TIMELESS RECORDINGS . . . CANBY

AUDIO

OCTOBER 1972 60c

The Authoritative Magazine About High Fidelity ®

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LONG ISLAND CITY NY 11106

16 CASSETTE RECORDERS TESTED

Tape Recorder Equalization

Noise Reduction Techniques

Building a VU Meter

An Op-amp Preamplifier

We started with the premise that you wanted better sound reproduction, and we took it from there.

PIONEER'S NEW SERIES
An acoustic achievement th
universally preferred sou

R700

S R SPEAKER SYSTEMS.

at is destined to become the
nd reproduction system.

R500

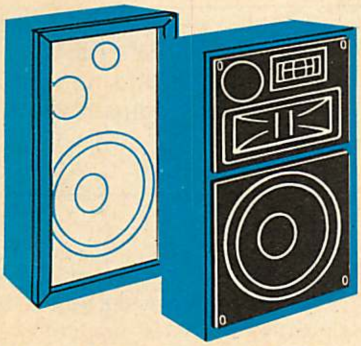
R300

Too often these days superlatives are used to camouflage mediocrity. Let's just say you'll be excited with the magnitude of the achievement of the new Pioneer series R speaker systems, once you hear them. They represent the culmination of our more than six years of intensive research in every phase of speaker design on just this series alone.

We investigated, tested and evaluated every known area: frequency response, dispersion, distortion, transients, drivers, configurations, cabinetry — rejecting, accepting, improving until we were completely satisfied that we had the perfect combination. The sound most people would prefer when compared with the conventional speakers now available.

The story behind the grille
To achieve this exceptional sound reproduction, Pioneer has endowed the new series R with a host of meaningful refinements that have become the hallmark for our extensive collection of high fidelity components.

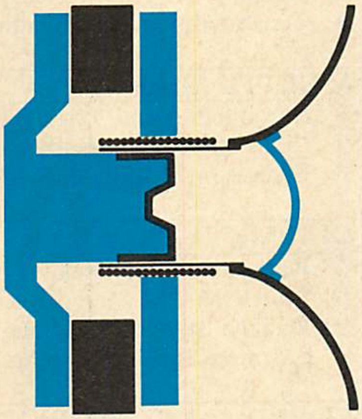
Flush mounting. Unlike other speaker systems on the market today, the R series' drivers are flush mounted to the face of the enclosure, rather than recessed. Combined with the advanced design of the individual speaker units, there is added vitality to the mid tones and wider dispersion.



Conventional recessed speaker mountings. New up-front flush mounting of Pioneer series R.

Exclusive FB cones assure robust bass, clear mid and high tones, improve damping, while keeping distortion at an absolute minimum. High input signals are handled with complete ease.

	R700	R500	R300
Speakers	12″ woofer, midrange horn, multicell horn super tweeter	10″ woofer, 5″ midrange, horn tweeter	10″ woofer, horn tweeter
Maximum Input Power	75 watts	60 watts	40 watts
Crossovers	750 Hz, 14,000 Hz	800 Hz, 5,200 Hz	6,300 Hz
Dimensions	15″ x 26″ x 13$\frac{9}{16}$″	13$\frac{3}{4}$″ x 24″ x 12$\frac{1}{16}$″	13″ x 22$\frac{1}{2}$″ x 11″
Price	$229.95	$159.95	$119.95



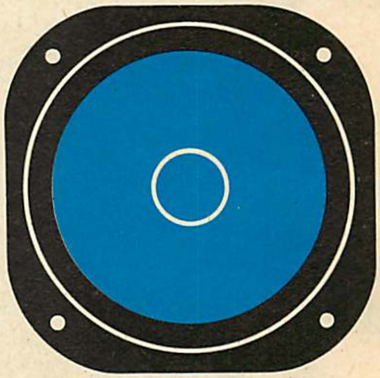
Unique concave center pole design and pure copper cap/ring combination. The concave center pole of the drivers' magnetic structure is covered with a pure copper cap. Not only does this reduce the inductance of the voice coil, it also decreases the voice coil's intermodulation distortion generated by the magnetic field. The result: vastly improved bass and midrange transient responses. Another example of Pioneer's meticulous engineering detail.

Improved design horn tweeters of die-cut aluminum have completely replaced the more conventional (and less costly) cone and dome-type tweeters in the entire series. You can hear the difference with wider dispersion, and you gain all the advantages of horn drivers, such as high transient response and lowest distortion.

Crossovers are precisely designed in each model. In contrast to other speakers that rely on the capacitance method only, Pioneer has combined both inductances and capacitances for minimum intermodulation distortion. And you'll never hear bass tones wandering to the tweeters, or highs intruding on the woofers. You couldn't ask for better linear response.

The acoustically padded enclosures are sturdily built and faced with handsome two-piece, two-color, removable grilles. The staining process of the hand selected walnut requires ten steps alone, and utilizes an exclusive oil created by Pioneer. Each unit is produced as if it was the only one.

Sound-absorbing foam polyurethane surrounds the woofers of the R700 and R500 to reduce distortion even further. The three R series models each employ long-throw voice coils providing greater cone movement for higher excursions.



There are many technical reasons why you should buy a pair of the new Pioneer series R speakers systems. But, in the final analysis, when you compare them with comparably priced speakers at your Pioneer dealer, their absolute superiority in sound reproduction is why you will buy them.

U.S. Pioneer Electronics Corp.
178 Commerce Rd., Carlstadt,
New Jersey 07072

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AUDIO

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FEATURE ARTICLES

CASSETTE SURVEY

EQUIPMENT PROFILES

RECORD AND TAPE REVIEWS

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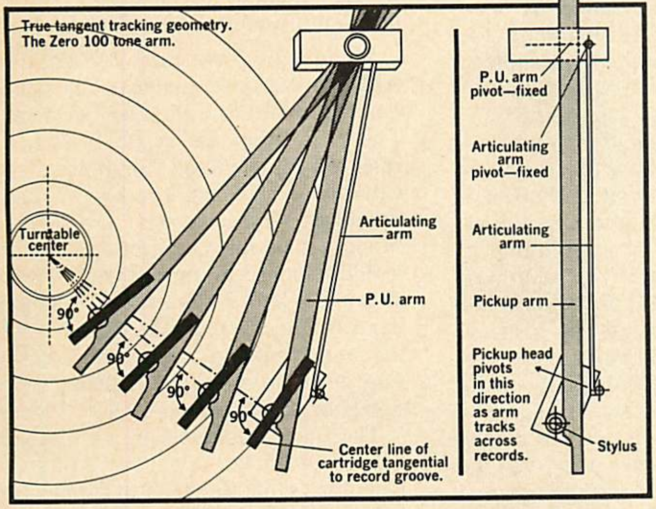
MUSIC GOES ON A RECORD AT A PERFECT TANGENT. NOW IT COMES OFF AT A PERFECT TANGENT.

For years, Zero Tracking Error has been the elusive goal of the automatic turntable maker.

The objective: to develop an arm which would keep the stylus perpendicularly tangent to the grooves . . . to each groove throughout the record, because this is the way music is put on a record.

Garrard's Zero 100 is the only automatic turntable to attain this. It is done with an ingeniously simple, but superbly engineered tone arm. Through the use of an articulating auxiliary arm, with precision pivots, the angle of the cartridge continually adjusts as it moves across the record. The stylus is kept at a 90° tangent to the grooves . . . and the cartridge provides the ultimate performance designed into it.



The results have been recorded by experts in their reviews of the Zero 100. Some of them are saying things about this instrument that have never been said about an automatic turntable before.

They have confirmed that they can *hear* the difference that Zero Tracking Error makes in the sound, when the Zero 100 is tested against other top model turntables, in otherwise identical systems. Until now, we cannot recall any turntable feature being credited with a direct audible effect on sound reproduction. Usually that is reserved for the cartridge or other components in a sound system.

Zero Tracking Error is more than just a technical breakthrough. It translates into significantly truer reproduction, reduced distortion and longer record life.

Once we had achieved Zero Tracking Error, we made certain that the other features of this turntable were equally advanced. The Zero 100 has a combination of features you won't find in any other automatic turntable. These include variable speed control; illuminated strobe; magnetic anti-skating; viscous-damped cueing; 15° vertical tracking adjustment; the patented Garrard Synchro-Lab synchronous motor; and our exclusive two-point record support in automatic play.

The test reports by independent reviewers make fascinating reading. You can have them, plus a detailed 12-page brochure on the Zero 100. Write today to British Industries Co., Dept. J12 Westbury, New York 11590.

GARRARD ZERO 100

The only automatic turntable with Zero Tracking Error.

$199.95
less base and cartridge

Mfg. by Plessey Ltd. Dist. by British Industries Company
Circle No. 3 on Reader Service Card

coming in November

Kit Building—Some hints and tips by Len Feldman

The Language of High Fidelity, Part 6 of Martin Clifford's Guide for Beginners

Binaural Sound by Billy G. Brant

Christmas Buying Guide

Equipment Reviews Include:
Revox A-77 Dolby Tape Recorder
Sony 2000F Preamplifier
Fairfax FX-300 Speaker System

About The Cover: Cassette recorders have come a long way during the past two years or so. The first models could hardly reach 7 kHz but the present-day contenders can reach 15 kHz with ease. And with low wow and flutter! However, open-reel machines still have many advantages for the enthusiast; our recent tape competition brought in 446 tapes and only five cassettes!

Audioclinic

Joseph Giovanelli

AM Bandwidth

Q. Under what circumstances can AM stations broadcast to frequencies higher than 5 kHz? If a 5 kHz tone will produce significant sidebands at plus or minus 5 kHz relative to the carrier frequency, it seems to me that such instances of "high fidelity" broadcasting must be rare. On the other hand, twice in recent readings I have come across passages which suggest that such a situation may not be as rare as I think it is.—Gary Roboff, Worcester, Mass.

A. The broadcast band is broken down into segments, each of which is 10 kHz wide. While we have come to think of a broadcast station as being assigned to a specific operating frequency, this station actually occupies a spectrum of frequencies lying above and below this assigned carrier frequency. As you indicated in your question, the reason for this is that the audio frequencies produce what are known as sidebands. If a 5 kHz tone is broadcast, the AM station will be transmitting its assigned frequency plus two additional frequencies, one 5 kHz above, and one 5 kHz below the station's assigned carrier frequency. (These outer frequencies represent the sidebands.) If we consider two broadcast stations assigned to frequencies 10 kHz apart, and if each one is transmitting tones of 5 kHz, the lower sideband of the station assigned to the higher frequency and the upper sideband transmitted by the station assigned to the lower frequency will each produce the same frequency sideband signal.

For example, one of the stations might be transmitting on 600 kHz; the other one on 610 kHz. With each station transmitting a 5 kHz tone, the station broadcasting on 610 kHz will be producing sidebands of 605 and 615 kHz; the station transmitting on 600 kHz will produce sidebands of 595 and 605 kHz. Note that both have sidebands of 605 kHz.

If now, we take our same two transmitters and transmit a 10 kHz tone on each, the situation will become even more interesting. The station transmitting on 600 kHz will be transmitting, in addition to this frequency, sidebands of 590 kHz and 610 kHz. The station transmitting on 610 kHz will transmit frequencies of 620 kHz and 600 kHz. Notice that the sidebands from the 600 kHz station exactly fall on the center frequency of the transmitter assigned to 610 kHz. Notice, too, that the 610 kHz station will be transmitting a sideband on 600 kHz. If, therefore, these two stations were assigned to the same market area, very severe interference would be produced if audio frequencies out to 10 kHz were transmitted by each station. However, the FCC never assigns stations on adjacent channels to one market area. Stations would be spaced 30 or more kHz apart. Thus, the sidebands of which we spoke would not result in interference between two stations within a given market area. Of course, good radio receivers can and do detect signals on adjacent channels. However, this is not a consideration of the FCC.

Many of us have come to think that AM stations are assigned an audio bandwidth not to extend beyond 5 kHz. This is not the case at all. In fact, the rules of the Federal Communications Commission which cover AM radio broadcast transmissions say that a broadcast station shall not depart from a flat response by more than 2 dB between 100 and 5 kHz, based on a midband frequency of 1 kHz. This does not mean, therefore, that the broadcast station must curtail all frequencies above 5 kHz or all frequencies below 100 Hz.

The only stipulation the FCC makes with regard to the upper limits of audio response is that the band of frequencies between 15 and 30 kHz must be attenuated 25 dB with respect to a signal of 1 kHz. Frequencies beyond 30 kHz must be additionally attenuated.

Therefore, if it were possible to design a filter so sharp that within the space of 1 kHz a 25 dB attenuation could take place, the AM stations could produce frequency response flat right out to 14 kHz. Of course, 15 kHz would then have to be attenuated by 25 dB, placing stringent demands on such a filter.

You can see from all of this that a broadcast station is free to broadcast audio frequencies considerably in excess of 5 kHz; probably a realistic limit is 10 kHz.

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.

Dear Editor

AM Buff No. 1 . . .

Dear Sir:

How do you express demand for tuners with good AM performance? I have been looking for one ever since the days of E. H. (not H. H.) Scott.

I agree with Mr. Herbert's letter in your July, 1972 issue. Most people today don't know how good AM can be and those who do can do nothing about it because no manufacturer now builds a quality AM tuner.

R. N. Servaas
Grand Rapids, Mich.

AM is not, as commonly supposed, inherently inferior to FM in terms of bandwidth or distortion. In Australia, where there is no FM, wide-band, low distortion tuners are used extensively. However, AM is subject to electrical interference, and there is not much room in the present AM broadcast band. (AM on VHF? Well, that would be a different story!) Signals on the broadcast band travel great distances—particularly after dark so the tuner bandwidth would have to be restricted to avoid interference effects from stations on adjacent channels. In England, before the FM network was established, top-quality AM tuners had to have 9 kHz whistle filters or variable-bandwidth controls and the net result was often pretty poor. And how about stereo. It can be transmitten on AM but . . . .

Having said all that, it must be conceded that many AM/FM tuners have low sensitivity AM sections. For instance, I like to listen to the news from Canadian AM stations, but I get better reception from my car radio than I can from quite expensive tuners!— ED.

And No. 2

Dear Sir:

I read David P. Herbert's letter (July, 1972) with great interest. It would indeed be nice to see quality AM tuners with quality specs, features, and component parts. Mr. Herbert has done audio science a great service with his letter. The only problem is that his comments will most probably be ignored! Let's hope not.

Besides the four items Mr. Herbert recommends, I'd like to see the following:

Fully shielded, regulated, and *filtered* power supplies;

The use of polystyrene capacitors of high tolerance (Mallory had nice 2.5% units);

The use of high stability, close tolerance resistors, such as Corning type C32's, a glass-metal oxide type;

Strong glass-epoxy PC boards on a strong chassis with robust yet light aluminum alloy materials, and finally

Simple, effective, and bug-free circuits with easy, razor-sharp adjustments.

Joe Frandeka
St. Louis, Mo.

Distorted Rock Recordings

Dear Sir:

In doing a bit of review work, I just noted a tape recording problem described in Herman Burstein's March, 1970 *Tape Guide* section of AUDIO. I have just finished fighting the same problem in a PA system and my experience might be helpful to many tape recording situations.

The problem described by Ben Miller is excessive distortion in live tape recordings of rock groups. Burstein correctly listed the three possible causes: 1) Too high recording level at the tape, 2) poorly designed first stage of the tape recorder, and 3) overloaded microphone. I would emphasize reason #2 rather than the other two.

The problem is created by the high sound level of rock music performances and is similar to the PA system problem when the entertainer or lecturer "eats the microphone." A good dynamic microphone can put out (at the secondary of the transformer) about a volt (that's right, a whole volt) under these conditions. Usually, this is applied to the input of a transistorized stage directly and the output of this stage fed to the level control. For normal levels, this is the best arrangement because the level control cuts out pre-amp noise when the level control is at a low setting. But, when the microphone signal hits a volt, the distortion is *gross* and no tinkering with the level controls will make the least bit of difference.

This explains why Miller's recordings from a large barn-like auditorium had less distortion. The sound intensity was less because the same acoustic power radiated by the rock performers had to fill a larger volume and supply the losses at a much larger surface area. This meant the microphone output was lower and overloaded the input stage by less.

What is the cure? Probably the simplest is to wire up a 20 dB attenuator with cable connectors which match the microphone connectors being used. This 20 dB pad is placed between mike and tape recorder input for loud level situations. There will still be plenty of signal going into the tape recorder to achieve good signal to noise ratio.

Most of the newer machines which have only one level adjustment afford a simple way to achieve this end. The "auxiallary" input, meant for levels of a volt or so (from pre-amps, tuners, etc.), is actually an attenuator which goes between this input and the microphone amplifier stage. Thus, by plugging the microphone into the AUX input instead of its normal input, the chances of overload are greatly reduced.

Prof. J. Robert Ashley
University of Colorado
Colorado Springs, Colo.

Construction Suggestion

Dear Sir:

Being a devoted listener to orchestra and classical church music, I like to work on improvements and extensions of my stereo system. Thus, I would like to see articles on construction projects which would improve an already good sound system or basic building blocks to up-grade or build a system.

My personal need is an 18 dB per octave crossover at 300 to 500 Hz and also at 3000 to 8000 Hz to be used with Altec Lansing or University high frequency horn and a Klipsch type low frequency horn. This is simply a suggestion, though I can well imagine that many hobbists have a similar requirement.

F. Machmuller
Kalthof, Germany

Miklos Rozsa Society

Dear Sir:

There has been increased interest of late in the music of Dr. Miklos Rozsa, both the music he has written for films and that he has written for the concert hall. Inasmuch as some of us feel that his music is unjustly neglected, we have founded, in his name, the Miklos Rozsa Society, the main purposes of which are to promote his music and to disseminate news and information about it to music lovers. Those interested in such a society may write: J. F. Fitzpatrick, 2604 Davidson Ave., Bronx, N.Y. 10468.

If you would print this notice in your letters column, we would be most appreciative.

Mark Koldys
Dearborn, Mich.

Check No. 7 on Reader Service Card

New Products

Leader multimeter

The LDM-850 digital readout a.c./d.c. multimeter will measure voltage, current, and resistance in any of 25 ranges and is said to have scale accuracy of 1.0% or better. The 3½ digit display is non-blinking and shows measurements up to 1,999. The unit offers a dual slope operating mode and has a maximum input voltage of 1,000 V d.c. or 350 V a.c. with 10 megohm input impedance. Sensitivity ranges from 100 μV to 1 V with current from 0.2 mA, to 1,000 mA, a.c. or d.c. Resistance is said to be 0.2 kilohms to 2,000 kilohms. Price: $299.50.

Check No. 134 on Reader Service Card

Philips GA 212 turntable

This manual turntable uses a d.c. servo motor and polyurethane belt drive with two independent potentiometers for speed calibration over a 3% range. Wow and flutter is rated at 0.2% and rumble at -62 dB ARLL and -42 NAB. The adjustable anti-skating control has separate scales for elliptical and conical styli, and the tracking force range is from 0.5 to 4 gms. The automatic stop is controlled by a photocell actuated at the end of a record. Price: $149.50.

Check No. 133 on Reader Service Card

Lafayette La-150 amplifier

This unit provides 125 watts (IHF, 4 ohms) with 1% (or less) distortion over a power bandwidth of 13 to 35,000 Hz. Built-in circuitry derives four-dimentional sound from normal two-channel sources; all that's needed are two additional speakers. Controls include bass, treble, volume/balance, mode, input, and speaker mode (with a two-position "rear" level setting). There are pushbutton switches for low and high filters, loudness (two levels), and power. The tape montior circuits allow conversion to discrete or SQ four channel with an auxiliary decoder/amplifier. Price $149.95.

Check No. 132 on Reader Service Card

ARP sythesizer

The Odyssey synthesizer offers most of the basic functions offered on larger sythesizers, including voltage controlled oscillators, filter, and amplifier, ring modulator, sample and hold circuit, envelope generators, noise generator, and mixers. The two-voice, 37-note keyboard has a seven octave range, and foot pedals are used to change timbre, bend notes, control "wawa" and activate portamento. Sounds include thunder, gong, fuzz guitar, and feedback distortion. High and low level outputs are included, and the unit can be hooked directly to any tape recorder, amplifier, or hi-fi system. Price: $1295.00.

Check No. 131 on Reader Service Card

Sequerra FM tuner

This solid state FM tuner offers four digit frequency readout of electronic tuning, phase linear filter and discriminator circuits, Dolby noise reduction, and oscilloscope displays for tuning, signal strength, multipath, vectorial stereo and quadraphonic. A panoramic adapter/display is optional. Specifications are 2 μV sensitivity, 0.1% THD at 100% modulation without de-emphasis, 140 dB selectivity, 50 dB separation at 1 kHz, 100 dB or greater spurious response rejection, and 120 dB dynamic range. Price: $1600.00.

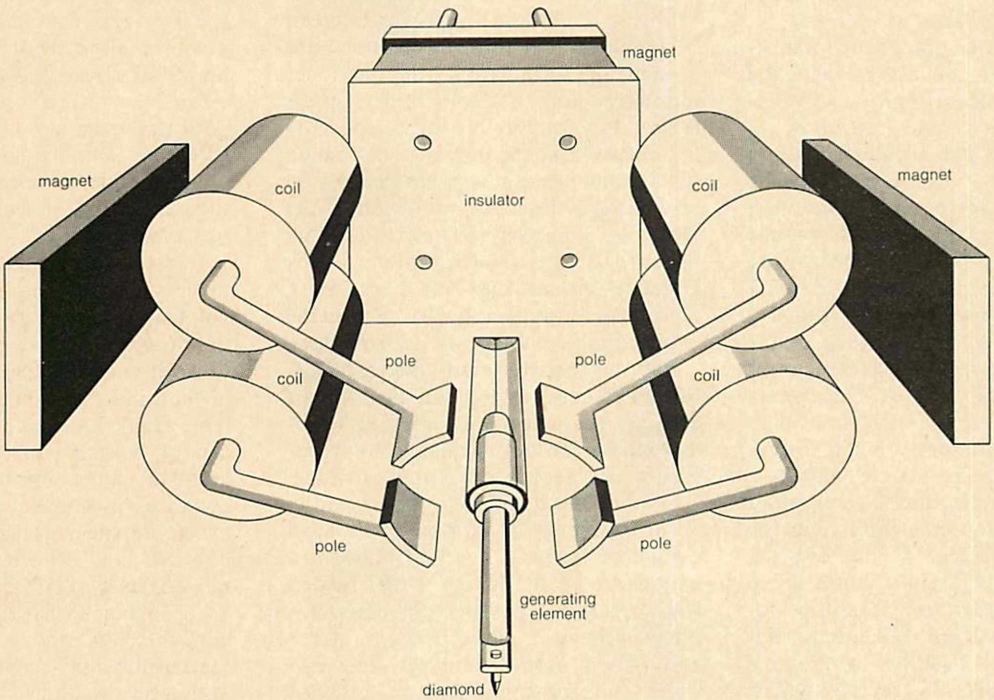
Check No. 130 on Reader Service Card

Justi-Meter III graphic level recorder

Designed to permit recording of the frequency-response characteristic of audio equipment on a frequency-calibrated chart over a linear range of 40 dB, Justi-Meter III is now being introduced to the market, after more than two years of use in preparing test reports on phonograph cartridges, headphones, tape recorders, and loudspeakers. Unit covers sweep range from 20 to 20,000 Hz, obtained from a standard test record, and plots the response in 50 seconds. Starts automatically from the test record signal, and measures response of phonograph pickups directly, and with external connections that of amplifiers, filters, and tape recorders. Also records impedance characteristic of loudspeakers over the same range, plotting directly in ohms. Price: $595.00.

Check No. 129 on Reader Service Card

All cartridges are different. Empire cartridges are more different than others! Take a technical look for yourself.



How it works.

If you know how moving magnetic cartridges are made, you can see right away how different an Empire variable reluctance cartridge is. With others, a magnet is attached directly to the stylus, so that all the extra weight rests on your record. With Empire's construction (unique of its type), the stylus floats free of its three magnets. So naturally, it imposes much less weight on the record surface.

Less record wear.

Empire's light-weight tracking ability means less wear on the stylus, and less wear on your records. Laboratory measurements show that an Empire cartridge can give as much as 50 times the number of plays you'd get from an ordinary cartridge without any measurable record wear! HI-FI SOUND MAGAZINE summed it up very well by calling the Empire cartridge "a real hi-fi masterpiece . . . A remarkable cartridge unlikely to wear out discs any more rapidly than a feather held lightly against the spinning groove."

Superb performance.

The light-weight Empire cartridge picks up the sound from the record groove with amazing accuracy. Distortion is minimal. (None at all could be measured at normal sound levels with Empire's 1000ZE/X and 999VE/X.) AUDIO MAGAZINE said of the Empire cartridge "outstanding square waves . . . tops in separation." HIGH FIDELITY noted ". . . the sound is superb. The performance data is among the very best." While STEREO REVIEW, who tested 13 different cartridges, rated the Empire tops of all in light-weight tracking.

X Designates newest improved version.

World Famous Long Playing Cartridges

empire

INSTITUTE OF HIGH FIDELITY INC.

For further details write:
Empire Scientific Corp., Garden City, N.Y. 11530.

Mfd. USA

Check No. 9 on Reader Service Card

Behind The Scenes

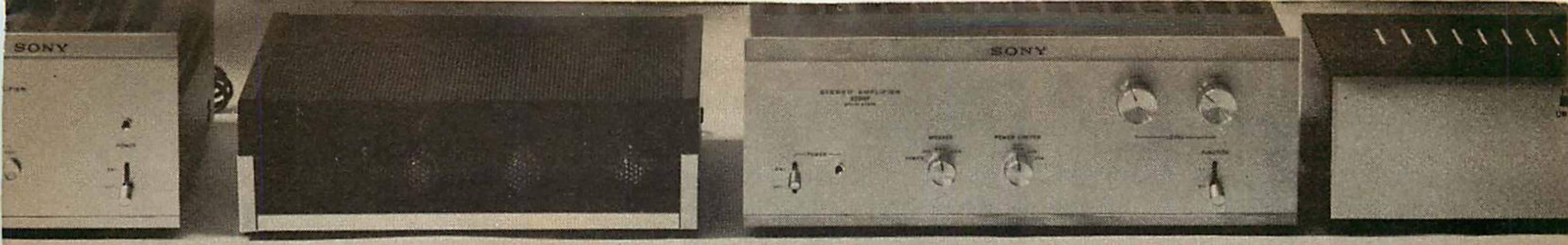
Bert Whyte

THIS COLUMN is being written during the "dog days" of August . . . my least favorite time of the year. The omnipresent noise of the air conditioners intrudes on music-listening activities (maybe Dr. Dolby ought to apply his talents to air conditioners). No one is in town, everyone fleeing from the muggy misery of New York. Nothing is happening on the four-channel front, except for some minor skirmishes in the pages of *Billboard.* Obviously everything is being held in abeyance until the AES and IHF shows in September, when presumably the discrete and matrix camps will each launch major offensives.

In the meanwhile, one of the interesting developments that came out of the CES was a significant renewal of activity in the field of 8-track cartridges. At the show there was an absolute plethora of new models of cartridge playback units for automotive and home use, including quite a few quadraphonic players. You may not have been aware of it, but after several years of "boom" type prosperity, 1971 was considered a very "soft" year in the cartridge industry. Many people were burned by a raft of inferior "cheap jack" cartridge players which flooded the market. There was a loss of confidence in the format on the part of many people, and as a consequence many manufacturers either folded completely or abandoned the production of players. Oddly enough, the recession was mainly confined to cartridge hardware. As far as the recorded cartridges were concerned, sales volume continued to climb, albeit at a slower pace than in previous years. After many pundits had declared that the cassette would obsolete the cartridge, as of now the recorded cartridge market accounts for more than 60 percent of the total dollar volume of tape sales in all formats. As you might expect, the vast majority of cartridges are sold for playback in cars, although there is an increasing "double-duty" playback of the cartridges in the home. Many of the new units displayed at the CES had improved drive systems and higher quality electronics with frequent use of IC's. The overall impression was that there was a considerable upgrading of player quality throughout the industry. There was also an increase in the number of cartridge record/playback units, but while there was more use of so-called "logic controls" on these units, "rolling your own" cartridges still entails complexities many people find quite exasperating. The recorded cartridges themselves seem to have been improved through better quality control in the duplication process. Frequency response is commonly maintained to 7 or 8 kHz, dropouts and print-through are infrequent. Crosstalk between tracks can be a problem traceable to the playback head in the machine, a "skew" problem in duplication, or a combination of both. In any case, with a cartridge player properly set up with a track alignment tape, crosstalk is not often encountered these days. Signal-to-noise ratio is, of course, the major problem with cartridges. There is no avoiding the fact that there is too much tape hiss. While no doubt some improvements can be made in S/N ratio through the use of new tape formulations, the cartridges ultimately must be Dolbyized to make them a high quality medium, especially for playback in the home. I have made this statement in these pages before and as we move closer to production of the Dolby IC chip, and a subsequent reduction of the cost of incorporating Dolby circuitry in cartridge playback units, there would appear to be reasonable expectations for B type Dolby cartridges.

All this activity with the cartridge format is encouraging, but in terms of automotive usage there is a serious problem which can negate all the improvements to playback deck and cartridge. I refer to the appallingly poor quality of the loudspeakers furnished with most car stereo systems. I recently bought a new car, a really deluxe model loaded with options. I got the top entertainment package . . . multiplex FM stereo and 8-track cartridge player. The FM stereo is surprisingly good in terms of sensitivity and selectivity and even in suppression of ignition noise and other spurious noises common to highway travel. The cartridge player is also of excellent quality with better motion characteristics than most home-type units. I am not happy with the tone control, typical of the kind found on most machines, in which as you increase treble, the bass is attenuated and when you increase bass, the treble is attenuated. There should be either separate bass and treble controls, or fixed treble equalization (considering the more or less standard interiors of cars with similar acoustic characteristics) plus a boost/attenuate bass control. I am also annoyed by the fact that there isn't any left/right lateral balance control. All this is nothing compared to the loudspeaker installation. The front speakers are disposed left and right underneath the dashboard, facing upwards and reflecting off the windshield (actually not a bad idea for a wider stereo image, and with such a short path length and with no absorption by the glass there is little attenuation of high frequencies). The speakers are three- or four-inch units, worth about 50 cents, and best described as "skeet targets." The rear speakers, slightly larger units, are mounted facing upwards on the shelf behind the rear seats. The trunk acts as the baffle and while this furnishes better bass response, with both speakers in a common chamber, this doesn't help localization. There is a control on the playback unit to adjust the levels of the speakers for front alone, ar alone, or a combination front/rear balance. The amplifier of the player puts out a fairly clean 2-3 watts, but the speakers are so poor that even at very modest playback levels the sound quality is just marginally bearable. Considering the cost of the car the use of such poor speakers is just plain insulting.

It goes without saying that recourse to the dealer or manufacturer just gets you blank stares. If you want to improve the quality of the sound, you will have to do it yourself. Oh well, being in the hi-fi business, this shouldn't be any problem. Hah! You soon find out what a can of worms you have bought. The area of sonic improvement, in this instance, is the replacement of those execrable speakers with units of better quality. One fortunate thing is that nowadays most car cartridge amplifiers are designed to have maximum output with speakers of 8 ohms impedance. In the earlier days they had this oddball 3.2 ohms situation which is what most garden variety automobile speakers were rated. Trying to find a good quality speaker of that impedance is a major task. At 8 ohms impedance, we have many fine speakers. There are excellent 8-inch speakers made by Electro-Voice, JBL, Wharfedale and others, and this larger size, plus the higher efficiency of these units should solve my problem, right? Wrong. The eight-inch speakers can be fitted into the rear shelf without much difficulty, but even the very shallow depth of the JBL unit is too much for the usual kind of front installation. Enter at this point car stereo expert extraordinaire, Mr. Harold Wally. Mr. Wally is the owner of Wally's Stereo Tape City in New York, a unique establishment devoted entirely to car stereo. Mr. Wally was a pioneer in the car stereo field and today his company has a reputation for "know-how" that brings customers from far beyond the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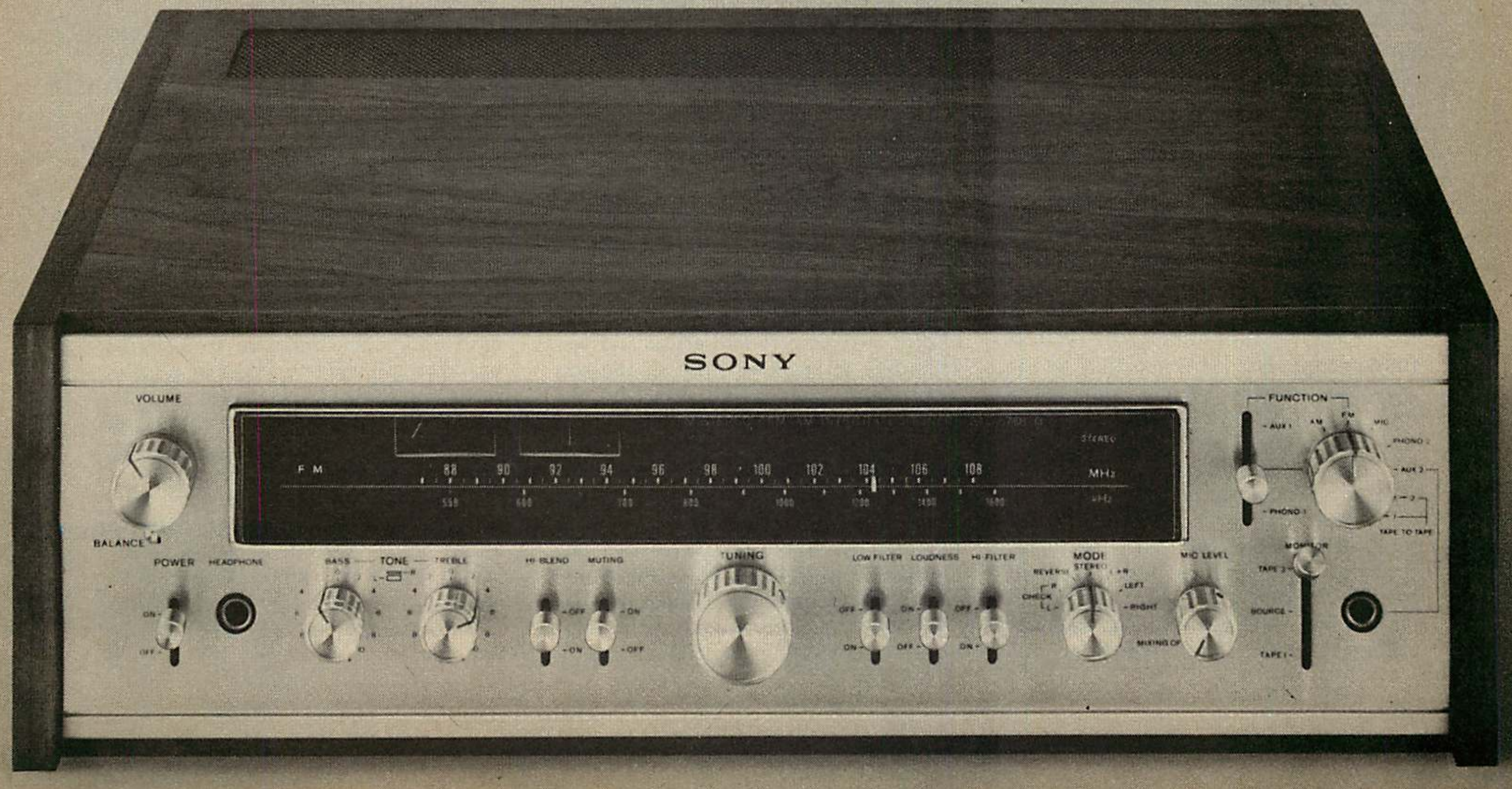
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metropolitan New York area. His company carries over 40,000 cartridges in stock, handles the top brands of cartridge players, as well as a special unit he helped to design, and has most comprehensive installation facilities. Mr. Wally knows and loves music and significantly, his credo is *"demonstrate!"* I had met Mr. Wally some years ago, and with my desire for a really high quality cartridge installation in my new car, decided to avail myself of his expertise. During our first conversation, I brought up the subject of using the aforementioned hi-fi speakers. To my surprise he told me that even if there were no physical problems in fitting in the speakers I had in mind, this was still not the best route to high quality car stereo sound. And thereby hangs a tale. My car will shortly be ensconsed in Mr. Wally's operating theatre, where his expert surgeons will snip out the old and put in the new . . . and I will soon be giving you a full report on the operation and how the patient fared.

* * *

The cocktail party is a great American institution, and as you well know, you can meet the damndest people at these affairs. I have been to every conceivable kind of party, and I'm sure you have too. I'll bet you also have a mental catalog of the myriad types and characters that seem to infest these parties. Well, I thought I had met them all . . . but I ran across a new type at a recent party. Would you believe a full-blown, card-carrying member of Women's Lib? Well, fellas, this creature I met was so typical of the Lib breed, she could have posed for a Lib recruiting poster, or maybe the cover of *Ms.* magazine. Let us be kind and say she was not comely of face. Typically she had a board-flat bosom, bangles, beads and kooky clothes, Gloria Steinem glasses. The only thing missing was a Bella Abzug hat. Unfortunately, I was introduced to her as being in the "recording and hi-fi business." Hoo boy! Was that a mistake!

Fueled by at least four Martinis and brandishing a cocktail fork, with which she impaled some hapless cocktail weenies at frequent intervals (she eventually finished the whole plate of weenies, which may have some dark Freudian implications, but I'll leave that to the psychologists), she began a tirade about how the recording and hi-fi industries were discriminating against women! I admitted that we did not have very many women in the industry, but there were some and that they occupied some pretty responsible positions. I gave her a few examples, which didn't seem to placate her very much, but fortunately the Martinis were beginning to anesthetize her and she finally wandered off. Obviously I'm not a booster of Women's Lib. I like my females feminine and compliant. Well, the little firebreather got me to thinking about the role of women in our industry and speaking personally of the gals I knew and know, they have handled a wide variety of jobs in both the hi-fi and recording areas, and they have done them very well indeed.

My first contact with a girl in the hi-fi world was way back in 1950 when I was with Lafayette/Concord Radio in Chicago. My boss had the idea that a girl could be trained to sell hi-fi equipment, and that she would be a unique addition to the traditional all-male sales staff. He asked me to train a Miss Grace Friedman, a young lady with a good background in music. Grace was a bright girl and a responsive student and within a few months she was an excellent saleswoman with a good grasp of the subject and even able to hold her own in conversations with the wild-eyed audiophiles of those days. Things worked out very well for Grace . . . she married the boss and now lives in Mexico City! Benefitting from this experience, years later when I had my own House of Hi-Fi, I trained my wife and my partner's wife, Esther Hollister, to sell hi-fi equipment. Both became absolute crackerjack saleswomen and they sold some very high-priced elaborate systems. Shortly after I sold my store and Mr. Harry Belock and I founded Everest Records, Esther Hollister was in a terrible automobile accident and in a hospital for three months. Mr. Harvey Sampson, owner of the prestigious Harvey Radio Co. of New York, was kind enough to give Esther a job selling hi-fi equipment at the main store on 43rd St. So for about a year and a half, Esther sold along with the "Harvey men," in what is probably the toughest and most sophisticated audio market in the country.

Talking about bright girls with very responsible jobs in the recording industry, the names Wilma Cozart and Rachel Elkind immediately come to mind. Wilma had formal music training and joined the classical division of Mercury Records. Within a few years she was largely responsible for most of the choice of repertoire and artists and was recording director on most of the sessions, with engineering done by the well-known Bob Fine, whom Wilma later married. By the time of her retirement from Mercury she was a vice president of the company. Rachel Elkind is the long-time producer and general factotum for Walter Carlos (of *Switched On Bach* fame) and his Trans-Electronic Music Productions Co. Rachel handles such diverse matters as contract negotiations, tape editing, special recording effects, and all the myriad details of producing a recording.

Teresa Sterne, also with classical training on piano, is talent co-ordinator and wears several other hats for Nonesuch Records. Mrs. Marianne Mantell and Mrs. Barbara Holdridge are the two attractive co-founders of Caedmon Records, who often supervise the recording sessions for their special spoken word recordings.

Joanne Nyquist works for Mark Aubort's Elite Recordings as tape editor and she is one of the best in the business. With formal music training and piano concertizing experience, she sits in front of a tape recorder with score to one side, and with amazing dexterity makes the many splices that add up to a completely edited tape. Mrs. T. Ugoda knows how to sell audio, so much so, that she is manager of the Brooklyn, N.Y. store of the Audio Exchange. Mrs. Saul Marantz used to help her husband in administrative matters, and Mrs. Rudy Bozak performs similarly for her husband.

Gertrude Murphy is a well-known figure in the hi-fi world for her sterling efforts in presenting the various IHF shows around the country. In a similar capacity, Jacqueline Harvey and Dorothy Spronk cope brilliantly with the multitudinous details of the AES conventions in New York and Los Angeles.

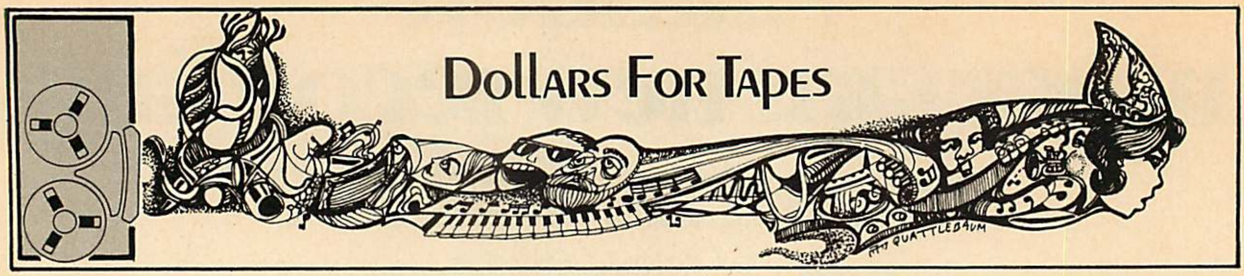
Dagmar Dolby handles administrative matters and can always be found manning the display booth at various conventions for husband Dr. Ray Dolby. Wherever you see a Tannoy speaker exhibit at a hi-fi convention, you'll find Mrs. Fred Towler, helping with the setup and dispensing charm and wisdom. Husband Fred is American rep for the British Tannoy company.

Mrs. Lincoln (Rick) Barr is a bright, attractive gal who is thoroughly conversant with all aspects of the hi-fi business and who does a solid selling job in her husband's Designatron stores on Long Island. Helen O'Connor is the attractive tall blond you'll find doing adminstrative work for husband Bill, TEAC rep for New York.

Last, but hardly least, of the hi-fi gals, is my dear wife Ruth. Ruth has been selling hi-fi since the House of HI-Fi days and, unencumbered by children, has been all over the world with me on recording sessions, usually handling the take sheets, in some cases helping with mikes and cables and quite often placating and "gentling down" temperamental conductors. She goes to every audio convention with me and is a fixture at manufacturer press demonstrations. She can operate any kind of equipment, including the most complex 4-channel.

Bless you, ladies! May we find more like you! Æ

Dollars For Tapes



THIS MONTH the first prize of $50.00 goes to *Conrad Parvin,* of Groton, Conn., for a recording of a religious program given by a rock group called The Crimson Edge. It took place in the Groton Municipal Auditorium, and the star vocalist was Garry Rand, who also played both acoustical and electric guitars. Recorder was a TEAC 1200 with an Altec 1567A mixer and Sennheiser microphones. Stereo image was excellent with good overall sound quality and no sign of overloading.

Second prize of $25.00 went to *Ross Whitecraft* of Stewartstown, Penna., for a recording of the South Williamsport School "Lab Band." I am not certain what "Lab" means in this context, but the SWLB plays well and with enthusiasm. Stereo image was good with realistic brass reproduction. Recorder was a Revox A-77 and mics Turner dynamics which were placed in front of the stage. Ross, who is 19, said this was the first recording he had made in the school hall—so congratulations are in order.

Now to the consolation prizes. The following are among those who will receive BASF or Maxwell low-noise tapes:

Tim Wilde of Dallas, Texas, for a fine recording of a vocalist with acoustic and bass guitars plus drums. Tape was made in three dubbings with the musicians wearing headphones. Recorders with a Sony 650 and an Ampex PR-10. An Ampex MX-10 mixer was used; also an Advent 100 Dolby unit. The final tape was "brightened" (Tim's description) with the aid of a Soundcraftsmen equalizer. Sound quality was clean and with low noise in spite of the dubbings.

Bill Hagera of Mesa, Ariz., sent in a 15 ips recording of his song called "Love Don't Matter Where It's At." I'm not certain what this means—Bill says this is a true story. . . . Be that as it may, the tape is well recorded with a Fender bass, acoustic guitar, accordian, tambourine, and "Hagera" bass. Recorders were Ampex PR-10 and 351 (sound-on-sound is used) with an E-V 654 mic and a Fisher reverb unit. Sound quality was very good with satisfying bass.

Charles Lauria of Staten Island made a tape especially for us. It consisted of "a series of bloops, swishes, and kerplunks selected from Moog records" plus what Charles calls his own creation. This composition was a collection of sound effects made by "connecting myriads of jacks" and by using the sound-on-sound facility on his Akai 250-D recorder. The results were fascinating, but I believe Charles is being unduly pessimistic when he suggests that this is "the music of the future"—but who knows?

Dan Dugan, of San Francisco, made an amusing tape called "The Ascention of Richard Nixon and Two Years After"—a cunningly wrought melange of material from TV, radio, and records with some acid comments. A painstaking exercise which probably acted as a mild cathartic. . . . Says Dan, "We are so conditioned by politicians on TV that they would have to take their clothes off to gain our attention." I forbare to comment on that. . . . Equipment used by Dan included four KLH 41 recorders, an Ampex 750 and a 500, Sony MX-12 mixer, Dyna PAT-4 preamp, a Quad 33 ditto, an Advent FBC unit, two Fisher reverb units, a H-K 830 receiver, and Bose 901's. Not all this magnificent array was used at the same time.

Michael Stosick, of Bolington, Ill., sent in a most ambitious tape made with a home-made quadraphonic matrix. Recorders were a Crown SX 724 and a Bell. The mics were Shure dynamic ribbons and a "home-built Dolby unit" was also used. The tape contains all kinds of exotic material ranging from speedboat noises to flushing toilets. Location was not particularly good when played through my SQ decoder, but it was fun to listen too for all that.

Richard Bailey, of Columbia, Mo., sent in a nice organ recording made in the First Presbyterian Church in Columbia. The organ is a four-manual, 44-rank job and the player was Perry Pettigrew (I hope I have that name right). It was originally recorded on an Ampex AG-440 and the mics were AKG C-451's with a C-24 fill-in. Mixer was an Ampex AM-10 and two Dolby 361 A units were employed. As you might expect, sound quality was first-class, but it seemed a little unfair to award Richard a prize in view of the professional equipment used.

The same applies to *Janet Nielson,* of Urbana, Ill., who sent in a tape made by mix-down from 24 channels, Neumann mics, and so on. Janet was a mixer for an educational organization which put on a show called "Up With People" which toured the country recently. Part of that show is on the tape and Janet has done a fine job. Last we heard, this enterprising gal, who is 20, was looking for a situation in the recording industry.

One of the most interesting of this batch of tapes was made by *Fred Giel,* of San Diego, Calif., and it is a recording of the Apollo 16 launch as heard from the grandstand three miles away. It is really awe-inspiring with a tremendous dynamic range. Recorder was a Uher 4400 and the two AKG D-200 mics were spaced only a foot apart. The roar of the crowd comes over very well —so does the commentary over the PA system. A most impressive tape.

Tom Hayes, of Teaneck, N.J., sent us a tape recording of "Fiesta" from the Montclair State College production of "Camino Real." The music was composed by Raymond Hanniston, a student at the college. Recorder was a Revox A-77 and E-V 635A mics were used for overall pickup and two E-V 674's with two Philips EL 6037's were employed for "spotting." Two Bogen PA amplifiers were pressed into service as mixers. A very nice tape, good clean sound with excellent locatization. Tom is better known as Professor H. Cramfosedi, an active researcher into Transpet technology, and he is now studying for his Masters degree in broadcasting at Marshall Univ. This move is undoubtedly due to the curious lack of interest shown in Transpets by the large commercial organizations.

PLEASE NOTE: This competition finished on June 30—so no more tapes until further notice. The final list of winners will appear in the November issue.

WE SPEAK SOFTLY

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AND CARRY A BIG SOUND

From the most delicate whisper to the thunder of a full orchestral climax, Sansui's new AS acoustic-suspension speakers reproduce the full dynamic range, distortion-free and with impartial precision.

Loud or soft—high volume setting or low—their special quality remains steadfast—and that quality will be a revelation to American ears. For the AS line was designed only after careful research into our listening preferences.

But traditional acoustic-suspension design was only the starting point. Next came new woofer cones blended of selected pulp and wool, then custom-impregnated for well-damped sound. Leakproof, mitred-joint cabinets. New wide-dispersion cone tweeters with excellent transient response. The results are lowered resonances, extended low-end response and smoother high-end performance. They add up to a new standard for reproduced sound, more natural yet more dramatic than anything you're accustomed to.

Listen to them yourself. You'll hear what we mean.

AS100: 2-way system with 10" woofer and 3" tweeter. Response: 45 to 20,000 Hz. Peak power: 40 watts. $89.95.

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Editor's Review

WALTER CARLOS will undoubtedly be criticised from many quarters for his opposition to matrix quadraphonic systems. In a long letter to *Billboard* recently, he said his SQ *Switched-On Bach* record is inferior to the original tape. Now, I like this recording myself but if Walter says it should have more movement or better localizing, I can hardly disagree. One inherent fault of the SQ system is its inability to localize a signal appearing at the rear center and this may be the cause of Walter's dissatisfaction. Electronic music might be the music of the future, but it only represents one section of the art today. I am not greatly concerned with center-rear positioning or 40 dB separation from four different sources when I listen to symphony orchestras, jazz groups, or chamber music but I *do* find the extra spaciousness of the SQ or Sansui recordings most satisfying. Even with opera or, in particular, a large scale work like the Bernstein *Mass,* I find the localization perfectly adequate—indeed in the Mass, it conforms closely to the actual score. Many ordinary stereo records gain a new dimension when played via four speakers and a decoder—especially choral works and older recordings made by the M-S method. Another thing, matrix records do not sacrifice playing time, dynamic range, signal-to-noise or frequency range—all of which are important.

Cecil Watts

Many years ago, I gave a record demonstration to the prestigious British National Federation of Gramophone Societies and when I got home, I found a note from Cecil Watts saying how much he enjoyed the program, which he said was "music as well as hi fi." Cecil was a perfectionist and praise from him was praise indeed. But it was typical of Cecil that he would take the trouble to write. . . . I suppose he is best known on this side of the Atlantic as the inventor of the ingenious record cleaning device, the Dust-Bug, but he has far greater claims to fame. He was one of the early pioneers of direct-disc recording and he formed a company for this purpose more than 40 years ago. This was MSS and they supplied acetate discs to the BBC and customers all over the world. Cecil was handicapped (but not deterred) by ill-health due to war wounds and he died in 1967. His widow, Agnes Watts, has now written a book called *Dust Bug Cecil, A Biography*, which tells of the trials, tribulations and financial difficulties of their early years and how they finally won through. Chapters are contributed by Gilbert Briggs and our sometimes—correspondent, Donald Aldous, and the book includes some of Cecil's famous photomicrographs of record grooves. A fascinating book, highly recommended. It can be obtained from Elpa Marketing, New Hyde Park, N.Y. 11040 at $5.50.

Looking East

"There is a market for American loudspeakers in Japan," said H. Tanaka of the Japanese Electronic Industries Association recently. He went on to say that the salary of Japanese workers has been increasing at a rate of 17% a year. Other news from Japan is that the EIA has standardized quadraphonic record systems by adopting the Sansui QS method.

New IHF President

Herb Horowitz, of the Empire Scientific Co., has been elected President of the Institute of High Fidelity. Herb has been in the industry since 1942 when he was a junior engineer with Pilot. For the past two years he has been the IHF's Vice President which job now goes to Bernie Mitchell of Pioneer.

* * *

I normally do not indulge in politics in this column but as this is election year, I suppose I could be excused. I had just read that the Association of Eunuchs was meeting to determine their election policy. "Phew!" I thought, "this will cause some alarm in George McG's camp, and will the Militant Eunuchs form a United Front with the Gay Liberation boys, or. . . . " But on reading further, I discovered that the news referred to India and *their* election. I breathed a sigh of relief and put on my Walter Carlos record again. *G.W.T.*

Engineer Brian Morgan gets ready for on-air disc playback.

Stanton. Everywhere you turn.

Charles Parker, Program Director, and Chief Engineer Wayne Mulligan, auditioning discs.

Hartford's "Top 40" WDRC AM/FM (serving the community for a half century!) relies on Stanton cartridges in a variety of operations.

Chief Engineer, Wayne Mulligan says "Stanton meets our stringent standards for reliability and sound quality in on-air playback and in the production of transfers."

Stanton's Model 681EE cartridge is their choice for auditioning original recordings and making transfers. Its incredible low mass moving magnetic system ($\frac{1}{5}$ to $\frac{1}{10}$ that of ordinary pickups) and its 10Hz to 20,000Hz response, contribute to its exceptional audio quality not only in professional but in home stereo systems, as well.

For on-the-air use, Stanton 500 Series cartridges are the choice for their ability to withstand rugged handling without sacrifice of audio quality, thus assuring high quality sound with minimum maintenance.

The Stanton Dynaphase headsets seen in both photos, enjoy professional acceptance for their true and full-bodied reproduction. They are lightweight and comfortable.

Whether it's recording, broadcasting or home entertainment, enjoy professional audio quality with Stanton products. Write for literature to Stanton Magnetics, Inc., Terminal Drive, Plainview, N.Y. 11803

STANTON

All Stanton cartridges are designed for use with *all* 2 and 4 channel matrix derived compatible systems.

Noise Reduction Techniques

H. W. Hellyer*

Let's take a look at one or two ventures into noise exclusion that have been at least a bit more ambitious than a mere clipping of playback peaks. One such system is Panasonic's NFD device. NFD, quite simply, mutes the line output unless the signals (on playback) are above a predetermined level and below a set frequency. This reduces hiss when the signal level is low. That is, you get what you want when you most want it.

In the RS 735US, there was a two-transistor, nine-diode circuit that gave very good results indeed. Figure 1 shows the basic configuration. Signal-to-noise ratio, when I tested it, with this noise filter employed, was as good as 66.5 dB. At 1 kHz, the improvement was a mere ¾ dB, but although at rated output level the NFD only made 1 dB difference to the S/N ratio, when the level of signal was down around the danger level, approaching what would have been obtrusive hiss, the circuit effectively blanked signal, and its action did not, as with so many compandor systems, provide an aural switchback.

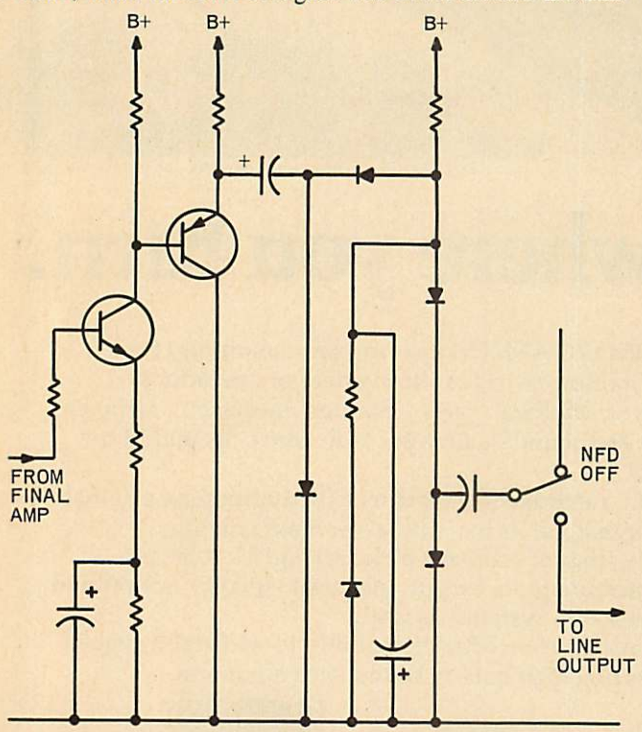

Fig. 1—A simple muting circuit used by Panasonic—simple, but effective, sensing the signal level and "killing" the line output when the signal drops dangerously near the noise level. The circuit shown is for one channel. The same two-transistor network is employed for the other channel, and this "commoning" can lead to problems.

*Bristol, England

Taking the replay system a step farther, Philips has the DNL innovation, which should make much cassette work with other folk's tapes a really feasible possibility.

DNL means Dynamic Noise Limiter, and Philips (Norelco to you) argues thus . . .

"When music is played softly, it is made up almost entirely of pure tones in the middle and low frequency ranges with hardly any harmonics. This is mainly because very few musical instruments produce tones whose fundamental frequencies are much higher than 4.5 kHz. Tape hiss, however, is made up of sounds in the higher frequencies so that it is during the soft passages and silent intervals that it becomes most noticeable.

"When music is played loudly, it not only contains the lower and middle frequency pure tones, but also a great deal of harmonics, which give character to the sound. It is in the loud passages that noise suppression is unnecessary as the high frequency harmonics hide the tape hiss. Any filter action would make the music sound dull and unnatural.

"Therefore, if tape noise or hiss is to be suppressed, it must be completely eliminated in periods of no music signal, reduced during the soft passages of music, and left unsuppressed during the loud passages."

Thus, the oracle—begging one or two questions, like: "Pure tones—**all** instruments played softly?" and "What happens to the soft tones of one instrument when another plays loudly?" and "How soon after the loud noise ends does the suppression take place?"

The Dynamic Noise Limiter acts on replay, the argument being that it therefore allows complete compatibility, giving the benefit of noise suppression even to those poor, deprived owners of untailored cassettes. It is, effectively, a steep, low-pass filter which acts when there are no high signal frequencies.

Philips has been rather clever about it, allowing high frequency signals that exceed a predetermined level to bypass the filter: so there are two signal chains. Fig. 2 shows the block diagram. From the splitter, the signal takes two paths, one path merely inverts the phase without affecting the linearity while the other passes it through the tailoring process.

This process chops off the lower and middle frequencies, leaving only those above 4 kHz (approximately—you can't do these chopping actions abruptly without introducing almost ineradicable distortions, whatever the advertising copywriters say). This remaining high frequency band is now monitored so that the quieter parts of higher frequency are boosted. Hence the variable attenuator—it is both level and frequency-conscious.

The TEAC 4010 GSL strikes another blow at built-in obsolescence.

In this throwaway age, you're something of a square when you keep upping the life-expectancy of your product. But this hasn't kept TEAC from producing tape decks like the 4010 GSL.

Of course, the transport in the 4010 GSL deck is world renowned for smooth, precise, incredibly gentle tape handling and quick-start characteristics. It's also one of the most rugged and reliable units in existence.
To begin with, the 4010 GSL has three ultra-reliable precision motors. And a solenoid system for smooth fingertip control. Automatic reverse and end-of-reel shut-off.

Operator conveniences rival those on professional studio equipment. A pushbutton pause control for easy cueing and editing. Switchable bias and dual-scale VU meters for perfectly equalized recordings on either low-noise/high-output or standard tape. Tape/source monitoring and MIC/LINE mixing with independent output level controls.

All told, the 4010 GSL may outlive you even if you come from a long line of nonagenarians. But if it does—what a way to go!

Salient 4010 GSL Specs
Frequency response: 30-22,000 Hz (40-18,000 Hz ±3 dB) @ 7½ ips.
Signal-to-noise ratio: 55 dB
Wow and flutter: 0.08% @ 7½ ips.
Crosstalk: 60 dB @ 1,000 Hz

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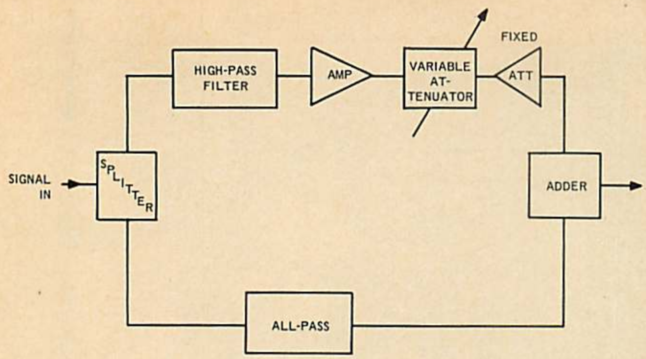

Fig. 2—Block diagram of the Philips (Norelco) Dynamic Noise Filter. The surprisingly effective though unsophisticated system acts on playback only and has the effect of an 18 dB/octave filter when the signal is low. A S/N ratio improvement of around 10 dB at 6 kHz and 20 dB at 10 kHz has been measured (unweighted). The high-pass filter takes effect above 4 kHz.

Fig. 3—The DNL circuit, four transistors, six diodes, and a handful of common components, can easily be made up into a neat set-side box—no bigger than a double pack of 20 cancer-sticks.

Adding together the processed and unprocessed chains should now, theoretically, give a signal whose low-level high frequencies have a quietened effect, while middle and low frequencies are unaltered and where the higher volume high frequencies are given their full, required weight. In theory, once again, the result should be a true replica of the original, but without the hiss.

And, I must admit, despite some initial misgivings because Philips demonstrated this device to us a year or so ago in an hotel room whose air-conditioning added some 30 dB to the ambient noise, the subjective effect is a cleaner sound, whatever the condition of the recording.

But I still feel that the answer is not to use a circuit that gives, as Philips claim, a 10 dB improvement of S/N ratio at 6 kHz and a 20 dB improvement at 10 kHz on replay, but to improve the overall record/replay process in such a way as to retain its original sound structure, not "tailor" it. Again, if you must have slow-speed, narrow-track recording, then you have to engineer out the hiss, not allow it to happen and *then* try to beat it.

So we come to Dolby and the now-famous stretching process that Dr. Ray Dolby pioneered. The original "A" process aimed at beating the "breathing" that compansion procedures forced disc users to suffer and cost more than some recording companies could afford. It begins its work during recording, splitting the audio path into a direct and a rectifier chain. But the expensive "A" system did this in four bites, carving up the frequency spectrum to give differential gain depending on signal level within the frequency bands. These are: below 80 Hz, from 80 to 3,000 Hz, above 3,000 and again above 9,000 Hz.

Both hiss and hum are present in the recording process, and while hum can be relegated to one low portion of the audio spectrum, hiss is a very different problem. It obtrudes into the very region where our ears happen to be most sensitive. It has measurable components that extend way upwards into what some engineer colleagues of mine call the "annoyance passband." Any crude way of militating against hiss will mutilate the upper frequencies which we need to preserve to get the clash and tingle of a full musical experience.

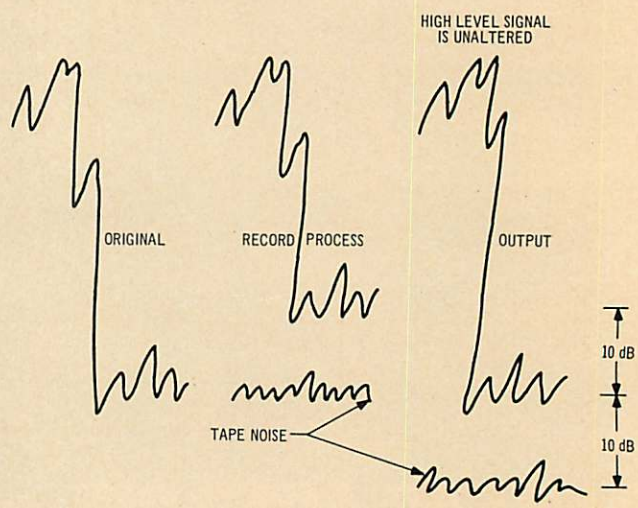

Fig. 4—One way of explaining the Dolby system: The original signal has its lower levels down around the system noise. Processing during record gains some 10 dB of S/N ratio. Replay retains this, raising the lower levels of signal that much above the noise.

Again, the procedure is to let the noise remain when the music is loud enough to mask it. Masking—as a technical term—is a peculiar business. It depends as much on relative frequencies as on loudness, and has some strange anomalies to do with time difference and phase factors. Subject for a later discourse, maybe. At present, please take my word for it that the phenomenon happens, and by letting the main, high level signals straight through the system, Dr. Dolby follows the method we have roughly outlined already.

Listen
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The sound of Martin Speakers can be as quiet and irresistible as the gentle meeting of sand and surf. Or vibrant and deepthroated as the roar of thunder in the summer sky.
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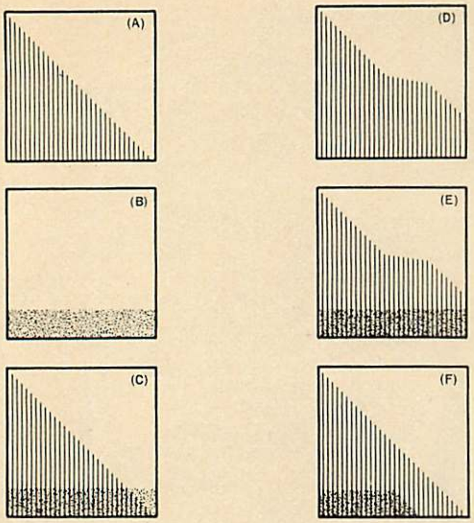

Fig. 5—An alternative explanation, as depicted by Dolby: A, music is made of sounds of different loudness with intervals of silence; B, noise of some kind is inescapable; C, when a tape recording is made and replayed the noise interferes with the low level signals, spoiling the program; D, the Dolby system boosts the lower signals during recording; E, those lower signals are still above the annoying noise during replay, as shown in F, the composite picture of the reconstituted sound with noise "reduced" by the carefully engineered boost and stretch system.

Fig. 6—Noise reduction units can be added quite easily to existing equipment. This Advent 100A has been enthusiastically received, despite the $250.00 price tag. My own special interest is harmonic distortion, and I was interested to note that the 100A was under 0.4% to 0 dB and less than 0.2% at lower levels. Output noise, –60 dB; noise reduction around 10 dB above 4 kHz, about 3 dB at 6 kHz. This is a stereo unit and well worth considering for slow-speed recording.

The subtlety lies in the treatment of the low-level signals, where noise is obtrusive. Dolby calls this the differential component, and this is, of course, relatively small—and hence more difficult to handle. It has to be remembered that the noise reduction system does not eradicate noise; it boosts weak signals to improve the signal-to-noise ratio, that's all.

That's all! Pause for hollow laughter! Arguable decisions are the threshold limit, below which noise-plus-signal will be processed, attack time, the response of filter circuitry to the information that a signal in need of treatment is coming along, the amount and nature of compression, and the way of ensuring a mirror image expansion and an avoidance of overshoot (which would process signals that did not need such treatment).

If the distortion has a duration of less than a millisecond, it will defeat the human ear. This is a smaller fraction than normal signal transients and our aural loudness-growth characteristic cannot distinguish the short-lived distortion.

The Dolby "B" system came into being when Ray Dolby was asked to dream up a modified noise reduction device for use with domestic equipment. The only feasible way to keep such a system within our budget was to forgo the technical requirement of four passbands and operate over the whole audio spectrum, this time making the sensor part of the apparatus listen for frequency as well as loudness, on a kind of sliding scale.

The system comes into action at about 600 Hz, with a maximum 3 dB effect. (O.K., so the ads say it extends above 2 kHz, but the sliding scale method means it really begins lower down). At 1.2 kHz it has a maximum 6 dB effect, has 9 dB at 2.4 kHz and reaches the advertised 10 dB above 4 kHz. The compression comes in about 45 dB below what has become known as the "Dolby level." This can be defined as a flux level on tape of 200 nanowebers per meter. Call this 0 VU.

In more technical terms, the differential chain splits into the rectifier path and into the linear path to the mixer for readdition to the main signal. The rectifier path contains boost circuits giving a 6 dB per octave flip to the higher frequencies. Then the output is rectified. This rectified signal effectively alters the dynamic resistance of an FET at the input end of the chain, and so gives a boost at low dynamic levels and practically no boost at high levels. By the simple device of driving the FET via a small coupling capacitor, Dr. Dolby achieved both a drop in gain with an increase in dynamic level and a change of the turnover frequency of the "threshold" as the level changes. The sliding scale, in fact.

At low levels the capacitor lets the FET see the full signal and gives a good 10 dB boost above 2 kHz. Increase the input level and the frequency above which this full boost is given begins to rise. Turn up the wick still more and the treble boost in the rectifier chain stops the over-saturation of the tape. To reinterpret, that means the tape is driven to its full limit when need be, at high dynamic levels (of original signal), but is allowed up to a 10 dB boost at lower signal levels. The replay mode is reciprocal.

The entire processed chain is inserted in a feedback loop around the main chain to subtract instead of add. The elegance of the system is that the same basic circuitry, and, indeed, a mirror-image printed circuit board makes production costs tumble and the add-on Dolby units now available should be within any enthusiast's purse. (Dolby IC chips are also coming soon.—Ed.)

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S/N	-60dB	-60dB

3 speeds - 15, 7½ & 3¾ips; hysteresis synchronous drive motor

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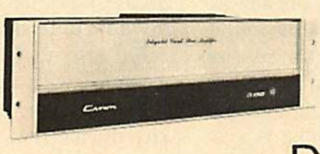

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Fig. 7—Slim, elegant, technically precise, one section of the Dolby A system as used by professional recording bodies throughout the world. Having had the chance to "rip one to bits," I can vouch for its engineering excellence.

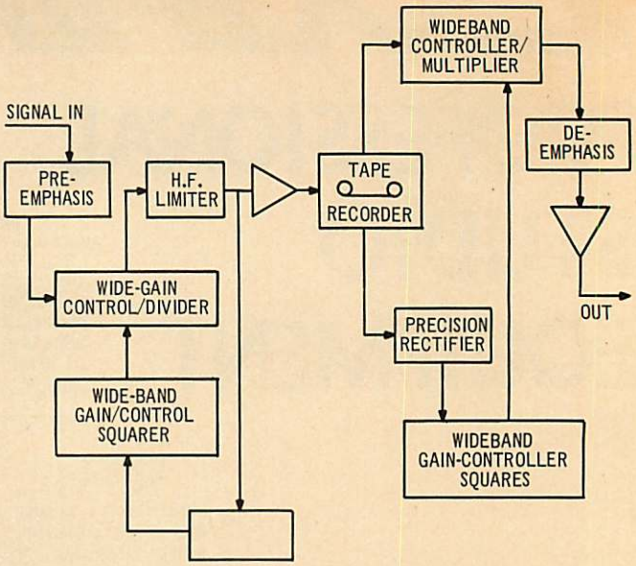

Fig. 8—Block diagram of the Burwen system, with refinements like active transformers and direct play equalizers omitted. The heart of the system is the rectifier module, monitoring the gain of two channels simultaneously in the "domestic" system. Operational amplifiers are used widely in this system with very high accuracy as a result.

My own tests with those available in the U.K. have confirmed that signal-processing of cassette-recorded music, speech, and sound effects have done wonders to guard against hiss and have not made detectable any audible worsening of the prime signal.

After Dolby, what? Well, according to Richard Burwen, quite a lot. In the December, 1971 issue of the Journal of the Audio Engineering Society, I came across the Design of a Noise Eliminator System which gave me much brain-searching and is at present exercising the pundits in those polite tomahawkeries of the erudite correspondence columns. (See also Audio, June, 1971.)

To begin with, the title of Richard S. Burwen's paper hits a sore point. The only way you eliminate noise, truly, is not to cause it. After the die is cast, all you can do is guard against it—which we have seen three different systems doing in the preceding notes.

Mr. Burwen took the critics by the ears at the 41st convention in New York on October 5, 1971. In February of that year, a paper of his entitled "A Dynamic Noise Filter" had aroused comment. He is more concerned with studio tape machines, just as Dr. Dolby was, and there seems little hope, at present, of such an elegant "domestic" solution to the noise reduction problem with a plain man's Burwen. But anyone who has been in the audio field as long as us (well, me) knows better than to say that something, anything, cannot be done.

So let's conclude with a brief look at Mr. Burwen's solution.

He set himself some pretty high parameters. His system was not, he told us, to exceed the present 1%, and preferably 0.5%, distortion level of good taping. He wants to record live music "with no audible noise whatsoever." So his first experiments were to determine peak recording levels.

Recording to +3 VU, a normal process, when 0 VU is the standard set limit and peaks above this as much as +6 VU are occasionally tolerated because of their short duration, meant that distortion on tape went over that critical 1%. He concluded—first point, and first stumbling block for his critics—that it is not always advisable to retain every peak.

Listening tests revealed that for noise to be negligible in the absence of program material, it had to be 90 dB or more below the 1% distortion level, i.e., better than -84 VU. Then he found that noise 65 dB down was audible with a 500 Hz sine wave but masked by frequencies above 3 kHz. You could reduce the bandwidth to about a half-octave centered on 500 Hz and get a pure tone—so the solution seemed to be split the waveband, per Dolby A.

But the multiband system, according to Richard Burwen, has the disadvantage of frequency response errors in the tape machine causing errors in the expansion process. The solution was to use the whole band but compress the 90 dB expected input to 30 dB at the tape. He then combined the principles of his dynamic noise filter (see June, 1972 issue of this magazine) with a single wideband compandor.

The dynamic noise filter acts as a low level expander at top and bottom of the frequency spectrum—again, something like we've seen before. Adding a high and low-frequency compression system seemed to be the answer, and high frequency pre-emphasis was intended to improve the S/N ratio. Some hellish problems raised themselves at this point, and Mr. Burwen went back to the drawing board. He finally produced three systems, A, B and C. Characteristic A is optimized for studio recording at 15 ips. It has a dynamic range of 110 dB and this is the one you'll see hailed in the ads! System B operates more modestly to give a 102 dB dynamic range at 7½ ips, and C is the one that may eventually interest us at 3¾ or 1⅞ ips for FM broadcasting, records or background music. If you want it in the words of the master: "The system . . . utilizes high and low frequency pre-emphasis and a single wideband cube root compressor to produce the recorded signal, and a complementary expandor and pre-emphasis for playback."

The important point slipped in later is that in the single-band system the frequency response is constant and is not affected by inaccuracy in the tape machine. Again, we shall leave the pundits to argue.

The high performance of the Burwen circuitry has been made possible by the low-noise two-quadrant multiplier/divider. Bettering Dolby by one magnitude in claim and applicable also to FM systems, it seems to offer possibilities, and we must wait and see what the outcome may be.

For my part, in this noise-polluted environment, I welcome any device that can help rid us of clamour. But noise is what you make it, and the tick of an obtrusive clock, as many an amateur recordist has found, can be as bothersome as a traction engine. The subjective results, applied to cassette, have been enormous—praise to the noise-breakers! Æ

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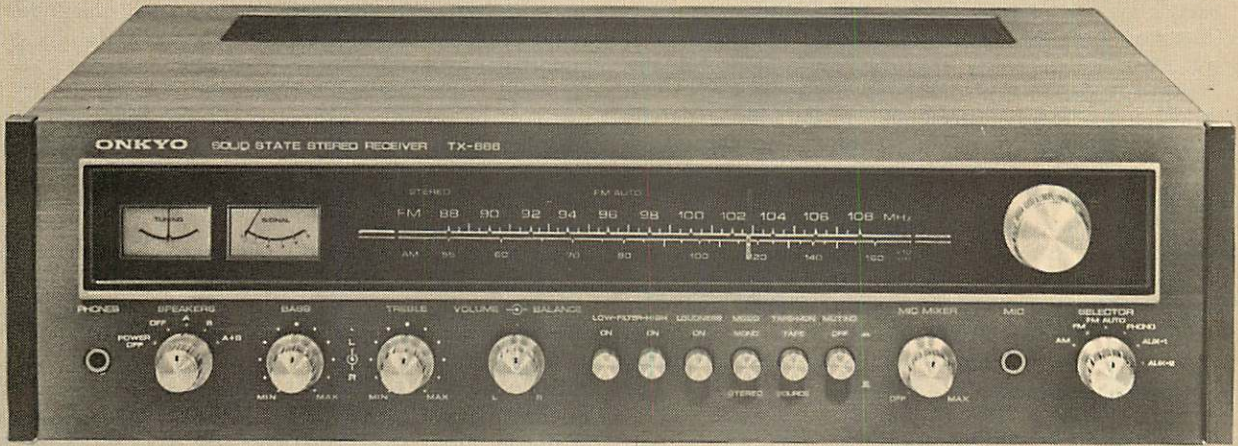

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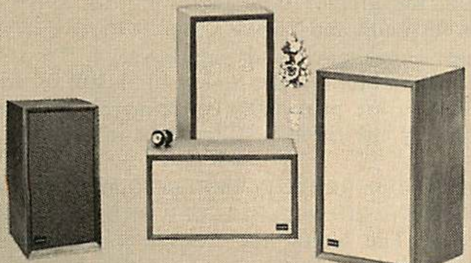

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The Tape Guide

All About Tape Recorder Equalization

Herman Burstein

FROM READERS' QUESTIONS and things that appear in the popular audio literature, it seems that tape recorder equalization is less well understood by audiophiles than its importance deserves. The mystery tends to be compounded by the variety of equalization characteristics necessitated by an assortment of tape formulations and tape speeds, as well as by the occasional promulgation or advocacy of new equalization standards.

Therefore the Tape Guide seeks to explain what tape recorder equalization is all about—why it is needed; how it is achieved; how it can be modified to optimize the interdependent requirements of extended treble response, low noise, and low distortion; the nature of the NAB equalization standards, and how equalization is affected by such things as tape speed, tape formulation, use of the Dolby system, etc.

For the most part the discussion assumes that tape speed is 7½ ips. Despite the greatly improved performance obtainable at lower speeds, 7½ ips is the NAB (National Association of Broadcasters) standard speed and is the one generally preferred for high quality home recording. (In fact, some home recordists prefer 15 ips.) In any event, what we have to say applies in principle to all tape speeds.

It is further assumed that the tape machine has: (1) clean and demagnetized heads so that no treble losses occur due to poor tape-to-head contact or magnetization; (2) heads in perfect azimuth alignment (gaps exactly at right angles to tape length) to eliminate treble losses owing to incorrect azimuth; (3) bias set for approximately minimum distortion at mid-frequencies, specifically at 400 Hz.

Why Equalization Is Necessary

Suppose that the tape machine we have just described has no equalization circuits to alter frequency response, and that it is employed to record and play a tape at 7½ ips. Further suppose that input signals of *constant level* are recorded throughout the 20-20,000 Hz range and then played back. A meter connected to the output would typically show the machine's record-playback response to be quite similar to Curve ABC in Fig. 1: Record-playback response climbs steadily at virtually 6 dB per octave (20 dB per decade, to be precise), reaches a peak around 3,500 Hz, and drops substantially thereafter.

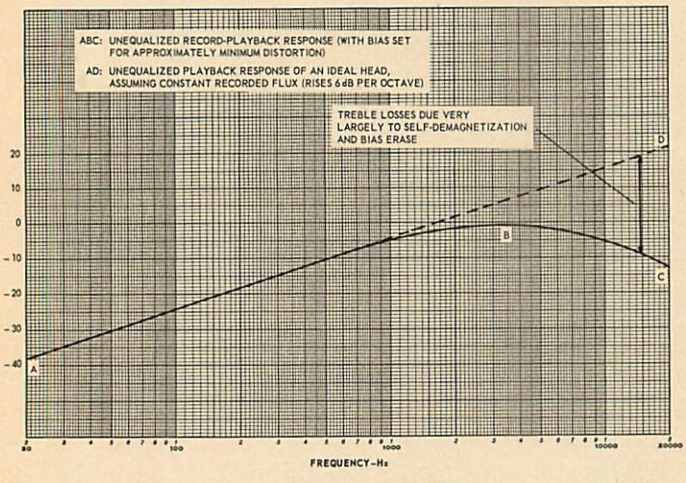

Fig. 1—Unequalized record-playback response of a tape recorder at 7½ ips.

Clearly, bass boost is needed to compensate for the drooping bass portion AB, and treble boost is needed to compensate for the drooping treble portion BC. That is the role of equalization—to provide bass and treble boost made necessary by the inherent nature of the tape recording process.

To help us see why Curve ABC is the way it is, Fig. 1 supplies line AD, which is the response of an "ideal" (perfect) playback head if a tape were recorded flat; that is, if the tape contained recorded flux of equal magnitude at all audio frequencies. At this point let us carefully note an important distinction between *applying* a flat signal to the tape and *recording* a flat signal on the tape. Losses, which we describe shortly, take place in the treble range of the recorded signal. However, line AD assumes there are no such losses so that a flat signal is recorded on the tape. In sum, AD is the playback response of an ideal head if the tape is *recorded* flat.

AD rises steadily at 6 dB per octave because the head is a velocity device. That is, the head is an electromagnetic generator with a voltage output proportional to the rate of change of the magnetic field of the tape. The field changes at a rate corresponding to the audio frequency. Hence the voltage output of the head is proportional to audio frequency. For example, at 10,000 Hz the playback head produces twice as much output as at 5,000 Hz, and 10 times as much as at 1,000 Hz. (That is why we say line AD rises 6 dB per octave or 20 dB per decade, since 6 dB represents (very nearly) a doubling of voltage, and 20 dB represents (exactly) a 10-fold increase).

Beyond approximately 800 Hz the record-playback curve fails to continue its 6 dB per octave climb due almost entirely to magnetic losses that occur *in recording* and become more severe as frequency increases. These losses are of two kinds, self-demagnetization and bias erase, and we shall return to them in a moment. There are also slight losses—especially slight at higher speeds—attributable to the playback head. Winding capacitance of the playback head may result in treble loss. And there may be some treble loss due to gap width (the wider the gap of the playback head and the slower the tape speed, the greater the loss.) But with a playback head that is well made and boasts a gap as narrow as 40 or 50 microinches, capacitance and gap losses at 7½ ips are usually quite negligible—on the order of 1 dB or less at 20,000 Hz. Thus we are principally concerned with recording losses described by the terms self-demagnetization and bias erase.

Self-demagnetization refers to the fact that the recorded signal on the tape in effect consists of a series of bar magnets end to end. The higher the frequency, the more bar magnets are recorded per inch of tape, so that each magnet is necessarily shorter. But the shorter the bar magnet, the closer together are its north and south poles, and the more

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their opposing magnetic fields tend to cancel; that is, the signal tends to self-demagnetize. In sum, with increasing frequency the strength of the recorded signal—the amount of magnetic flux on the tape—tends to weaken.

Bias erase is a side-effect of the high frequency signal, typically 75,000 Hz or higher, which is fed in moderate amount to the record head to minimize distortion and generally maximize the amplitude of the recorded signal; this is called bias current. In much greater quantity, about 10 times as much, the oscillator current powers the erase head. Unfortunately, bias current in the record head has the deleterious side effect of also accomplishing erasure—not nearly as effective as the erase head, but erasure nonetheless. Bias erase increases with frequency because the higher frequencies penetrate the tape less deeply and hence are more vulnerable to an erasing field. Altogether, bias current produces treble loss; the larger the bias current (for reduced distortion), the greater the treble loss.

The magnitude of the magnetic losses in recording is indicated by the interval between Line AD and Curve ABC. Recall that AD is the response of an ideal playback head in the absence of recording losses, and that an actual high quality playback head is close to ideal. Therefore the interval between AD and ABC represents recording losses. For example at 15,000 Hz the interval shows a loss of about 30 dB. Roughly 20 dB of this may be ascribed to self-demagnetization and the other 10 dB to bias erase.

Equalization for Flat Response

A major goal of high fidelity is of course flat frequency response, output signals having the same relative levels as

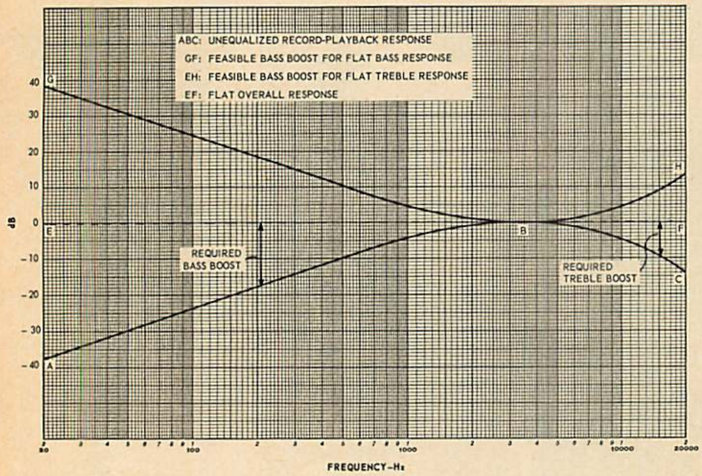

Fig. 2—A feasible pattern of equalization for a tape recorder at 7½ ips.

the input signals at all audio frequencies. In other words, for constant level input there should be constant level output in the range of approximately 20 to 20,000 Hz. Hence flat response is represented by a straight horizontal line, such as EF in Fig. 2.

Record-playback Curve ABC from Fig. 1 is repeated in Fig. 2, and a feasible scheme of equalization for flat response is straightaway evident. The interval between EB and AB may be interpreted as bass loss, and therefore represents the bass boost needed for flat bass response. Similarly the interval between BF and BC represents the needed treble boost. Accordingly, GF is a suitable bass equalization curve, rising in a fashion that mirrors the decline AB. And EH is a suitable treble equalization curve, rising in a fashion that mirrors the decline BC. Together, GF and EH complement record-playback Curve ABC to produce flat response.

Figure 2 is a workable scheme of equalization and something fairly like it is used. However, matters are not all that simple. In addition to flat response, high fidelity has low noise and low distortion as major goals. For reasons connected with improving the signal-to-noise ratio, actual equalization (the generally employed NAB standard) is a modified version of GF and EH in Fig. 2. But we must postpone, and pave the way for, discussion of NAB equalization in order to deal first with the question of where equalization takes place in a tape machine so as to best serve the triad of goals—flat response, low distortion, and low noise.

Where Equalization Takes Place

We begin with an important observation. Figure 1 shows great treble losses in recording, reaching about 30 dB at 15,000 Hz and 36 dB at 20,000 Hz. Yet Curve EH in Fig. 2 indicates that a treble equalization curve with only 10 dB of boost at 15,000 Hz is needed. The seeming paradox is explained by the fact that treble boost is not required to fully make up for treble losses. Only enough treble boost is needed to achieve flat response. Putting it differently, the rising response of the playback head (the portion of AD above 800 Hz in Fig. 1) compensates for a substantial part of the treble losses. Only the remainder of the treble losses must be made up by Curve EH in order to achieve flat response in the treble range. Thus we note that rising response of the playback head has a key role in treble compensation.

Where should equalization circuits be placed in the tape machine? One might expect that they could be placed in the record amplifier, or in the playback amplifier, or in a combination of the two. However, not just any combination will do, because some offer better results in terms of noise and distortion, while others offer worse.

Without yet explaining anything, one may offer a descriptive general rule: *Playback losses are equalized in playback and record losses in recording.* Thus Curve GF in Fig. 2 would be supplied by an equalization circuit in the playback amplifier. And curve EH would be supplied by an equalization circuit in the record amplifier.

Why this general rule? If the large amount of needed bass boost were supplied in recording, this would tend to apply excessive signal (magnetic field) to the tape and overload it, resulting in excessive distortion. Alternatively, one would have to greatly lower the recording level, resulting in a poor S/N ratio. Therefore bass boost is applied (largely or altogether) in playback. Moreover, Curve GF in Fig. 2 may be viewed in the guise of a treble cut characteristic. In this vein it serves to reduce noise of the entire tape recording system when used in playback.

Turning to treble boost, we must consider that noise, while prevalent at equal *amplitude* throughout the audio spectrum, is usually most evident from about 3,000 Hz upward. This is partly because of the human ear's sensitivity in the vicinity of 3,000 to 5,000 Hz. Mainly it is because of the increasing amount of random noise energy as one goes up each octave of the audio spectrum; the more frequencies per octave, the more must be the noise energy. (Clearly there are more frequencies between, say, 3,000 and 6,000 Hz than in the preceding octave of 1,500 to 3,000 Hz.) Thus we characterize tape and amplifier noise as high-pitched (hiss, spitting, frying, etc.) even though low-pitched noise is also present. If treble boost were applied in playback, it would magnify tape noise and noise of the record and playback amplifiers, resulting in a poorer S/N ratio. Therefore treble boost is applied

Ampex, Media Sound, and the AR-LST.

Until now, most parameters of the recording art have been significantly better defined than has loudspeaker performance. A quantitative standard for the monitoring of recordings has therefore been lacking. Recently Ampex and other recording companies have turned to the AR Laboratory Standard Transducer, a speaker system that represents the efforts of Acoustic Research to come to grips with this problem.

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instead (largely or altogether) in recording, where it only magnifies noise of the record amplifier.

A logical and important objection is in order at this point; Won't the treble boost in recording overload the tape (much as a large amount of bass boost might)? The answer would be yes if, for typical sounds, all frequencies had equal peak amplitudes. But for most recorded sounds desired by humans, particularly music, amplitude is usually a good deal less at high frequencies than at mid-range ones, as suggested in Fig. 3. This figure shows for a typical orchestral selection the relative peak levels of audio energy throughout the spectrum.

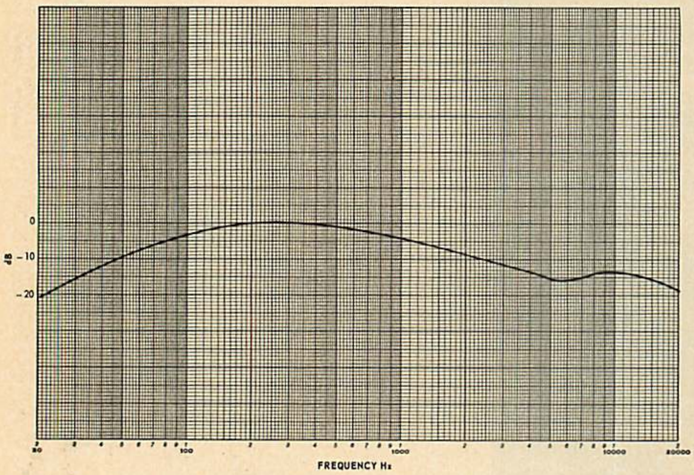

Fig. 3—Smoothed approximation of relative peak amplitudes for a typical orchestral selection.

Compared with peak amplitude at 400 Hz, there is a dropoff of 15 dB or more at higher frequencies.

Therefore, in dealing with the kind of sound generally recorded, a good deal of treble boost is feasible in recording. This boost is offset by the decline in amplitude of the higher frequencies, which helps prevent the tape from being overloaded. (Another preventative, when necessary, is reduction of recording level by the user.)

A Modified Pattern of Equalization

We have already noted that low noise is one of the three major goals of high fidelity. Put differently, we are interested in high S/N (signal-to-noise ratio). This can be achieved by recording more signal on the tape, especially at high frequencies, where the extra signal can mask the noise.

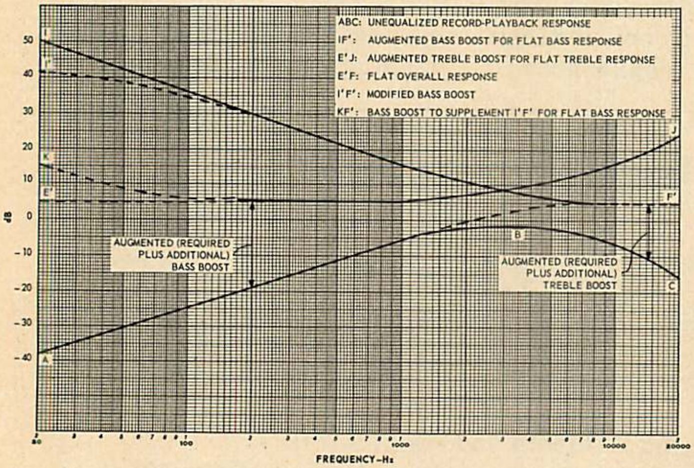

Fig. 4—A modified pattern of equalization to obtain improved signal-to-noise ratio (at 7½ ips).

Figure 4 shows a modified pattern of equalization that uses additional boost in recording yet results in flat response. Desired flat response is denoted by Line E'F'. It is 6 dB higher than the corresponding line EF in Fig. 2, reflecting an improvement of 6 dB in S/N ultimately achieved at higher frequencies.

Curve ABC, as before, is the unequalized record-playback response. The interval between AF' and ABC is the treble boost needed to approach flat response at the higher frequencies; that is, response 3 dB below flat at about 3,200 Hz, and increasingly flat as frequency rises. We may refer to this interval as "augmented" treble boost, consisting of the amount originally required in Fig. 2 plus an additional amount for higher S/N. (The interval between BC and the O dB line is the originally required treble boost, so that the remainder of the interval between AF' and ABC is the *additional* boost.) Thus Curve E'J is the augmented treble equalization needed for flat treble response. (E'J is the same distance from E'F' as ABC is from AF'.)

The required bass boost is the interval between flat response E'F' and drooping response AF' (keep in mind that AF' represents the response of an ideal head to a recording made with treble boost E'J). We may refer to this interval as "augmented" bass boost because it consists of the amount originally required in Fig. 2 plus an additional amount. (The interval between AB and the O dB line is the originally required bass boost, so that the remainder of the interval between AF' and E'F' is the additional bass boost. Thus

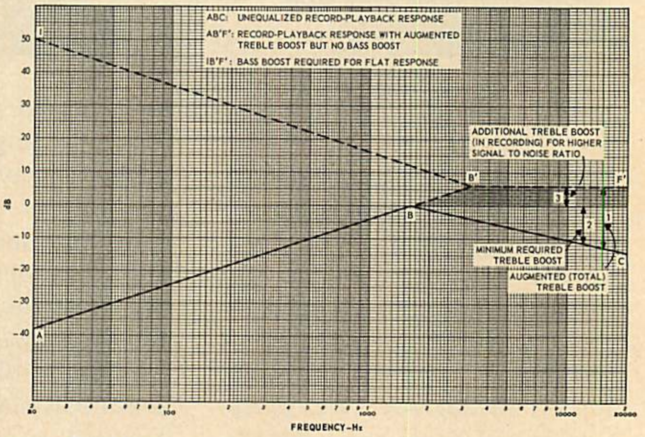

Fig. 4A—Basic scheme of the modified pattern of equalization.

Curve IF' is the augmented bass equalization needed for flat bass response. IF' is the same distance from E'F' as AF' is from E'F'.)

The story told by Fig. 4 is somewhat complex. It can be made more clear by presenting its essentials in simpler form in Fig. 4-A. (We haven't yet finished with Fig. 4 and shall return to it shortly.) ABC in Fig. 4-A represents in linear form the unequalized record-playback response. Line AB'F' shows the record-playback response that would result if there were only augmented treble boost and no bass boost. Augmented treble boost is depicted by Arrow 1, minimum required treble boost by Arrow 2, and additional treble boost by Arrow 3. Additional boost is further spelled out by the shaded area between BB'F' and BC. Given record-playback response AB'F', it remains to supply bass boost IB'F' in order to achieve overall flat response. AB'F' in Fig. 4-A corresponds to AF' in Fig. 4; and IB'F' in Fig. 4-A corresponds to IF' in Fig. 4.

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Returning to Fig. 4, we may ask: Why stop at a 6 dB improvement in S/N at the higher frequencies? Why not add yet more treble boost in recording to achieve still higher S/N. The answer lies in Fig. 3, which shows that, relative to 400 Hz, the higher frequencies are down roughly 15 dB at 15,000 Hz and a bit more at 20,000 Hz. Correspondingly, this allows treble boost of about 15 dB at 15,000 Hz and a bit more at 20,000 Hz without excessive risk of serious tape distortion. Treble boost curve E'J does just about that, with no margin of safety to spare. In other words, in the present state of the art, treble boost in recording which approximates E'J is about as far as one dare go without risking excessive distortion in the upper end of the treble range. (Here lies the reason why some recordists still prefer 15 ips. Treble losses in recording are less than at 7½ ips, so that less treble boost is needed in recording and there is less risk of overloading the tape due to such boost. The recordist speaks of the greater "headroom"—margin between the amount of treble signal applied to the tape and the amount which causes tape saturation—available at 15 ips.)

It is difficult in practice for a tape amplifier to fully supply the amount of bass boost indicated by Curve IF' in Fig. 4. For one thing, an enormous amount of amplification is needed to achieve bass boost which at 20 Hz is up 44 dB from the reference line E'F' and still rising. High amplification is costly, may unduly magnify hum frequencies, and entails the risk of oscillation owing to phase shift or stray feedback. Therefore a preferred course is to allow bass boost to level off, as shown by I'F' in Fig. 4. Now bass boost is up about 35.5 dB at 20 Hz and soon reaches a maximum of 36 dB below 20 Hz.

To compensate for the levelling off of bass boost in playback, some bass boost may be introduced in recording, as shown be Curve KF' in Fig. 4. However, this isn't always necessary, because at low frequencies the playback head often tends to exhibit a slight rise in response owing to what is called the contour effect. Low frequencies correspond to long wavelengths (bar magnets) on the tape. In the presence of long wavelengths, the entire playback head, not only its gap, tends to react to the magnetic flux of the tape. The resultant rise in bass response may approximate KF' well enough to obviate the need for bass boost in the record amplifier.

If bass boost is supplied in recording because the contour effect is minimal, ordinarily this raises no problem of overloading the tape. Figure 3 shows that the typical decline of peak amplitudes at low frequencies would easily offset the bass boost of Curve KF'.

A final and key note on Fig. 4: Comparing this with Fig. 2, we observe that an equalization pattern which calls for increased treble boost in turn requires greater bass boost. Conversely, a decrease in treble boost is accompanied by a decrease in required bass boost. *In sum: A given recording characteristic implies a complementary playback characteristic; or a given playback characteristic implies a complementary recording characteristic.*

NAB Standard Equalization

The approach of Fig. 4 is followed by the NAB standards for tape recorder equalization. In fact, I'F' is the NAB playback equalization *characteristic* for 7½ ips (and for 15 ips as well). For greater clarity, I'F' is repeated in Fig. 5. We underscore the word "characteristic" because the NAB standard does not merely describe the frequency response of an equalization circuit in the playback amplifier (as is the case for RIAA phono playback equalization and for FM tuner equalization). True, measured frequency response of the tape

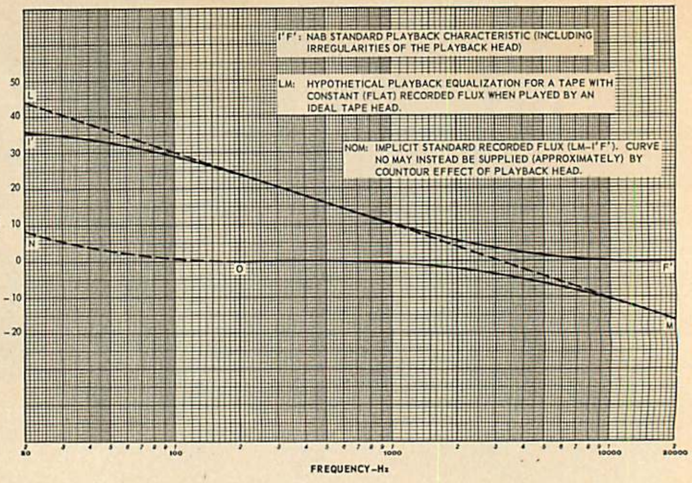


Fig. 5—NAB standard playback equalization and recorded flux.

playback amplifier is ordinarily quite close to Curve I'F', but it is not necessarily the same as I'F' in order to achieve flat response. The NAB playback characteristic in Fig. 5 is the *sum* of playback equalization provided by the tape amplifier plus irregularities in frequency response of the playback head. As already discussed, these irregularities tend to consist of some boost in the low bass region and a slight dropoff in the high treble region.

To illustrate, assume that a playback head is significantly deficient in high treble; that is, its output rises with frequency but at less than the theoretical 6 dB per octave rate of an ideal head throughout the audio spectrum. Then, if flat response is to be maintained, the playback amplifier must supply enough treble boost to compensate for the head's deficiency. *Together,* the amplifier and playback head supply the NAB playback characteristic, Curve I'F' in Fig. 5 (or something like I'F' if the contour effect is pronounced).

Without elaborate test equipment, how is one to ascertain whether a tape machine (playback amplifier plus playback head) provides the NAB playback characteristic? The answer lies in a standard test tape. (This is supposed to have been available from NAB by now, but hasn't yet been released. In its place, the Ampex test tape is customarily used.) The test tape contains a series of audio signals recorded at such relative levels that a tape machine with the NAB playback characteristic will provide flat response when playing this tape. That is, a meter connected to the machine's output will read equal output level for all the test frequencies.

Accordingly the manufacturer of a tape machine designs the playback equalization circuit to yield flat response when playing the standard test tape. The equalization circuit allows for bass and/or treble irregularities of the playback head he uses—that is, departures of the actual head from the response of an ideal head (AD in Fig. 1).

Some machines include adjustments which enable the technician or the user to touch up playback equalization on the basis of a test tape. It is then merely necessary to connect a meter to the machine's output, play the test tape (after making sure heads are cleaned, demagnetized, and aligned for azimuth), and touch up the playback equalization for flattest response as indicated by the meter. In some machines the VU meter can serve this purpose.

Now, what about treble boost in recording? Does NAB specify a treble recording characteristic in terms of what gets on the tape? Or does it specify a given amount of treble boost in the record amplifier, such as Curve E'J in Fig. 4? The answer is that, at least *directly*, NAB does neither. What NAB specifies is that, after playback equalization has been

(Continued on page 79)

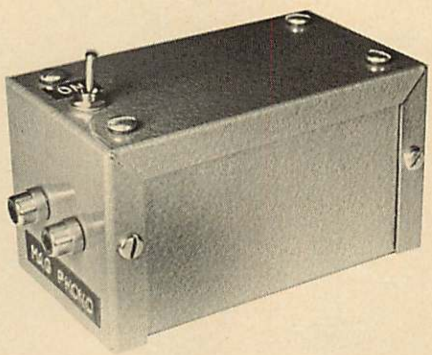
A Quiet Phonograph Preamplifier*

*but not for everyone

James P. Holm

YOUR AMPLIFIER has at least two noise specifications. The PHONOGRAPH input is usually rated at -60 to 65 decibels (dB) below 10 millivolts and high level inputs such as TUNER and AUX at -70 to -75 dB below 0.25 volts. On occasion, a third noise level will be listed, volume control in minimum position, about -90 dB referred to rated output. These figures indicate how wide your amplifier can open the "Dynamic Range Window" for the various signal sources presented to it.

Until now, the -65 dB figure for PHONO was sufficient, however, new phono records are being mastered using the Dolby "A" tape system and pressed on the quieter "skinny discs" making many amplifiers obviously deficient since audible background hiss remains after the phono pickup has been lifted from the record. This noise situation is further aggravated by the fact that the output of the very best phono cartridges is significantly less that of the poorer quality phono cartridges in the same product line. The person who is shooting for a really quiet high quality phono system is put in a bind as to the best mix of components for his particular needs since -78 dB preamplifiers are currently selling for a half kilobuck. In the past, the author's policy has been "Damn the noise, full fidelity ahead!"



But no more. In an effort to capture the stereo preamplifier parts market, National Semiconductor has come up with an integrated circuit rated at 0.5 microvolts input noise. This is three to five times quieter than most preamplifiers made with discrete components. National's LM 381A chip can be made to deliver a peak-to-peak output voltage of 38 volts from a +40 volt supply. It also features cross-channel isolation of better than 60 dB from 20 to 20,000 Hz. This is achieved by an individual internal power supply decoupler-regulator for each channel. The regulator also provides 120 dB power supply noise rejection.

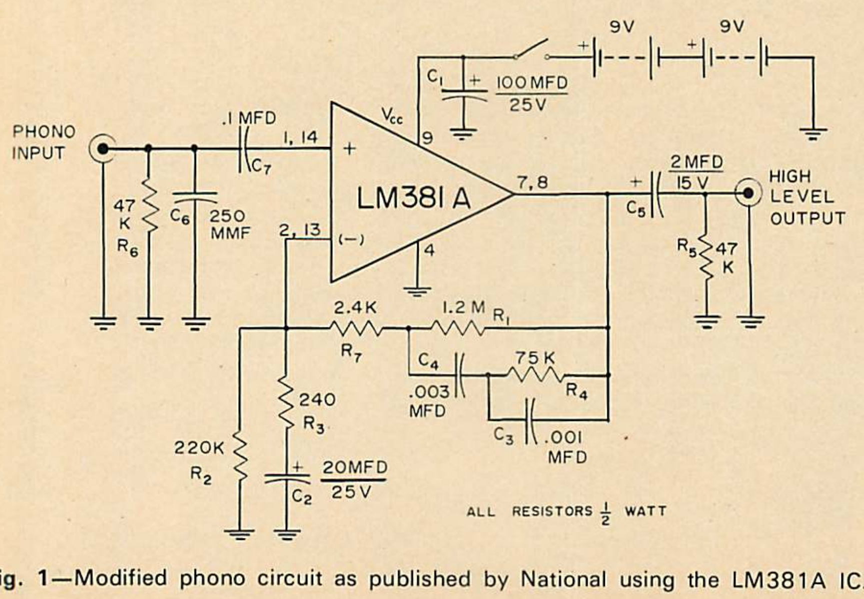


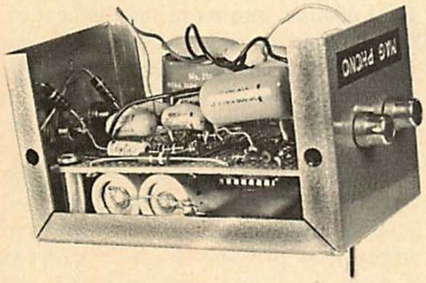
Fig. 1—Modified phono circuit as published by National using the LM381A IC.

To exploit this integrated circuit efficiently, one merely builds it into a small phono preamplifier and drives one of the HIGH-LEVEL inputs on his existing amplifier with it. This should produce a phono playback system with a dynamic range window about 75 to 80 dB wide—even with a top quality phono cartridge.

Building up the preamplifier as an auxiliary component, the author used the phono circuit as published by National and modified it to suit his particular needs and tastes (see Fig. 1). Since no particular good comes from having a 38 volt signal going into a 2 volt HIGH-LEVEL input, the source voltage was reduced to 18 volts which still provides better than 5 volts before clipping. The 18 volts comes from two 9-volt transistor radio batteries—a source long known for its ripple-free output. The 100 μF buffer capacitor (C_1) and the internal regulators should keep the distortion low until the batteries get extremely weak.

The LM 381A is an operational amplifier having differential inputs. The phono cartridge is connected to the input that is in phase with the output (the noninverting or + input). The amplification process is controlled by connecting the output back into an input that is 180° out of phase with the output (the inverting or (-) input). By being able to cancel out its own input, the amplifier can control its own sensitivity (negative feedback). By adding capacitors to the feedback resistors, the amplifier's sensitivity can be made frequency selective. The voltage multiplication factor of an amplifier is called "gain." The amplifier's d.c. operating point is established by R_1 and R_2. The ratio of their values is 5.5:1. This gives a d.c. gain of about 5.5. C_2 acts as the a.c. equalization "sink," providing a virtual ground down to about 50 Hz for R_3, the a.c. gain resistor. R_4 acts as the 1 kHz gain reference resistor. Above 2,200 Hz, C_3 provides high frequency equalization (gain reduction) by bypassing R_4. Below 500 Hz, C_4 starts increasing its reactance value and provides low frequency equalization (gain boost) until it becomes bypassed by R_1 as the input frequency approaches d.c. Since the integrated circuit is operating effectively in the class "A" amplifier mode, its quiescent output voltage is 0.5 V_{cc} or 9 volts. C_5 blocks this d.c. component and R_5 terminates C_5. C_6 and R_6 provide approximately the proper termination for a Shure V-15 II phono cartridge and 18 inches of signal cable. C_7 couples the signal into the non-inverting input of the integrated circuit. R_7, ten times the value of R_3, prevents the amplifier from going into unity a.c. gain—a condition in which the LM 381A is not stable.

If you are uncertain of your proper value for C_6, omit it—it's trivial. If you pick some other value for your V_{cc}, R_2 will have to be adjusted until the quiescent output is 0.5 V_{cc}. Equalization should be quite accurate for any V_{cc} between 9 and 40 volts since the open loop gain of the LM 381A only varies from 108 to 112 dB through this V_{cc} range. At 18 volts, the total current drain is about 10.5 mA.



The mechanical design is centered around 0.010-in. perforated board and a 14 pin DIP socket. Sponge rubber is used as a spacer between the batteries and circuit board. As can be seen in the photograph, the author built his unit as a utility rather than a showpiece device. You may want to tap into your amplifier's power supply to avoid having to remember to turn on and off a separate battery powered unit.

National rates distortion at less than 0.1% of 75 dB gain. The author made only a frequency response test on the assembled unit and found it to be within ±1.5 dB of RIAA between 30 and 15,000 Hz. Subjective noise comparisons between this unit and some preamplifiers rated in the -75 to -80 dB range produced few A-B differences. The unit rates among the best but not significantly superior to all preamplifiers in the test group. This is a bit disappointing as National's 0.5 microvolt input noise value is better than the figures quoted for discrete components. But then, what do you want for less than $20.00 in parts and two evenings' work? Æ

THE LANGUAGE OF HIGH FIDELITY
Part V

Martin Clifford

THE TRANSITION from tubes to transistors in high-fidelity equipment was not without its anguish, for a number of tubes, particularly those for the output stages of power amplifiers, gave excellent results. Tubes, though, were (and are) afflicted with a number of disadvantages. The indirectly heated cathode system means more watts from the a.c. power line. Further, these extra watts result in heat, the arch-enemy of resistors, capacitors, and other miscellaneous parts used in hi-fi components. Tubes also require a certain amount of warm-up time. And, added to this list of woes, tubes need relatively frequent replacement if a high-fidelity system is to be maintained at peak performance.

Solid-state devices, so-called because electrons move through a solid material rather than the vacuum of the tubes, form a rather large family of which transistors are just one member. Transistors require no warm-up time, have a longer life than tubes, take up less room, do not need sockets, and with the exception of power type transistors, do not pose a heat problem.

What is Solid State?

Knowledge moves in expanding circles, and the accretion of electronic learning is no exception. Early electrical and electronic experimenters always used solid conductors for the conduction of currents. With the introduction of the vacuum tube and the satisfactory current control it afforded, we were well into space-age electronics, even though that space was within the confines of a tube. However, early tubes, those manufactured circa 1919, were quite costly. An inexpensive alternative was a bit of crystalline material, iron pyrites, that had diode properties. Unlike the diode tube, this substance required no batteries, had no need for filament heating time, and had a useful life expectancy far in excess of any tube diode. It supplied the heart of early radio receivers, popularly known as crystal sets. They were ideal in many respects, for they could be turned on and left on indefinitely, requiring no on-off switch. Every ointment has its fly though, for the crystal set (unlike the triode tube) had no amplification. Headsets were the order of the day. This, plus the poor selectivity of such receivers, made the crystal set's day in the sun mercifully brief, for triode tubes soon bulled their way into more powerful, and more selective, receivers. The crystal detector or demodulator was relegated to the electronic attic, only to be dusted off and used in its original occupation later on in radio and television receivers. That crystal was the forerunner of semiconductor electronics.

Conductors and Insulators

A conductor, as its name properly implies, is a substance that permits the relatively easy flow of electrons through it. The word "relatively" is essential, for no two substances have this property to an equal extent. Some materials are unyielding to electron flow, hence are called insulators. Again, a relative term, for some substances are more obstinate in this respect than others. Certain crystalline materials, such as germanium or silicon, when completely pure, are insulators. They can be made conductive, though, by adding very small amounts of various elements, such as antimony, boron, aluminum, gallium, indium, or thallium. These elements do not change the chemical composition of the germanium or silicon. Add a few grains of pepper to a box full of salt and all you have is salt with a few grains of pepper. The analogy is limited, however, for in the case of germanium and silicon, the added substances do form an atomic bond with them.

The Problem of Germanium and Silicon

Atoms of germanium (Fig. 1) and silicon are characterized by an outer ring structure of four electrons, an unsatisfactory condition as far as these elements are concerned, for their preference is for a total of eight in the ring.

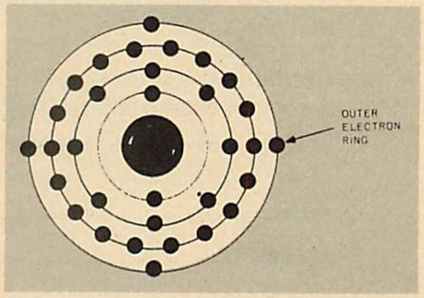


Fig. 1—The outer ring structure of germanium has four electrons.

A pair of germanium electrons form a stable atomic union by sharing their outermost electrons—four electrons from one atom, four from another. Thus the requirement for a total of eight is satisfied. Since atomically bonded atoms of germanium have no further need of electrons, any electron current trying to move through pure germanium will have its problems—it isn't wanted.

An element such as antimony has a total of five electrons in its outermost ring. If this element is added to germanium or silicon, a process known as doping, atomic bonding will take place, just as in the case of pure germanium or pure silicon, but now electron bookkeeping comes to our rescue. Antimony's five outer ring electrons plus germanium's (or silicon's) four, makes a total of nine, one more than is needed. Germanium or silicon, doped with antimony, has an electron surplus. The germanium (or silicon) is no longer an insulator but has acquired some conducting properties—certainly not as good as silver or copper—but much better than originally. While it is called a semiconductor, this does not mean to imply it is precisely halfway between a good conductor, such as silver, and an insulator, such as glass. The antimony is a donor material, for through its generosity, it has not only contributed the four electrons required by the semiconductor atoms, but one electron in excess for each antimony atom. Semiconductor material doped in this way is called negative-type, abbreviated as N-type, or simply N. Obviously negative-type since each electron, no matter how supplied, carries a negative charge.

Unlike germanium or silicon which have four outer ring electrons, and antimony which has five, an element such as boron has only three. This electron-deprived element, as in the case of antimony, germanium, or silicon, would prefer having eight outer-ring electrons. When this substance is used for doping germanium or silicon, the result is an atomically bonded pair which has only seven outer ring electrons—four from the semiconductor element and three from boron. Again, the properties of the germanium or silicon are changed, from a good insulator to a substance which has current carrying capability.

Semiconductors doped with a three-electron outer-ring element are called positive type, P-type, or simply P, to

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indicate the existence of an electron shortage.

The Semiconductor Diode

We now have available two blocks of semiconductor material: P-type and N-type; one with an electron surplus, the other with an electron shortage. When these two are made to butt against each other as intimately as possible (Fig. 2), a small, but measurable voltage will exist between them. Some small movement of electrons will take place at the junction or interface, with electrons traveling from the electron-rich or N-type over to the electron-deprived or P-type. Once these electrons have migrated, they will join the semiconductor atoms at the junction, but as soon as they have their outer rings electron satisfied, they will block the passage of any further electrons, acting as a barrier for all the unsatisfied, electron-hungry atoms behind them.

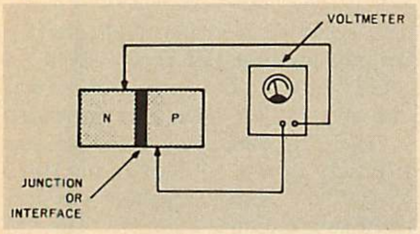

Fig. 2 —A small, but measurable voltage, exists across the junction of the two semiconductor blocks.

Semiconductor Electron Movement

To force electrons through this self-imposed barrier, a small battery can be connected across the P-N combination, as in Fig. 3. The minus terminal of the battery is wired to the N block; the plus terminal to the P block. Electrons will now move from the crowded minus electrode of the battery into the N-block, creating such an electron jammed condition in it, that numbers of them will force their way into and through the P-block. Since the positive terminal of the battery is a region of far fewer electrons, a place where they will not suffer the nearness of other electrons, they continue moving toward this terminal. The end is not in sight, for they move through the battery, arriving at the negative terminal. And so the whole current flow process continues.

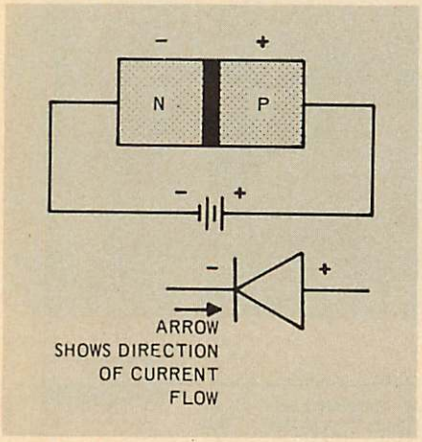

Fig. 3—A battery placed across the semiconductor diode overcomes the potential barrier block (A); diode symbol (B).

Forward Biasing

The battery used in connection with the two semiconductor blocks is called a forward biasing battery, but there is no relationship between this battery and that used for control grid bias in the triode tube. With forward biasing, current moves, as usual, from minus to plus, but there is no current control—as yet.

Reverse Biasing

It is only when the leads to the semiconductor blocks, (Fig. 4), are transposed that the true nature of what we have becomes evident. The generous current supplied by forward biasing drops to a trickle. What we have is diode behavior since current flows much more readily in one direction than the other. The semiconductor diode, then, made of two blocks of germanium, or silicon, N-type and P-type, permits the flow of current in one way, opposes it in the other. This means that whatever the tube diode can do, the semiconductor diode can do. The great advantage is that no heating current is needed; further, since the two blocks are in contact, the forward bias, equivalent to anode voltage, is much smaller.

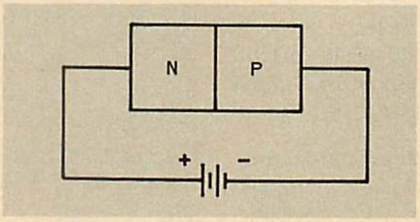

Fig. 4—Very little current flows through the reverse-biased diode.

The A.C. Biased Diode

The semiconductor diode can be used as a rectifier or demodulator, changing a.c. to d.c. as in Fig. 5. When the a.c. voltage source has a forward-biased polarity, current flows through the diode. When the a.c. voltage changes its polarity, the diode is reverse biased, and so current through the diode be-

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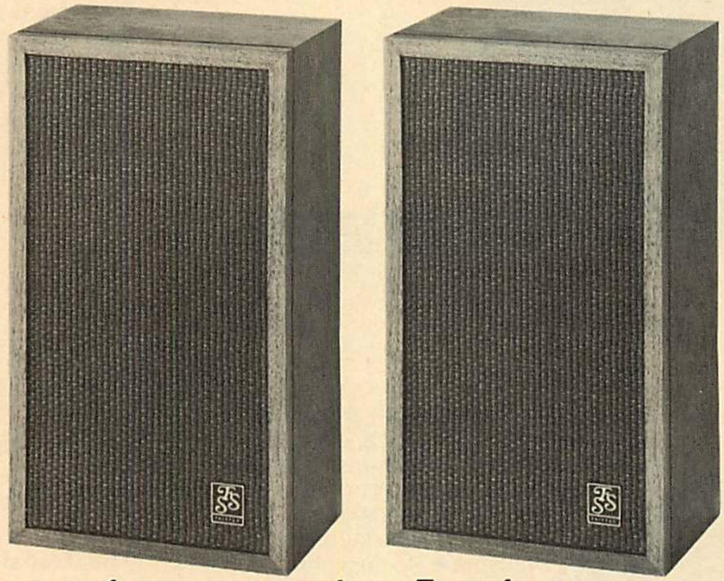

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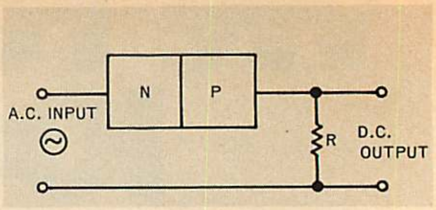

Fig. 5—The semiconductor diode can be used as a rectifier or demodulator.

comes negligible. If this current is allowed to flow through a load resistor, R, the voltage produced across this resistor will be d.c. Current flows through that resistor in one direction only. Except for technique, this is similar to the behavior of the tube diode. Further, the semiconductor diode can be used as a signal rectifier or demodulator, in somewhat the same manner as the tube demodulator (Fig. 6). This receiver circuit, a crude, elementary type, can pick up signals, but cannot separate or amplify them, an acceptable condition at one time with single station broadcasting, but intolerable today.

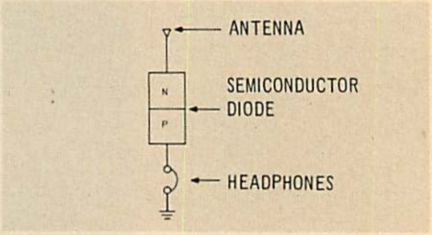

Fig. 6—The simplest receiver, even more so than the tube diode used in this application.

The Transistor

The transistor, an amplifying type of semiconductor, consists of a pair of diodes placed back to back. Fig. 7 shows a pair of such diodes with the N-block of one in close contact with

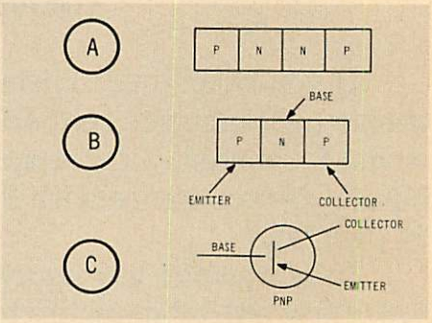

Fig. 7—The transistor consists of a pair of semiconductor diodes placed back to back (A). The two blocks of N-type semiconductor can be combined into one (B). PNP transistor symbol (C).

the N-block of another. The two N blocks can be replaced by a single unit, and so, reading from left to

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We've redesigned it not just to incorporate the new features or circuitry:

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right, we have P-N-P. Since each will be working in a specific manner, they can be labeled as emitter, bass and collector, rather odd designations since the emitter doesn't emit, the base forms no foundation, and the collector doesn't collect. A rose by any other name, etc.

Transistor Current Control

Although the two semiconductor diodes have been joined, with the base material common to each, they can still

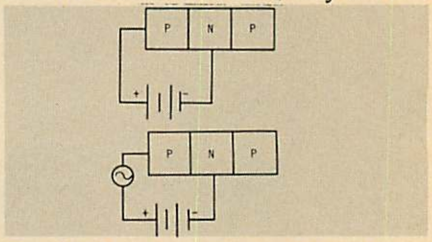

Fig. 8—One half of the transistor is still a diode and can be forward biased as such (A). An a.c. voltage, placed in series with the forward biasing voltage, will have the effect of varying the forward bias.

be treated as individual diodes. Fig. 8 shows one of these diodes, consisting of the emitter and base, as forward biased. In this arrangement, the collector block is momentarily disregarded.

Current control is obtainable by varying the amount of forward bias voltage. This can be done by putting a variable resistor across the forward biasing battery and taking off different amounts of voltage. The greater the forward biasing voltage, the larger the amount of forward current, comparable to putting more voltage on the anode of a tube. If an a.c. voltage is put in series with the forward biasing battery, the amount of forward current will keep changing in step with the changing a.c. voltage, depending on its polarity at the moment. When the a.c. voltage opposes that of the forward bias battery, forward current will decrease. And conversely.

The base and the collector form the second diode and this diode section is now reverse biased (Fig. 9). However,

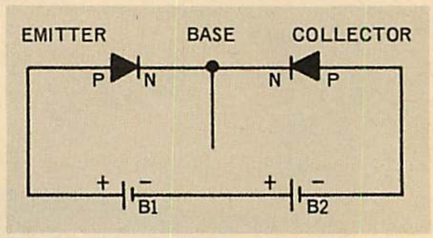

Fig. 9—The direction of current flow in this PNP transistor is from collector to emitter.

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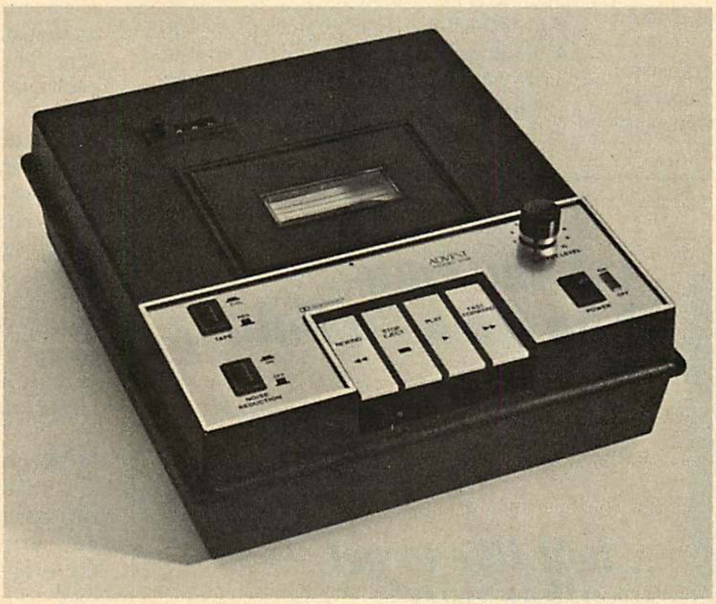
A Turntable for Cassettes



The Advent Model 202 cassette playback deck is the first full equivalent in tape equipment of a precision turntable for records.

Designed for highest-quality playback of recorded cassettes, the Advent 202 employs the Dolby System of noise reduction. It also provides proper playback equalization for both iron-oxide and chromium-dioxide cassettes – including a soon-to-be-issued series of premium-quality cassette recordings on Crolyn from Advent.

The 202 is an ideal machine for anyone more interested in listening to cassettes than in recording his own. It is also a perfect source deck for any cassette dubbing application, including the growing number of professional uses.

With the number of Dolby cassette releases increasing rapidly (there are more than 400 now, and the majority of new releases employ the process), the time is ripe for a cassette player designed to realize the full potential of pre-recorded cassettes. It is clearly possible now to make cassette releases that equal (and in some ways surpass) the sound quality of the best records. The 202 will yield everything any pre-recorded cassette can offer.

The transport mechanism of the 202, very low in wow and flutter, is designed to stand up to heavy everyday use. It has a precise tape counter for easy location of recorded selections. Its controls are simple and positive in action. And its overall operation day after day is easier than that of most record-playing equipment. Included with each 202 is a head-cleaning cassette that helps make normal maintenance quick and simple.

For schools, libraries, and other institutional users, a special version, the 202 HP, comes equipped with a headphone amplifier and jack. The 202 HP and a set of headphones provide about the lowest-cost high-performance sound system imaginable, one that will probably become a starter system or dorm system for some people with tight budgets and high aims.

Using the coupon below will bring you full information on the 202 and a list of dealers where you can hear it. We also have compiled a complete and up-to-date listing of cassette releases employing the Dolby System that we will be happy to send you.

We hope you will test our feeling that the time has come for a high-performance cassette player.

Thank you.

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if the connection to the base is removed, it is apparent that both batteries, forward and reverse, are in series. Electrons will now move through both diode sections, in the arrangement shown in Fig. 9. If the connection to the base is replaced, a small current will flow through it, and so the current through the reverse biased diode will now be slightly less than the forward biased current.

The whole action of the transistor revolves around the fact that a relatively small a.c. voltage—possibly that supplied by a signal source such as a radio station, record or tape player—is used to control the current flowing through the transistor (Fig. 10). If this current is allowed to move through a resistor, a voltage will develop across that resistor having a waveshape that is a reasonably good reproduction of that of the original signal voltage. There is one important difference, however. It will be much larger, that is, it will have a greater amplitude.

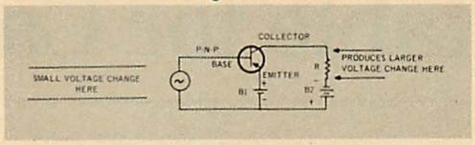

Fig. 10—Basic PNP transistor circuit. A small voltage change in the emitter-base circuit results in a much larger voltage change across the load resistor in the collector-base circuit.

The action here is essentially the same as that obtained in the triode tube, except that the technique is different. In each case current or voltage is supplied by a d.c. voltage source—in the tube by a battery connected to the anode and in the transistor by a pair of biasing batteries. The current supplied by these d.c. voltage sources is made to vary directly in step with an a.c. signal. This current is then passed through a resistor and so the conversion process is completed. We start with a small voltage, control a current, and then convert that current into an equivalent, but much larger, varying voltage.

NPN and PNP

Unlike triode tubes, transistors form two basic groups: NPN and PNP. The only difference is in the way in which the original semiconductors are placed back to back. PNP and NPN transistors work in the same way, but to maintain proper biasing polarity, their connections are opposite (Fig. 11). In the case of the NPN, current flows from the emitter to the collector, while for the PNP current moves from the collector to the emitter. This is of no consequence to the output load resistor, for the amplified voltage developed across it is the same. All that is different is the polarity of that voltage.

(To be continued)

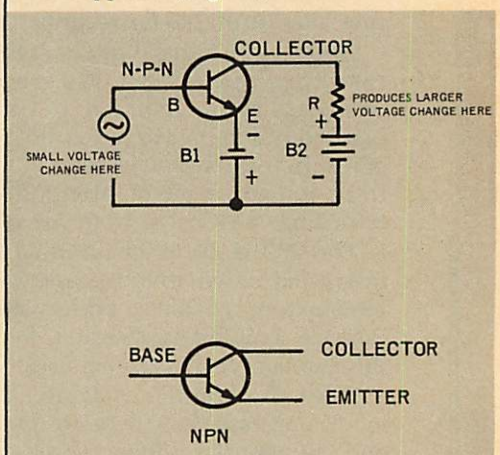

Fig. 11 —The NPN circuit (A) is essentially the same as the PNP except that the batteries are transposed. NPN symbol (B).

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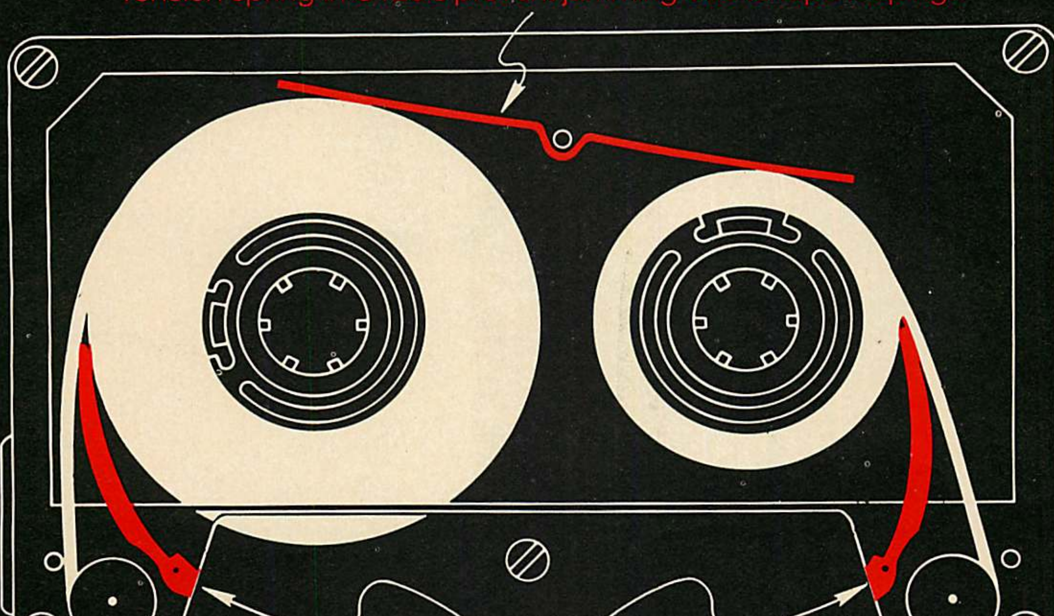

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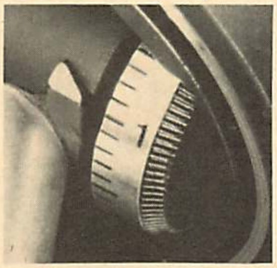

Stylus pressure dial calibrated in tenths of a gram from 0 to 1.5 grams; in quarters of a gram from 1.5 to 3.0 grams.

For example, the 1229 has a built-in illuminated strobe for 33-1/3 and 45 rpm. With a typical Dual innovative touch: an adjustable viewing angle that you can set to your own most comfortable position.

Another refinement is on the stylus pressure dial which is now calibrated in tenths of a gram from 0 to 1.5 grams. This provides finer control in setting optimum stylus pressure for today's finest cartridges, designed for tracking in this range.

Such refinements, while giving you more control over your Dual, don't actually affect its performance. Dual performance is a function of the total precision inherent in the design which has long made Dual's premier model the best-selling "high-end" turntable of them all.

The gyroscope is the best known scientific means for supporting a precision instrument that must remain perfectly balanced in all planes of motion. That is why we selected a true gyroscopic gimbal for the suspension of the 1229 tonearm. This tonearm is centered and balanced within two concentric rings, and pivots around their respective axes. Horizontal bearing friction is specified at less than fifteen thousandths of a gram, and Dual's unerring quality control assures that every 1229 will meet those stringent specifications.

The platter of the 1229 is a full-size twelve inches in diameter, and cast in one piece of non-magnetic zinc alloy. Each platter is individually dynamically balanced. Dual's powerful continuous-pole/synchronous motor easily drives this massive seven pound platter to full speed in one quarter turn.

A turntable of the 1229's caliber is used primarily in its single-play mode. Thus, the tonearm was specifically engineered to perform precisely as a manual tonearm: parallel to the record instead of tilted down. For multiple play, the Mode Selector raises the entire tonearm base to parallel the tonearm to the center of the stack.

All these precision features and refinements don't mean that the Dual 1229 must be handled with undue care. On the contrary, like all Duals, it is quite rugged and virtually foolproof.

Illuminated strobe with adjustable viewing angle, from directly overhead to 20° away.

So we're not being rash when we include a full year guarantee covering both parts and labor. That's up to four times the guarantee you'll find on other automatic units.

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A Peak-Reading VU Meter

With Compensation For Tape Saturation

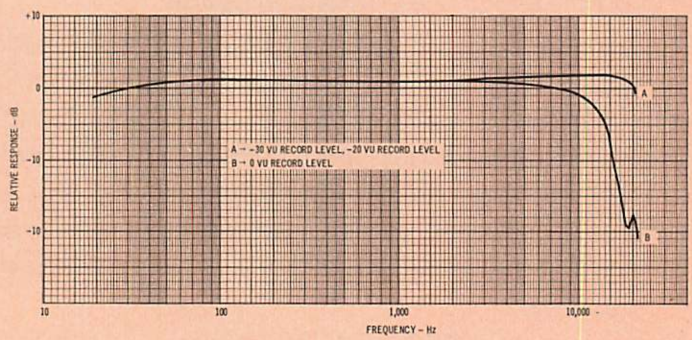


Fig. 1—Record-playback response at 7½ ips. 0 VU corresponds to a 400 Hz signal recorded 8 dB below the 3% THD level.

E.A. Ballik*

IT IS WIDELY RECOGNIZED that peak recording levels can be considerably greater than the average levels. The majority of tape recorders employ average-reading VU meters, primarily because of circuit economics. Futhermore, VU meters generally have a frequency response which is relatively uniform in the region of 20 Hz to 20 kHz. Unfortunately magnetic tape does not have a uniform frequency response, and therefore considerable recording experience is required with standard VU meters in order to achieve high signal-to-noise ratios together with low distortion.

This article describes a simple, and relatively inexpensive, peak-reading VU meter circuit which can be used either at the high level output of a tape recorder (PHONE OR LINE) or which can be incorporated into the recorder inself. The circuit also provides compensation for the recording and saturation characteristics of the tape medium. This compensated peak-reading VU meter circuit makes it possible to achieve the maximum available signal-to-noise ratio from the tape and ensures that THD and intermodulation distortion are kept at acceptable levels over the whole of the audio spectrum.

A slightly modified two-track Revox A77 tape recorder and Scotch 206 tape were used for all the measurements reported below. The Revox meters were calibrated so that 0 VU corresponds to a 400 Hz signal recorded 8 dB below the 3% THD level. Playback response, as measured with an Ampex 21690010-01 two-track test tape, was well within ± 1 dB. The unweighted record-playback signal-to-noise ratio at 400 Hz was 60 dB for 1% THD.

Tape Record-Playback Characteristics

Figure 1 illustrates the relative record-playback response at 7½ ips, taken at constant input with frequency. Curve A corresponds to record levels of -30 VU and -20 VU. The only difference noticed during these two measurements was a decrease in the 20 kHz response of approximately ½ dB at the higher input level. Curve B corresponds to a record level of 0 VU. The decrease at higher frequencies results from tape saturation. Clearly curve A would be the response quoted in manufacturers' literature or in test reports.

Several parameters affect the high frequency response of the tape and consequently the saturation behaviour. Several of these are inherent in the tape. These include:

Oxide Layer: The oxide material, the particle size, and the coating thickness can all have a significant effect. These effects can only be controlled in the tape manufacturing processes. Oxide coatings have been slowly but constantly improved in recent years and are expected to continue to do so.

*McMaster Univ., Hamilton, Ontario

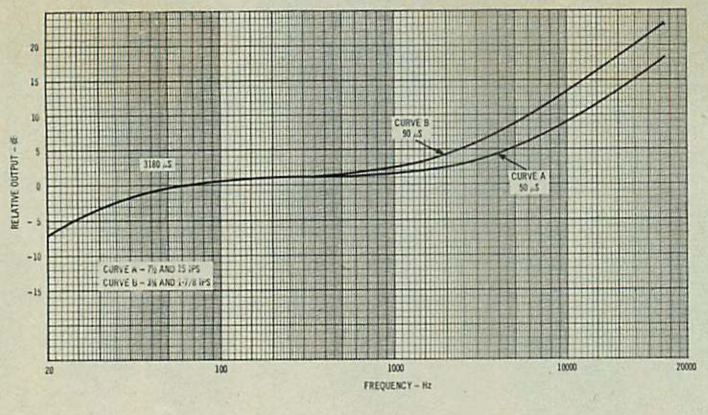


Fig. 2—NAB standard reproducing characteristic. Reproducing amplifier output for constant flux in the core of an ideal reproducing head.

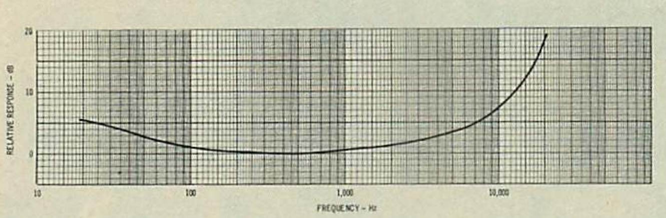


Fig. 3—Revox A77 record amplifier response. The curve is essentially the same for both 3¾ and 7½ ips.

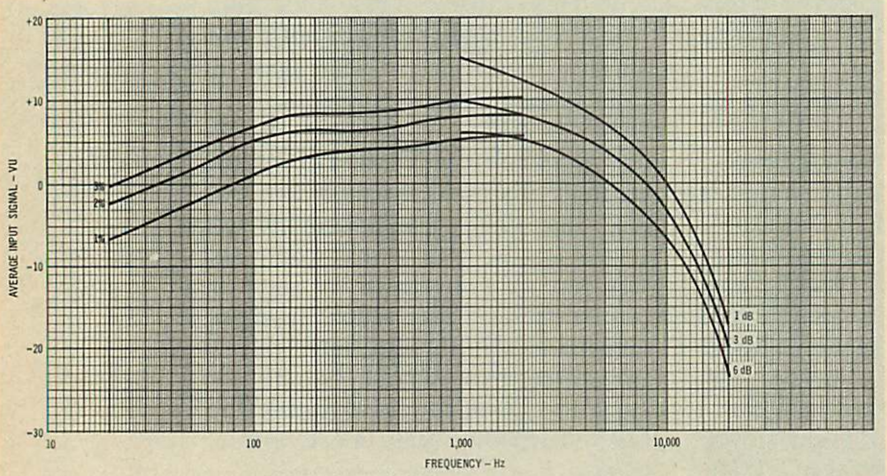


Fig. 4—Tape distortion-saturation data. Curves are given for 7½ ips. Those below 1 kHz correspond to THD; those above 1 kHz to the output in decibels below the peak saturation output.

Penetration Losses: At low frequencies the full depth of the tape is magnetized. With higher frequencies (i.e. short recorded wave-lengths) the depth of magnetization decreases, until only the surface of the oxide coating is magnetized. The high frequency recorded intensity is therefore decreased. Penetration losses for a given oxide can only be modified by varying the tape thickness. However this usually affects other parameters such as tape uniformity and signal-to-noise ratio, particularly at lower frequencies.

Self-Demagnetization: At high frequencies the recorded magnetic poles are closely spaced and thereby cause a decrease in the recorded signal. This effect is usually small. However it can increase with storage time of the recorded tape. Losses of a few decibels at the highest recorded frequencies are possible after storage of several years.

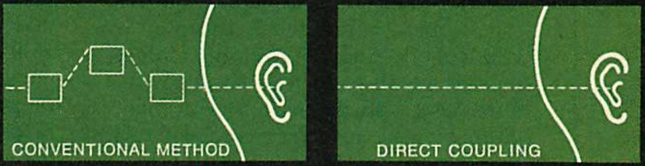
Other sources of high frequency losses are primarily caused by the tape recorder characteristics. These include:

Recording Demagnetization: Increasing the recording bias results in high frequency attenuation (i.e. self-erasure). A low bias cannot be used because it would result in high distortion levels. Generally the optimum bias is characteristic of the particular tape used.

Head Losses: The playback output drops to zero when the playback head gap is equal to a recorded wavelength. The effect can be made negligible by the use of an extremely narrow gap. This will result, however, in a very small output, with decreased signal-to-noise ratio. In practice a compromise is made in the gap size which results in significant head losses at the higher recorded frequencies.

Equalization to compensate for high frequency losses is carried out in *both* the record and the playback amplifiers. In order to allow interchangeability of recorded tapes a standard playback equalization is used in the better audiophile recorders and in professional equipment. The current standard reproducing characteristics used in North

Your next receiver should have 3 things missing.



The input transformer. The output transformer. And the output capacitor. Because when you cut those three things out of a receiver, you cut down on a fourth thing. Distortion. We do it with a system called direct coupling. And Panasonic puts it in all its FM/AM/FM Stereo Receivers.

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You can also find that music on the SA-6200. With 150 watts of power. Plus 2 RF stages and 6 IF stages. To provide selective station tuning. And there are PNP low-noise silicon transistors in the differential amplifier drive-stage. To give almost noise-free performance. No matter who's performing.

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America is the NAB standard, shown in Fig. 2. The curves are for a constant flux in the core of an ideal reproducing head (i.e. zero frequency-dependent head losses). Note that with zero playback equalization a constant flux would give a playback output which increases at the rate of 6 dB per octave.

The equalization illustrated in Fig. 2 provides a 6 dB per octave boost at high frequencies (3 dB up at 1.6 kHz for 3¾ and 1⅞ ips, and 3 dB up at 3.2 kHz for 7½ and 15 ips). In addition there is a 6 dB per octave cut at low frequencies (3 dB down at 50 Hz). Standard playback tapes are recorded in such a way that an ideal reproducing head will give constant output with frequency.

is proportional to the voltage developed across the resistance. A resistance value of 100 ohms or less can typically be used. It should, however, be made several times smaller than the d.c. resistance of the record-head, unless it is already an integral part of the circuit.

The measured record-amplifier response of the Revox recorder is shown in Fig. 3 and was essentially similar for both 3¾ and 7½ ips. The curve indicates that tape saturation will occur more easily at both the low and high frequencies in comparison with the mid-range. This is acceptable for many recording applications because most of the signal is *usually* in the mid-range of the audio spectrum.

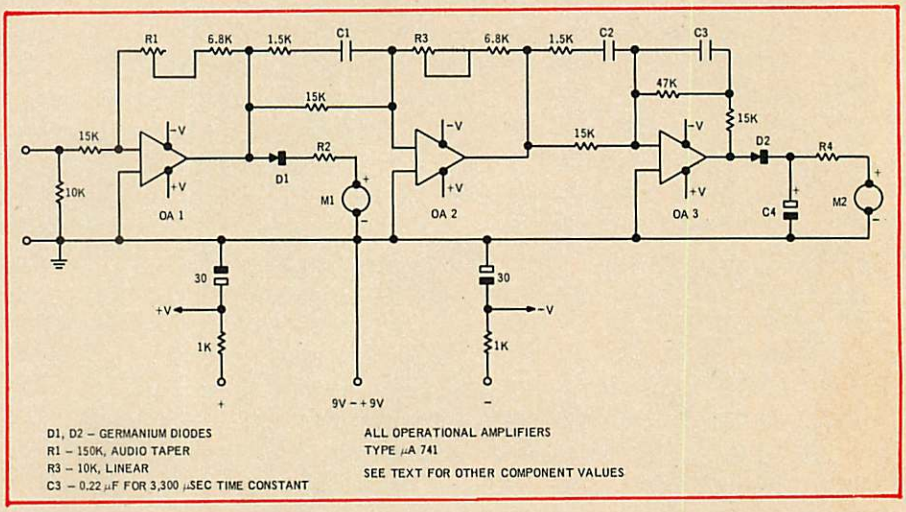

Fig. 5—Compensated peak-reading meter circuit. The circuit provides for both peak-reading and average reading capability.

Note that all recorders will have some additional playback equalization to correct for playback head losses.

It should be clear from Fig. 2 that the record amplifier requires a 6 dB per octave boost (3 dB up at 50 Hz) to compensate for the playback characteristics at low frequencies.

As mentioned previously the high frequency boost in Fig. 2 only partially compensates for the high frequency losses; additional boost is provided in the record amplifier. The record-amplifier response can be determined by measuring the record current in the record head. For this measurement the bias oscillator is disconnected. A low value of resistance is placed between the "ground" terminal of the record-head and "ground." The record-head current, in the record mode of the tape recorder,

Figure 4 illustrates record-playback distortion and saturation measurements at 7½ ips. These were made by monitoring during recording. The curves below 1 kHz are input levels in VU for 1, 2 and 3% THD. The curves above 1 kHz are for input levels 1, 3 and 6 dB below maximum output. These latter curves were obtained by increasing the signal input until the playback output started to decrease, and then *decreasing* the input until the output is decreased the appropriate decibels below the *peak* output level. In general the THD measurements have little value at the higher frequencies, and the saturation measurements have little value at the lower frequencies.

It can be seen that the 6 dB below maximum output curve makes a good match with the 2% THD curve. This combination was used for all subsequent work.

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New RCA Red Seal Cassettes

COBALT ENERGIZED

For cleaner, more brilliant sound RCA Red Seal cassettes are cobalt energized . . . offer low noise, better frequency response, **superior performance over conventional low noise tapes.** There's improved signal output, especially at higher frequencies, with increased signal-to-noise ratio.

They are compatible with existing playback and recording equipment . . . no need for special bias or equalization circuitry. And, low friction virtually eliminates head wear.

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RCA

The advantages of peak-reading meters are obvious. It should also be obvious from the above that the meter amplifier response should compensate for the distortion-saturation curve of the tape. Such a meter circuit will allow the maximum possible recording levels while minimizing distortion caused by transients and tape saturation.

Comparison of Fig. 4 with Fig. 3 shows that the saturation response characteristics relate closely to the record-amplifier response characteristics. Thus either the record-amplifier characteristics or the distortion-saturation curves can be used to determine the compensation for the meter amplifier. The latter, however, is considerably more accurate because it includes the complete record-playback response.

reading capability is not desired. Alternatively a single meter can be switched to provide either average-reading or peak-reading.

The first stage (OA1) has an input impedance of 6 kilohms and provides a low output impedance drive for the average-reading meter and for the following stage. An input capacitor should be used if d.c. components are present in the input signal. Potentiometer RI provides a first stage gain which is variable from -7 dB to +20 dB. Potentiometer R3 gives a second stage gain in the range -7 dB to +½ dB. This is used to calibrate meter M2 relative to meter M1. Operational amplifier OA3 provides a low impedance drive for the peak-reading meter M2. Low frequency boost results from C3 in series with 15 kilohms. A 0.22 μF capacitor gives a time constant RC=3,300 μSec, which is close to the NAB standard of 3,180 μSec. The 47 kilohms resistance in parallel with C3 limits the extreme low frequency gain in order to prevent low frequency instability.

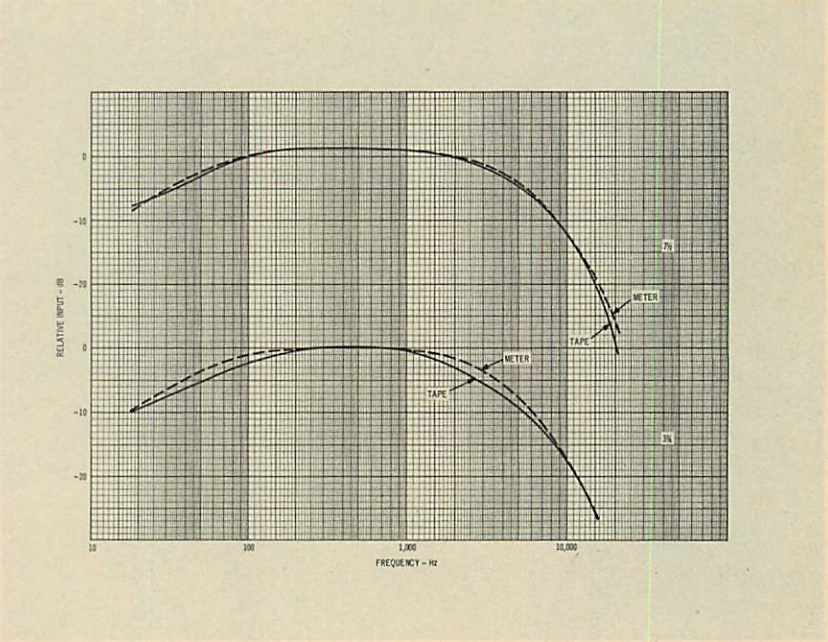

Fig. 6—Comparison of tape saturation characteristics with meter circuit compensation. The solid curves correspond to the distortion-saturation characteristics of the tape; the dashed lines correspond to the meter amplifier equalization.

Compensated Peak-reading Meter Circuit

The complete circuit is shown in Fig. 5 and includes both an average-reading and a compensated peak-reading meter. It is based on inexpensive operational amplifiers, namely the μA741, and simple RC networks. The μA741 is particularly useful because it is internally compensated and therefore requires a minimum of external components. No attempt has been made to correct for d.c. offset or bias current because of the relatively low d.c. gain. Meter Ml can be omitted if the average-

High frequency boost, at 6 dB per octave, results from C1 in parallel with 15 kilohms and by C2 in parallel with 15 kilohms. The ultimate boost is therefore at the rate of 12 dB per octave. The 1.5 kilohm resistors in series with C1 and C2 limit the maximum gain in order to prevent instability at the ex-

(Continued on page 81)

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You'll listen in comfort hour after hour. Because the new Koss HV-1 is lighter than 10 ounces. And because it has the perfect balance you expect in a Koss Stereophone. Not to mention a glove soft vinyl-covered headband and acoustical sponge ear cushions.

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Cassette Deck Survey

16 Models Tested

SINCE OUR cassette recorder survey was made in August of last year, several new machines have appeared on the scene and there have been significant improvements in tapes. When those tests were made, Crolyn (CrO_2) tape was almost as scarce as golddust but now almost every tape manufacturer has added it to the range. Of the 16 decks in this roundup, no less than 14 have provisioned for CrO_2 and 12 have Dolby or other noise suppression circuits. The new high energy tapes, (mostly using cobalt formulations) like the Maxell UD, BASF LN, TDK LN, and Sony UHF, are also available in cassette form, and the frequency range and low noise levels are not far short of CrO_2—another example of the benefit of competition! With all these advances, it might be asked, how does the present-day cassette recorder compare with open-reel machines? Well, in terms of frequency response, distortion, and signal-to-noise, there is no doubt they are getting pretty close. Here we are thinking of open-reel machines in the same price range because in the higher price bracket you can get remote control, monitor heads, sync facilities, provision for 10-inch reels and all kinds of gadgets. These recorders have a rather better signal-to-noise ratio and distortion is usually based on 1% for 0 level on the VU meter instead of 3%. In other words, there is more "headroom" to take care of transient peaks. But, on the other hand, a cassette unit fitted with a Dolby system has such a low noise level that the recording level can be reduced and still come up with a low noise tape.

The more expensive open-reel recorders are solidly built and often fitted with two or three heavy duty motors so they can operate 24 hours out of 24 if necessary. For direct recordings made with top quality microphones they would clearly be superior to cassette machines but the margin would decrease roughly with price. The $250 recorder might still appeal to the serious enthusiast because of the editing facility but for many others, this advantage would have to be assessed against the cassette deck's greater convenience and ease of operation—and portability.

The ultimate performance of a tape recorder is largely a function of tape width and speed. Thus a quarter-track open-reel machine working at 7½ ips has more than a head (!) start over a cassette machine playing at 1⅞ ips. The fact that serious comparisons can be made is a tribute to the designers who have taken the Dolby system, servo-controlled motors, special ferrite heads, and low noise circuitry to achieve a standard of performance not believed possible with open-reel machines only a few years ago.

Basic features of the decks—distortion, signal-to-noise, and of course the price—are listed on the easy-to-read chart. Response curves and other details follow with a capsule description.

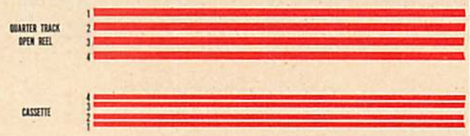


Fig. 1—Showing the difference between quarter-inch, quarter-track open-reel tape and 0.150 inch cassette tape. Spacing is 0.03 inch between tracks on the open reel, with 0.037 inch track width. Cassettes have 0.024 inch track width, with spaces of 0.011 inch between tracks 1-2 and 3-4 and 0.032 down the center.

Measurements

First, a few words about the measurements and how they were carried out. After connecting up the machine, a head cleaning tape (Advocate or Realistic) is quickly run through and then a standard frequency (40 Hz to 10 kHz) is played. Then swept frequency recordings are made using standard FeO and CrO_2 tapes—and LN low noise tape if appropriate. These frequency runs are made at a level of 20 dB below 0 VU. If the recorder is fitted with a Dolby or other noise suppresion system, the measurements are repeated at 10 and 30 dB below 0 VU with the suppressor in circuit. These curves are not shown as the differences are not significant if the correct tape is used and the Dolby calibration is accurate. Next, recording level is increased to 0 VU and distortion measurements made using a 1 kHz signal and the Ferrograph RTS-1 Test Set. Levels are then increased to determine the 3% distortion point. Then signal-to-noise measurements are made by recording the 1 kHz signal at 3% level for a minute or two and comparing it with unrecorded tape. The signal is then erased and the efficiency noted. CrO_2 was used for these tests where applicable. Next, wow and flutter were checked, again using the Ferrograph test set. This uses the new DIN standard of 3.15 kHz and the tape is passed through six times to get an average figure, thus avoiding sum and difference errors. The read-out figure is a combined one giving a weighted peak value in accordance with DIN standard 45507 approved by the IEEE. Wow and flutter varies slightly from one end of a cassette to the other so the same tape section was used for all measurements. Microphone and line input sensitivities were then measured—also the output voltages. Then the cassette rewind time is clocked. Finally, recordings were made from selected discs and the general handling of the machine evaluated. As a test for stability and reliability, the recorders were left running for 8 hours (not all at the same time) and then they were checked again. No significant changes were noticed—if anything, wow and flutter decreased slightly in some instances.

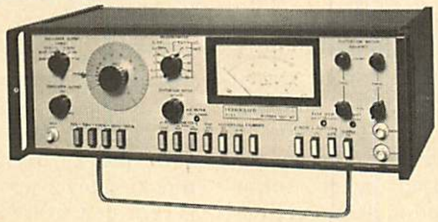
Two points ought to be stressed: one, it is essential that the tape heads be kept clean, and two, use the maker's recommended tape. Use a soft brush to remove oxides and occasionally pass a head cleaning tape thorough. Standard tapes vary considerably and if a LN tape is used on a machine adjusted for a standard tape, the response will tend to rise 3 to 4 dB in the 5 to 8 kHz region. CrO_2 tapes are quite consistent and variations between the different makes was no more than a dB or so. These included Norelco 400, Sony CR-60, Advent Advocate, Memorex, and BASF Chromdioxide.

Some makers frown on the use of long playing C120 tapes but recently Advent announced that such tapes could now be used with their 201 without causing problems. The BASF anti-jam cassette is a step in the right direction—so is the new TDK LN 180 series. This is a very thin (0.25 mils) low-noise tape which has a three hour playing time. It was used on all the machines for the reliability tests with no trouble whatsoever. Output is some 5 dB below normal—which might be a disadvantage under some circumstances.

But Which One To Buy?

SEVERAL OF THE DECKS tested came very close to each other in terms of basic performance so the choice will have to be based on features like a Memory switch which stops the tape at a pre-determined point so the start of a particular recording can be found without relying on the counter. Mixing facilities might be considered worthwhile—so is a limiter. Some models do not have a stereo-mono switch; this might be considered important if you wish to record from a single source and play back through both loudspeakers. Especially if you do not have such a switch on your receiver or amplifier. Again, some models feature output level controls—a definite advantage if your amplifier does not have preset input controls. A DIN connecter is a must for some enthusiasts who have European equipment.

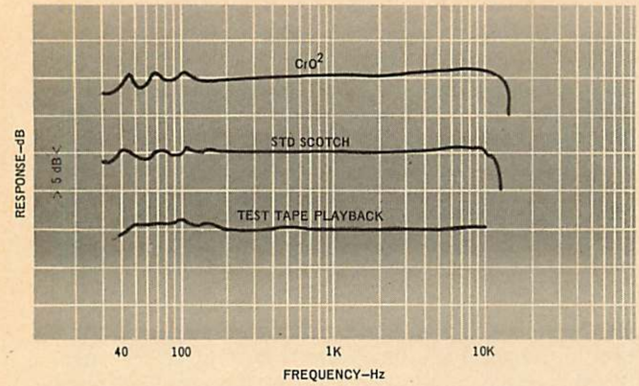
As to ease of operation, none of the machines tested were really bad but my ideal recorder—mechanically speaking—would have the Advent tape direction lever (perfect for inching) but with a lock, the pause control of the Pioneer, the eject button of the TEAC, Realistic or Lafayette, the Sansui VU meters, the stop control of the JVC and the input controls of the Concord. It would use the Panasonic auto-reverse and a Harman-Kardon servo motor, the Pioneer tape run indicator, the Sony ferrite heads—and it would be too expensive!

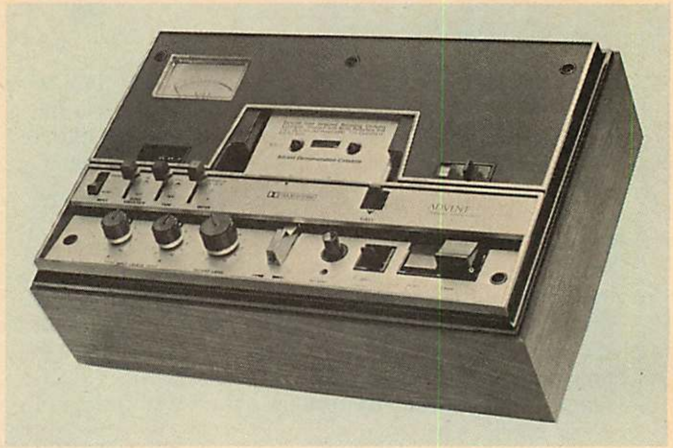


Ferrograph RTS-1

Manufacturer and Model Number	Noise Supp. system	S/N	CrO2 Erase dB	THD at 0 VU %	Level 3% dB	Input MIC mV	Input LINE mV	Output mV	Wow & Flutter (DIN)	Bias Freq. kHz	C60 Rewind secs.	Sereo/ Mono Switch	Dimensions	Weight lbs.	Price $
Advent 201	Dolby	51 57*	51	1.8	+2.5	**	28	600	0.14	100	44	No	13¾x8½ x5¼	14	280.00
Concord Mk IX	Dolby	51 57*	50	1.9	+2.5	0.45	150	790	0.13	100	97	Yes	16¼x10¾ x4¼	15	319.95
Harman-Kardon 1000	Dolby	53 59*	53	1.6	+3.0	0.20	34 180	520	0.14	105	98	Yes	15¾x10¼ x4⅛	12½	299.95
Heathkit AD 110	–	47	46	2.9	0	0.20	33	550	0.18	110	100	No	13⅝x11 x3⅛	8	129.95 (kit)
JVC 1668	ANRS	50 55*	49	2.1	+1.0	0.30	82 20	700	0.12	95	90	No	17x15 x5½	13	269.95
Kenwood KX700	Dolby	50 55*	50	2.5	+1.0	0.30	70	980	0.19	85	80	No	15½x11⅜ x4⅝	13	259.95
Lafayette RKD 400	Dolby	49 54*	48	2.5	+0.5	0.40	100	1500	0.18	100	95	Yes	11¾x11¾ x4¾	12	179.95
Norelco 1200	DNL	49 53*	49	2.1	+1.0	0.20	87	600	0.18	85	105	Yes	12¾x10½ x3⅞	6¾	219.95
Panasonic 272 US	–	50	49	1.8	+2.5	0.20	35	770	0.17	100	95	Yes	16⅝x10½ x4⅜	11	249.95
Pioneer CT4141	Dolby	51 57*	51	1.7	+3.0	0.50	41	790	0.18	85	80	No	15¾x9½ x3¾	11¼	249.95
Realistic (Allied) SCT-6	Dolby	49 55*	48	2.4	+1.0	0.95	80	650	0.17	100	90	Yes	16½x10¼ x4½	11¾	199.95
Sansui SC700	Dolby	51 57*	51	1.6	+3.0	0.50	63	910 1200	0.13	85	80	No	15¼x10 x4	12½	299.95
Sony-Superscope TC 134SD	Dolby	51 57*	51	1.6	+3.0	0.12	42	700	0.13	85	105	No	16¼x8¾ x3¼	10½	239.95
TEAC 220	–	51	51	1.7	+3.0	0.20	72	900	0.18	100	90	No	16¼x9¼ x4½	10	199.95
Toshiba 403 DC	–	45	42†	3.1	–	0.20	95	800	0.24	40	120	No	11¾x8⅝ x3¾	5	119.95
Wollensak 4760	Dolby	51 57*	57	1.6	+4.0	**	27	500	0.12	100	45	No	13¾x8½ x5¼	14	299.95

*With noise suppressor; **separate unit required; †standard tape.





ADVENT 201

Controls: Three slide switches for stereo-mono, Dolby, and VU meter. Rocker switch for power on-off, record push-button, record level controls for each channel in addition to master control. On the right hand side are the record-play and stop piano keys and the pause button. In the center, at the front, is a horizontal lever for fast forward and rewind. On the left side is a recessed panel with input and output sockets, output level control, an 18-volt connection for optional microphone amplifier, and push-button to switch on the Dolby calibrating oscillator. A single VU meter (peak-reading) is used and the switch selects either channel or higher of both. The meter characteristics rise 12 dB from 100 Hz to 10 kHz to give a safer overload indication. Requires external microphone pre-amp (Model MPR-1, \$20) for recording from microphone.

This was one of the first cassette machines to make proper use of CrO_2 tape and the necessary equalization is applied in both record and playback modes to get optimum results.

Frequency response within 2 dB from 40 Hz to 15 kHz with CrO_2 and up to 13 kHz with standard tape. The slide tape-direction lever was found exceptionally easy to use but no lock is provided so it has to be held in position. The pause control is a little awkward and stiff—some patience is needed to get used to it! A circuit diagram is on the bottom of the cabinet and the instruction manual is unusually detailed with all kinds of information therein. The 201 is well-made and it comes complete with head cleaning tape plus a test tape showing what can be achieved.

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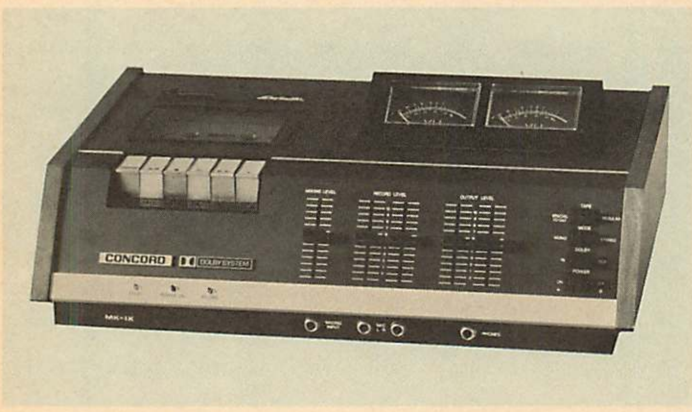

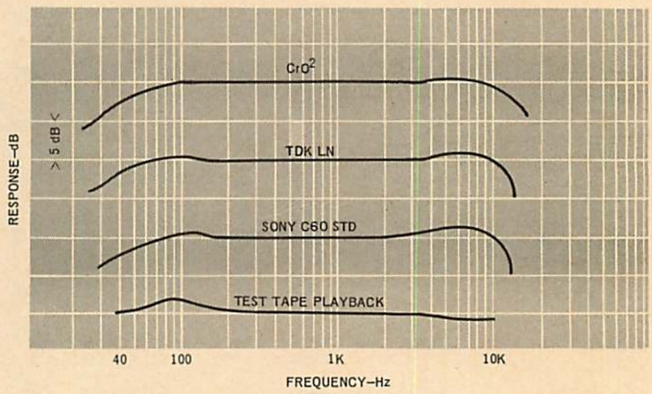

CONCORD MK-IX

Controls: Six keys for record, playback, rewind, fast-forward, pause and stop. Four push-buttons for Dolby, power on-off, stereo-mono, and CrO_2 -Std. tapes. Two slide controls for output, two for record level plus a separate mixing level control which enables another signal to be added to both channels. These slide controls are mounted on the angled front panel and at the bottom are the microphone, mixing, and headphone jacks. Above the slide controls are the indicator lights for record mode and Dolby. At the rear are the input jacks—two high level and two low level plus the output sockets. The two 2½-inch meters are mounted on a panel which is tilted up some 30 degrees.

The frequency response with CrO_2 was within 2dB from 50 Hz to 14,500 Hz and up to 13 kHz with LN and 11 kHz with standard tapes. Motor is d.c., servo-controlled. The large VU meters are easy to read at a distance and the controls all worked smoothly with a nice professional feel. The instruction manual contained no technical information but the operating procedure is quite well presented.

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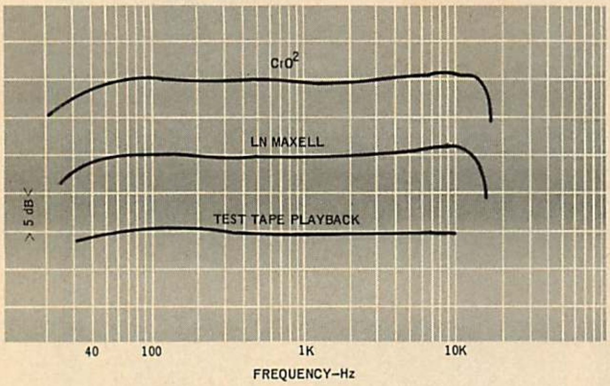


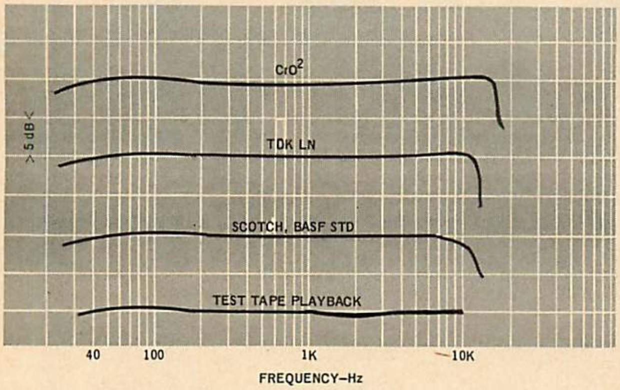
JVC CD-1668

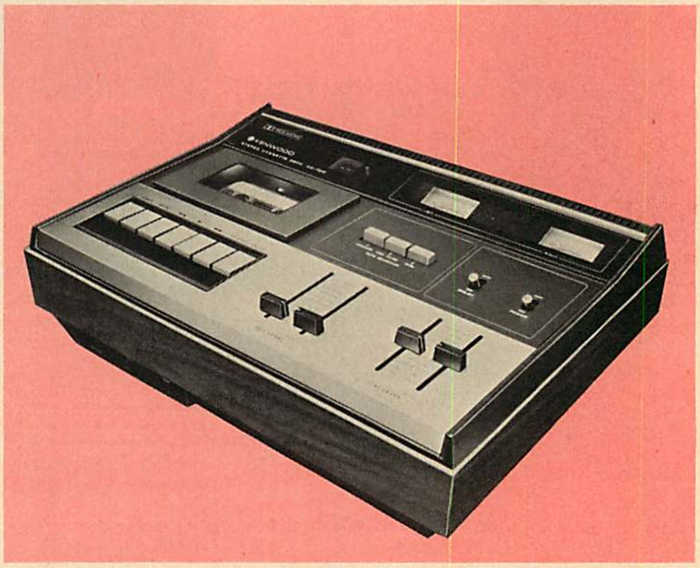
Controls: Five keys for record, playback, rewind, fast-forward, and pause. Separate buttons for eject and stop. Three position lever switch for CrO_2, Std., and LN tapes. Lever switches for ANRS noise reduction and on/off. The two VU meters are mounted on an angled panel with the tape counter and Memory switch at the right. Between the meters is an indicator light which flashes at peak record levels. At the left are dual slide controls for record level and next to those, immediately behind the tape selector and ANRS switches, are illuminated indicators for those functions. At the front, in a recess, are the mic and headphone jacks—the latter input having a 2 position level control. At the rear are input and output sockets with a DIN connection.

Frequency response was within 2 dB from 40 Hz to 16 kHz with CrO_2 and up to 14 kHz with LN tape. The ANRS noise reduction system operates by boosting low level input signals above 500Hz and then receiving the process for playback. It is reasonably compatible with Dolby "B" but not so elaborate or effective.

A nicely styled machine with some interesting features. Controls were easy to use and many enthusiasts will like the idea of separate stop and eject buttons which are placed to the left and right of the piano key set.

Check No. 57 on Reader Service Card





KENWOOD KX-700

Controls: Seven keys for record, playback, fast-forward, rewind, eject, stop, and pause. Three push-buttons for tape selection (CrO_2, LN, Std.). Lever switches for Dolby and on-off; slide controls for record level and output. The two VU meters are angled and in between them are indicator lights for record mode and Dolby. At the front, right at the bottom, are the microphone and headphone jacks. At the rear are the input and output sockets plus a DIN connector.

The frequency response was within 2dB from 30 to 16,000 Hz with CrO_2 and up to 13 kHz with LN tape. This is one of the few machines having provision for Standard, Low-Noise and CrO_2 tapes. The instruction manual includes a schematic and has a good description of the Dolby system. A well-made deck, easy to handle. Styling is relatively clean and uncluttered.

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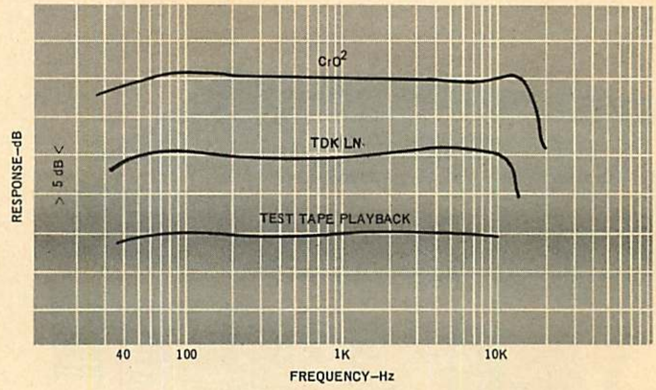

HARMAN-KARDON 1000

Controls: Seven keys for record, playback, fast-forward, rewind, pause, eject, and stop. Lever switches for stereo-mono, CrO_2-Std. tape, Dolby and Memory. Push-button on/off and test switch for Dolby calibration, slide controls for record level and playback. Also on the front panel are microphone input jacks with separate level controls and a headphone socket. At the rear are the output sockets with the high and low level input sockets. Other features include illuminated bars to indicate record and Dolby modes and special peak reading VU meters. A d.c. servo motor is fitted and a speed adjustment control is at the rear.

Frequency response was within 2 dB from 40 Hz to 16.5 kHz with CrO_2 and up to 13 kHz with LN tape. Signal-to-noise was the best of those tested being 53 dB without Dolby and 59 dB with (unweighted). Controls were easy to use and the machine appears to be well-made. The plug-in circuit boards will certainly make life simpler for the service engineer!

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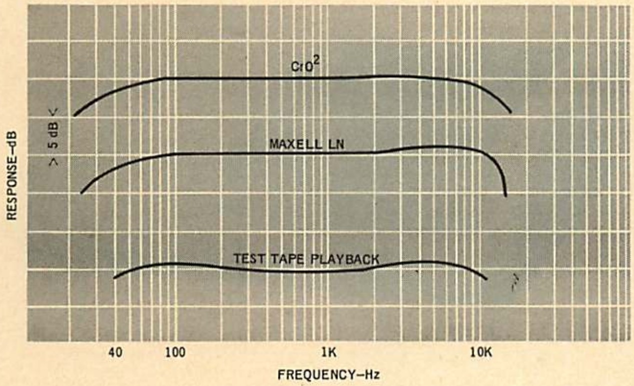

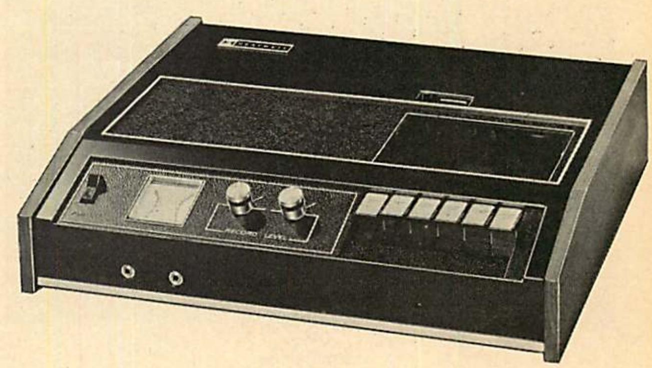

HEATHKIT AD-110

Controls: Keys for record, playback, stop-eject, fast-forward, rewind, and pause. Separate rotary record level controls, power on-off switch. At the rear are the input sockets for high level signals, output sockets, and pre-set output controls. This recorder comes as a kit but the transport section with piano key switches is already assembled. A large printed board is used for most of the electronics and total assembly time is about 5 hours. The built-in VU meters are used for setting the bias, circuit checking, and trouble-shooting.

Frequency response was within 2 dB from 40 Hz to 13 kHz using low-noise tape and up to 14 kHz with CrO_2. Unfortunately, there is no tape selector switch. CrO_2 bias changes are given in the manual and it would not be *that* difficult to wire in a switch if both kinds of tape are going to be used. The two separate rotary input controls are a little difficult to use when controlling stereo signals. Apart from these criticisms, the AD-110 is an excellent general-purpose machine with a minumum of "frills." It should appeal to those who prefer to build their own or those on a limited budget.

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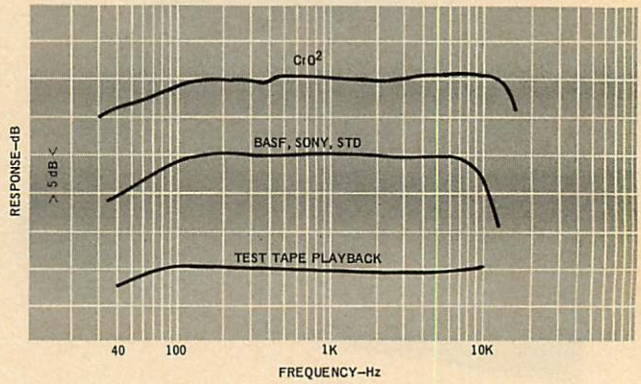

LAFAYETTE RK-D40

Controls: Six keys for record, playback, fast-forward, rewind, stop, and pause. The eject button is mounted on top near the cassette recess. On the angled front panel are the two VU meters, two concentric controls for microphone, two more for line inputs, and a set of 3 push-buttons for CrO_2-Std. tapes, Dolby, and stereo-mono. At the extreme right are the microphone jacks, and at the left are the on-off push-button and headphone jack. At the rear are the input and output sockets, a switched power outlet, and a 3-position headphone sensitivity switch.

Frequency response was within 2 dB from 50 Hz to 15 kHz with CrO_2 and up to 10 kHz with standard tape. Both mic and line input sockets are connected at the same time to facilitate mixing. The instruction manual includes a schematic as well as a component location chart. At $179.95, this is the cheapest machine with a Dolby system and is good value for money.

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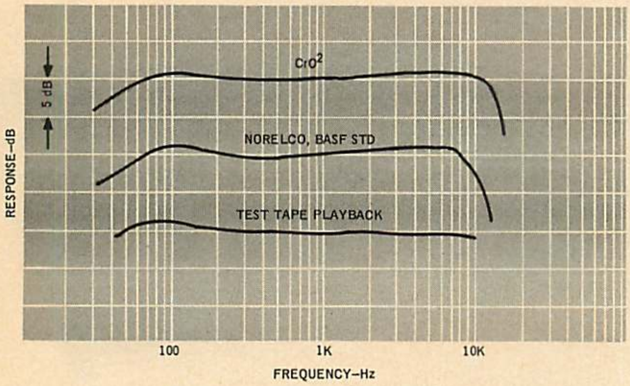

NORELCO 2100

Controls: Keys for record, playback, fast-forward, rewind, pause and stop-eject. Three push-buttons for tape selection (CrO_2, Std, and Low-Noise), push-buttons for stereo-mono, DNL noise reduction, on-off, and two slide controls for record level. At the front right, at the bottom, are the microphone and headphone sockets. Input and output sockets are at the rear. Above the slide controls are two lights, one indicating record mode and the other showing DNL operation. This noise reduction circuit functions on playback only and so is not comparable with Dolby-type systems. However, an improvement of 2 dB at 1 kHz and over 14 dB at 10 kHz was measured. Motor is servo-controlled.

Frequency response was within 2 dB from 50 Hz to 13 kHz with CrO_2 and up to 12 kHz with LN tape and 10 kHz with standard tape. The DNL system sounded better than the figures indicate and of course it can be used with any recorded tape. Controls are positive but if the stop key is pressed too enthusiastically, the cassette will fly out—a little disconcerting! Styling is unprententious rather than streamlined—but functional.

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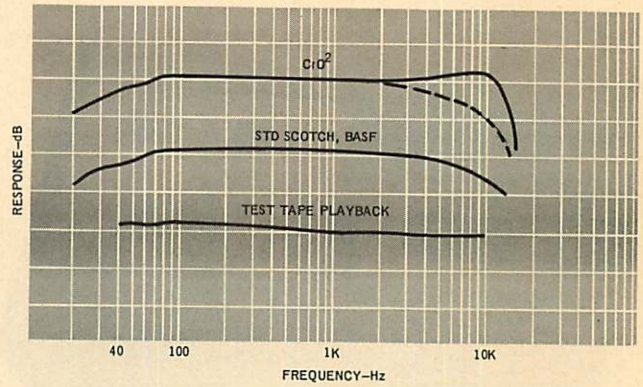

PANASONIC RS-272US

Controls: Seven keys for playback, record, fast-forward, rewind, eject, stop, and pause. Four rotary controls for input and output levels, lever switch for CrO_2-Std., lever switch for noise reduction, and two push-buttons for tape direction. Auto-reverse is incorporated but manual control is also provided. The tape reverses at the end of its traverse so after tracks 1 and 2 are played, 3 and 4 follow without turning the cassette over. There are two capstan assemblies–one at each end and the head is a 4-track type. This ingenious arrangement works on playback only.

Frequency response was within 2 dB between 40 Hz and 14,500 Hz with CrO_2 and up to 10 kHz with standard tape. The dotted line shows the effect of the treble cut (NS) switch. No provision is made for Low-Noise tape–if such tape is used the response shows a rise of 3 to 4 dB in the 4 to 8 kHz band which is difficult to correct with tone controls. One small criticism–there is no lock on the pause control.

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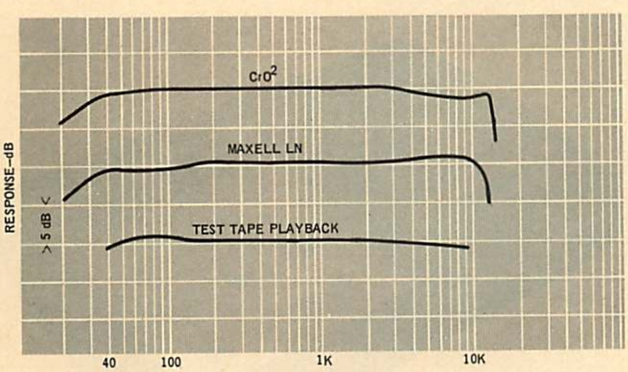

PIONEER CT-4141

Controls: Keys for record, playback, fast-forward, fast rewind, stop, and eject. Separate button for pause. Other switches for on/off, tape selector for CrO_2, Std., Memory, skip button and Dolby. Four slide controls for input and output. On the left is a tape running indicator which uses a circular pattern. Illumination is white during playback, red during recording. Next to this device is a Dolby light and a peak level indicator which flashes at overload. The skip button just in front increases tape speed during playback while the tape is still in contact with the head. It is useful for finding a specific item on the tape and the output control can be turned down and headphones used for this purpose.

At the extreme right are the microphone and headphone jacks and the input-output sockets plus a DIN connector are at the rear. Motor is d.c. servo controlled.

Frequency response with CrO_2 was within 2 dB from 40 Hz to 15 kHz and up to 14 kHz with LN tape. Controls are easy to use and this machine was one of the most versatile tested. The mic and line inputs are not connected at the same time–which may be a disadvantage. A schematic is included with the instruction manual which is very comprehensive.

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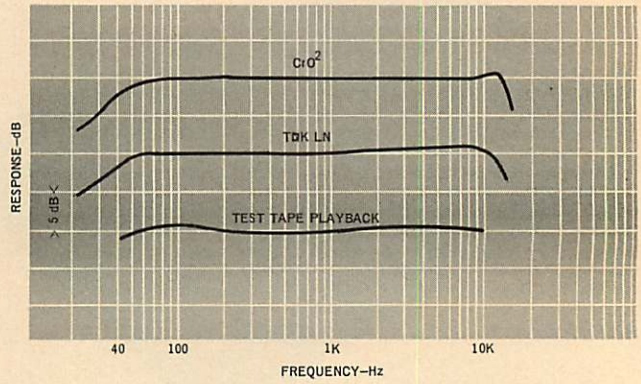

REALISTIC SCT-6

Controls: Seven keys for record, playback, fast-forward, rewind, eject, stop, and pause. Four lever switches for Dolby, CrO_2-Std. tape, stereo-mono, power on-off. Above these are 3 rotary controls, one being the master record input control and the other two controlling the individual channels. Between the two VU meters is a record level indicator which flashes at overload point. At the rear are the input and output sockets, microphone jacks, preset output control, and the Dolby calibration controls and test signal button.

Frequency response was within 2 dB from 40 Hz to 14 kHz with CrO_2 and up to 12 kHz with LN tape. The input controls look a little clumsy compared with slide controls but they work very smoothly. The instruction book describes the Dolby system quite effectively and a schematic is included.

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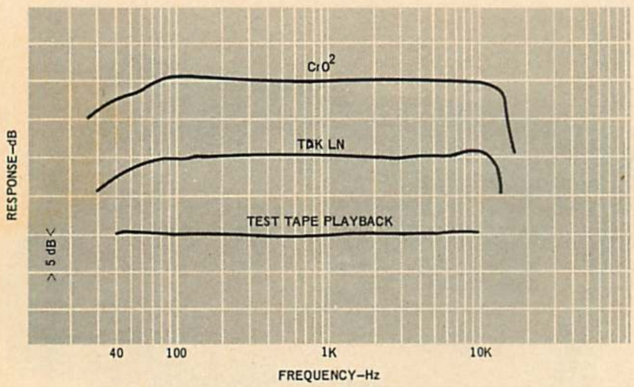

SANSUI SC 700

Controls: Six keys for record, playback, fast-forward, rewind, stop-eject, and pause. Three dual-concentric controls for center mic and line inputs and outputs. Push-buttons for CrO_2-Std. tapes and Dolby. There are 3 microphone input sockets—L, R, and Center and they are located at the front with the headphone jack. The two VU meters are mounted on an angled panel at the back and in front of them are the Dolby and record mode indicator lights. At the rear are the line output sockets (high and low levels), the input sockets, and a DIN socket. The motor is d.c. servo-controlled.

Frequency response with CrO_2 was within 2 dB from 40 Hz to 15 kHz and within 2 dB from 40 Hz to 13 kHz with LN tape. The provision of a center channel mic input is an unusual feature and the output can be mixed with the line inputs if so desired. The VU meters are illuminated in green, white, and red and can be read at a considerable distance. A special felt-tipped pencil for head cleaning is supplied with the SC 700 and the instruction manual—which includes a schematic—is one of the best.

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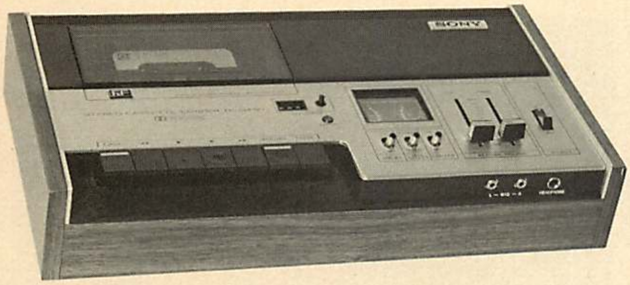

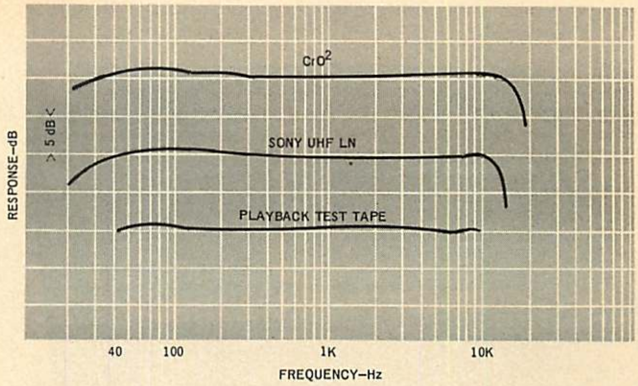

SONY TC-134 SD

Controls: Seven keys for record, playback, fast-forward, rewind, pause, stop, and eject. Three lever switches for Dolby, CrO_2-Std. tape, and limiter. At the extreme right are the two slide record input controls and the on-off switch. At the right front are the microphone and headphone jacks. The record mode indicator light is just in front of the tape counter. At the rear are the input and output sockets.

Frequency response was within 2 dB from 32 Hz to 16 kHz with CrO_2 and up to 13 kHz with LN tape. The limiter attenuates peaks above the +3 VU point and would be useful if the signal levels are not known. The piano keys are set back a little in a kind of recess and they have a positive but not too heavy feel. The automatic shut-off is designated TMS (Total Mechanism Shut-off) which is self-explanatory. This model is smaller in depth then most—which might be a plus if space is at a premium. No instruction manual was available (TC-134 SD is a new model) but it is assumed it will be complete and well-written in the Sony tradition.

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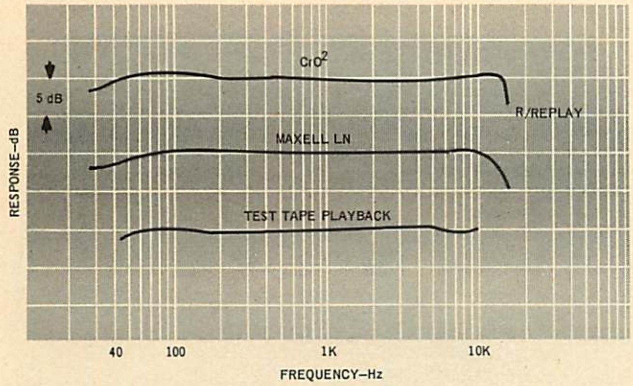

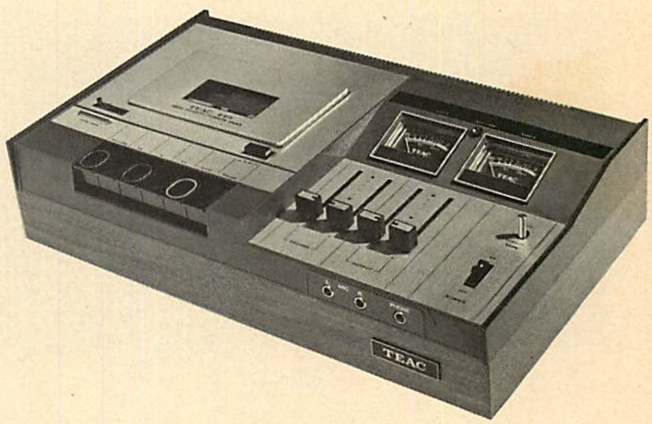

TEAC 220

Controls: Six keys for record, playback, fast-forward, rewind, stop and pause. Separate button for eject, CrO_2-Std. switch, on/off, two pairs of slide switches for record level and output. At the front, on the right, are the microphone and headphone jacks. The two large VU meters are mounted on an angled panel and between them is the record indicator light. At the extreme left is a tape travel indicator which consists of a long amber lens on which a light shines through a slotted disc. At the rear are the input and output sockets with a DIN connector.

Frequency response was within 2 dB from 40 Hz to 15 kHz with CrO_2 and within 2 dB from 40 Hz to 13 kHz with LN tape. This unit was one of the nicest machines to handle—the piano keys are indented and the separate eject button was less confusing than some. A version is available with a Dolby unit, this is Model 350 and it costs $289.50. Appearance is very similar to the 220 and it incorporates a peak recording level indicator and a line-mic switch. The peak indicating device uses light emitting diodes and is mounted between the VU meters.

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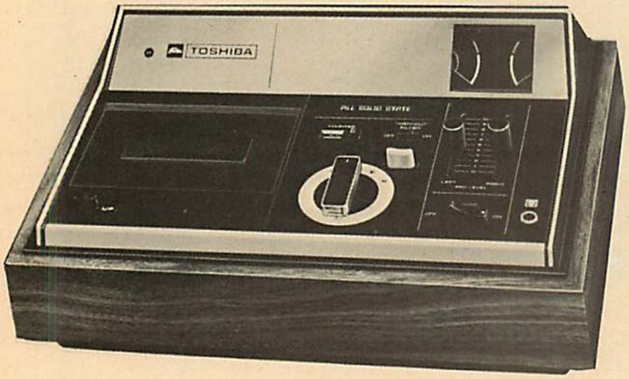

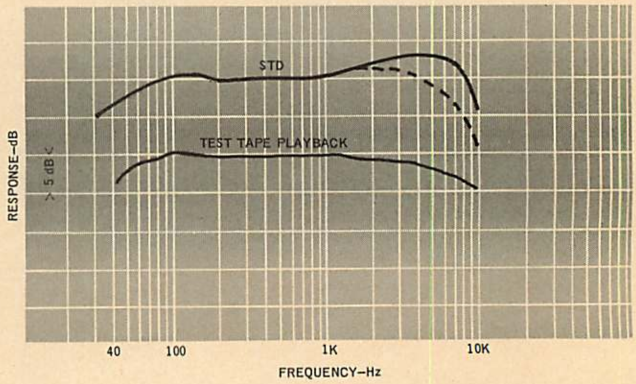

TOSHIBA KT 403D

Controls: Indented rotary switch for record-playback, stop, rewind, and fast-forward. Push button for record, two slide input controls, top cut slide switch, eject button, on-off switch. Tape end and record mode lights.

Frequency response was within 3 dB from 60 Hz to 10 kHz with standard tape. The dotted lines on the graph show the action of the tone control switch. This is a fairly inexpensive machine and we must admit we had some reservations about including it in this particular survey. However, wow and flutter—usually an unpleasant feature of such machines—is commendably low and frequency response is adequate for some "non hi-fi" requirements. No pause control is provided, and there is no automatic shut-off.

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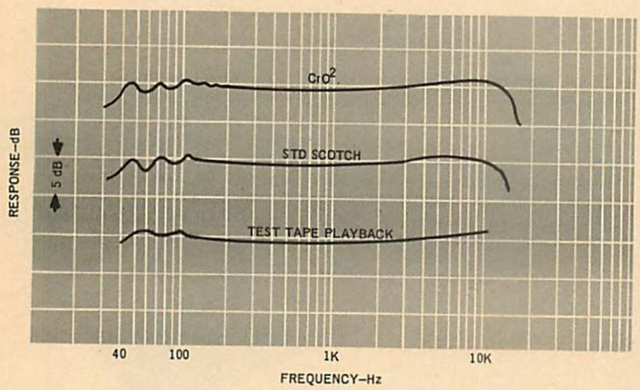
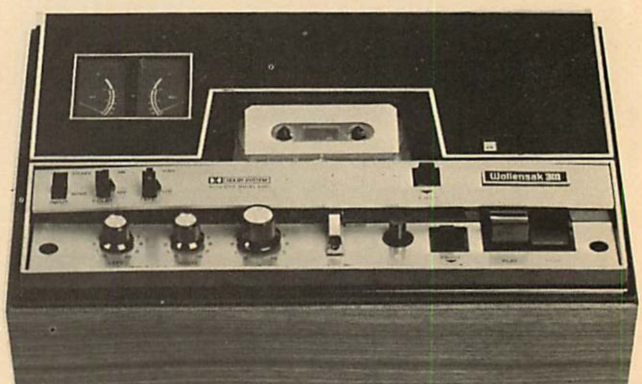




WOLLENSAK 4760

Controls: Stereo/mono rocker switch, Dolby and CrO_2-Std. lever switches, slide switches for on/off, separate buttons for pause, record and eject, rotary controls for record level (one for each channel, plus master). In the center is a horizontal slide lever for fast-forward and rewind. On the left side is a recessed panel in which are mounted the input and output sockets, output level control, a Dolby calibrating push-button and an 18 volt connection for an optional microphone amplifier. This machine is very similar to the Avent 201, the major difference being the provision of two VU meters.

Frequency response was within 2 dB from 40 Hz to 15 kHz with CrO_2 and within 2 dB from 40 Hz to 14 kHz with LN tape. Overall performance was comparable with the Advent and the same remarks regarding the pause control and tape direction control also apply. The cost is $20.00 more and whether the convenience of having two meters justifies this will be a matter of personal choice. Instruction manual is comprehensive and a schematic is on the underside of the recorder.

Check No. 66 on Reader Service Card

Equipment Profiles

Panasonic RS-736US Stereo Tape Deck

MANUFACTURER'S SPECIFICATIONS

Speeds: 15, 7½, and 3¾ ips. **Reel Size:** 7 in. max. **Motor:** 4-pole hysteresis sync. **Frequency Response:** 20-32,000 Hz at 15 ips, (30-25,000 Hz ±3 dB); 20-28,000 Hz at 7½ ips, (30-23,000 Hz ±3 dB); 20-15,000 Hz at 3¾ ips. **Wow and Flutter:** Below 0.09% at 15 ips; below 0.09% at 7½ ips; below 0.13% at 3¾ ips. **Signal-to-Noise Ratio:** 53 dB or more. **Input Sensitivity:** Microphone, 0.3 mV; Phono-1 (ceramic or crystal), 100 mV; Phono-2 (mag), 2 mV; AUX-1, 30 mV; AUX-2, 100 mV. **Outputs:** (fixed) 1.0 V; (variable) 0 to 1.0 V. **Headphone Output:** 55 mV across 8 ohms. **Dimensions:** 17 in. W., 18½ in. H., 8½ in. D. (upright position). **Weight:** 33 lbs. **Price:** $329.95.

As the average recordist becomes more proficient in his hobby, he is likely to want to try some "professional" assignments in which he plans to end up with some commercially produced phonograph records, and for this purpose, he will want to use a higher speed than is usually available on the average recorder. The Panasonic RS-736US will answer his desires for the higher speed—15 inches per second. At the same time it provides the usual 7½ ips which he will use for his not quite so important work, as well as the economical 3¾ ips which he is likely to use for recording the spoken word or possibly for casual programs recorded off the air. And in all these speeds, this machine will give him adequate service, as well as the sort of flexibility he needs for his various activities.

NOTE: Due to last minute space considerations, the review of the Revox A-77 Dolby had to be held over until next month.

When we speak of flexibility, we are referring to the many uses to which this deck can be put, since it provides a wide range of inputs—two pairs of PHONO inputs, two pairs for AUX (all of which are phono jacks), and two standard phone jacks for MICROPHONE inputs. In addition there are two pairs of phono jacks for outputs—one pair with a fixed output and one variable, and controllable from the front panel with separate slide controls for each channel. Since the machine has three stereo heads, you can monitor while recording from either source or tape so you can determine during the process if you are actually getting anything on the tape, as well as comparing the quality of the two. You can make sound-on-sound recordings monophonically, enabling you to create a quartet, for example, from a single performer. You can add echo, record a "language-lab" procedure in which the instructor records on one channel while the student listens to the playback of this channel and then records his own reply on the other. All these facilities are simplified by the provision of separate level controls for most of the inputs. While these level-set controls are ganged to operate on both channels at once, you still have separate recording level controls for each channel. It is a very flexible machine.

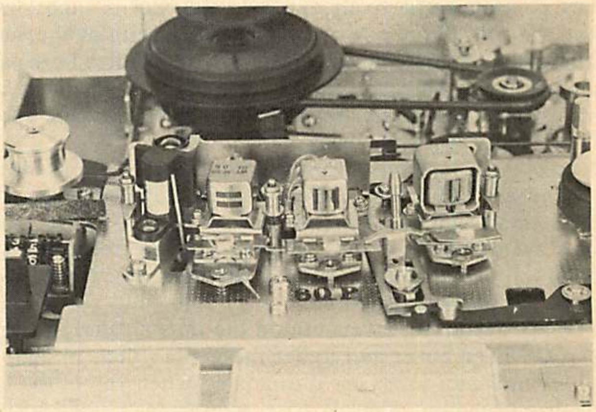


Fig. 1—Close-up of the head assembly. Heads are of hot-pressed ferrite material for long wear.

Physically, the RS-736US has the usual two reel hubs across the top of the panel, with the speed control knob between them at the very top of the panel. At the left center is the left tension lever around which the tape is passed before passing the guide roller. For ease in threading, the tension level locks its maximum counterclockwise position, giving easy access to the guide roller. The head cover is just to the right of the guide roller, and its upper part covers the wiring to the heads and accommodates the power indicating pilot light. The lower twothirds of the head cover hinges upward to make threading as easy as possible, as well as to give access to the heads for cleaning. The tape next passes the capstan and the large idler roller, thence past the right tension arm and upward to the takeup reel. Underneath the idler or pinch roller is a small lever which serves to disable the retracting mechanism when winding rapidly to cue the sound to aid in locating the desired portion of the tape.

The pinch roller is removable, and to change from 7½ ips to 15, it is replaced with a smaller one, and at the same time the small capstan screw is replaced with a large screw which holds the larger capstan sleeve. Thus the two lower speeds are selected by the knob on the panel, using the small capstan screw and the large pinch roller, while the selector switch remains in the 7½-15 position and the screw and roller are changed for the highest speed. This is a method that has been in use on U.S.-made machines for perhaps 20 years, and it is effective and serviceable. Next to the right is the function lever which controls tape motion.

The lower third of the front panel is given over to the amplifier and its controls. In the upper portion are the two 4-in. meters, flanked by the two recording-level slide controls—one for each channel. Next come the two slide controls for output level—again one for each channel—followed by the two monitor switches which select between SOURCE and OFF-THE-TAPE monitoring—one for each channel. Next is the NFD switch—which actuates the noise-level control that reduces highs during the absence of a sufficiently high level of sound in the output. This is followed by the tape selector switch, which should be actuated whenever low-noise tape is being used. It serves to decrease high-frequency equalization slightly.

Along the lower section of the panel a number of jacks and controls are located. First there is the three-circuit headphone jack which is fed from a transistor stage through a transformer to feed the usual low-impedance stereo headphones. Next are the two microphone input jacks. The next item is a knob which actuates a switch that selects inputs from MICROPHONE, PHONO 1, and PHONO 2. This is followed by an input level-set control for the selected source of the preceding switch. The next two knobs control, respectively, AUX 1 and AUX 2 input levels. These controls all operate on both channels with dual controls, but individual channel level control can be handled by separate recording-level controls—one for each channel. The next knob controls the equalization required for the three tape speeds, both for record and playback.

Next is the level control for the specialized functions—sound-on-sound and echo. This is followed by three switches which control these functions—first is the SOUND-ON-SOUND switch, then a switch which selects whether you are recording from right to left or left to right, and finally there is the echo switch with its ON and OFF positions.

The two recording levers are on the upper panel just to the left of the head cover and under the guide roller. In addition, separate indicator lights are illuminated when any of the three specialized function controls are turned from the OFF position.

For aid in locating the actual gaps on the recording, erase, and playback heads, their positions are marked on their shield for easy readability.

On the right side of the cabinet in the lower portion is another panel on which are mounted the two PHONO-1 (ceramic or crystal) input jacks, the two PHONO-2 (magnetic) input jacks, the two pairs of AUX jacks—low level and high level—and the two pairs of OUTPUT jacks—fixed and variable. Then there is a five-terminal DIN receptacle for connection to receivers and amplifiers similarly equipped to provide both record out and playback in connections, a ground terminal, and two convenience outlets—one switched and one unswitched. The power cord also enters at this panel.

Fig. 2—Connection panel located on the lower right side of the cabinet.

Circuit Description

The unit contains two separate amplifiers for each channel—one for recording and one for playback. The record amplifiers employ six transistors each. The first two provide the preamplification for microphone and Phono-2 for magnetic pickups, and the required equalization is furnished by feedback around these two transistors in the preamp section. The low-level AUX input connects directly to the input of the following stage, while the high-level AUX-2 input feeds through a resistor to one of the specialty controls.

The remaining four stages serve to provide further amplification, with the last stage being equalized for recording at the three speeds, using resonant circuits across the emitter resistor. The output of this last stage feeds the record head directly, with controllable bias voltage being furnished through a capacitor and a variable resistor.

The playback amplifiers each have seven transistors, with playback equalization for the three speeds around the first two stages, monitoring selection between the preamp section and the next stage. The ensuing three stages provide the necessary gain to feed the output lines, with the remaining two used to drive the headphone amplifier and the metering circuit.

The NFD noise suppressor circuit utilizes two additional transistors to which are fed the outputs of the two playback amplifiers, and then, in turn, furnish a d.c. voltage which causes the high frequency response of the amplifiers to be reduced, thus reducing the apparent noise. One additional transistor serves as a voltage regulator to supply a constant source to the amplifiers, and two more are employed as the bias/erase oscillator. (For a basic schematic of Panasonic's NFD circuit, see Fig. 1 of H.W. Hellyer's article in this issue.)

Performance

We tried out the machine in all its functions and found that it performed just as described. Measurements on all the possibilities would take up more space than is available, so only the most important response curves are shown. As to details, bias/erase frequency was measured at 187 kHz, which is well above average. Most measurements were made at 7½ ips, with the exception of the frequency responses at all three speeds. Distortion was found to be 0.4% at 10 dB below indicated zero level, increasing to 0.8% at zero, and rising to 3% at an indicated level of +8 dB. Fast forward and rewind times for 1200 feet of tape were 2 minutes and 40 seconds. Wow checked out at 0.05 per cent at 15 ips, 0.08 at 7½, and 0.11 at 3¾; flutter at the three speeds was measured at 0.08, 0.1, and 0.14 respectively. Signal-to-noise ratio was a comfortable 55 dB below the 3% distortion point, and with the NFD noise suppressor in operation the S/N was increased by 6 dB.

Fig. 3 shows the response from a standard tape for playback response, along with a comparison of the phono equalization provided in the PHONO-2 position (magnetic pickups) with the standard RIAA curve. Note that they are with ±2 dB throughout the range.

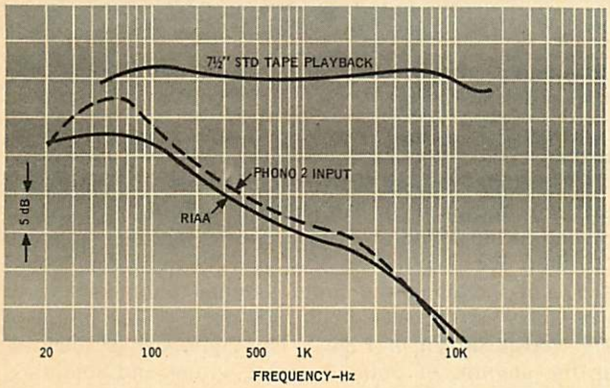


Fig. 3—Comparison between RIAA curve and that of the PHONO-2 input shown in the lower section. Upper curve is playback from a standard tape at 7½ ips.

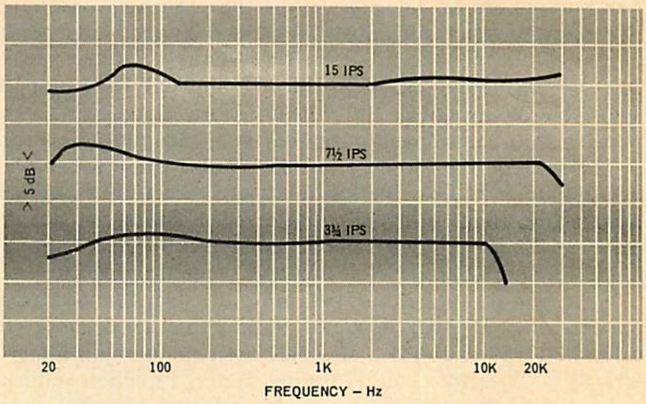


Fig. 4—Frequency response at the three speeds of the machine.

The frequency response curves in Fig. 4 were made from the Bruel & Kjaer sweep record QR-2009, which extends from 20 to 20,000 Hz. The output of a Stanton 681EE cartridge was equalized to within 1 dB of the RIAA curve over the entire range and fed to the AUX-2 input. The output was then recorded on a graphic recorder. For the phono equalization curve of Fig. 3, the cartridge was fed directly into the PHONO-2 input of the Panasonic, and the output similarly recorded.

To sum up, the machine is easy to handle, and with the exception of a slight loosening of the tape tension when the machine is stopped after fast winding, no problems were encountered. It is a handsome machine, and it is certain to provide all the flexibility the average user could imagine.

C. G. McProud

Check No. 69 on Reader Service Card

H. H. Scott Model 477 AM/FM Stereo Receiver

MANUFACTURER'S SPECIFICATIONS

FM Tuner Section IHF Sensitivity: 1.9 μV. **S/N Ratio:** 70 dB. **THD** (Mono): 0.5%. **Capture Ratio:** 2.5 dB. **Selectivity:** 40 dB. **AM Suppression:** 55 dB. **38 kHz Suppression:** 95 dB. **Suprious Response Rejection:** 80 dB. **Stereo FM Separation:** 35 dB.
AM Tuner Section IHF Sensitivity: 100 μV/Meter. **Selectivity:** 32 dB. **THD** (@60% Modulation): 2.0%. **S/N:** 40 dB. **I.F. Rejection:** 30 dB. **Image Rejection:** 48 dB.
Amplifier Section Power Output: 70 watts continuous, 8 ohm loads/channel, both channels driven; 100 watts continuous/channel, 4 ohm loads. **THD at Rated Output:** 0.5%. **Power Bandwidth:** 15 Hz to 40 kHz. **Damping Factor:** 30. **Input Sensitivity:** Phono, 8 mV/4 mV; Mic, 5.5 mV; High Level; 550 mV. **Hum and Noise:** High Level Inputs, -75 dB; Low Level Inputs, -65 dB.
General Dimensions: 17½ in. W. x 6 in. H. x 15½ in. D. **Shipping Weight:** 30 lbs. **Power Consumption** (at 117 V A.C.): 500 watts max. **Suggested Retail Price:** $419.90.

H. H. Scott's rugged high power Model 477 stereo receiver is a good example of how solid-state technology has made possible powerful receivers no larger or heavier than units offering half as much power just a few years ago. The front panel of the receiver, shown above, differs in styling from earlier Scott designs in that it is primarily matte black in color, highlighted by a heavy anodized aluminum edge frame and dial frame. Metal knobs and push buttons of matching color result in a clean uncluttered look, despite the abundance of controls. Along the lower half of the panel are rotary knobs for selection of INPUT, and for BALANCE, VOLUME, BASS and TREBLE levels. The tone control knobs are of the dual concentric type (with clutch action for simultaneous rotation), affording individual channel adjustment of bass and treble. At the right end of the panel are two banks of push buttons. The upper five buttons are of the push-push type and activate the LOUDNESS, TAPE MONITOR, MONO/STEREO MODE, HIGH FREQUENCY FILTER and FM MUTING circuits. The lower five buttons are of the interlocking type (pushing one button releases any other previously depressed button) and control choice of speaker pairs. Up to **three** pairs of stereo speaker systems can be connected to the 477, but only two pairs are selectable at any given time. Buttons are marked 1, 2, 3, 1&2 and 1&3. A separate push-push POWER on-off button is located at the extreme right end of the panel, above the usual stereo headphone jack. Near the selector switch are TAPE IN and OUT jacks wired in parallel with those to be found on the rear panel and a pair of microphone input jacks which utilize the phono-preamp circuitry for low-level preamplification.

With power applied to the unit, the blacked out upper portion of the panel becomes illuminated to disclose well calibrated FM and AM dial scales, a signal strength meter as well as a center-of-channel tuning meter. Function indicator lights below the dial scale indicate selected program source and there is a stereo indicator light as well. A large tuning knob, coupled to an effective flywheel, completes the front panel layout.

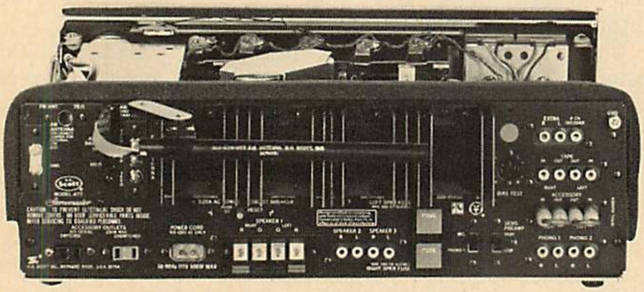


Fig. 1—Rear panel of the Scott 477

The rear panel (shown in Fig. 1) is a good deal "busier" looking than the front panel. At the left end are antenna terminal strips for external AM or 300 ohm FM antenna transmission lines. There is also an antenna jack for connection of 75 ohm antenna plugs usually used with coaxial types of transmission lines and a slide switch for selecting the correct antenna impedance. A pair of a.c. convenience receptacles (one switched, the other unswitched) are located below the antenna strips. The main speaker terminals accept the stripped end of your speaker cable by simply pressing on a spring-action button which discloses a small hole into which the bare wire ends can be pushed. Releasing the button clamps the wire in place. Connection of the second and third sets of speakers is made by means of phono-tip plugs. A circuit breaker reset button eliminates the need for a line fuse, but two speaker fuses are supplied in just about the cleverest fuse holder we have run across. Pressing the lower portion of the square fuseholder cap releases the fuse—no unscrewing required. A pair of slide switches select phono or microphone inputs and equalization as well as phono input sensitivity. There are the usual jacks for TAPE IN and OUT, extra high level inputs, PHONO 1 and 2 and a FOUR CHANNEL DECODER jack intended for some future demodulator-decoder which may be required when and if the FCC approves some form of discrete four-channel FM broadcasting. A pair of short jumper cables interconnect IN and OUT jacks labelled ACCESSORY. With the jumpers removed, these would be the points at which you could connect such extras as a matrix four-channel decoder or any of the other "accessory" products which require another "circuit interrupt" point. A four-terminal test jack for easy access to bias voltage and a grounding terminal complete the rear panel layout.

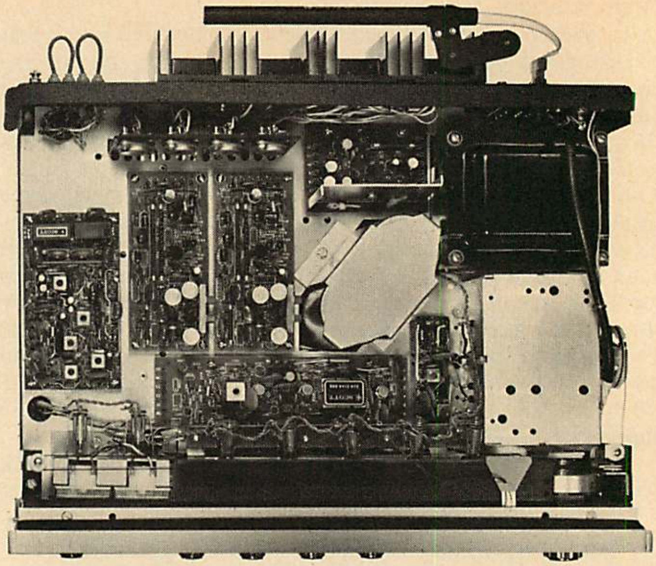


Fig. 2—Interior of the Scott 477. Note the modular PC board approach to design.

Circuitry

H. H. Scott was among the first companies to pioneer the modularized approach in component high fidelity manufacture and in the Model 477 they have refined this approach even further. We counted no less than 12 individual board modules, not including the input antenna balun. Many of these modules can be seen in the top view of the inside of the 477 chassis shown in Fig. 2. This approach, besides reducing the amount of point to point wiring and soldering, enables Scott to offer rapid servicing, if required. If you ever have to send a Scott unit such as this to the factory or an authorized service station for repairs, instead of "trouble shooting" the defective module, it is replaced by an identical module for a flat fee of $10.00, speeding the return of your unit. Solderless "tension wrap" connections are used wherever possible, eliminating a good deal of hand soldering and attendant "cold solder joint" possibilities.

The front-end of the 477 employs an FET r.f. amplifier for FM and another FET as an r.f. AM amplifier. Mixer and oscillator stages are bi-polar NPN devices for the FM section. Three high-gain IC's are used in the FM i.f. section along with a six-pole interstage filter which does away with all i.f. alignment except touch-up of the ratio detector transformer. The AM i.f. section consists of an input FET, followed by a high-gain IC stage and a dual-diode detector.

The multiplex module of the 477 utilizes nine bipolar transistors and an FET in one of the most sophisticated stereo decoder circuits we have examined. It takes into account background noise and signal strength before automatically switching from mono to stereo reception when a stereo broadcast is tuned in. A bridge demodulator circuit plus 38 kHz notch filters at the left and right outputs account for the excellent 38 kHz rejection figures cited in the manufacturer's specifications (and easily met in practice).

A single 17-pin dual inline IC is the main component of the stereo preamplifier section of the receiver, with equalization components mounted external to the IC on a small p.c. board located close to the low level input jacks. Tone control circuits are of the feedback (Baxandall) type and utilize an FET for each channel. Further voltage amplification, driver circuits and electronic protection for drivers and output stages are incorporated in two six-transistor modules (one for each channel). The input stage of each of these modules takes the form of a differential amplifier, with its inherent stabilizing characteristics (both thermal and signal-level). Complementary-symmetry output stages are operated from positive and negative 44 volt supplies which permit direct coupling to the loudspeakers at zero d.c. potential. All lower voltage supplies are electronically regulated by another pair of module boards.

Electrical Measurements

While IHF FM sensitivity was 2.5 μV, only 5 microvolts of signal input was enough to provide 54 dB of quieting—an excellent figure. Ultimate quieting was a remarkable 75 dB, and mono harmonic distortion measured a low, low 0.12% at 100% modulation (this compared to 0.5% claimed). These important characteristics are plotted in Fig. 3. Here, then, is

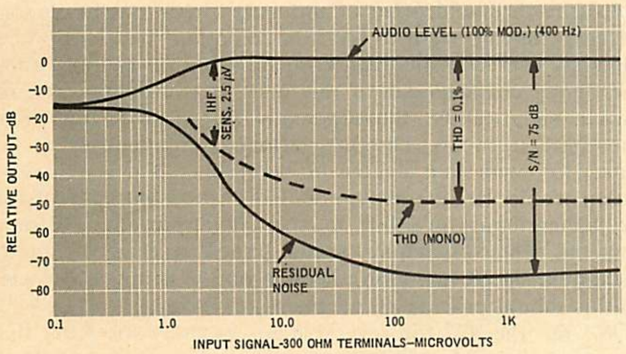


Fig. 3—Mono FM characteristics.

a receiver whose FM distortion characteristic is as good as its amplifier THD characteristic—quite a rarity. THD in FM at other frequencies (not plotted) was measured and found to remain below 0.3% over the useful audio spectrum.

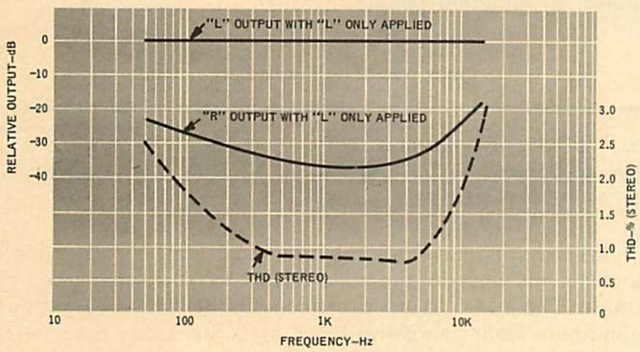


Fig. 4—Stereo FM separation and THD versus frequency.

Stereo separation, shown in Fig. 4, exceeded published specs by a couple of dB at mid-band frequencies, decreasing to about 25 dB at 50 Hz and 10 kHz. As you can see in Fig. 4, something new has been added to our reports. As we promised, we have begun to measure THD at various frequencies in stereo, and a word about these measurements is in order. It is a fact of "stereo multiplex life" that when trying to recover high audio-frequency stereo information, beat frequencies occur at audio frequencies above about 6 or 7 kHz. For example, a 10 kHz signal may beat with the ever-present 19 kHz sub-carrier frequency to produce an unwanted tone of 11 kHz. While this tone is not, strictly speaking, "harmonic" distortion, it will nevertheless be measured on a conventional harmonic distortion analyzer. The instantaneous presence of such "beats" when listening to music is far less objectionable than the "percentages" would seem to indicate, since they are "random" and rather momentary. Nonetheless, some receivers exhibit this undesirable characteristic more than others, and we shall be reporting on it in future reports for comparative purposes. Since this is the *first* such presentation, and since *any* figure of 3% THD might frighten the reader (that figure is observed at 15 kHz in Fig. 4), we must advise readers that we have measured percentages as high as 10 and 15 per cent at 15 kHz on competitive equipment! Evidently, this is a much overlooked area in design—and achieving a figure which never exceeds 3% at any useful frequency is a compliment to Scott engineering, rather than the other way round. Note, too, that throughout most of the very important mid-band region, stereo THD is well under 1%.

Continuous power output with 8 ohm loads turned out to be 72.6 watts per channel at mid-frequencies, a bit better than claimed, while IM distortion, for which no manufacturer's spec is provided, measured 0.5% at exactly 70 watts output per channel. (In all cases, both channels were driven.)

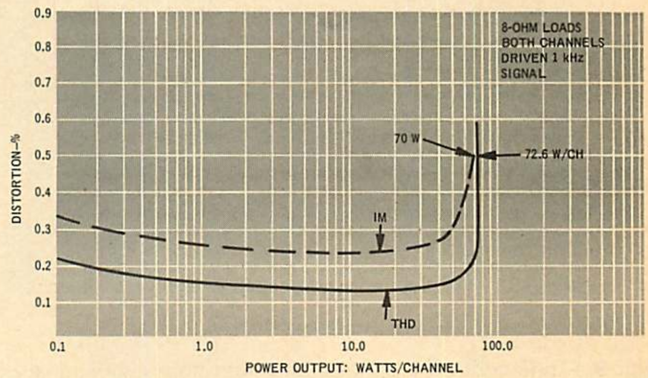


Fig. 5—THD and IM distortion characteristics.

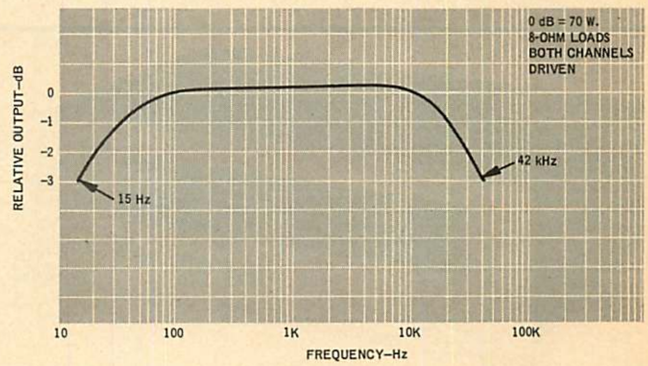


Fig. 6—Power bandwidth.

These characteristics are plotted in Fig. 5. Power bandwidth of the 477 extends from 15 Hz to 42 kHz, as shown in Fig. 6. Figure 7 is a plot of harmonic distortion versus frequency for power/channel levels of 50 watts and 1 watt and at no frequency or power level between the two extremes did THD exceed rated 0.5%.

Tone control, loudness compensation, and high frequency filter characteristics are plotted in Fig. 8 and are conventional

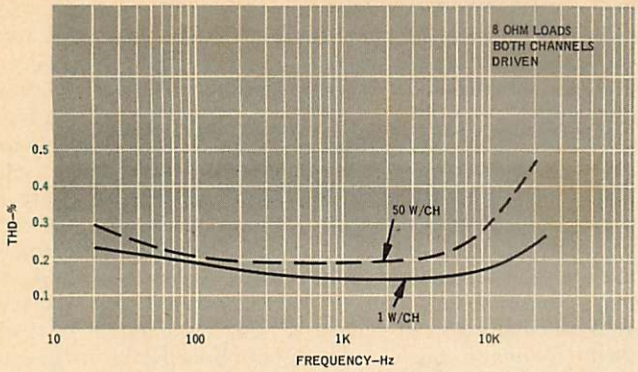


Fig. 7—Frequency versus THD at 1 watt and 50 watts per channel.

but satisfactory. The filter switch, in addition to providing a six dB roll-off characteristic, also "cross-feeds" stereo information between channels, reducing stereo separation somewhat but greatly cancelling stereo FM noise which appears under weak signal conditions.

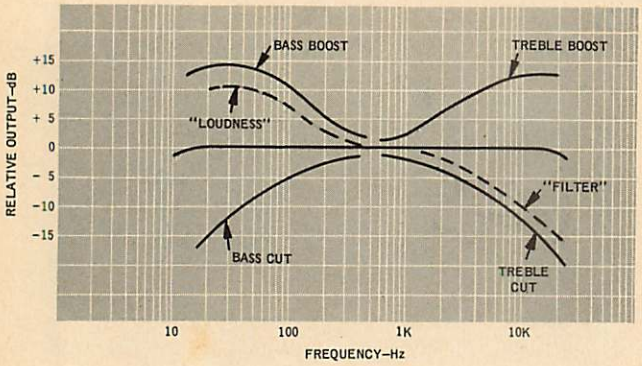


Fig. 8—Tone control, loudness, and high filter characteristics.

Listening Tests

Musical reproduction in our test set-up using the Scott 477 was flawless. We did, however, find that it was easier to get the volume level up to where we like it in the FM mode than it was when listening to recordings, where we were pretty close to the top of the volume control. We attribute this to the somewhat low gain of the phono inputs (4.0 mV and 8.0 mV). Some 2 to 2.5 mV for the high gain inputs is more typical of receivers these days, since a great many cartridges put out that order of voltage and since so many people use low-efficiency speakers. We did "make it" with our set-up (which includes both a nominally 2 mV rated cartridge and about as low-efficiency speakers as you can buy), but with not too much to spare on the volume control.

The superiority of the FM circuitry was quite apparent. We logged 44 stations with the muting circuit activated and some 47 with the muting defeated. Interestingly, however, the three new stations received when we defeated the mute circuit were quite listenable. Considering the fact that they must have been coming in at signal strengths below 6 microvolts (the threshold point of the mute circuit on the unit we tested), one can begin to see how important that early, steep quieting characteristic really is. A word of caution about the tuning characteristic of this unit: If you detune a stereo station significantly, the automatic stereo switching circuit flips back to mono. This may actually be a blessing in disguise, for, with that degree of mis-tuning, the stereo separation would be off anyway and distortion would probably be higher than you'd like to hear. In any event, we found that the center-of-channel meter coincided exactly with the maximum signal strength indication on the companion meter, so this should provide no problems to the user.

We ran the 477 for several hours per day for more than two weeks at high power levels (both on the test bench and under musical reproducing conditions) and found that heat is no particular problem for this hefty receiver.

In summary, if you feel you need 70 watts per channel capability in a receiver and have just around $400.00 to spend, this product of the many years of Scott experience and engineering skill should not be overlooked. Always noted for their expertise in r.f. and FM design, they have now produced a first-class high-power solid-state amplifier in a price category that speaks well for American-made products. More power to the good people in Maynard, Massachusetts!

Leonard Feldman

Check No. 72 on Reader Service Card

Dynaco FM-5 Stereo Tuner

MANUFACTURER'S SPECIFICATIONS

IHF Sensitivity: 1.75 μV. **S/N:** 65 dB (S/N at 5 μV: 50 dB). **THD** (Mono): Better than 0.5%; Stereo, better than 0.9%. **Capture Ratio:** 1.5 dB. **Selectivity:** 65 dB. **AM Suppression:** 58 dB. **38 kHz Carrier Suppression:** At least 55 dB. **Drift:** Less than 0.02%. **Muting and Stereo Threshold:** 4 μV. **Stereo FM Separation:** 40 dB @ 1 kHz (30 dB @ 50 Hz and 10 kHz). **Frequency Response:** 30 Hz to 15 kHz (de-emphasized) ±1 dB, Mono and Stereo. **Dimensions:** 13½ in. W, 4¼ in. H, 9 in. D. **Retail Price:** $149.95 kit, $249.95 wired.

Dynaco kits have long been noted for a basic, simple look on the outside and state-of-the art performance on the inside. The FM-5 is no exception. Its business-like extruded aluminum front panel and black metal enclosure house some sophisticated r.f. engineering and layout that is ideally suited to the kit-builder of limited experience but will serve the FM enthusiast who elects to buy the unit fully wired equally well. The front panel controls include an on/off volume control and a large tuning knob, coupled to a flywheel that easily propels the dial pointer from one end of the dial to the other with one twist of the knob. In addition, there are three three-position rocker switches. The first of these selects MONO or STEREO operation, with a center FILTER position available for improving signal-to-noise ratios when weak stereo signals are received with some sacrifice in high frequency stereo separation. The next rocker switch is labelled AUX-FM and enables the user to select another signal source, such as tape-recorder outputs, which can be connected at the rear panel. The built-in volume control is active for this auxiliary source as well as for FM. The last rocker switch has to do with the interstation muting circuitry designed for the FM-5 and has positions for OFF, MUTE and DYNATUNE®, about which we'll have more to say later.

The large dial scale area includes a logging scale with 100 divisions in addition to the usual frequency scale. A signal strength meter is located at the left of the dial scale area and adjacent to it are two indicator lights—one of which is labelled TUNED, the other STEREO. The STEREO light, of course, becomes illuminated in the presence of a stereo broadcast. The TUNED light is the end result of a carefully engineered sensing or logic circuit in combination with a closed-loop

Fig. 1—Rear panel layout of the Dynaco FM-5

AFC tracking circuit which insures center-of-channel tuning and which will be described shortly, when overall circuitry is analyzed.

The rear panel of the FM-5 tuner is shown in Fig. 1. Antenna connections are provided for 300 ohm or 75 ohm transmission lines and there is a convenience a.c. outlet as well as a line fuse for circuit protection. A fixed pair of outputs labelled TAPE OUT provide approximately 2 volts of audio (under conditions of 100% FM modulation) regardless of volume control settings, and these outputs are intended for connection to a tape recorder input pair which can be controlled at the recorder itself. The AUDIO OUT jacks are for connection to your amplifier or amp-preamp components while the AUX jacks, as previously mentioned, will accommodate a stereo high level signal source. In the event that you want to make the FM-5 your "operations center" and have only a basic stereo power amplifier, Dynaco will make available a separate phono preamp (Model PPM-5) which will accommodate a magnetic phono cartridge. The outputs of this accessory could then be connected to the AUX inputs on the FM-5.

In Fig. 2, the assembled and wired FM-5 is shown with the top cover removed and back panel swung down. There are three major assemblies, all of which come fully wired, aligned and tested. The kit builder is concerned only with the mechanical assembly of the modules to the chassis and

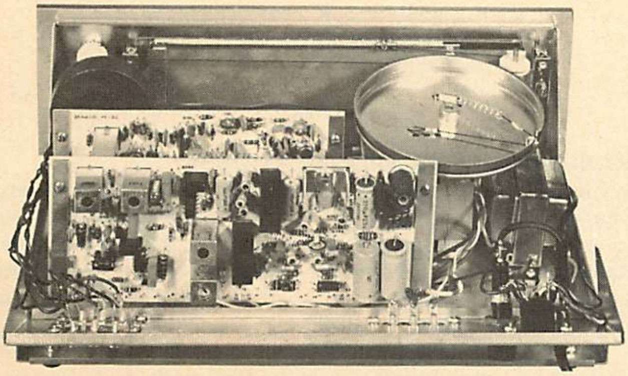


Fig. 2—Internal view showing major p.c. modules.

their interwiring. With so much of the Dynaco FM-5 prewired and pre-aligned, the kit building phase of the project is quite minimal and well worth the effort for the difference in price between the wired and kit price of this tuner. There are 22 initial assembly steps (mechanical), 87 steps concerned with the actual wiring (mostly cutting lengths of wire and hooking them up from here to there and 12 final assembly steps. In general, we have found that Dynaco's step-by-step instructions are a bit on the brief side and could benefit from a few more illustrations. A novice kit-builder may not be able to readily identify the less familiar parts which are merely referred to by name. The kit was built by a fairly well experienced kit builder in a little over five hours, but a novice might well take a little longer.

The front-end (obscured in the photo by the large dial string drum) includes a tuned r.f. input to a Field Effect Transistor amplifier, followed by interstage double-tuning to a FET mixer. A bi-polar transistor is used for the local oscillator. The output of the first i.f. stage is tuned by a section of the four-section variable capacitor.

The basic i.f. section of the FM-5 consists of two IC amplifiers followed by a high gain limiter IC. There are four cascaded ceramic filter sections between the first and second stages and three additional filter sections between the second and third stages. Another high-gain amplifier (also an IC) drives a ratio-detector which feeds an emitter follower for audio output. There follows a 67 kHz filter for SCA rejection and an FET which feeds the muting and multiplex circuits. An IC multiplex circuit includes a cross-coupled multiplier-demodulator for additional SCA rejection. Also included are additional 19 kHz and 38 kHz rejection filter circuits and a two transistor audio amplifier which provides low output impedance and incorporates the necessary de-emphasis circuits.

The muting circuit is controlled by a logic circuit which is fed by the detector's emitter follower audio output. Sensing the detector's d.c. level, audio is switched off when the variation from "zero center" exceeds 80 kHz. This circuit is also activated by a second signal (the output of a 150 kHz high pass filter) which consists of interstation noise. If such noise is present, audio is also switched off.

The Dynatune Circuit

This automatic circuit consists of an amplified closed-loop tracking circuit with a narrow "window." The amplified d.c. output of the detector is fed back to the front-end through a limiter. This signal controls the frequency of the local oscillator and "tracks" for zero d.c. at the detector output. Since the "looking action" is so strong that it might track a single signal over wide ranges of frequency, the circuit is so arranged that when the d.c. level reaches a predetermined value (as the tuning dial is moved), the muting logic switches off before audible noise or distortion is heard.

Electrical Measurements

Figure 3 is a graphic plot of major FM performance characteristics. IHF sensitivity was reached at a near-theoretical limit of 1.7 μV but, even more important, notice the excellence of the quieting slope. At 5 microvolts input, we observed over 55 dB of quieting (fully 5 dB better than Dynaco's published specification) and ultimate S/N for any signal level beyond 50 μV was 68 dB (as compared with 65 dB claimed by the manufacturer). Harmonic distortion in mono was a mere 0.3%, while in stereo we measured 0.55% at mid-band frequencies. As can be noticed in the graph, stereo threshold (the point at which the circuits "open up" the stereo circuitry) was 4 μV and that corresponded to the muting threshold as well. This last figure is particularly significant. Less sophisticated muting circuits invariably restrict the listener to signals of greater than 7 to 10 μV—which means that if you want the benefit of interstation silence and have the muting circuits turned on, you're liable to "block out" otherwise listenable stations. In the case of the Dynaco FM-5, with a threshold of 4 μV in its muting circuits, just about any station you'd deem worth listening to (in terms of signal-to-noise ratio) defeats this muting circuit positively—with no "half-way" distortion points so common to other

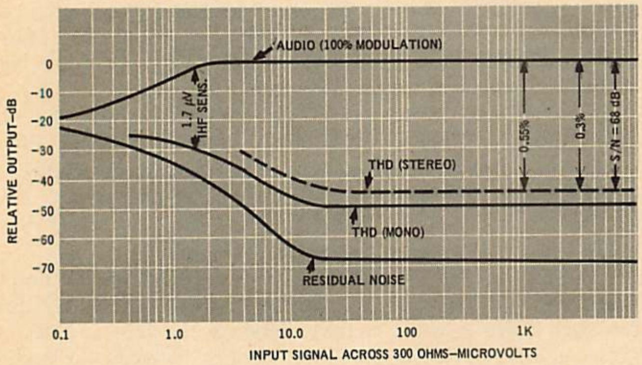


Fig. 3—FM characteristics.

forms of this circuit. Stereo separation actually exceeded published specs, measuring 42 dB at mid-band and maintaining 30 dB from 50 Hz to 10 kHz.

Listening Tests

Tuning the dial of the FM-5 offers immediate proof of the superiority of Dynaco's Dynatune circuit. While the signal strength meter gives some indication of the fact that you are approaching a station, with the switch set in the Dynatune position it really is not needed. That TUNED light comes on and clear distortion-free audio is heard. There is none of the "side skirt" noise often associated with lesser "muting and tuning" circuits. No pops, no clicks—just audio when-

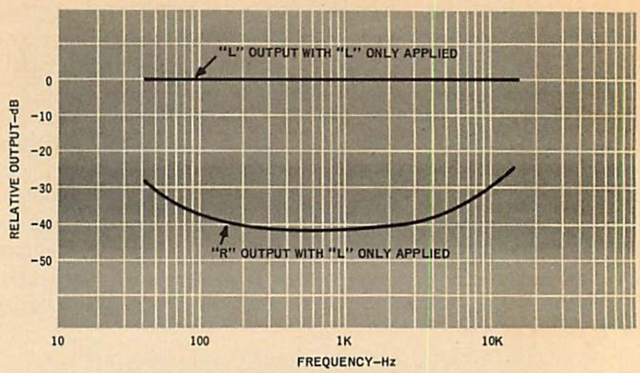
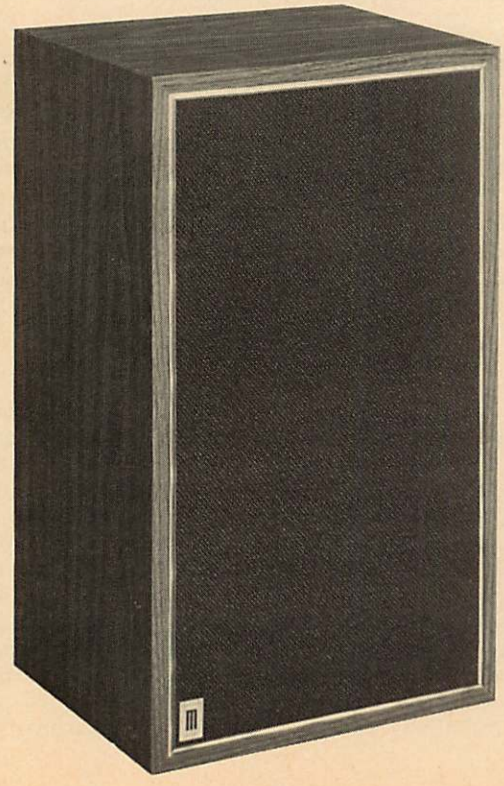


Fig. 4—Stereo FM separation characteristics.

ever that light lights. We found the so-called "window" to be quite narrow and critical, but that is one of the penalties you have to pay if you're going to get absolute accuracy in center-of-channel tuning. With the switch set to the MUTE position, stations came on over a somewhat broader range of movement of the dial, but of course center-of-channel precision was then left up to the user and there is some margin for the introduction of distortion as one nears the edge of the mute defeat range for each station. Dynaco suggests tuning for stations in the MUTE position and introducing the Dynatune feature only after the station has been tuned in (for final center-of-channel accuracy) and this may be the best way to work it, although the *tune* light must be illuminated before you can switch to this latter position for the "tracking" circuits to take over.

In our location, we were able to pick up exactly the same number of listenable stations with or without the mute circuit on—a total of 51 with our outdoor Yagi antenna facing New York City, of which 28 were broadcasting in acceptable noise-free stereo—which further attests to the desirability of Dynaco's low threshold in this new muting circuit. There was no evidence of drift at any time and, most surprisingly, calibration was excellent—never off by more than 100 kHz at any point on the dial. That's quite an accomplishment for a tuner whose front-end was aligned in Philadelphia and whose dial string and dial pointer were assembled months later at a remote kit-builder's home! In all, you're not afraid to mount some parts, cut some wires, and do a bit of easy soldering, the Dynaco FM-5 offers you expensive sounding stereo FM at a budget price. *Leonard Feldman*

Check No. 74 on Reader Service Card



EASTMAN SOUND MARTIN CRESCENDO

430 SPEAKERSYSTEM

MANUFACTURER'S SPECIFICATIONS

System Type: three-way, totally enclosed. **Components:** One 12-in. woofer, one 3½-in. mid-range and one 2½-in. cone tweeter. **Frequency Response:** 30 to 18,000 Hz **Power Handling:** 60 watts. **Nominal Impedance:** 8 ohms. **Dimensions:** 25½-in. H by 14½-in. W by 12-in. D. **Finish:** Walnut formica finish. **Price:** $169.95

Although we have heard Martin speaker systems at audio shows from time to time, this is the first model to be reviewed in these pages-apart from the small model included in last

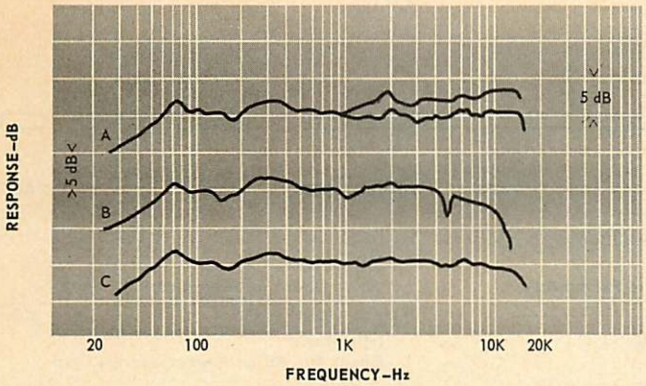


Fig. 1—Frequency response taken with one-third octave pink noise. A is taken on-axis, B is 45 degrees off-axis and C is an average at 5 positions.

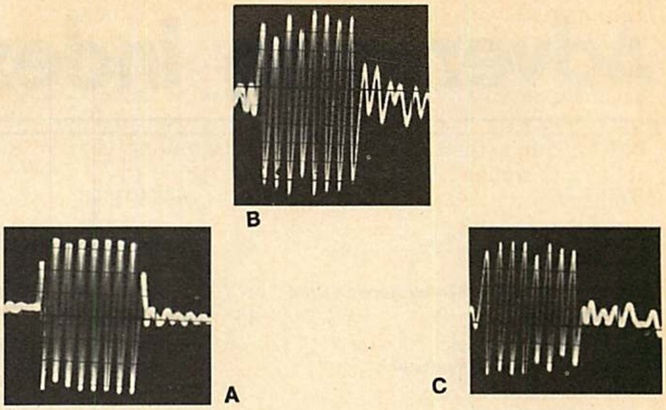


Fig. 3—Tone-burst response at **A**, 200, **B**, 1000, and **C**, 5000 Hz.

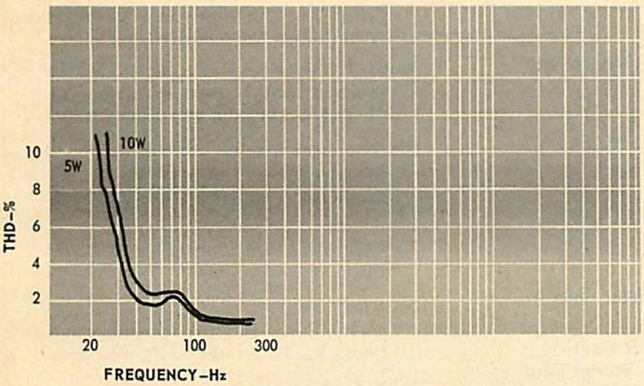


Fig. 2—THD at low frequencies.

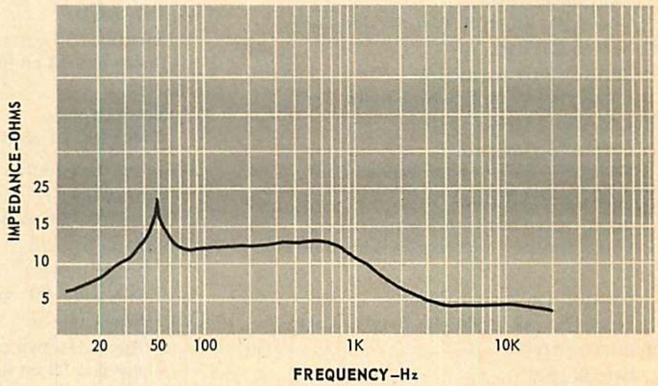


Fig. 4—Impedance characteristics.

month's survey. The "Crescendo" is the largest bookshelf system in the range and it certainly compares favorably with its competitors. The bass unit has a large magnet and a 2-in. voice coil with a flexible cone surround to permit wide excursions. Free air resonance is 22 Hz and the cross-over frequency is around 700 Hz. The midrange speaker is a 3½-in. closed-back type and it has a small center-dome to aid dispersion. At 6 kHz, another crossover transfers the output to the tweeter which also has a center-dome. Both cross-over slopes are very gentle at 6 dB per octave, thus giving a smooth transition and avoiding the annoying impression of three separate sound sources which sometimes occurs with steep-cut cross-overs. Level controls are fitted for both middle and treble ranges. In short, the Martin "Crescendo" is an excellent example of a solid, well-proven design with no gimmicks or "revolutionary acoustic principles."

Performance

Frequency response taken with one-third octave band pink noise is shown in Fig. 1. With the controls at maximum it will be seen that there is a rise in output from about 5 kHz. With the treble control turned back about one third and the mid-range slightly more, a response of + 3dB was obtained from 200 Hz to 10 kHz—a creditable achievement. Figure 1 also shows the response 45 deg. off-axis and an average of 5 positions. Dispersion is well-maintained up to 10 kHz after which there is some beaming and response falls off from 17 kHz. White noise showed up no objectionable coloration unless the midrange control was turned to near-maximum. Distortion characteristics are given in Fig. 2 and tone-burst responses at 3 frequencies (2 near the cross-over points) in Fig. 3. System resonance was exactly 50 Hz and the Crescendo would handle a continuous sine wave power of 10 watts without audible frequency doubling at 30 Hz and 20 watts at 40 Hz. Sensitivity is somewhat higher than average and an SPL of 100 dB at one meter was produced by an input of just over 1 watt. Thus, an amplifier power of 20 watts per channel would be adequate for quite large rooms. The impedance curve is shown in Fig. 4 and it will be seen that the lowest point is 4 ohms, with an average of about 10.

Listening Tests

Listening tests with a variety of program material confirmed the test figures. Bass was solid, rather tight and well-controlled with no trace of boom. The high frequencies were commendably free from harshness and the transient response was good. In general, the sound quality could be described as being slightly forward but not strident. Rather like being in the first three rows of a concert hall instead of way back in the tenth. At $169.95 it represents excellent value and is worthy of investigation by those in search of a bookshelf system with high performance at a modest price. *T.A.*

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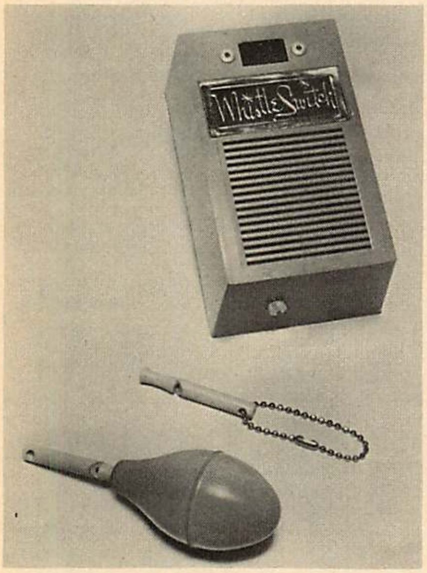
THE WORKBENCH

Whistle Switch



If you have ever felt the need for a remote control device to switch on (or off) lights, amplifiers, or what-have-you from a distance without messing about with wires, the Whistle Switch might be the answer. Essentially it is a relay operated by a transducer sensitive to high frequency signals. These signals are generated by a special whistle which can be blown, operated by a squeeze bulb, or there is a deluxe model which uses a push button. The equipment to be switched is plugged into the unit which is then inserted into the wall socket. In our tests, we found the operating frequency was around 18 kHz. The range was really amazing and the switch would function from a whistle range of nearly 50 feet—even from the next room! The relay is double-pole, as the switch is on-off alternately. Makers are Signal Science, Inc.

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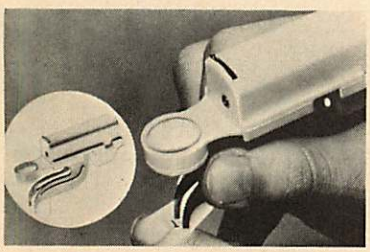

Lighted Magnifying Tweezer

This handy gadget from Lesco uses a single penlite battery and a mini bulb. Ideal for working with subminiature components. Price: $2.25.

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Editall Tape Splicing Kits

Type KP-2 is for use with ¼-in. tape, KS-1 for 0.150-in. tape. Kits include Editall Blocks, special splicing tabs, demagnetized cutting blade, grease marking pencil, and instruction book. Three other kits are available which use splicing tape in roll form, also several kits for video tape.

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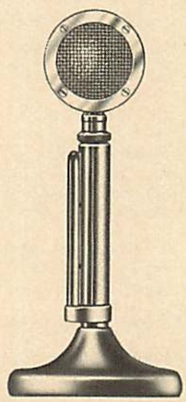

Astatic mic stand adaptors

These stand adaptor kits and complete transistorized desk stand convert plug-in microphones to the new transistorized CB and HAM outfits. The TG and TU kits convert the Astatic G grip-to-talk stand and the UG8 stand respectively. The T-UG8 stand is a complete grip-to-talk unit. All three have a transistorized amplifier with a screw-adjusted volume control under the base.

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Catalogs

Hard-to-find Tools—The Brookstone Company, 2893R Brookstone Bldg., Peterborough, N.H. 03458, has a very comprehensive catalog of unusual tools, such as files and drills for plastics, holding jigs, all kinds of clamps, and so on. A one-year subscription for three issues costs 50¢—a bargain.

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Musical Heritage Society offers a catalog of classical recordings sold through the Society, including many pieces of music not otherwise recorded. Nearly 1000 different discs are listed with most priced at $2.99.

Check No. 123 on Reader Service Card

Switchcraft has released a new catalog of audio accessories, listing its line of phone jacks and plugs, switches, connectors, adapters, and molded cable assemblies.

Check No. 124 on Reader Service Card

Edmund Scientific offers its catalog of more than 4,000 items for the scientist, hobbiest, and arm-chair engineer from the fields of ecology, physical sciences, optics, photography, etc.

Check No. 125 on Reader Service Card

Mueller Electric offers catalog no. G172, Electrical Clips and Insulators, a newly revised 8-page brochure covering the firm's line, which ranges from miniaturized clips to large ground clamps.

Check No. 126 on Reader Service Card

Advent Corp. has released data on its new Model MDC-1 microphone, a low-impedance, cardioid pattern, dynamic microphone, featuring high performance, moderate cost, ruggedness, and consistence from unit to unit.

Check No. 127 on Reader Service Card

Memorex has announced a new 8-page brochure on its consumer line of low-noise, high output recording tape, detailing its engineering and performance characteristics.

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(Continued from page 32)

adjusted for flat response when playing a test tape, the record equalization should be adjusted for flat record-playback response.

There are good reasons for NAB not specifying a specific treble boost curve in the record amplifier: (1) Treble losses in recording vary among types and brands of tape, so that the amount of required treble boost varies according to the tape which the manufacturer envisions will be used with his machine. (2) These losses vary according to the amount of bias the machine manufacturer elects to use. He tries to come fairly close to the bias which achieves minimum distortion. However, minimum-distortion bias may entail excessive treble loss, causing the manufacturer to reduce bias somewhat rather than increase treble boost in recording and thereby heighten the risk of overloading the tape. In other words, the manufacturer may find that the increased distortion resulting from a slight decrease in bias is not as bad as the increased distortion which would occur if more treble boost were used.

The NAB Recording Characteristic

Indirectly, NAB does stipulate a recording characteristic in terms of the relative levels of recorded flux on the tape at various frequencies in the audio range. To explain, let us repeat our dictum on recording/playback characteristics: "A given recording characteristic implies a complementary playback characteristic; or a given playback characteristic implies a complementary recording characteristic."

Hence the NAB recording characteristic is Curve NOM in Fig. 5. Given playback characteristic I'F' and flat response, then the flux recorded on the tape must vary with frequency in the manner portrayed by NOM.

NOM is derived as follows. We draw LM to show the hypothetical playback equalization required if the recording characteristic were flat and if an ideal playback head were used (or a playback head with its irregularities fully compensated in the playback amplifier). That is, LM declines 6 dB per octave with increasing frequency, thereby complementing the playback head's 6 dB rise per octave. However, any departure of the acutal playback characteristic (I'F') from LM implies a corresponding (complementary) departure of recorded flux from a flat characteristic. Thus NOM is the difference between hypothetical and actual equalization, namely between LM and I'F'.

At the low end, I'F' supplies less than the hypothetical bass boost. Therefore the deficiency must be made up in recording by bass boost NO (unless the deficiency is made up by the contour effect of the playback head). At the high end, I'F' does not drop as rapidly as LM; thus I'F' in effect is contributing treble boost. And a corresponding drop in treble must occur in recording, namely the treble decline of recording characteristic NOM.

The implied recording characteristic NOM—flux on the tape—is the sum of magnetic losses in recording, equalization in the record amplifier, and response irregularities of the record head. All told and together with playback characteristic I'F', they produce flat response.

If, after all, there is an NAB standard recording characteristic, why doesn't NAB specify this explicitly (in the way that the RIAA phono recording characteristic and the FM broadcast characteristic are specified)? The answer lies in the kind and quality of laboratory test equipment required in order to measure recorded flux. It is far easier for the manufacturer, technician, or user to check the playback characteristic with the aid of a test tape and meter than to measure recorded flux. Since a playback characteristic implies a matching recording characteristic when overall response is flat, then if the playback characteristic is known to meet the standard (on the basis of playing a test tape) the recording characteristic perforce also meets the standard.

This signifies that if my tape machine and yours both have flat record-playback response, and if both produce flat output when playing the standard test tape, mine will record tapes that play back flat on yours, and vice versa.

We have several times commented on NO in Fig. 5. To bring things together, at the cost of repetition, this slight bass boost may be achieved by an equalization circuit in the record amplifier, by the contour effect of the playback head, or by a combination of the two. Even if there is no appreciable contour effect, the manufacturer may choose not to supply bass boost in recording. This is consistent with the NAB standard for frequency response, which permits record-playback response to be down 3 dB at 50 Hz.

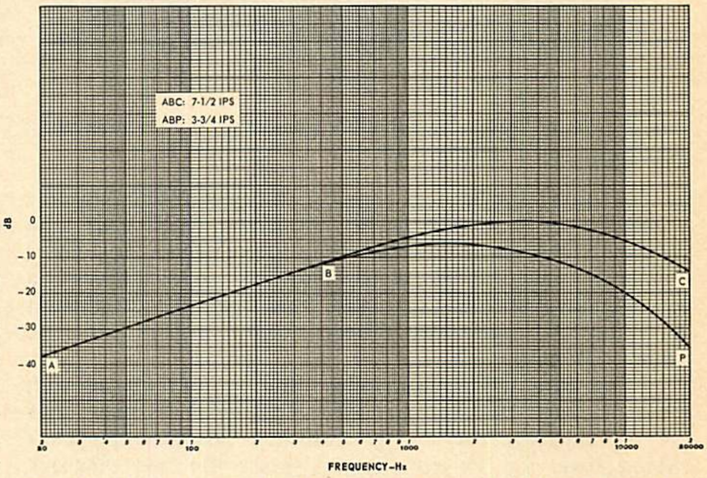


Fig. 6—Comparison of unequalized record-playback response at 7½ and 3¾ ips.

Other Speeds, Other Tapes, Other Matters

All that we have said about problems and techniques of tape equalization at 7½ ips also applies in essence to the lower (higher) speeds in home use. However, as speed is reduced, equalization must be changed, the principal reason being the greater magnetic losses that occur in recording at reduced tape speed. This is illustrated in Fig. 6, which compares unequalized record-playback response at two speeds, 7½ and 3¾ ips.

Why do recording losses increase with reduced speed? The answer lies in the fact that these losses actually depend on recorded wavelength rather than on frequency as such. We refer again to the length of the bar magnets that in effect are recorded on the tape. At a given frequency, a corresponding number of bar magnets are recorded per inch of tape. To illustrate, consider a 1,000 Hz tone, which is recorded as 2,000 bar magnets—one magnet for each positive portion of an audio cycle and one for each negative portion. At a tape speed of 7½ ips, the 2,000 magnets are recorded on 7½ inches of tape, so that the length of each magnet is 7.5/2,000 inches or .00375". But at 3¾ ips, the length is 3.75/2,000 inches or .001875"—half as long. Earlier we pointed out that the shorter the wavelength (bar magnet), the greater the loss due to self-demagnetization and bias erase. Thus at a given frequency the wavelength is reduced and the recording loss is increased as tape speed is reduced. In going, say, from 7½ to 3¾ ips, losses are of the same magnitude at 5,000 Hz as they were at 10,000 Hz at the higher speed; losses are of the same magnitude at 10,000 Hz as they were at 20,000 Hz; etc.

To offset the greater treble loss at low speed, more treble boost is needed in recording. But the requisite amount would

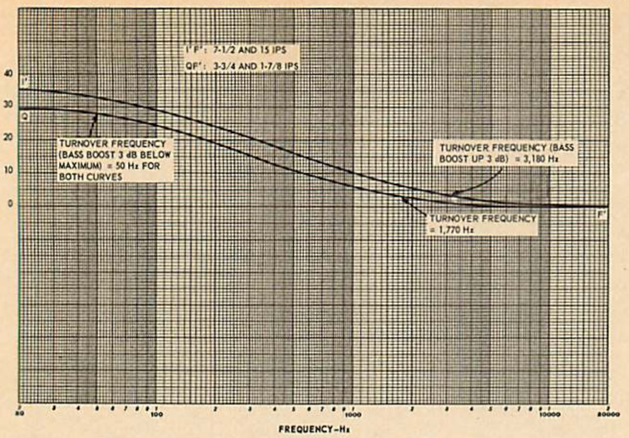


Fig. 7—NAB standard playback equalization curves (including playback head characteristics).

overload the tape and cause excessive distortion. A viable alternative is to reduce treble boost and match this with reduced bass boost in order to attain flat response. As pointed out in our dictum on record/playback characteristics (in conjunction with Figs. 2, 4, and 4-A), reduced treble boost correspondingly calls for reduced bass boost in order to achieve flat response.

In this light the NAB standard for 3¾ and 1⅞ ips calls for a playback characteristic with 5 dB less bass boost than the characteristic for 7½ ips (which is also the playback characteristic for 15 ips). Fig. 7 shows the two playback characteristics. Curve I'F' is the NAB standard characteristic for 7½ and 15 ips, and QF' is the standard for 3¾ and 1⅞ ips.

I'F' entails a total of 36 dB bass boost; QF', 31 dB. In technical terms, I'F' is described as having turnover frequencies of 3,180 and 50 Hz (or, respectively, time constants of 50 and 3,180 microseconds). This signifies that the curve has achieved 3 dB boost at 3,180 Hz, and at 50 Hz is 3 dB below maximum boost. QF' has turnover frequencies of 1,770 and 50 Hz (or, respectively, time constants of 90 and 3,180 microseconds), signifying 3 dB boost at 1,770 Hz, and boost 3 dB below maximum at 50 Hz. (The relationship between time constant t in microseconds and turnover frequency f in Hz is expressed by $t = 159{,}155/f$. The factor 159,155 derives from the technical relationship between the values of capacitance and resistance needed in an equalization circuit to achieve a 3 dB change in frequency response.)

According to Fig. 7, two playback equalization characteristics are used for four speeds, one characteristic for 7½ and 15 ips, and the other for 3-¾ and 1-⅞ ips. But the sense of this article is that each tape speed requires its own equalization in order to obtain optimum results with respect to frequency response, S/N, and distortion. In other words, why don't we have four standard equalization characteristics instead of two? The indicated answer is that four characteristics would complicate matters too much for those making tape machines, and perhaps for those using them. An equalization characteristic appropriate for a given speed can be used for the next higher speed without undue departure from optimum performance. So all in all, two playback characteristics for four speeds affords a practical compromise without unduly deleterious consequences.

What happens to equalization requirements as tape formulations change, resulting in higher output, lower noise, better treble, different bias requirements? So far as playback equalization is concerned, the answer in essence is *nothing*, or very little. Essentially it is only record equalization that changes (except in the unlikely event that changes in tape formulation would someday result in a new standard playback characteristic, which would be a very unhappy day for those with substantial collections of recorded tapes).

If a new tape has increased treble output, the tape machine manufacturer may choose not to extend treble response but to reduce the amount of treble boost supplied by the record amplifier, thereby lessening the chance of tape saturation. Alternatively, he can leave treble boost about the way it was, and increase bias to achieve less distortion, yet without reducing treble. Or, in increasing bias, his purpose may be not to reduce distortion but to permit recording at a higher level at the same distortion as before, thus improving S/N. Or the manufacturer may follow a compromise course which results in some combination of improvements in treble response, distortion, and S/N.

If a new tape has higher output, the machine manufacturer can in similar fashion take advantage of this to improve S/N, treble response, distortion, or a combination of them. Higher tape output enables the machine to apply somewhat less signal to the tape without sacrificing S/N; hence there is less danger of tape saturation, permitting more treble boost for better treble response; or permitting more treble boost together with more bias for lower distortion. Higher tape output enables the machine to reduce recording level for less tape distortion. Higher output enables the machine to keep bias and treble boost as before, with an increase in recording level to achieve higher S/N, yet without increase in distortion.

In similar ways, reduction in tape noise not only permits higher S/N but can also be translated into improvements in distortion and treble response, which might entail changes in treble boost, bias, or recording level. Changes in a tape's bias requirements do not in themselves entail changes in treble equalization. However, changes in bias requirements for a tape tend to accompany changes in noise, treble, and output characteristics of the tape, and it is then that the machine manufacturer may find it advisable to change record equalization.

Does use of the Dolby noise reduction system (or other noise reduction systems such as the Burwen) affect tape equalization? The answer, essentially, is only in recording if at all. Introduction of the Dolby system in a tape recorder installation does not necessarily call for a change in recording equalization. One records as before, except than the incoming signal first goes through a treble-boosting Dolby circuit; and one plays as before, except that the playback signal afterward goes through a matching treble-reducing Dolby circuit to achieve noise reduction and restoration of flat response. Overall record-playback response is not changed by Dolby, which therefore does not *compel* a change in tape equalization.

On the other hand, the Dolby (or a similar) system may *invite* changes in equalization for reasons already suggested here. To illustrate, assume that Dolby achieves a 10 dB reduction in noise. The tape machine manufacturer might decide to sacrifice part of this improvement, say 4 dB, in exchange for better treble response. He could adjust the tape machine (adjust the reading of the record-level indicator) to operate at 4 dB lower recording level, permitting 4 dB more treble boost without increase in danger of tape saturation. Or he could exchange part of the Dolby reduction in noise for improvement in distortion, by using more bias along with more treble boost, as well as a lower recording level. Or he could achieve some improvement in all three respects—noise, treble response, and distortion. Æ

(Continued from page 54)

treme high frequencies. Capacitors C1 and C2 are chosen so as to give the best fit to the distortion saturation curve. This can be done either by calculation or by "trial and error."

Series meter resistors R2 and R4 should be chosen to allow full scale meter deflection (+3 VU) for an rms input signal of about 1 volt at the meter diode. The meters used in the design were inexpensive d.c. microammeters with VU scales. These had full scale sensitivities of 400 μA (for +3 VU) and d.c. resistances of 650 ohms. It was found that 470 ohms was a suitable value for R2 and 2.2 kilohms for R4. A value of $C4=60$ μF was found to be satisfactory. This provides a decay time-constant of $RC=0.17$ sec (since $R=2.2$ kilohms + 0.65 kilohms) for the peak-reading meter. A decay time-constant of about 0.2 sec appears to be the optimum value for most recording applications. The measured charge time-constant was about 15 mS and corresponds to an equivalent input resistance of about 250 ohms. The limitation here is the particular diode used for D2 (a small signal germanium) rather than the operational amplifier. The measured effective OA3 output impedance is considerably lower than 250 ohms. Although it doesn't appear to be necessary, the transient response can be improved by decreasing the charge time. This can be done either by use of low forward resistance germanium diodes or by the use of more sensitive meters. The latter will allow the use of a larger value of R4 (and also R2), and therefore a smaller value of C4.

A constant input with frequency gives a constant average reading. The relative input required to give a constant indication on the peak-reading meter is shown in Fig. 6 for both 7½ and 3¾ ips. The solid curves are distortion-saturation curves derived from Fig. 4 and similar data. The dashed curves represent measurements which give the relative input required for a constant peak-reading indication. For 7½ ips, C1 and C2 were each chosen to give time constants of $RC=25$ μSec. There is clearly an excellent match between the tape saturation curve and the peak-reading meter compensation. For 3¾ ips, C1 was chosen to give a time constand of $RC=37$ μSec. The match here is good but can obviously be improved by some adjustments of the time constants. Clearly the appropriate time constants are determined by the tape speed, the particular tape used, and by the tape-recorder characteristics.

It should be noted that the roll-off on the saturation curves occurs at lower frequencies with decreasing tape speeds. Thus frequency compensated meter circuits are particularly essential for quality recording at the lower tape speeds.

Performance

A two-channel system was built for stereo recording. Initial test recordings helped establish the optimum relative mid-range sensitivity between the average and peak-reading meters. As a result of these tests the peak-reading meter was calibrated to give a reading of -3 VU at 400 Hz for an average-reading meter indication of 0 VU. From inspection of Fig. 2 it can be seen that a peak reading of 0 VU corresponds to about 1% THD at all frequencies, and +3 VU corresponds to about 2% THD at all frequencies. Here the saturation is considered in terms of the equivalent THD because this will directly determine the magnitude of the intermodulation products.

Several live recordings have been made at 7½ ips and the results have been most gratifying. If the peak-reading value is *always* kept below about +2 to +3 VU, then there is negligible audible distortion. The distortion increases rapidly when the recording levels are increased above these levels.

Various types of live concerts were used. An organ recital provided an excellent check of extreme low frequency behavior. The highest average recording levels were reached with the pedal tones. The compensated peak recording levels were generally 4 to 5 VU above the average readings (actual difference is 7 to 8 dB!), even on sustained notes.

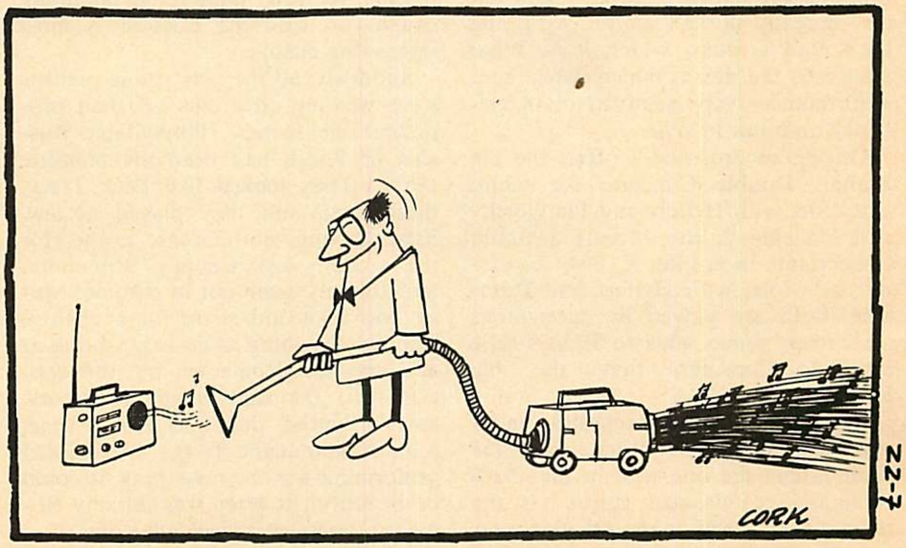
Several recordings of mixed choirs indicated that the average and compensated peak readings are generally comparable (actual difference 3 dB). Occasionally, however, the compensated peak readings were 3 to 4 VU above the average readings (actual difference 6 to 7 dB!).

With woodwind quintet it was found that both readings were also generally comparable (actual difference 3 dB). Only rarely did the peak indication exceed the average indication.

In summary it was found that average-reading meters on a professional quality tape recorder could achieve excellent recording quality at 7½ ips, provided that the 0 VU indication was set 8 dB below 3% THD at 400 Hz, and that the signal levels were *always* kept below 0 VU. With average program material, where the low and high frequency components were of relatively low intensity, this results in a sacrifice of 3 to 4 dB in signal-to-noise ratio. More dramatic differences will obviously occur at slower tape speeds because the high frequency roll-off occurs at lower frequencies.

A major advantage of the system is the complete confidence and ease of operation that it provides during recording because there exist well defined limits on the maximum recording levels. Thus the compensated peak-reading meters allow utilization of the full signal-to-noise capabilities of the tape under all recording conditions.

It should be noted that the cost per channel is quite modest even though the circuit contains more components than absolutely necessary. This was done in order to keep the design as simple as possible and also to achieve maximum flexibility. A more sophisticated design can obviously result in a considerable reduction in the number of components, and consequently in the cost. Æ



Audio ETC

Edward Tatnall Canby

Canby Looks At Timeless Recordings

Heifetz, Piatagorsky, Primrose. Two Great Double Concertos: Brahms, Double Concerto for Violin and Cello, Op.102. Mozart, Sinfonia Concertante in E Flat, K. 364, for Violin and Viola. With orchestra under Alfred Wallenstein, Izler Soloman. RCA LSC 3228, stereo, $5.98.

EARLIER IN THESE pages I've spoken of that *timelessness* in recorded music which so dramatically compares to, shall I say, the *timefulness* of a live musical performance, precisely located at one point in time and space. In this period of plenteous record reissues, new qualifications to timelessness are showing up. Sometimes the recording itself tells you its own time in terms of the music you hear. And it isn't necessarily the moment when the recording was made.

I have in mind a new stereo release on the regular RCA label. It is for all we can tell a brand-new recording. But it features three of those timeless stars which RCA has been giving us these 40 years and more. Heifetz, Piatigorsky, Primrose. Do those names march down recorded history! Could they have made a new recording?

RCA doesn't say *No.* RCA doesn't say anything. Unless you take as an indirect clue, on the jacket, "Rerecording Engineer: Edwin Begley." Rerecording? Or the title, "Two Great Double Concertos." In record world jargon, "Great" usually means a reissue, like "Best of" or "Legendary." The recordings are in stereo, you will note. Nothing about rechanneling. Another clue.

Well, *is* this a new recording? I'm avoiding the phone call that might tell me. It really doesn't matter, assuming the sound is okay, which it is. What matters is the music, which dates these performances very neatly. Not in calendar time but in style.

On this record, side 1 offers the big Brahms Double Concerto for violin and cello, with Heifetz and Piatigorsky and, on side 2, the Mozart Sinfonia Concertante in E Flat, K. 364, for violin and viola, with Heifetz and Primrose. Both are played by anonymous orchestras, which adds to RCA's little mystery. Consider, first, the big Brahms.

It's played by an orchestra under Alfred Wallenstein. What, not *the* Wallenstein, the one who in the 1930s brought live classical music to the radio? That's the man. Of this performance, Life magazine said (when?), it "brings off Brahms with a rare shimmering brilliance." It is in truth a superb performance, the best I know. And it comes straight out of a way of musical thinking that is now departed. Might call it neo-classical streamlining. Exactly what the doctor ordered for this particular Brahms—*circa* 1940.

The Double Concerto was Brahms' last orchestral work and, with two soloists, his thickest, darkest, heaviest, and most sprawling. Nobody knows how it sounded in the 1880s, though there were then doubts as to its practicality —it could sink of its own weight. We know that in the pre-WW II era, when electrical recording came to this sort of music, there was still no desire to "tighten it up," to modernize performance; for this kind of music didn't then sound old fashioned. Even on early 78 shellacs, with time at a minimum, the big Romantic pieces continued to take their own pace in the time-honored way, side after side. Not even the impact of jazz, Gershwin, Stravinsky, had produced any real effect on the familiar giants of symphony and concerto literature. Performance styles change slowly.

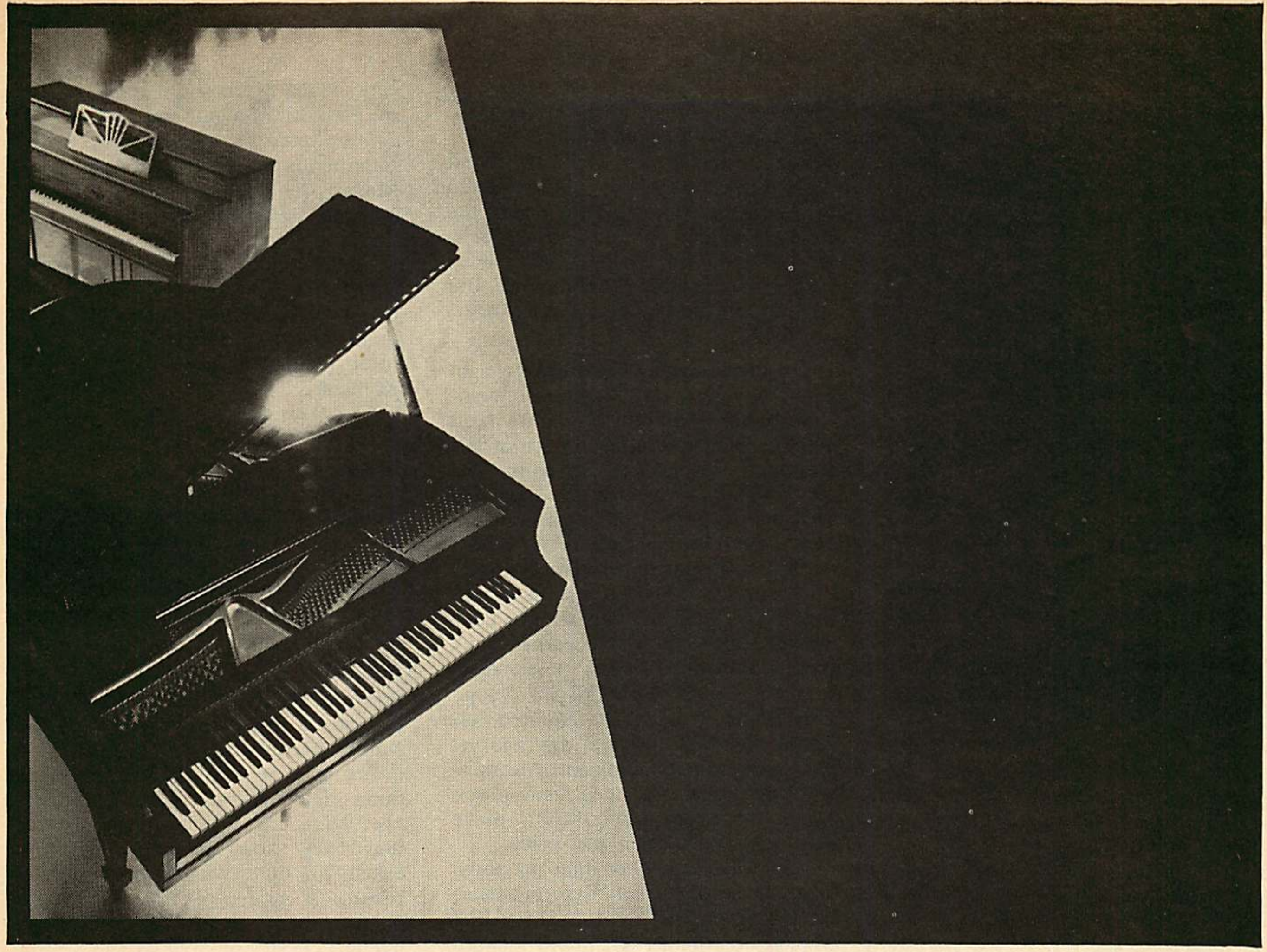
But a new era was on its way, nevertheless, and it finally arrived late in the thirties and on through the war period. At last, modern streamlining caught up with the classics! A most interesting change.

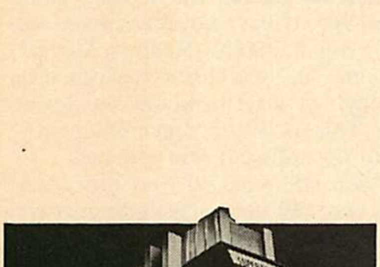
Suddenly, all the new young pianists were wearing crew cuts and had pronounceable names. (Polysyllabic Russian or Polish had been the pianistic norm.) They looked like Dick Tracy, these men, and they played a new, hard, driving, no-nonsense music, for the modern age. Chopin, Schumann, and Brahms came out in chrome. Music was lean and spare for a change. The whole thing was very shorthair and very anti-Romantic; but this was, after all, the mid-twentieth century, and it figured, didn't it? About time, a lot of us thought. Tough, streamlined performing was the new thing. It could be beautiful; it often was. Moony Romantic poesy was decidedly out.

The big, old orchestral pieces got the treatment too. They were tightened up all along, dejuiced, their frumpy shapes smoothed and polished, their tensions jacked up to new voltages, their old fashioned eccentricities played 'way down. In this manner, Romantic music finally faced up to the age of the motor car and the Zephyr train. True, a good many older musicians blithely ignored the whole business and went right on as before. (Some of them still do.) But Toscanini, whose music had always been in a hurry, was the hero of the day and it was his intense, economical style which became a norm for later years. Romantic music had made it into the new century.

Yeah, yeah. Look where we are now. We've undone the whole thing. In those heady days, we wanted to get rid of Victorianism. We tore down all the old Victorian houses ("monstrosities") and we laughed at the zany horsehair furniture with the fringes, the cluttery décor, which we found inside. Now we have Nostalgia. Victorian mansions are carefully being put back together again. Streamlining is out. Clutter is in. Horsehair sofas are priceless, if you can find them. And in Romantic music we are going right back where we came from, only more so. But by now, of course, the music isn't old fashioned. It's antique. A big difference.

Now, the young pianists sport long hair again, and play slo-owly, with pain and ecstacy written on their sensitive faces. Just like Chopin. It's amazing! Dick Tracy in longhair. Now we play the big orchestral pieces even more slowly, and heavily, than they used to play them. Some reversal! Now, we are once again all for eccentricity (i.e. *doing your own thing*) and emotionalism (read: *sensitivity*). There were immense musical benefits, mind you. (There always are, in every style change.) Wagner is coming back. Bruckner, Mahler, Sibelius, even Scriabin. These gentry took badly to streamlining. Their music never was economical to begin with, so why force the issue? Now, we feel, the only way to *really* recreate this big, fat music,





and all the rest of it, is to give it its head, if I may borrow an expression from the age of the horse. And so, today, down with streamlining.

Back to the Double Concerto. What can we hear on this new but non-dated record? Simple enough. It is one of the finest examples of successful 1940s-style streamlining that has ever been recorded. A stunning performance. But stunning in the manner of thirty years ago.

The music, again, is real heavyweight Brahms. Here, you will note immediately, it takes off quickly, flows right along smoothly, without a trace of lost motion, every note to the point. The two soloists are beautifully integrated into the orchestra, their music clean and economical, precise in pitch and rhythm and right up to time. No soloistic nonsense. No out-of-tune grunts and groans from the impassioned cello (as was the style of the earlier day), no heady violin swipes, passionately spewing musical sweat! All this is gone. This music is neat, concentrated, efficient, slimmed out of all fat, and yet it remains warm and fluent. An absolute masterpiece of neoclassic discipline, and it goes a long way to prove how right we were in the 1940s.

You will remember that in those times, these three men were outstanding leaders in the performance world, among the younger and more forward looking influencers. It shows. That's what you hear on RCA, now in 1972.

How about side 2, Mozart? A briefer story, and not as favorable. Here Heifetz is joined by William Primrose and an anonymous orchestra (the same?) conducted by Izler Soloman. This, too, is a 1940s styling, but not a very successful one.

Mozart has had a rough time, these last 100 years or so. The Romantics patronized him, while giving adulation. If only he had been able to write Romantic music, they thought. As it was, Mozart was a charming miniaturist, if ineffable (the word that usually turned up), and this idea persisted well into our own century. But in the neo-Classic, anti-Romantic 1930s, Mozart suddenly was rediscovered in depth. Here was a composer who came to us pre-streamlined, ready to play! Mozart's classic restraint, his economy of emotion, his crystal clarity, were things the new age desperately wanted. And this is the way we played him. He was too pure, we felt, to be sullied by Romantic expression. His musical sense must be distilled out, the meanings underplayed, with delicacy. Thus, this man's music became the model for all that was new-fashioned in performance.

Mozart pianists touched their concert grands as though they were made of glass and might break. Jewel-like sounds came forth, exquisitely shaped in miniature. Large orchestras played Mozart deliberately small. In an age of understatement, he was the arch-understater. For years we could not think of Mozart in any other way, and even today, most musicians, and listeners too, take this kind of Mozart for granted. But styles do change. As you must realize, Mozart has now gone Romantic.

The newest young Mozart pianists plunge into their concert grands, hair flying, and come out with the most startling sounds, like something by Schumann or Liszt. Wow! Try Peter Serkin on RCA. Impressive, if unsettling for older ears. This isn't the Mozart *we* knew. But it'll probably be okay, even so. At least, the poor man is life-size.

So what do we find via Heifetz and Primrose on RCA? The Sinfonia Concertante is positively gem-like, played with a puritan restraint that must be heard to be believed. If restraint is the thing, then here you have it. Heifetz' big violin sings a tiny song, pure as the driven snow, precisely tuned and exactly in time, with never a slur or rubato, a model of primness. From Heifetz, this is almost "Look, Ma, no hands." Primrose follows his every move in the intertwining viola part, as chaste as Heifetz himself. It is superb playing indeed, but need it really be so bleached out? Well, in Heifetz' world they have always thought so. Two things really mar the performance. First, the familiar Heifetz tone, that near-human violinistic cry, is still audible, though muted, and it is not what we expect in Mozart. Somehow, we hear Sibelius or Tchaikovsky lurking near. Much more important, the orchestra here is so "restrained" that the light of human intelligence fades to near zero. I have not for years heard such a rigid, bland, deadpan Mozart. Give me an overblown performance any day! At least it would say *something*. This is 1940s streamlining carried to absurdity, if you ask me.

So you still want to find out when these two full stereo recordings were actually made? Well, it would be interesting to know, I suppose. But it wouldn't prove very much, when you come down to it. As I say, music on records is timeless. Dates of recording are incidental information, if and when available. When you play a record, it is always *now*. It is happening. And so the only real "date" is in the style. That's Heifetz for you.

Recorded Tape Reviews

Bert Whyte

American Airlines Astrostereo, Ampex/London Phase 4 Classical Program CW-238, 3¾ ips, $27.95.

As I am sure you are aware, these Astrostereo tapes are of three hours duration. With the pop versions, their use for background music is obvious and convenient. In the classical programs, such as this, we are confronted with a splendid array of works which can hardly be equated with background music listening. The music and the overall high quality of the sound command your attention, and if you are fortunate enough to spend three hours of your time, you can hear such gems as the *Prelude to Act 3 of Lohengrin*, the suite from *Der Rosenkavalier*, Rachmaninoff's *2nd Piano Concerto*, the *Firebird Suite*, excerpts from *Carmen*, Bach's *Brandenburg Concerto #5*, and a number of shorter pieces. All are first rate recordings with orchestras of the caliber of the London Symphony and conductors like Stokowski and Leinsdorf. Generally clean, well-balanced sound is complemented by the excellent Ampex tape processing, with little evidence of crosstalk or print-through and with moderate levels of tape hiss.

The Music of Leonard Bernstein, Eric Rogers conducting the Royal Philharmonic Orchestra, **Ampex/London Phase 4 L75048,** 7½ ips, $9.95.

Herewith a potpourri of Bernstein's patented brand of bright, bouncy, inventive and often impudent music, eminently listenable and performed with obvious zest tempered with respect for the composer's craftsmanship. We are offered the *Overture to Candide*, *Times Square 1944* from *On The Town*, the suite from *On The Waterfront*, excerpts from *Fancy Free* and symphonic dances from *West Side Story*. The Phase 4 sound is typically close-up with plenty of detail and with sonic spotlighting of various instruments, occasionally giving larger-than-life perspectives. However, this is the kind of music that adapts very well to this kind of recording, and aided by judicious use of reverberation, the overall sound is quite pleasing. Here again, good Ampex tape processing, with lower than usual tape hiss as a bonus.

Tchaikovsky: 1812 Overture; Borodin: Polovtsian Dances from Prince Igor; Stravinsky: Pastorale, Leopold Stokowski cond. the Royal Philharmonic Orch. and Chorus, Welsh National Chorus, and the Band of the Grenadier Guards, **Ampex/London L75041,** 7½ ips, $7.95.

This recording of the *1812 Overture* may upset the purists, but if you want an all-out, no-holds-barred, stunningly dramatic, and grandiose rendering of this venerable war horse, this will fill the bill. Stokowski essays a very slow build-up, lingering over details, elongating phrases, finally reaching the tremendous climax, complete with choruses, brass bands, roar of cannon, and wild pealing of bells. A typically dramatic Stokowskian touch . . . the pealing of the bells continues *after* the last note in the score! The familiar *Polovtsian Dances* receives a similarly rousing performance and the Stravinsky piece is a little innocuous "filler." The sound is Phase 4 at its best . . . or worst depending on your tastes. It is big, bright, blatent. Very clean, but rather a study in sonic excesses. If you are looking for a "lease-breaker," this will do nicely. Some years ago Stokowski told me about the time he conducted the *1812* in Guatemala, sometime during the 1920's. It was performed in a town square with the local symphony orchestra, Guatemalan army brass bands and an array of cannons. Trouble was that the artillery men just couldn't get their firing cues straight, so there were random cannon blasts all over the place! What a scene and what a sound! I'd have given a great deal to witness that happening!

Bing 'n Basie (Bing Crosby and Count Basie), **RCA/Daybreak Records P8Dr-2014,** 8-tk. cart., $6.95.

What a combo . . . the old Groaner and the Count! It is nice to hear old pros like this, utterly relaxed, supremely confident of their abilities. Bing's voice has grown darker with age, but it is still remarkably responsive and steady. As for the Count, those nimble notes of his sound like he will be tickling the ivories forever. Bing and the Count complement each other perfectly on such numbers as *Gentle On My Mind*, *All His Children*, *Little Green Apples*, and *Snowbird*, as well as several others in the same vein. The sound is quite clean, rather close-up, but leavened with enough reverb for good presence. A fine cartridge to help one bear the "world's longest parking lot," otherwise known as the Long Island Expressway!

Classical Record Reviews

Edward Tatnall Canby

Black Box #1 (audible poetry). Assorted poets reading and singing their own works. Two C60 cassettes. *(Black Box, 3735 Jocelyn St., N.W., Washington, D.C. 20015.)*

The implications of this relatively modest new venture in recorded sound via cassettes are of interest to us all, whether we are attracted by contemporary poetry and its relatives or can leave it to others. *Black Box* is a "magazine," six issues a year. It accepts contributions like any other mag, publishes some, rejects others; it has a subscription rate, $20 for six issues (institutions pay more), $5 a single "copy" (2 cassettes in a black box). It is devoted to spoken poetry and to the music of various sorts, sung and played, which now often accompanies, or constitutes, what is still called poetry.

What is unusual is that for the first time, I think, *Black Box* publishes 100 per cent in the audio medium. There is no printed text, only liner notes, as in an LP release. The magazine has deliberately put aside the age-old idea of poetic expression *in print* in favor of a new medium that is, of course, even older than print—the actual sound of the voice. That is where all poetry began.

This uncompromising decision goes further than you may think. Most people, and plenty of poets, still think of the printed or written word as the "original" of their expression, even if the words can on occasion be read aloud or recited from memory. *Black Box*, on the other hand, refuses flatly to accept manuscripts. All contributions *must* be recorded. The tape is the original. (How many times I have been asked for a "script" of my broadcasts in New York! There is no script. Only a semi-typed memory-teaser, to keep me on the track as I speak. My "originals" are also the tapes themselves.)

As might be expected of a first issue, the content of these cassettes is wildly varied and uneven (if my unpoetic viewpoint may be taken), both aesthetically and technically. But the stuff is interesting and you will not be bored. There is challenge in plenty. And four sides of C60 cassette is a lot of material, let me tell you. Most of the stuff is youthful, very determined and far-out—though this is a matter of viewpoint. A good deal is pretty naive, I say, though that idea admittedly comes from an ancient poetry listener, who has heard the Greats and the Littles in his day. If this were a movie it would get a qualified X rating, maybe, for a few items such as Edmund Skellings' "Ultra-red: an Electronic Love Poem." I will not try to describe *that* one in words.

Music is inevitable and frequent, as is natural today. Why stick to the voice alone in this flexible medium? It comes via electronics, instruments, and the singing voice itself. I'm sorry to say that I found the electronic music pretty primitive (heavy tape-echo rhythms, for instance) and the all-too-frequent guitar songs of minimal interest, to put it mildly. In the folk and rock areas and elsewhere there have been much more cogent and original things done. There seems to be an idea going around that if the words of your song have significance, the tunes and harmonies don't really matter. In any case, why such abysmally conventional musical settings for supposedly new and far-out verbal expression? As a musician I can only deplore. Music also speaks!

Sound quality varies from good to not good at all. The poets for the most part are obviously not familiar with the prosaic needs of the lowly mic. They are used to live performing, by the sound of it, and they tend to punch, shout, and do all those things you don't do before the mic no matter who you are. Having tried for years to record non-mic-type voices, I sympathize with the *Black Box* editorial staff, which has done wonders under the circumstances.

One cassette is in mono, the other stereo. Hopefully, all will be stereo in future issues. It does help in getting over presence and personality, even for the solo voice. I make one big suggestion: *Black Box* should go Dolby B, and quick. All the arguments for Dolby apply with a vengeance to this sound-poetry medium.

Performances: B to D
Sound: C+ to D

John Blow: Venus and Adonis. Margaret Ritchie, Margaret Field-Hyde, Gordon Clinton et al., L'Ens. Orch. de l'Oiseau-Lyre, Lewis. **L'Oiseau-Lyre OLS 128**, synth. stereo, $5.95.

Mr. Bach at Vauxhall Gardens. Elsie Morison, Jennifer Vyvyan, sopranos, Thurston Dart, organ, Boyd Neel Orch. **L'Oiseau-Lyre OLS 103**, synth stereo, $5.95.

All of a sudden, a vast release of these famous L'Oiseau-Lyre recordings of the fifties has arrived, all beautifully packaged in lavender gray with a flower reproduction in the middle and the lyre bird top left. I'll be into them on and off for months to come. Do I remember most of them! Life passing by anew, repeat show. But times have changed and so have the values of the originals, here given a modest stereo spread for modern equipment.

John Blow was the great Henry Purcell's mentor, his predecessor as organist at Westminster Abbey and his successor too, after Purcell's tragic early death. This is an astonishingly moving little opera, for all its restoration styling, the leading roles being Cupid, Venus (his mother) and her lover on earth, the handsome Adonis. Adonis is killed by a boar while hunting—he dies at Venus' feet. Awful. Really heartrending in Margaret Ritchie's unforgettable performance. She was one of the great singers of the past generation, and the other Margaret, Field-Hyde, matches her in power and in style of delivery. If you are onto Purcell, if you know "Dido and Aeneas," you will respond to this remarkably appealing music, less vigorous than Purcell but on very nearly an equal of expression. An old-fashioned performance already (it dates from 1953), but splendid of its British sort. The sound, for its time, is nothing to boast about; a bit edgy in the vocal parts throughout, but it will not bother a musical ear.

"Vauxhall Gardens," a recording of music by J. C. Bach, youngest son of *the* Bach and a genial, long-time resident of London, was the subject many years ago of a Canby broadcast which has been repeated periodically every since. I populated the Gardens with the sound of people, to make a more realistic background for the music. Nice to have these charming works, for one and a pair of sopranos and for organ, in a renewed release—it is a memorable album. Same slightly edgy sound, from 1956. (It really ought to be better.) The two sopranos are two more of the great English singers of recent times, Morison and Vyvyan.

By all means, if you are musically inclined in the right direction, browse through the many titles in this reissue series. It was a pioneer collection, unprecedented in its day.

Mozart: Suites from the Great Operas, Delightfully Arranged for Wind Ensemble. Members of the London Symphonic Band, John Snashall. **Columbia M 31310,** stereo, $5.98.

"Delightfully"—yes, even though the term is Columbia's self-pat on the back. In Mozart's day, the equivalent of the "original cast" album was an arrangement of show tunes, for flute and piano perhaps, or violin, or for the popular wind groups that played all over town, indoors and out, in Vienna. Mozart himself did a wind arrangement of tunes from *The Seraglio* only a few days after its successful premiere, when the demand for the music in some form *outside* the opera house was acute. That wind suite has vanished, but somebody has had the bright idea of doing the same all over again, plus suites of tunes from other well known Mozart operas—*Don Giovanni, Marriage of Figaro, Magic Flute.*

What's nice about this disc, then, is the genial, well-played wind sound, wonderfully pert, lively, well-phrased. It is the sound of the wind quintet or quartet amplified to orchestral breadth with something like 46 wind players, immersed in a big, golden liveness which makes the music fairly shine.

Maybe you won't want to play both sides all at a sitting; the wind sound gets monotonous after a while, here as elsewhere. But a side at a time is glorious Mozart background stuff, and most tastefully arranged, too, without a trace of anachronism. Mozart could have done the job himself.

Performance: A Sound: A

Weingarten Looks At

Gil Garfield

Sherwood L. Weingarten

Debut! The word evokes images of a razzmatazz opening, replete with fancy dress and pastel spotlights and media hoopla. Sometimes, though, it merely marks a soft beginning, a quiet but potent thrust forward for someone with talent.

The latter pigeonhole applies to Gil Garfield, a virtually unknown singer-composer, and his recording debut on A&M. Almost all the rules have been broken, for the debut is not via an album but a single, the subject matter is not introspective as much as universal, and the two sides are not individual but linked in theme.

Garfield, who was executive producer for the original cast recording of "Boys in the Band," deals with the difficult existence of a lad who knows he is different . . . and his parents' misunderstand that difference.

"Are You Going Out Tonight?" is a sensitive protrait of the child who feels neglected. The boy pretends to be asleep as his parents peek into his bedroom, apparently because of an inability to communicate with them, despite the subsequent darkness filling him with fear. When they close their own bedroom door, the youngster, his imagination taking hold, wonders if there's something "I shouldn't know."

The tune, simple in its execution yet stark in its reality, paints a word-picture of the insecurity every child knows. If they're going out, the lad ultimately decides, "I'll get out my fantasies . . . and think of things that make me think you're there."

Side Two is even more poignant. "The Prodigy" is a study in contradictions, a musing of things obtained and things wished, a confrontation of two worlds.

Garfield sings—again from the child's viewpoint—of the young pianist, sitting on stage atop phone books so he can reach the keys, watching his parents in the audience. Their obvious pride, and what should be a storybook picture, is marred in his mind's eye however. For despite their "holding hands like lovers," they remind him of the night before, "when he yelled at her and she screamed at him, and it was all about me."

How many children, ordinary or special, have had the same feelings? "He said all she cared about were clothes and how to spend money like water." And (the father asks) why wasn't she there when he got home from school, instead of being off somewhere playing mah jongg?

And the mother retaliates verbally with the barbed comment that he, too, is more absent than present, interested only in whether the boy practiced the piano? The routine goodnight kiss, she insists, is "the only thing you two have ever shared."

The sadness, something felt by the three (*and* the listener, if he can identify at all), is heightened by the climactic line: "They were the parents of a prodigy and maybe they'd have nothing to talk about if they didn't have me."

The single, both sides included, forces the listener to examine himself, his relationships with his family, his memories, and his failures to communicate. It becomes an object lesson in humanity. It is a work of art, despite Garfield's unspectacular but clear voice.

Both tunes, unadorned and sometimes simplistic in their approach, carry an impact that lasts long after the turntable has stopped. Hopefully the concept LP in which they will be included, one that will deal with the character as an adult, will do the same.

GREASE (MGM, 1SE-34 OC) is an original cast album of a Broadway show that looks back fondly to the '50s and the advent of rock 'n' roll. The 18 cuts are amusing, nostalgic, and pleasant. But they fail to capture the magical height of the era's music.

RATCHELL (Decca, DL 7-5330) is a quartet that has great difficulty rising above the mediocre. The dozen cuts are schlock-rock with hints of country and soul.

BE-ALTITUDE: RESPECT YOURSELF (Stax, STS 3002) provides good contemporary gospel-soul via three gals and a guy comprising The Staple Singers. Stress is placed on faith, love and Christian ideals. Among the best of the 10 tracks are "Are You Sure," an effectively underplayed tune with traditional gospel motif; "I'm Just Another Soldier," which claims love is the only weapon against hate; "Respect Yourself," a swinger with good sound, beat and message, and "I'll Take You There," which features good interplay between guitar, drums, brass and vocal, all within the Memphis sound framework.

MANFRED MANN'S EARTH BAND (Polydor, PD 5015) offers solid rock with Mann singing and playing the organ and synthesizer on 10 cuts, half of which are Mann's own (alone or in collaboration). The four-man group also stars Mick Rogers, who plays guitar and sings.

YANKEE'S REBEL SON (Kapp, KS 3655) showcases folksinger-tunesmith Tom Ghent with what he calls "simply a collection of my songs, each one of which tells a story . . . aesthetically pleasing and musically varied." He's right. All 10 tracks of his original material are interesting, wrapping together pain and joy.

YOU'VE GOT A FRIEND (Columbia, KC 30797) backs Andy Williams with chorus and lush strings. The star manages to inject more feeling into his vocals than on previous outings. Best are "It's Too Late," "Help Me Make It Through the Night," "Rainy Days and Monday" and the title tune.

THE BEGINNING (Evolution, 3009) introduces Nanette Natal, a New York-reared gal who is better at writing songs than singing them. Backing herself with acoustic guitar, she offers a multitude of nature images in front of music that ranges from velvety ballads to electric jumpers. The theme of the recording, distributed by Stereo Dimension, is the "continuing cycle of positive rebirth." Heavy, man!

ELVIS NOW (RCA Victor, LSP-4671) is way into the Nashville sound, with Presley singing up his usual storm. Among the 10 successes are "Help Me Make It Through the Night," "Hey Jude," "Put Your Hand in the Hand," "Until It's Time for You to Go," "Early Morning Rain" and "Fools Rush In." He'll be around another decade, at least, in case you miss this one.

JOHNNY MATHIS IN PERSON (Columbia, KG 30979), a double-disc gig, was recorded in Las Vegas; it contains a dozen cuts (including, however, three extended medleys). Highlight is the Mathis-hit medley that includes "Twelfth of Never," "Wild Is the Wind," "It's Not for Me to Say," "Chances Are," "The Impossible Dream" and "Wonderful! Wonderful!"

'S WONDERFUL, 'S MARVELOUS, 'S GERSHWIN (Daybreak, DR-2009) is the original cast recording from the video show that starred Jack Lemmon, Fred Astaire, Leslie Uggams and Peter Nero. The songs were/are great, but the renditions lack much, probably because there's excessive schmaltz and an all-medley format that doesn't give any tune a chance to shine alone. The recording is distributed by RCA.

ACCELERATION (RCA Victor, LSP-4674) spotlights a three-man, one-woman outfit that despite its European popularity should quickly find obscurity Stateside. Middle Of The Road is the quartet's name, one sure *not* to become a household world.

FRANK CHACKSFIELD PLAYS EBB TIDE AND OTHER MILLION SELLERS (London "Phase 4 Stereo," BSP 23) is a double-disc package with 20 heavily stringed cuts by an orchestra full of verve. It's good instrumental music for conversation background or for just plain listening. Best are "Come Together," with flaring brass; the catchy "James Bond Theme;" the classic rendition of "Ebb Tide," complete with wave and bird sounds, and the silky combination, "Moonglow/Theme from Picnic."

BARBRA JOAN STREISAND (Columbia, KC 30792) has the thrush doing melodies by Laura Nyro, Carole King and John Lennon. Also interesting are her renditions of Michel LeGrand's "The Summer Knows" (the theme from "Summer of '42"), with its superimposed sound of waves, and a medley.

TO YOU WITH LOVE (MGM, SE-4797) is crammed with teenage traumas, exploited neatly by high-voiced Donny Osmond. Included is the hit single "Go Away Little Girl" and "I Knew You When," examples of the bubble-gum banality record-buyers in their just post-puberty state demand.

THE ORANGE BIRD (Disneyland, STER-3991) is both an album and a cartoon creation from the Disney studios. Both are sort of promotion pieces for the new amusement park in Florida. The album features the voice of Anita Bryant and the word-and-music combine of Richard M. and Robert B. Shermon, duo responsible for such successes as "Mary Poppins." The LP contains half a dozen tunes and a story line. For kiddies only.

NEVADA JUKEBOX (*Atco, SD33-384*) showcases *60,000,000 Buffalo* which, in reality, is four humans. *Judy Roderick,* who also strums guitar, is the lead vocalist. She's trying too hard to be another Joplin, and won't make it. Judy and the three male assistants try what once was termed acid-rock, embellishing it with country and blues. It's adequate, if you're hard up.

PEACEMAN'S FARM (Dunhill-ABC, DSX 50117) is routine rock by trio, *Noah.* For the most part, they provide mellow-rock, but occasionally get the screamin' meemies.

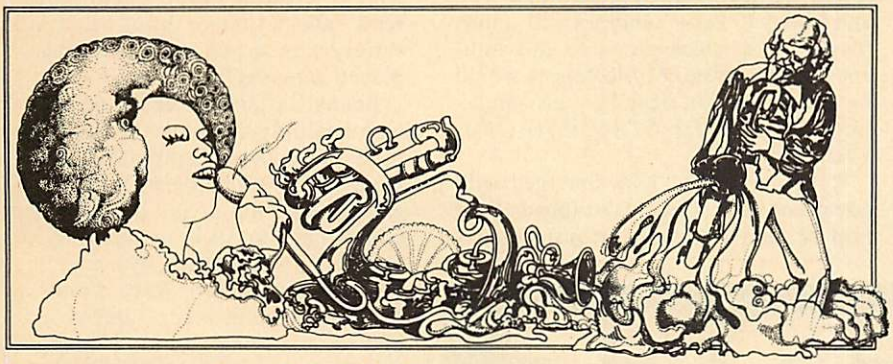
ROBERTA FLACK & DONNY HATHAWAY (Atlantic, SD7216) fills the room with music worth hearing. Soul plus jazz plus a couple of people who know how to use their charisma. Style is what they used to call it. Or class. Ten cuts, each worth wearing out, especially Carole King's "You've Got a Friend" and a melody they joined with Charles Mann to pen, "Be Real Black for Me." Both, for the uninitiated, sing and play piano.

ENGELBERT HUMPERDINCK LIVE AT THE RIVIERA, LAS VEGAS (Parrot-London, XPAS 71061) contains a lot of familiar stuff, including a six-song medley of his hits (featuring "The Last Waltz" and "Les Bicyclettes de Belsize"). Among the best entries are "It's Impossible," "Release Me," "You'll Never Walk Alone" and another medley, "Around the World in 80 Days" and "Till." Middle-agers' delight.

THE CROFTERS (London International, SW 99535) is a trio offering a sound that's a pleasant throwback to the folk era of the '50s. The three, from Aberdeen, Scotland, provide a good sound individually and as a group in the Peter, Paul & Mary tradition, but with a brogue added. This, their first LP, contains 14 cuts that sparkle, aided by the instruments they collectively play, three guitars, one harmonica, and one violin. Best tunes are "Bottle of Wine," "Drunken Sailor," "This Land is Your Land," and "We Will Not Be Moved."

Jazz & Blues

Martha Sanders Gilmore

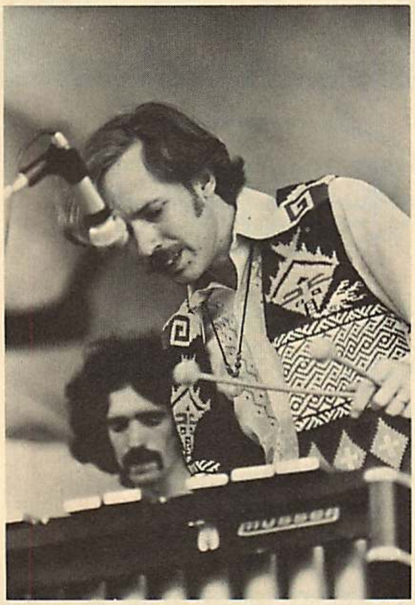


Newport—N.Y.C.

THE NEWPORT JAZZ Festival-New York stole some of the luster and polish from the Big Apple and scurried up and down the sidewalks and avenues of New York for nine exhausting music-filled days during which sleep and meals were the only victims. Although one might have initially looked upon a metropolitan host with apprehension and dreaded the claustrophobic propensities of the city, New York swung wide its gates and displayed a winning hospitality that caused producer George Wein to pronounce New York the festival's new home.

It was an altogether different Newport Jazz Festival this year, having traded soporific segues around a seaside resort for a more intensely intellectual musical experience in such places as Lincoln Center, Carnegie Hall, Radio City Music Hall, Yankee Stadium, and the Commodore Hotel, not to mention the Staten Island Ferry. The greatest jazz show on earth had in its six acoustical rings afternoon connoisseur concerts which were experimental and esoteric in nature, more traditional evening concerts, midnight jam sessions, a cruise along the Hudson to the tunes of several Dixieland bands, and a dance at the witching hour at the Commodore Hotel to the orchestras of Count Basie and Sy Oliver playing the music of Jimmie Lunceford. If one were energetic enough to attend them, the Rutgers University Institute of Jazz Studies sponsored some extremely enlightening morning seminars on such aspects of jazz as history, education, sociology, and the recording industry.

The Modern Jazz Quartet opened the festival at Carnegie Hall with their usual cool precision and expertise that appear so effortless. The hall's acoustics are wonderfully bright and resonant, and enhanced the foursome's Flaubertian search for the *mot juste.*



Gary Burton

"Django" flowed like a quiet breeze with pianist John Lewis taking off in finger-light trumpet-like lines, followed by "Bag's Groove," with Milt Jackson feather-soft and frolicksome on his vibes.

Alto saxophonist Stan Getz, who spearheaded the bossa nova movement in the sixties, followed in a rather uncohesive set which was redeemed in full by the guest appearance of vibist Gary Burton who has no match on his instrument. Burton played an absolutely spellbinding solo of Keith Jarrett's "In a Quiet Place" which hypnotized the audience so that you could hear a pin drop. Burton unfolded an impressionistic rainbow of colors that fused blue notes with bluegrass and vacillated between insinuations of Debussy and Ravel but was every bit Gary Burton in a sugar plum fairy dance with his mallets.

Pharaoh Sanders and his Quintet appeared as a specter in violent contrast to the pastel musical rainbow that preceded them. Their brushes were filled with natural earth colors and were wielded in expressionistic strokes that engulfed the hall. Squatted on the floor was a musician who opened and shut a Pandora's box of an organ while a siren vocalized against the drone of Sanders' soprano and tenor saxophones. Sanders surrounded us with love in "Love Is Everywhere"; an emotionally-wrought aboriginal music forged by percussive tools.

Saturday night's performance at Lincoln Center was *SOLD OUT* and no wonder with a program stacked with giants such as Art Blakey, Dizzy Gillespie, Al McKibbon, Thelonius Monk, Sonny Stitt, Kai Winding, Max Roach, and vocalists Sarah Vaughan and Billy Eckstine.

Alto saxophonist Sonny Stitt, who deserves much more recognition than he receives, played a compelling "I Can't Get Started" which the crowd loved. Monk set forth his very own "'Round Midnight," inscribing it with his spare percussive attack against Dizzy's graceful note-bending on trumpet. Then handsome Billy Eckstine swaggered out, projecting his basso voice in ballads "Summer of '42" and "I Apologize." It was clear by Eckstine's showmanship that he is accustomed to the glitter of club performing and subsequent banter with an audience.

A drum duet between Blakey and Roach ensued, fast and furious, ending with Blakey tossing up his sticks. Monk then played a nursery ditty which coaxed Sarah Vaughan out center stage for the *piece de resistance* of the evening. Sassy scatted "I'll Remember April," submitted Olympic leaps in "Misty" and "Fly Me To The Moon" and descended to the coolness of the cellar in "What Are You Doing the Rest of Your Life?" from her recent album with Michel Legrand. Her tones were lovely and soft—cool dark-greens breaking into warm rose-vermilions.

A Carnegie Hall connoisseur concert Sunday afternoon produced some of the most interesting music of the festival. The JPJ Quartet of Johnson, Pemberton, Jackson, and Jones sailed swiftly along the mainstream of jazz in one of the most infectious sets of the entire festival. Tenor saxophonist Budd Jonson's tribute to Lester Young in "Body and Soul" was captivating and garnered a standing ovation upon whose heels followed "the queen of jazz from whom all blessings flow," the great Mary Lou Williams. It is not surprising that Mary

Lou has accrued so many disciples over the years with her highly rhythmic style comprised of blues, boogie, ragtime, and swing. But this afternoon her sidemen were an unfortunate distraction and she lost her mic. Nonetheless, Mary Lou carried away a bouquet of flowers and it was Europe all over again.

The iconoclastic Cecil Taylor, wearing a skullcap that clung to his head as if glued, played an incredible 45-minute piano solo, "Spirit of the Ram," that was nothing short of phenomenal. Taylor tumbled upon his keyboard like an avalanche, sprinting about the keys with claw-like fingers in densely textural strata comprised of cross-rhythms, dissonances, cakewalks, phrase fragments, and tangled nerve endings, all intermeshed and which ensnared the audience at the outset. Musicologists would be hard put to decipher his multilingual curriculum. *STANDING OVATION!*

Rahsaan Roland Kirk emerged with a seaweed of instruments strapped about him so that he could inconspicuously breathe his music into two or three of them at a time. He achieved a certain and rounded tone as he rocked to and fro in "Satin Doll" and "Eleanor Rigby," creating ocean waves of music. Kirk talked into a flute, made sirens shriek, blew a police whistle, and even played a masterful conch.

Benny Carter and the Swing Masters, who had only been together three days, gave ample musical proof that swing is alive and well in New York City. A galaxy of swing greats included Tyree Glenn, Quentin Jackson, Benny Morton, Dickie Wells, Earle Warren, Buddy Tate, Teddy Wilson, Milt Hinton, and Jo Jones among others. Benny Carter played a dazzling alto in "Honeysuckle Rose" against Wilson's tinkling piano and the whole set was a good-humored musical sharing that was not only uplifting but was the every essence and spirit of swing. One of the highpoints was the Swing Masters' recreation of "Sleep," bottled in 1939 and once again uncorked in this 1972 Newport Jazz Festival, clear evidence that it certainly is no sleeper!

Maxine Sullivan floated onstage, serene and cool, a grande dame of music in standards such as "I've Got a Right To Sing the Blues," "I've Got the World on a String," and "The Lady Is a Tramp" which won the blue ribbon.

Then Count Basie and His Orchestra rolled along buoyantly, the epitome of swing, taking us along on a trip in nostalgia and ever the more enhanced by Big Joe Williams who sang with the band. They rolled along like caissons, the big man with the huge voice bellowing "Every Day I Have the Blues," "All Right, OK," and "Bye, Bye Baby" with Basie's crisp, sparkling blues riffs prodding him along. A tribute to the late Jimmy Rushing featured Al Hibbler singing "I Want a Little Girl," and we went up the avenue to hear the TV bands of Bobby Rosengarden and Billy Taylor.

The Rosengarden Band, smooth as glass and strong as steel, was a collection of some of the most versatile and technically brilliant musicians that jazz has to offer, while Taylor's band was loose, bouncy, full of wit, and also thoroughly accomplished. The trombone work of Bill Watrous in the Rosengarden Band stood apart. One cannot say enough good things about his solo on "Snooks," and the fact that the band resurrected "Spring Is Here" brought them into even better graces.

The Thad Jones-Mel Lewis Orchestra was also on the bill and was a kind of blend of its TV predecessors. Although a usually competent force, the band bogged down in "Suite for Pops" which lacked cohesion, but Roland Hanna's piano work in "Farewell" proved delightfully unpredictable and the Jones-Lewis Band flew high in "Fingers."

On Monday afternoon, the Quintet of Don Burrows, a reedman from Australia, played one of the most enjoyable sets of the festival, the first group from Down Under to play at a Newport Jazz Festival. Guitarist George Golla made some significant contributions and Burrows played clarinet with the understatement of Jimmy Giuffre, then picked up a B-flat school flute which he played with zest and a vibrant rhythmic pulse.

Alto saxophonist Lee Konitz and his Quintet moved along experimental innovative lines, toying with the twelve-tone row in "Twelve-Tone Rose," a fitting title. Trombonist Marshall Brown bent under the weight of his rather symphonic phrasing in highly intellectual music that was cleverly executed.

When Ruth Brisbane strutted out, flaunting an orange feather boa, the mood switched to the low-down blues of Bessie Smith and the songs that made her so famous such as "C.C. Rider," "Yellow Dog Blues," and "Cakewalk with Me" which Miss Brisbane literally threw herself into.

Later in the afternoon drummer Elvin Jones played his vital contemporary music with Steve Grossman on tenor saxophone and David Liebman on soprano and flute. Liebman proved he's no flash in the pan in a low-keyed solo in "A Time for Love" while "Children's Merry-Go-Round" was a vehicle for Jones that served his talent well.

The Bill Evans Trio explored fresh fields of sound in a poignantly lyrical and Legrandish interlude that was suggestive of France—existential, involuted, contoured inward. Evans' harmonic progressions were beyond belief in "Emily" where he modulated up so appealingly in this attractive jazz waltz.

Then Chase strode up, sinewy, full of pluck, five trumpets strong, and with a battery of amplifiers. Wein's concession to rock this year, they discharged decibels that chased people away, singeing the moldings around Carnegie Hall in a not so subtle jazz-rock fusion.

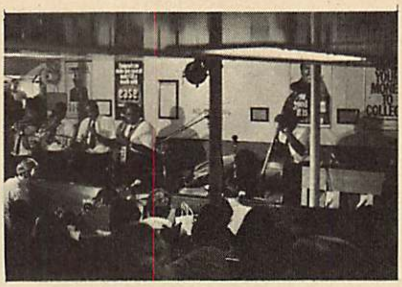
Blue Monday night was anything but blue with the orchestras of Stan Kenton and Woody Herman. The Kenton Band became a disquieting jungle of percussion and multi-layered rhythms, bringing back June Christy to sing her breathy treatment of Jerome Kern's "Remind Me" and ending with "Artistry in Rhythm," Kenton's theme song.

The Herman Band snapped, crackled, and popped in "Adam's Apple," displaying a crisp, tight approach and musical muscle-flexing. The reunion of Herman alumni Al Cohn, Stan Getz, Chubby Jackson, Flip Phillips, and Zoot Sims in "Four Brothers" will ever be memorable.

The curvaceous crescent shell of Radio City Music Hall packed 6,000 fans into its spacious circumference for a midnight jam session on Monday and Thursday nights that lined jazzmen up like a row of Rockettes. But Monday's free-for-all was dominated by an over-enthusiastic Roland Kirk and a faulty sound system while Thursday's was more successful and permitted Gerry Mulligan, Jimmy Smith, and Sonny Stitt—among others—to engage in a musical exchange that begrudgingly allowed saturated souls to sleep by 3:30 A.M.

What better way to spend a 4th of July than aboard the Staten Island Ferry on a cruise along the Hudson River to the music of Kid Thomas and the Preservation Hall Band and Papa French and the Original Tuxedo Jazz

Band from New Orleans. It was like the Newport of old as fans meandered about, munching hot dogs, guzzling beer, and dancing in the aisles as the bands blew their happy notes right past the Statue of Liberty and Brooklyn Bridge.



Jazz on the Ferry

Walking about on the "John F. Kennedy" gave me the opportunity to chat with Wein's soundman Bob Bennett who had to literally hop, skip, and jump around the city to get his very demanding job done. The festival subcontracted to Hanley Sound Co. of Everett, Mass. this year. (Bennett had worked with one of Hanley's men back in 1953). Bennett commented that he used basically the same equipment (Altec Lansings 210's) that he did in '71, simply lowering the volume. He plans to buy some new equipment next year. Said Bennett laughingly, "The boat is not wired for quality!" but the sound carried well and clearly.

The only fly in the ointment during the entire festival was that Miles Davis' scheduled appearance Tuesday afternoon never occurred because of a purported misunderstanding in contract. However, Freddie Hubbard did much more than save the day and became a kind of festival hero in replacing Davis.

Then Sonny Rollins stepped forward on tenor saxophone, dispersing revulets of sound that left few open spaces in "There Is No Greater Love" and his renowned "St. Thomas." Rollins was decidedly a festival favorite and we welcome his return! When pianist McCoy Tyner's turn came, he played a penny whistle, then embarked on rapid-fire Niagara runs on piano.

Tuesday night at Lincoln Center featured the geniuses of Ornette Coleman and Charles Mingus and was a history-making event in that Coleman premiered his suite, "Skies of America," with the 80-piece American Symphony Orchestra. The ambitious work incorporated touches of Schoenberg, Bartok, and Copeland and was fervent in its patriotism as Coleman soloed against the great granular sweep of the orchestra as if in the middle of a prairie in the Midwest. The textures were as cross-grained as plywood.

Mingus, in a cheerful mood, walked on stage, wearing a hat that resembled a pith helmet, then stood at the helm of his bass and propelled his orchestra along like sixty in the imaginative, lyrical way that only Mingus can. The music was beautifully rich and magestically heraldic as Mingus fomented a swelling sea of sound that was free form and fascinating.

Rainy Wednesday merely made spirits brighter in a concert at Carnegie Hall which featured Gato Barbieri, Kenny Burrell, Eubie Blake, and Herbie Hancock. Barbieri, a tenor saxophonist from Argentina, played a striking set which borrowed heavily from South American folk tunes, inserting them into a jazz context that was firey and frenetic. Barbieri bears watching; he will travel far.

A concert of variety continued with a youthful 89-year-old Eubie Blake who romped through some ragtime piano pieces, full of pranks and puns. Blake played his own compositions, "Charleston Rag" and "Classical Rag," and was understandably loudly applauded. Then guitarist Kenny Burrell played some funky guitar but shone most in Thad Jones' "A Child Is Born," followed by Herbie Hancock who swam in deep percussive pools. The Hancock Sextet had no less than three bags of soundmakers and juxtaposed them one against the other like so many crawling insects or moving jaws. It was unfortunately a bit difficult to pick Hancock's piano out of this swarming thicket of sound.

Lee Wiley came out of retirement to perform at Newport late in the afternoon and although she was naturally nervous, her flawless phrasing and punctual timing came right through. Eddie Condon and His Gang were aboard and thoughts roamed to the first Newport in 1954 on the lawn tennis courts of the Newport Casino.

The World's Greatest Jazz Band played a contrastingly slick and predictable set that caused us to whisk away up 7th Avenue to catch Charlie Byrd at Philharmonic Hall. Byrd was refreshing against the heavies who came after him and demonstrated his fine technique in a Brazilian tune "The Little Boat."

Vibist Lionel Hampton and guests Milt Buckner, Roy Eldridge, Dexter Gordon, Illinois Jacquet, Gene Krupa, Joe Newman, Teddy Wilson, and Garnett Brown created considerable merriment in a sock-hoppish "Sunny Side of the Street," and "How High the Moon," "Avalon," "I Got Rhythm," and "Sing, Sing, Sing" which would have been

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complete if Benny Goodman had been there. And it was nice to welcome Dexter Gordon back from Denmark.

Thursday afternoon's Sacred Concert with Dizzy Gillespie and John Motley and the New York Choir was a joyful occasion in which Dizzy performed to his utmost. Maestro Gillespie led the 60-member choir in some of his own material, such as the very moving "Brother King," and it was hard to believe that this was only a high school choir. Dizzy's group also played some lively tunes such as "Kush" amd "Shake It" and Al Gafa's guitar work was, as always, superb.

Dizzy Gillespie

A concert later featured the Adderley brothers, who always manage to swing, as well as pianist Oscar Peterson and the Mahavishnu Orchestra with John McLaughlin. Nat Adderley played a lovely ballad treatment on cornet of "Autumn Leaves" which gathered momentum as it went along, then Oscar Peterson played a rhapsodic solo concert that evidenced his tremendous technical ability that somehow seems dispassionate.

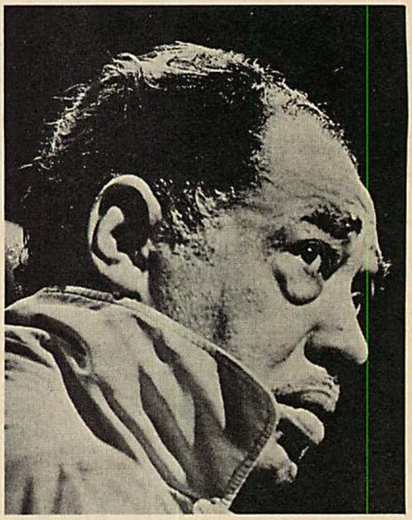
One of the most intriguing groups to perform was the Mahavishnu Orchestra which explored Eastern spirituality in a cerebral combination of jazz, rock, and Indian music. They were so heavily amplified that ears popped, but were thoroughly inventive, boasting violinist Jerry Goodman who strummed his fiddle like a guitar, then converted it into a screaming siren in "The Dance of the Mind."

Up the street and around the plaza fountain at Lincoln Center marched the Olympia Brass Band with its big bass drum and Grand Marshall begarlanded with flowers, re-enacting a funeral parade which was anything but mournful. And back inside Philharmonic Hall, the Preservation Hall Band and the Tuxedo Jazz Band marched in the aisles, followed by a train of jazz enthusiasts.

Then bluesman Robert Pete Williams uncovered some roots and wailed in his twangey haunting voice and Robert Greene, a devotee of Jelly Roll Morton, scampered up and down the keyboard doing Jelly's music that ingratiated parlors back in the twenties and thirties.

Weather Report was stormy on Friday afternoon, a veritable tangle of wires and rhythm in a frenzied rendition of leader Joe Zawinul's "Directions." The Tony Williams Lifetime followed in a formless musical display that took heavily from rock and featured a female sorceress of a vocalist who writhed about suggestively. But Roy Haynes saved the day with his sensitive, subtle drumming. Haynes used lots of snare and stick-ticking count-downs and was privileged to have pianist Carl Schroeder by his side. The Archie Shepp Quintet ended the afternoon on an oblique African note which incorporated chanting with a rather organic instrumental development.

George Wein planned two evening concerts at Yankee Stadium, hoping to pack 'em in by presenting the more popular side of jazz. But the rains came, Nina Simone fell ill, and although Wein used only half the stadium—30,000 people worth—the concerts did not draw. A Jimmy Smith jam session with Zoot Sims playing "The Man I Love" had some happy moments but Dave Brubeck merely pounded out block chords. It was a pleasure however to hear that pure Paul Desmond intonation again after which B.B. King and Ray Charles shouted out the blues.



Duke Ellington

A concert Saturday afternoon presented Duke Ellington and his Orchestra and proved elegant and worthy of the undertaking. Most striking was the Duke's "Tone Parallel to Harlem," a program piece full of shifting rhythms and Kandinsky colorings. Ellington appeared entranced as he leaned over the piano to hear Bobby Short's tribute to Ivie Anderson, a vocalist with the Ellington Band from 1931-42. Short is a very special artist whose voice in its operatic qualities is perfection itself.

Saturday night at Yankee Stadium featured the Giants of Jazz with Art Blakey, Dizzy Gillespie, Thelonius Monk, Sonny Stitt, and Kai Winding unwinding in "Jeepers Creepers." But Les McCann's attempt to be soulful fell flat and it was up to Roberta Flack to make things right in "Reverend Lee" and "Ain't No Mountain Higher." Lou Rawls churchey voice was appropriate to his material, but Herbie Mann proved glib and garrulous on flute and was upstaged by David Newman on that same instrument.

Roberta Flack

Sunday morning gave way to a gospel concert which presented some of the best moments of the nine days. Marion Williams, a former member of the Clara Ward Singers, sang a glowing "Amazing Grace" and "Standing Here Wondering," and Dorothy Love Coates' voice had a lovely full quality as she easily evoked audience response.

The festival ended on a peaceful albeit inspiring note at St. Peter's Lutheran Church in a concert by Max Roach and the J.C. White Singers who artistically combined jazz improvisation with spirituals which rang throughout every niche and cranny of the church.

Thus came to an end nine noteworthy days in New York during which fans raced all over the City and stirred up the New York jazz world from Harlem to the Village. George Wein said the festival finished in the black and "is in New York to stay." This was jazz on another type of island. Certainly those were days short on slumber, but Newport-New York was essentially one standing ovation. See *YOU* there next year?!? Æ

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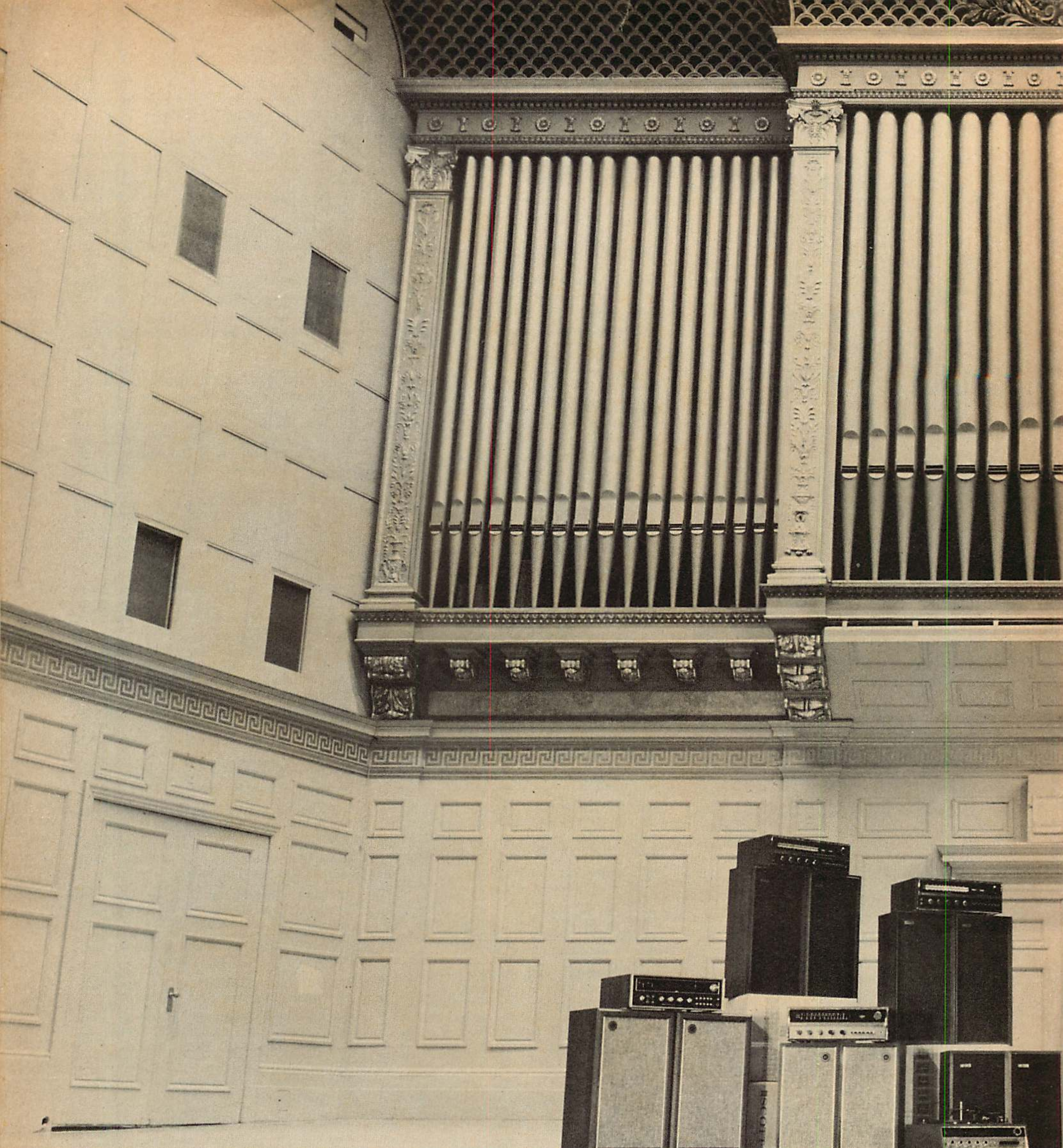

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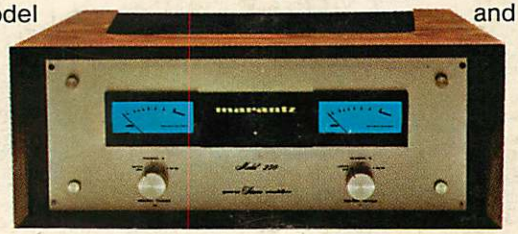

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