Messiah* (Handel). Hits all.

This huge chorus, well over three hundred voices, plus the Philadelphians, present a formidable challenge to the recording art. Let me say that Columbia has risen to this challenge in sterling fashion. Surfaces are silent, dynamics are wide, the stereo spread is enormous, and there is not the slightest difficulty tracking the record. Inside to out, it reproduces with ease.

If you have no other Mormon Tabernacle recordings, get this one. On the other hand, it must be admitted, that if you have *all* the others, you don't need this one. R.L.L.

Performance: A *Sound:* A

France: London Festival Orchestra and Chorus. Stanley Black, cond.
London Phase 4 SP 44090 stereo

Stanley Black and Phase 4 stereo conduct us to a visit across the channel to France. As with all Black efforts in this vein, the attack gets somewhat out of hand, what with sound effects that fade down as music sneaks in. But it is all in good sport, so who cares? The simple fact is that this record is lots of fun. All of the standard, cliche French tunes are here, brought up to date with a hard-driven interpretation of recent hit, *What Now My Love*. Musically, the really redeeming selection is a beautiful reading of *Plasir D'Amour* by a contralto/soloist and the voices of the Mormon Choir of England.

But sound is the admitted star here. Admitted by the fact that the deluxe liner devotes more space to Phase 4 talk than to the music or musicians, or for that matter, to a complete listing of all Phase 4 discs. Sound-fanciers will be delighted with this one. It has everything from the sharp rat-tat-tat of military drums to the delicate tones of the harp. Everything is recorded at ultra-high modulation, providing a supreme test for your cartridge's tracking ability. If you can get through it, the resulting sound truly deserves a high rating. Best of all, Phase 4's tendency to instrument wander and perspective change seems to be under control of this record.

Hi-Fi fans take note. This one will really impress your friends. R.L.L.

Performance: B *Sound:* B+

JAZZ AND BLUES

BERTRAM STANLEIGH

Bob Thiele: Thoroughly Modern
ABC Mono ABC 605

Producer Bob Thiele, who's responsible for both the jazz label, Impulse, and the new BluesWay label, makes his debut as a bandleader on this set of "Twenties" favorites inspired by the film hit *Thoroughly Modern Millie*. Two of the dozen numbers offered are the film's title song and *Jimmy*, both stylishly delivered by Theresa Brewer. But it's the balance of the program that offers some amusement for jazz fans whose memories go back a bit. A group of sidemen that includes Pee Wee Russell, Jimmy McPartland, Max Kaminsky, Urbie Green, Lou McGarity, Milt Hinton, George Duvivier, and Don Butterfield are heard in deft arrangements of *Sugar Blues, Charleston, Betty Coed, Changes, Whispering, Give Me Your Kisses, Japanese Sandman, San, I's Just a Vagabond Lover*, and *Barnacle Bill the Sailor*. The last two items are sung by Steve Allen in an evocative fashion. The mono recording is run-of-the-mill for present day releases, but it sounds extra good to anyone who expects music of this vintage to emerge from scratchy-surfaced 78's.

Performance: B *Sound:* C

Cajun Fais Do-Do
Arhoolie Mono F 5004

Nathan Abshire and his Pine Grove Boys, the Breaux Brothers, Isom Fontenot, Cyprien and Adam Landreneau, and Jerry Devillier are all represented on this recording made in Basile, Mamou, and Crowley, Louisiana. For field recordings, made under less than ideal conditions, quality is good, particularly on the side devoted to Abshire. The music, sung in a French patois, consists of simple, country dance tunes, such as two steps, polkas, and waltzes. The instrumentation is comprised of fiddle, guitar, accordion, harmonica, bass, triangle, and drums. Not surprisingly, there are moments when the music takes on a country-and-western flavor. At other times it's reminiscent of bal musette and ceili bands, but it is clearly one of the strong creole influences in jazz, and this recording deserves the attention of both jazz scholars and all of those folk enthusiasts who like simple, happy sounds.

Performance: B *Sound:* C—

John Lee Hooker Live at Cafe Au Go-Go
BluesWay Stereo BLS-6002

Recorded at a Greenwich Village cafe in August 1966, Hooker is heard with the Muddy Waters band featuring Otis Spann on piano. A veteran blues singer whose style has gradually shifted from country, to city, to jazz, Hooker offers eight of his own tunes: *I'm Bad Like Jesse James, She's Long, She's Tall, When My First Wife Left Me, Heartaches and Misery, One Bourbon, One Scotch, and One Beer, I'll Never Get Out of These Blues Alive*, and *Seven Days*. The perfect pacing in John Lee's delivery is beautifully matched in Spann's piano accompaniments, and the mood created is rich, sustained, and appropriately low down. The recording by Rudy Van Gelder is one of the better examples of what can be done under live conditions.

Performance: A *Sound:* B

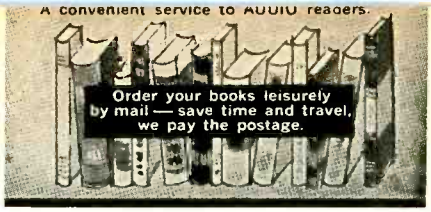
Anthony Williams: Life Time
Blue Note Mono 4180

Miles Davis' brilliant young drummer is heard in five of his own compositions. These are far-out pieces of great sensitivity and intense feeling. That feeling is deeply probed by musicians with whom Williams has been closely associated and who are among the elite of the "new music." Side one is a highly inventive composition in two movements, *2 Pieces of One*. Bassists Rich Davis and Gary Peacock, tenor saxophonist Sam Rivers, and Williams are the performers. Peacock, Rivers, and Williams are heard again in *Tomorrow Afternoon*, an especially close knit collaboration. *Memory* is a slightly tentative, nostalgic piece performed by Williams with Bobby Hutcherson, vibes and marimba, and Herbie Hancock, piano. And Hancock and bassist Ron Carter play the faintly oriental *Barb's Song to the Wizard*.

Performance: A *Sound:* A

B. B. King: Blues Is King
BluesWay Stereo BLS-6001

A master of the belting, shouting, urban blues school, as well as an artist of great personal style and sophistication, B. B. King is above all else a showman, and it is only under conditions of active contact with a sympathetic audience that his vigorous, gutsy singing and guitar playing is heard to



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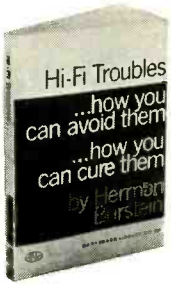

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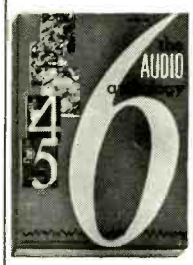

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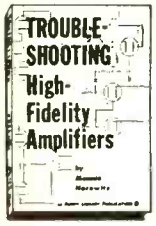

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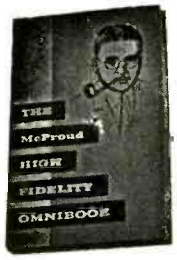

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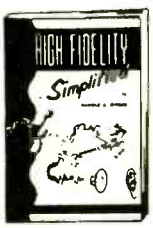

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its best. To achieve the best kind of performance, producer Bob Thiele moved his recording equipment into a noisy Chicago night club where a hard-drinking crowd was clearly in rapport with King and his group, made up of Kenneth Sands, trumpet; Bobby Forte, tenor; Duke Jethro, organ; Louis Satterfield, bass, and Sonny Freeman, drums. The music-making is first rate, and quite a bit of it filters through the audience sound. Such finicky refinements as balanced stereo effect, even frequency response, and natural reverb may be notable for their absence, but there's a lot of music on this record. It's an exciting first disc for what promises to be a great series.

Performance: B+ *Sound:* C—

Lightning Hopkins, Clifton Chenier, Mance Lipscomb: Blues Festival
Arhoolie Mono F 1030

Recorded at the Second Annual Berkeley Blues Festival in April 1966, this recording includes five numbers by Lightning Hopkins that are probably his finest performances on disc. Mance Lipscomb, the 71-year-old Texas sharecropper who has contributed three volumes of blues to the Arhoolie label, provides four numbers that are characteristic but slight, and Clifton Chenier, the Louisiana cajun guitarist whose blues and "zydeco" are the subject of another fascinating Arhoolie platter, offers three spirited, but badly miked, tunes. It is the side devoted to five Hopkins songs that makes this one of the important blues classics. There is a rhythmic excitement to Lightning's performances that is not often present in the work of this very relaxed singer, and balance between his voice and guitar, and the drumming of Francis Clay, is perfect. Lightning sings *Last Night, Going to Louisiana, Black Cadillac, Short Haired Woman,* and *Lightning's Boogie.* If you have difficulty getting this disc in your area, write to Arhoolie Records, Box 9195, Berkeley, California 94719. This is far too important a recording for anyone interested in this type of music to miss out on.

Performance: A & B *Sound:* C

Otis Spann: The Blues Is Where It's At
BluesWay Stereo BLS-6003

Recorded under the same conditions as the John Lee Hooker platter, with the same band, but with a different engineer, this disc has a quite different balance between the soloist and the Muddy Waters group. Spann, who is Waters' half-brother, delivers his vocals in a bold, shouting blues style, and he accompanies himself on the piano in a stomping, striding fashion. The musical performance is excellent; the live recording is above average for this kind of music, but its release in close juxtaposition with the John Lee Hooker disc makes one wish that it had the same keyboard clarity and overall balance.

Performance: B *Sound:* C

Fred Neil: The Dolphins
Capitol Stereo ST2665

Neil is a strong, introspective blues singer whose work reflects intensity and deep conviction. Most of his performances are of his own music, and his lyrics concerning love, war, and society often have a powerful impact. In performance he has a tendency to hunch over his 12-string guitar, and unless mike placement is perfect, it is difficult to understand every word of his relaxed drawl. The present disc, his first for Capitol, is not nearly as fine—from the technical standpoint—as his two previous platters on Elektra. Much musical detail in the colorful instrumental backing is obscured, and the cutting level is higher than usual and may cause tracking problems on some equipment. The songs pack a real emotional wallop, even when all of the words don't come through, and the rich accompaniment that includes a variety of guitars, bazouki, mouth organ, cymbals, tambourine, drums, and assorted percussion effects helps to sustain the mood of highly personal protest. Side two ends with an instrumental raga that has somewhat better balance than the rest of the disc.

Performance: B *Sound:* C

Lou Rawls: Carryin' On!
Capitol Stereo ST2632

A strongly rhythmic vocalist, Lou Rawls has a superb sense of timing, crisp enunciation, and a solid grasp of the blues-rock idiom. Backed by an energetic trumpet, guitar, and rhythm combo, he offers one side of strong but conventional blues material that rocks, swaggers, and seethes with excitement. Side 2 is devoted to more popular items such as *Yesterday, Trouble Down Here Below, You're Gonna Hear From Me, Something Stirring in My Soul,* and *On Broadway.* Sound is bright and close up, but there is a goodly helping of echo on the voice track.

Performance: (side 1) B, (side 2) C *Sound:* B—

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